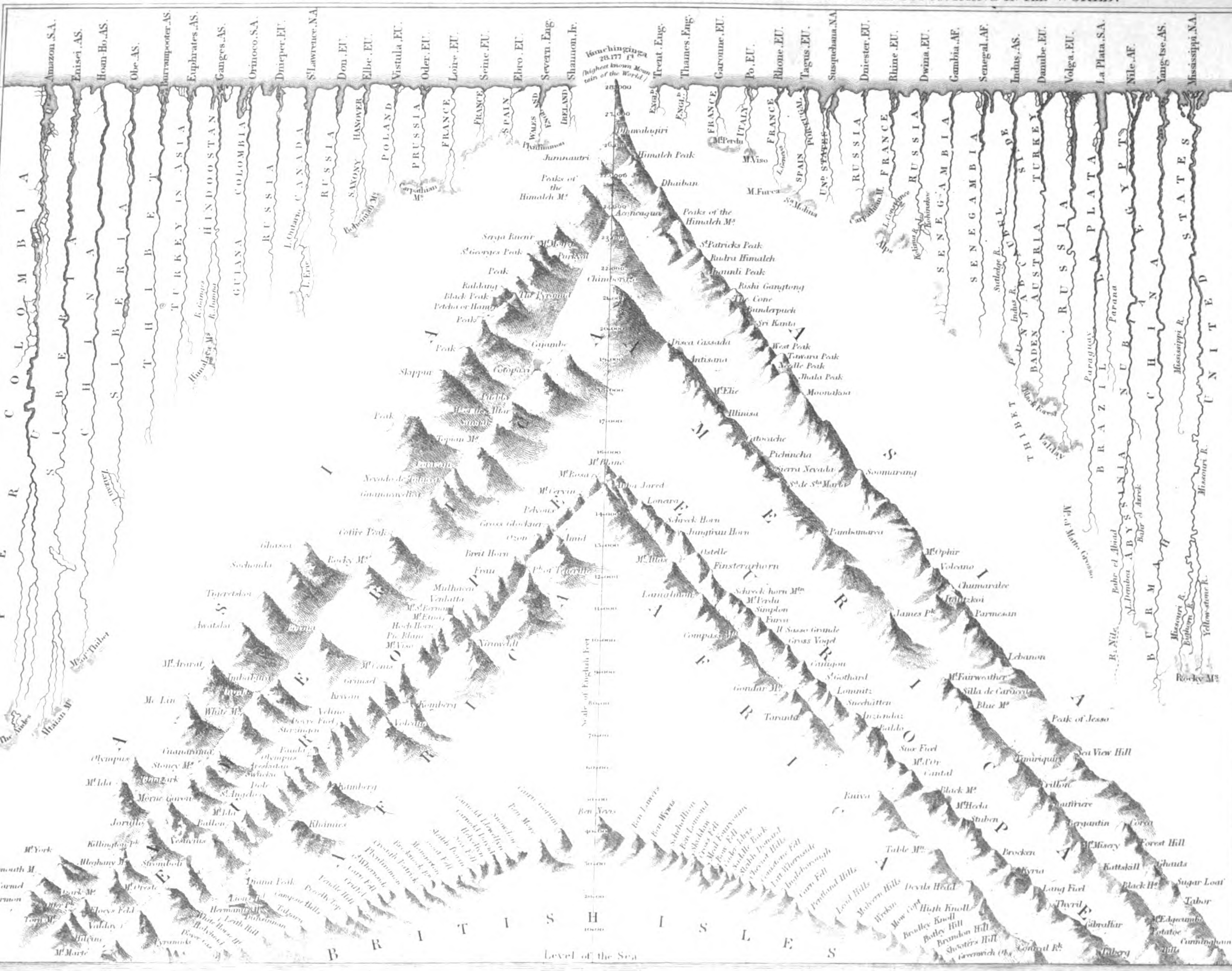
A
DESCRIPTIVE ATLAS
OF
ASTRONOMY,
AND OF
PHYSICAL AND POLITICAL GEOGRAPHY.

A VIEW OF THE COMPARATIVE LENGTHS OF THE PRINCIPAL RIVERS, AND HEIGHTS OF THE PRINCIPAL MOUNTAINS IN THE WORLD.



Abbreviations: AS. ASIA. AF. AFRICA. EU. EUROPE. N.A. N^{th} AMERICA. S.A. S^{th} AMERICA. Eng. ENGLAND. Sc. SCOTLAND. Ir. IRELAND.

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A

DESCRIPTIVE ATLAS

OF

ASTRONOMY,

AND OF

PHYSICAL AND POLITICAL

GEOGRAPHY.

With Descriptive Letter-press,

BY THE REV. THOMAS MILNER, M.A, F.R.G.S.
AUTHOR OF "THE GALLERY OF NATURE." ETC.

THE MAPS OF PHYSICAL AND POLITICAL GEOGRAPHY, CONSTRUCTED OR CAREFULLY REVISED AND CORRECTED

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PREFACE.

The present Volume is designed to represent by Maps and Letterpress the general phenomena of the planetary and stellar universe, the physical constitution and features of the globe, and the artificial distribution of its surface into states, with details respecting their internal economy, and foreign relations. Ranging over so wide a field, upon which new light has dawned since the publication of this work commenced, it is very likely that the Editor may be chargeable with some inadvertencies or omissions: but he indulges the hope that those are few and unimportant, and that the desire of the Publishers to meet the demand of the age, will, in some degree, be answered by this Volume, intended to be a book of reference for the student and general reader on Astronomical Science, Physical and Political Geography.

Norwood, Surrey,
Dec. 10th, 1849.

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ASTRONOMY.

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A
DESCRIPTIVE ATLAS
OF
ASTRONOMY.

INTRODUCTORY.

CHAPTER I.

NOTICES OF ASTRONOMICAL DISCOVERY.

I. **Astronomy**, as the term signifies, treats of the laws of the stars, and comprehends generally the motions and appearances of the sun, moon, earth, and all the heavenly bodies.

II. Before Europe occupied a place on the page of history, astronomy was assiduously cultivated by several eastern nations, the Chaldeans, Indians, Chinese, and Egyptians.

They established observatories, invented instruments for observing and measuring distances, noted and gave names to the planets, grouped the stars in constellations for facility of reference, marked the sun's apparent annual path in the heavens, estimated the length of the year, and in various ways contributed to lay the foundations of modern astronomical knowledge.

III. An extended and accurate acquaintance with the phenomena of the universe is, however, comparatively, a recent attainment. The following are some of the more distinguished names that have marked the historical period of the science, and aided in the course of discovery.

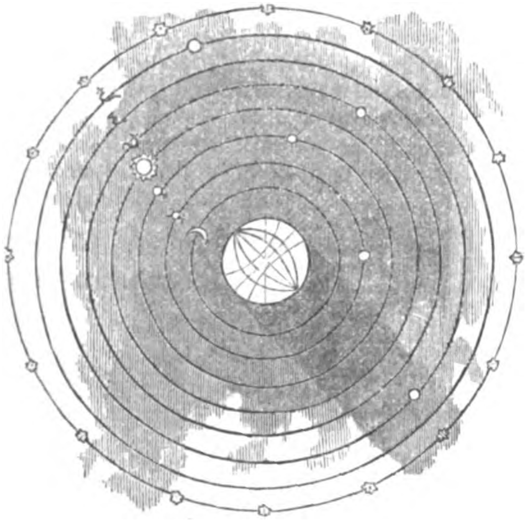
Thales predicted the solar eclipse, B.C 610.

Aristarchus of Samos, B.C. 280, made the first attempt to measure the magnitudes and distances of the sun and moon.

Eratosthenes of Cyrene, B C. 240, observed the obliquity of the ecliptic, and approximated upon a true principle to the earth's magnitude.

Hipparchus, B C. 160—125, discovered the precession of the equinoxes, calculated eclipses, determined more exactly the length of the year, ascertained the mean motion of the moon, of her nodes, arrived at several of her inequalities, and made a catalogue of the latitudes and longitudes of 1081 stars.

Ptolemy, of Alexandria, A.D. 130—150, discovered the refraction of the atmosphere, the lunar evection, an inequality such as would be caused by the alternate diminution and increase of the eccentricity of the moon's orbit, but is better known as the founder of a theory of the universe, which ruled the mind of Europe for fourteen centuries, till the era of Copernicus. The Ptolemaic system recognised the earth as the common centre, the sun, moon, planets, and fixed stars, revolving round it, as shown in the diagram, but in very complicated courses. After him, scarcely a name appears deserving notice till we come to the modern era.

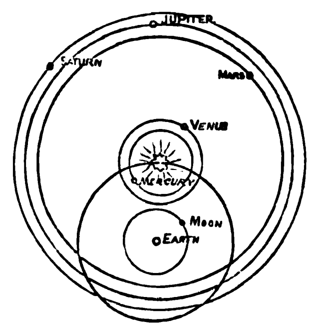


☽ The Moon. ☿ Mercury. ♀ Venus. ☉ Sun. ♂ Mars. ♃ Jupiter. ♄ Saturn. ✱ Fixed Stars.

Ulug Beg, A.D. 1443, grandson of Tamerlane, had an observatory at Samarcand, and made a catalogue of the stars.

Copernicus, 1543 [died,] was the first formally to propose the true scheme of the universe, resolving the diurnal revolution of the sphere into an optical illusion, caused by the actual diurnal motion of the earth on its axis, and recognising the sun as the centre around which the earth and the planets revolved. This is the Copernican system, offered in the first instance as an hypothesis, but subsequently demonstrated in its outline, and modified in the detail.

Tycho Brahe, 1601, remarkable for extending and improving astronomical apparatus, for the amount and exactness of his observations, made a catalogue of the stars, estimated the effects of refraction, corrected altitudes by them, but rejected the Copernican theory, proposed one of his own, which has obscured his fame. He held the Ptolemaic doctrine of the earth being the immovable centre of the universe, but conceived the planets to revolve round the sun, and to be carried with their centre in revolution round the earth, as shown in the diagram.



Keppler, 1630, announced the elliptical orbits of the planets, their different velocities in different parts of their orbits, and that the squares of the periodic times of the planets are in proportion to the cubes of their distances from the sun—his three great laws. (See chap. iii., Laws of Keppler.)

Galileo, 1642, constructed the first telescope, from a general description of a magnifying instrument made in Holland, discovered the satellites of Jupiter, the phases of Venus, and some then inexplicable peculiarity about Saturn.

Hevelius, 1687, first accurately delineated the lunar surface, and discovered the moon's libration in longitude.

Huygens, 1695, discovered the ring and fourth satellite of Saturn, with the great nebulæ in Orion, and made the first pendulum clock.

Roemer, 1710, invented the transit instrument, and ascertained the progressive transmission of light.

Cassini, D., 1712, determined the rotation of Jupiter and Mars, and discovered four of the satellites of Saturn.

Flamstead, 1719, framed a catalogue of 3000 stars, a vast collection of lunar and planetary observations, and materially helped to perfect the lunar theory.

Newton, 1727, explained and demonstrated the causes of the planetary motions, by the joint action of attractive and projectile forces or the law of universal gravitation, and laid the foundation of physical astronomy.

Halley, 1742, announced the periodic time of the comet of 1682.

Bradley, 1762, discovered the aberration of the stars, establishing the fact of the earth's revolution in space.

Herschel, 1822, discovered the primary planet Uranus, with six satellites, and also two more belonging to Saturn.

Piazzi, 1826, published a catalogue of 7646 stars, the largest and best extant, and discovered the planet Ceres.

Harding, 1833, discovered the planet Juno.

Olbers, 1840, discovered Pallas and Vesta.

The dates given above, commencing with Copernicus, are those of death.

IV. During the last quarter of a century, enormous masses of observations have been published, chiefly in relation to the sidereal heavens, its multiple stars and nebulæ, and every year is silently adding to our knowledge of the system of the universe, from public and private observatories.

The principal continental observatories are, in France, at Paris, Strasburg, and Marseilles; in Italy, at Turin, Milan, Naples, Rome, Padua, and Florence; in Sicily, at Palermo; in Switzerland, at Geneva; in Germany, at Berlin, Konigsberg, Munich, Vienna, Prague, Buda, Bremen, Altona, Gottingen, and Dorpat; in Russia, at Petersburg, Wilna, and Abo; in Norway, at Christiana; in Denmark, at Copenhagen; and in Belgium, at Brussels.

Great Britain has public observatories at Greenwich, Oxford, Cambridge, Durham, Portsmouth, Edinburgh, Aberdeen, Dublin, Armagh, St. Helena, Cape of Good Hope, Madras, and Paramatta.

Besides these, there are the following in the hands of private individuals, at

Slough . . .	Sir J. F. W. Herschel.	Kensington . .	Sir James South.
South Kilworth	Rev. Dr. Pearson.	Bushey Heath .	Colonel Beufoy.
Bedford . .	Captain Smyth, R.N.	Blackheath . .	Hon. J. Wrottesley.
Regent's Park	George Bishop, Esq.	Makerstoun . .	Sir T. M. Brisbane.
Ormskirk .	Rev. W. R. Dawes.		

V. One of the most remarkable events of the present day, and costly efforts of private enterprise affecting astronomy, is the construction of the great reflecting telescope of Lord Rosse, the speculum of which has a diameter of six feet, weighs nearly four tons, and has a tube of fifty feet focal length. By this wonderful instrument, nebulæ before irresolvable have been resolved into systems of stars, thus destroying the foundations of the nebular hypothesis—but its achievements have not yet been given in detail to the world.

CHAPTER II.

GENERAL DEFINITIONS.

I. In order to facilitate the study of the heavens, artificial representations have been made, similar to those of the surface of the earth; or celestial globes, on which the stars are depicted in their natural positions, the observer being supposed to be in the centre, viewing them in the concave surface.

To represent the apparent diurnal motion of the heavenly bodies, the celestial globe must be turned from east to west.

II. To be able to designate with precision the situation of the sun, moon, and stars, imaginary circles have been considered as drawn in the heavens, most of which correspond to, and are in the same plane with similar circles supposed to be drawn for similar purposes on the surface of the earth.

A plane is that which has surface but not thickness. The plane of a circle is that imaginary surface which the circle bounds.

III. The axis of the earth is an imaginary line passing through its centre, north and south, about which its diurnal revolution is performed: the poles of the earth are the two extremities of the axis, where it is supposed to cut the surface. The axis of the heavens is the earth's axis produced both ways to the concave of the sky: the poles of the heavens are two imaginary points exactly above the terrestrial poles.

IV. Great circles are those which divide the globe into two equal parts, as the equator, the ecliptic, and the colures. Small circles divide the globe into two unequal parts, as the tropics, polar circles, and parallels of latitude.

Every circle is supposed to be divided into 360 equal parts or degrees. A degree is further subdivided into 60 equal parts or minutes; and a minute into 60 seconds. Degrees are marked °, minutes ′, seconds ″. The space included by a degree of a great circle in the heavens, is equal to nearly twice the apparent diameter of the sun and moon, when considerably above the horizon.

V. The equator of the earth is an imaginary great circle passing round the globe, east and west, everywhere equidistant from the poles, dividing it into northern and southern hemispheres. The equator of the heavens, or the equinoctial, is the plane of the terrestrial equator extended to the concave surface of the heavens, and called the equinoctial, because, when the sun appears in it, the days and nights are equal all over the world.

VI. The ecliptic is the *via solis*, or sun's path, the great circle which he appears annually to describe among the fixed stars; though, more properly, it is the track which the earth actually describes among the stars, as viewed from the sun. The ecliptic is so called, because solar and lunar eclipses only can happen when the moon is in, or very near this circle. It cuts the equinoctial obliquely at two opposite points, making an angle with it of 23½°, which is called the obliquity of the ecliptic. One half lies on the north side of the equinoctial; the other half on the south side. The points of crossing are the equinoctial points. A zone or girdle extending 8° on each side of the ecliptic, or 16° in breadth, is the zodiac, in which are the orbits of all the planets, with the exception of three of the asteroids. The ecliptic and zodiac are divided into twelve equal parts, called signs, each containing 30°. Their names, with the days on which the sun enters them, are as follows:—

Northern signs, being north of the equinoctial.

Spring Signs.	*Summer Signs.*
Aries, the Ram, March 21.	Cancer, the Crab, June 2.
Taurus, the Bull, April 19.	Leo, the Lion, July 22.
Gemini, the Twins, May 20.	Virgo, the Virgin, August 22.

Southern signs, being south of the equinoctial.

Autumnal Signs.	*Winter Signs.*
Libra, the Balance, Sept. 23.	Capricornus, the Goat, Dec. 21.
Scorpio, the Scorpion, Oct. 23.	Aquarius, the Water-bearer, Jan. 20.
Sagittarius, the Archer, Nov. 22.	Pisces, the Fishes, Feb. 19.

VII. The colures are two great circles passing through the poles of the heavens, dividing the ecliptic into four equal parts, and marking the seasons of the year.

One passes through the equinoctial points, Aries and Libra, and is therefore called the equinoctial colure. When the sun is in either of these points, the days and nights on every part of the globe are equal to each other. The other passes through the solstitial points, Cancer and Capricorn, which mark the sun's greatest declination, north and south of the equator, and is thence called the solstitial colure. When the sun is in or near these points, his meridian altitude undergoes scarcely any sensible variation for several days; and hence the term solstitial applied to them.

VIII. The horizon is a great circle, whose plane passing through the centre of the earth, and extended to the sphere of the fixed stars, divides the heavens into two hemispheres, of which the upper is the visible, and the lower the invisible hemisphere. This is the rational or true horizon, which determines the rising and setting of the sun, planets, and stars. It is represented by the wooden horizon of the artificial globe. The sensible, or apparent horizon, is the circle which bounds our view, where the land or water and sky seem to touch each other, more or less extensive according to the position of an observer.

The sensible horizon of a person changes as he moves, and in an open country enlarges or contracts as his station is high or low. Standing on a plain, the eye having an elevation of 5 feet above the surface, the radius of the sensible horizon will be less than 2¾ miles. At an elevation of 6 feet it will be just 3 miles.

Rule, to find the distance when the height is known—Increase the height in feet one half, and extract the square root for the distance in miles.

Thus, in the preceding case the eye is supposed to have an elevation of 6 feet above the surface of a plain, and 6 with its half is 9, the square root of which is 3, which gives the distance in miles which a person will be able to see in a right line upon that surface.

Again—a tower, 32 yards above the level of the ocean, may be seen along that level from a distance of 12 miles. For 32 yards = 96 feet, increased one-half = 144, the square root of which is 12.

IX. The poles of the horizon are the zenith and the nadir. The zenith is the point in the heavens which is directly over our heads; the nadir that which is exactly under our feet. The zenith to us is the nadir to our antipodes, and the nadir to us is their zenith. Circles drawn through the zenith and nadir of any place, cutting the horizon at right angles, are called azimuth or vertical circles; and that which passes through the east and west points of the horizon, is the prime vertical.

X. Meridians are imaginary great circles passing through the terrestrial and celestial poles, cutting the equator and equinoctial at right angles.

A meridian is supposed to pass through every place on the earth, and every point in the heavens, but only 24 are drawn on the globes through every 15° of the equator and equinoctial, including altogether 360°. These meridians mark the space which, in consequence of the earth's diurnal rotation, the heavenly bodies appear to describe every hour through the 24 in the day. They are sometimes called, therefore, hour, or horary, circles. As 15° answer to an hour, 1° answers to four minutes of time, ½ to two minutes, and ¼ to one minute.

Longitude on the earth is distance east or west from a fixed meridian measured on the equator. The Fortunate Islands, supposed to be the Canaries, supplied the ancients with their first meridian. The western extremity of Africa, as then known, was taken by Abulfeda, the Arabian geographer. The meridian of Terceira was used by the Spanish and Portuguese in the sixteenth century; and that of Ferro by all nations in the seventeenth and eighteenth centuries. We now adopt the meridian of the Greenwich, and the French that of the Paris, observatories.

Longitude in the heavens is distance east from the great meridian which passes through the first point of Aries, or the equinoctial colure, measured on the ecliptic.

Right ascension is distance east from the same meridian measured on the equinoctial.

Terrestrial longitude being reckoned in two directions from a fixed point, east and west, can only extend to 180°. Celestial longitude, and right ascension, are only reckoned in one direction, east from the prime meridian, and may, therefore, extend to 360°.

XI. Parallels of latitude are small circles supposed to be drawn on the surface of the earth, north and south of the equator, and parallel to it, dividing the globe into two unequal parts. Parallels of declination are such circles produced in the heavens, north and south of the equinoctial, and parallel to it.

Latitude on the earth is the distance of a place from the equator, measured on a meridian, north or south.

Declination is the distance of the heavenly bodies from the equinoctial, measured on a meridian, north or south.

Latitude in the heavens is distance from the ecliptic, at a right angle, north or south.

Terrestrial latitude and declination may extend to 90°. The sun has no declination when in the equinoctial. His greatest declination is 23½° north or south. He has no latitude, being always in the ecliptic. The greatest declination of a planet is 30½°, and latitude 8° north or south, with the exception of the asteroids. It is more convenient to describe the position of the heavenly bodies by their declination and right ascension, than by their latitude and longitude, the former corresponding to terrestrial latitude and longitude.

XII. The tropic of Cancer is a small circle 23½° north of the equator, and parallel to it; and the tropic of Capricorn is a similar circle, at the same distance, on the south. The polar circles are also small circles, each 66½° from the equator, and at the same distance from the poles as the tropics from the equator.

The tropics on the celestial sphere mark the limits of the sun's farthest declination north and south.

The tropics on the terrestrial sphere divide the torrid from the two temperate zones, and the polar circles divide the temperate from the two frigid zones.

Twice in the year the sun is vertical to those who dwell in the torrid zone. Consequently, at noon they deflect no shadow, and are hence styled *ascii*, meaning shadowless. At other times their shadows fall at noon, north or south, according as the sun is north or south of them. They are then called *amphiscii*, signifying, that their shadows fall both ways.

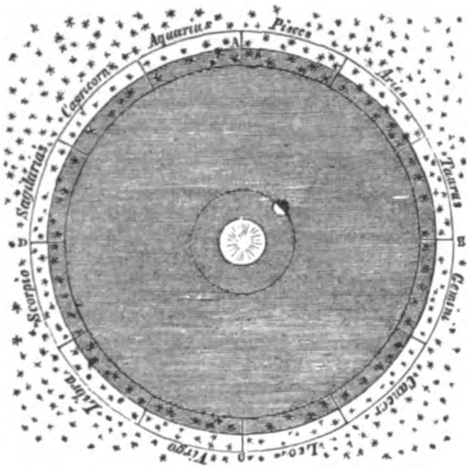
Those who dwell in the temperate zones have their shadows at noon always cast one way: towards the north in the north temperate zone, and towards the south in the south temperate zone. They are styled *heteroscii*, meaning, that they have their shadows at noon always one way or other, north or south.

The inhabitants of the frigid zones are called *periscii*, signifying, a shadow turning about, as, during a revolution of the earth on its axis, their shadows are projected towards every point of the compass.

XIII. Disk is the apparent face of the sun and moon, as seeming perfectly flat though spherical bodies. The planets exhibit disks as seen with the telescope. The diameter of the disk of the sun and moon is considered to be divided into twelve parts, called digits.

XIV. The orbit of a planet is the path described by it in revolution round the sun.

XV. The plane of a planet's orbit is an imaginary surface cutting through the centre of the sun and the planet, and reaching out to the stars.



The diagram shows the plane of the earth's orbit. The stars to which it extends form the constellations of the zodiac. The circle A, B, C, D, is the ecliptic, the sun's place in the heavens, as seen from the earth, and the earth's place as seen from the sun.

XVI. The inclination of the orbit of a planet is its plane referred to the plane of the earth's orbit, to which it is inclined.

If we suppose the shaded part of the diagram to be a surface of water, a ring or hoop held inclined so as to be half immersed will describe the relation of the planetary orbits to that of the earth. They are all inclined towards it, one half being below, and the other half above it. The angle of inclination varies, but exhibits at the greatest only a slight divergence.

Mercury . . .	7° 0′ 9″	Jupiter . . .	1° 18′ 51″
Venus	3 23 28	Saturn	2 29 35
Mars	1 51 6	Uranus . . .	0 46 28

XVII. The nodes of a planet are the two opposite points where its orbit appears to cut the orbit of the earth, or the ecliptic.

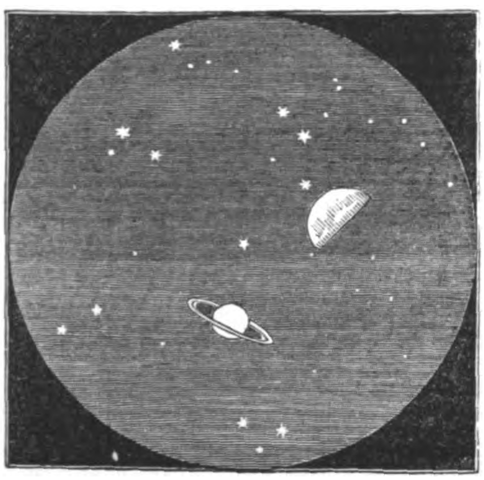
That where the planet appears to rise above the orbit of the earth is called the ascending node; the opposite point, where it appears to go below it, is called the descending node.

XVIII. Conjunction and opposition are terms used to denote certain situations of the planets with respect to the sun and to each other.

A planet directly between the earth and the sun is said to be in inferior conjunction with the sun. This can only take place in the case of Mercury and Venus, but along with them the earth may be in inferior conjunction with the sun to Mars, and with Mars to Jupiter, &c.

A planet with the sun directly between it and the earth is said to be in superior conjunction with the sun. The terms inferior and superior refer to the smaller or greater distance of the planet from the earth.

A planet with the earth directly between it and the sun is said to be in opposition. This can never take place in the case of Mercury and Venus, whose orbits are included in that of the earth.



Planets are said to be in conjunction with each other when they are in the same sign and degree. This is a common occurrence in the case of two; but the very rare phenomenon of Mercury, Venus, Mars, Jupiter, and Saturn, being in conjunction between the wheat ear of Virgo and Libra, took place Sept. 15, 1186. It will be ages before they cluster again in that part of the heavens. Venus, Jupiter, and the moon, were in conjunction in Leo when the peace of 1801 was proclaimed. A telescopic view of the conjunction of Venus and Saturn, on Dec. 19, 1845, is annexed.

The aspect of the planets to each other is said to be sextile, when they are two signs apart, the sixth part of the zodiac; quartile, when they are three signs distant, the fourth part of the zodiac; trine, when they are four signs distant, the third of the zodiac; and in opposition, when they are six signs, or half the zodiac, from each other.

XIX. Apogee is that point of the moon or a planet's orbit which is farthest from the earth; perigee, is that which is nearest.

XX. Aphelion is that point of the orbit of the earth, or of any planet and comet, which is farthest from the sun; perihelion is that which is nearest. A straight line joining the points of aphelion and perihelion, is called the line of the apsides.

XXI. Culmination is the act of coming to the meridian in the case of any star or planet, when it attains on any given day its greatest altitude in the heavens.

XXII. Daily acceleration is the interval of time that the stars rise, culminate, and set, sooner every succeeding day than on the one preceding. It amounts to about four minutes daily, or two hours a month.

Besides the apparent diurnal motion of the stars caused by the earth's rotation upon its axis, they appear to have a motion westward, in consequence of the earth's orbital course eastward. They gain, therefore, on the sun, rising, culminating, and setting sooner, day after day. Thus, those stars and constellations that on any given evening rise at ten o'clock, will, at the same hour, a month afterwards, be 30° above the horizon; and three months afterwards, they will be advanced over our heads; and six months afterwards be setting in the west, having accomplished half of their apparent annual revolution.

Hence the same constellations are not always visible to us through the year. Some, not visible before, successively rise to view in the east, while others sink in the west and are not seen again, until, having passed through the lower hemisphere, they reappear in the east.

XXIII. Cosmical, achronical, and heliacal rising and setting of the stars and planets, are phrases of the old poets, who spoke of the phenomena in reference to the rising and setting of the sun.

A star or planet rising and setting with the sun was said to rise and set cosmically.

A star or planet rising at sunset, or setting at sunrise, was said to rise and set achronically.

A star or planet appearing a little before the sun, in the morning, after having been so near him as to be hid by his effulgence, was said to rise heliacally, and to set heliacally when it ceased to be visible after him in the evening, on account of its proximity to his orb.

XXIV. Day, apparent solar, is the time included between the centre of the sun leaving the meridian of any place to its return to the same meridian again.

It varies continually in length, owing to the unequal motion of the earth in its orbit, and the obliquity of the ecliptic, being sometimes more and sometimes less than 24 hours. The greatest variation occurs about Nov. 1st, when the solar day is 16′ 17″ less than 24 hours, as shown by a well-regulated clock.

XXV. Day, mean solar, is the time which would elapse between consecutive returns of the sun to the meridian of any place, if moving in the plane of the equator with an equable motion. It is the mean of the true solar days throughout the year, and consists of 24 hours as measured by a time-piece, which, on some days of the year, is as much faster than the sun-dial, as on other days the sun-dial is faster than the time-piece.

XXVI. Day, sidereal, is the time which elapses between consecutive returns of any fixed stars to the same meridian, or, in other words, the period which the earth takes to accomplish one rotation on its axis. This period is unvarying and immutable, 23 hours, 56 minutes, 4 seconds, which would always be the length of the solar day, if the earth stood still in space, and only turned upon its axis.

In comparison with the immense distance of the stars, the diameter of the earth's orbit is but a point, and consequently in relation to them the diurnal rotation is performed precisely the same as if our globe had no translation in space. This is not the case in relation to the sun, a nearer neighbour; and owing to the earth's change of place, somewhat more than one diurnal revolution, or 24 hours, is required to bring the sun round again to the same meridian.

XXVII. Day, astronomical, is reckoned from noon to noon; and consisting of the same length of 24 hours in all latitudes, is called a natural day.

XXVIII. Day, artificial, is the time between sunrise and sunset, and varies with the latitude of places.

XXIX. Year, solar or tropical, is the time which the earth takes in moving in its orbit, or apparently the sun in the ecliptic, from one equinox or tropic to the same again, consisting of 365 days, 5 hours, 48 minutes, 49 seconds.

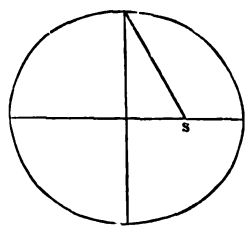
XXX. Year, sidereal, is the time occupied by the earth in moving in its orbit, or apparently the sun in the ecliptic, from a determinate point in relation to any fixed star to the same point again, and consists of 365 days, 6 hours, 9 minutes, 12 seconds.

CHAPTER III.

THE LAWS OF KEPPLER.

I. In the year 1609 Keppler delivered to the world the first and second of his three great laws, and announced the third in 1618, which reduced to order seeming anomalies in the motions of the planets, disclosed the unity of the solar universe, and laid the foundation of astronomy as an exact science in mechanical philosophy.

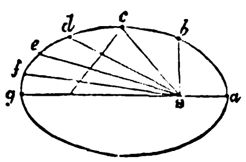
II. The FIRST law of Keppler refers to the true figure of the planetary orbits. This he pronounced to be an ellipse in the case of Mars, after having tried no fewer than nineteen hypotheses with regard to the motions of that planet, and calculated the results of each. The elliptic form found for the orbit of Mars, he extended analogically to all the other planets, and modern astronomy has completely established the presumption to be a matter of fact. The planets describe ellipses in their orbital revolution round the sun.



An ellipse is a curve of an oval shape, as in the diagram, but which is made much more elliptical than the orbits of the planets, in order to show the form. Optically, in the case of the great planets, they would not be perceived to differ from perfect circles. The ellipse may represent the orbit of the earth, or of any other planet, in which s is the position of the sun, not in the centre, but in one of the *foci*, one of the two points around which the ellipse is formed.

The distance from the sun at s, or from a corresponding focus on the opposite side, to the centre, is the eccentricity of the ellipse, which varies to some extent in the orbits of the planets. The distance, or eccentricity, in the instance of the orbit of Mercury is about 7,000,000 miles; in that of Venus less than 500,000 miles; in that of the Earth somewhat more than 1,500,000 miles; in that of Mars upwards of 13,000,000 miles; while in that of Juno and Pallas it is 64,500,000 miles.

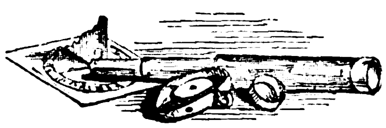
III. The SECOND law of Keppler refers to the velocities of the planets, and brings into conformity to rule an apparent deviation from it. They are observed to move with different velocities in different parts of their orbits; and this want of uniformity in the rate of motion he ascertained to be the effect of uniform obedience to the principle, technically expressed, of equal areas being swept over by the revolving radius-vector in equal times. This may be readily understood.



A line drawn from a planet, in whatever part of its orbit it may be, to the sun, is called in astronomy the radius-vector (literally, *carrier-radius*).

Let the ellipse represent the orbit of a planet, and s the sun in one of the foci. The line drawn from the planet at *a* to s is the radius-vector, likewise from *b*, *c*, *d*, *e*, *f*, and *g* to s. These lines bound certain areas of the ellipse which may be supposed to be equal to each other in extent, the greater length making up for the diminished breadth. Now, obviously, for the radius-vector to sweep over the area between *a* s and *b* s, in the same time as over that between *f* s and *g* s, the planet must travel with greater velocity in the former case than in the latter, because the actual orbital path to be compassed is greater. Thus its different velocities in different parts of its course are the result of orderly obedience to a general law governing the phenomena of its motions.

IV. The THIRD law of Keppler refers to the mutual relations of the orbits of the planets, and connects their relative distances from the sun with their comparative velocities. It is expressed technically by saying, that "the squares of the times in which the different planets revolve around the sun are proportioned to the cubes of their mean distances from his centre." From this it follows, that the distances of two planets being known, and the period or year of one of them, the year or period of the other can be detected by a simple proportion, and *vice versâ*. Thus, Mars is about 4 times the distance of Mercury from the sun; his period of revolution is about 4 times that of the latter; and the cube of 4, or 64, is equal to the square of 8. The discovery of this law clearly shows, that the bodies to which it relates have not been thrown at random in their places, are not independent of each other, but compose a family with a fine bond of relation subsisting among its members; a system having a distinct and definite oneness.



CHAPTER IV.

LAW OF GRAVITATION.

I. The forms of the planetary orbits being known, with the law of the velocities, and their mutual relations, it became interesting to show from what principle their motions result, and how they are preserved in curvilinear paths round the sun, instead of flying off in straight lines from him, obeying the impulse of the projectile force evidently impressed upon them. This principle is the attraction of gravitation, of which we know nothing but from its effects, which are open to daily observation.

The idea of gravitation as the secret all-pervading power which balances the planets in their orbits, and maintains the system in complex but harmonious movement, was not, as commonly supposed, the original conception of Newton. It had been entertained by Keppler and others, and dawned simultaneously upon Hooke and Wren. Newton's merit lay not in suggesting the grand principle, but in practically applying and mathematically demonstrating it, and explaining the law of the force.

II. Every material atom in the creation gravitates, or has a tendency to unite itself with every other atom, whatever be the distance.

The force of this attraction of gravitation, or tendency of bodies to each other, varies according to the quantity of matter they contain. As a large magnet will take up a larger object than a small one, so with attraction, a piece of lead weighing two pounds will attract with double the force of another piece of lead weighing one pound.

The force of attraction also varies with the distance between the attracting and attracted bodies. If two equal substances be placed at unequal distances from the attracting body, the nearest will be acted upon with greater power than the more remote.

The attraction of gravitation is reciprocal. All bodies not only attract, but are themselves attracted, according to their respective quantities of matter, and distances. The sun attracts the earth and all the other planets, and they attract the sun. The earth attracts the moon, and she attracts the earth. An apple hanging on a branch tends to attract the earth upward to meet it, but the earth being so incomparably the superior body, its attraction is incomparably greater, so that the moment the apple is severed from the branch, it yields to the superior attraction, and drops to the earth. Suppose a mass of land of a thousand tons in the place of the apple, it would attract the earth more powerfully, but be so completely overpowered by the attraction of the earth as to fall to it, the earth rising to meet it by a quantity wholly inappreciable by mortal sense, though not by computation. Thus, the quantity of matter in the sun so far surpasses that of all the planets together, that were they all on one side of him, he would never be more than his own diameter from the common centre of gravity. Thus, too, the quantity of matter in the earth being about 80 times greater than that of the moon, their common centre of gravity is 80 times nearer the earth than the moon, or about 3000 miles from the terrestrial centre.

If we see no proofs of attraction in practice, between small bodies at the earth's surface, it is because the enormous mass of the earth completely neutralises its effect, by bringing these smaller bodies to itself. But the earth's attractive power is seen in whatever falls, whether a pebble from the hand, an apple from the tree, or an avalanche from the Alps. All terrestrial bodies are continually solicited, or gravitate, towards the centre of the terraqueous globe; and by this tendency, animals on all parts of its surface stand with their feet pointing to it. A cannon-ball fired upwards from the earth again returns to it, the earth's attraction overcoming the projectile force, and producing a motion of the ball to itself.

III. The law of universal gravitation is thus technically expressed:—The mutual attraction between any two bodies is directly proportioned to their masses, or quantities of matter, and inversely to the square of their distances from each other.

Two bodies may be of equal size or magnitude, but unequal in their masses, or respective quantity of matter. Thus, a globe of cork of equal dimensions with one of lead has less matter, being more porous. The matter of the sun is so much less dense than that of the earth, that though the sun is 1,300,000 times larger than the earth, it only contains 355,000 times more matter. Consequently, the sun only exerts upon the earth an attractive force 355,000 times greater than that which the earth exerts upon the sun.

The attractive force or energy varying with the distance between two bodies according to a certain ratio, *i.e.*, decreasing as the square of the distance increases, and conversely, increasing as the square of the distance decreases, is easily understood. The square of a number is that number multiplied by itself, the square of 2 being 4, 3—9, 4—16, &c. Suppose, therefore, the earth to be removed to 2, 3, or 4 times its present distance from the sun, the solar attraction would be diminished to it in each case by the square of these numbers, or 4, 9, and 16 times, and its own attractive energy in relation to the sun would be diminished in the same proportion. Or, if removed nearer to the sun 2, 3, or 4 times, the mutual attraction of the two bodies would be increased 4, 9, or 16 times.

IV. It may now be explained how the law of gravitation operates in producing the curvilinear paths of the planets.

Every body in a state of rest will remain so, unless compelled to change it by the impression of force.

Every body put in motion will continue to go forward in a straight line if it encounters no resisting or diverting force.

If a body be acted upon by two forces at the same time and in the same direction, it will preserve that direction, but proceed at a quicker rate than if under the impression of one force.

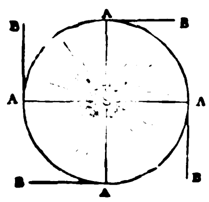
If a body be acted upon by two equal antagonistic forces it will remain in a state of rest.

If a body be acted upon by two unequal antagonistic forces it will follow the direction of the greater force.

If a body be acted upon, at the same time, by two forces, not in the same nor in opposite directions, it will not follow either of the forces, but proceed in a line between them, and in a curve line if the forces are not uniform.

The last rule solves the problem of the curvilinear paths pursued by the planets, for those bodies are acted upon by the primitive projectile impulse with which they were launched in space, and by the solar attraction. The combined result is, that they are deflected from the natural right lines which would be described under the influence alone of the projectile force, by another force drawing them to the sun, and hence move in a curve. These forces continually operating, the effect is constant, and the unfailing prosecution of an orbital route round the sun ensues.

The straight lines, A B, in the diagram may represent the rectilinear path in which a planet would travel, simply obeying the projectile force. The straight lines, A S, represent the course it would pursue, simply obeying the solar attraction. The curve is the orbit formed by the joint action of the two agencies.



V. Thus, while on the one hand, the sun, from his immense magnitude, by the power of his attraction, would draw all the planets to him, if his attractive force were not kept in check by the primitive impulse of the planetary bodies to move in straight lines, given at the time they were launched in universal space; on the other hand, under that impulse the planets would fly off at a tangent line from their orbits, but for the solar attraction. The attractive power of a body is called the centripetal force; and the projectile impulse, or the tendency to fly off from the centre in a straight line, is called the centrifugal force. The maintenance of order in the solar universe is due to the fine balancing of the opposing powers—the regulated strife of the two tendencies.

VI. Our common phrase, the weight of bodies, is synonymous with the force of terrestrial gravitation, or of the earth's attraction. It is greatest at the surface of the earth, and decreases upwards and downwards, but not after the same ratio.

Upwards, it decreases as the square of the distance from the earth's centre increases. At the same distance above the surface as the surface is from the centre, the gravitating force, or the weight of a body, will be only one fourth of what it is at the surface. Thus, a ball of lead weighing one pound at the surface, raised 4000 miles above it, about equal to two semi-diameters of the earth from the centre, would be reduced one-fourth in weight, or weigh only a quarter of a pound. Raised 12,000 miles above the surface, about equal to four semi-diameters from the centre, it would be reduced one-sixteenth in weight, or weigh but one ounce.

Below the surface, the force of terrestrial gravitation decreases in the direct ratio of the distance from the centre. Thus, at three parts of the distance between the surface and the centre, at half, and at a quarter, it will be $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{1}{4}$, of what it is at the surface, and the ball of lead be respectively reduced in weight to three quarters, half, and one quarter of a pound. At the centre it would be without weight, being equally attracted on every hand.

VII. The centrifugal and centripetal forces being mutual opposing powers, the weight of bodies in relation to the earth, or to any other orb having a motion upon its axis, depends not only upon its quantity of matter, but upon the velocity of the rotation. Thus, the centrifugal force engendered by the earth's diurnal motion diminishes the power of gravity at the equator, or the weight of bodies, in the proportion of 1 for every 290 pounds; in other words, a body now weighing 290 pounds at the equator, would weigh 291 pounds if the earth were at rest upon its axis. Supposing the velocity of the rotation to be increased, the weight of bodies would be proportionably diminished by the greater action of the centrifugal force; and bodies would have no weight at all, gravity being counterbalanced, supposing the earth to whirl round in 84 minutes. By a greater velocity, gravity would be overcome, and bodies fly off from the equator as water from a mop when it is trundled.

THE SOLAR SYSTEM.

CHAPTER I.

GENERAL VIEW.

I. Directing a telescope to the heavens, the fixed stars still remain points of light, but a few other bodies undergo a sensible change of appearance, presenting disks, or flat surfaces, which enlarge with the magnifying power of the instrument employed. They are observed also by the naked eye to have motions of their own, independent of the apparent revolution of the great celestial concave. Sometimes they appear to be stationary, then to be moving from west to east, and back again from east to west, altering their place with respect to the earth, each other, and the heavenly bodies. Hence they have been called planets, or wanderers.

Five planets were known to the ancients, and received names from their mythology: Mercury, Venus, Mars, Jupiter, and Saturn. Five more have been discovered in modern times: Uranus, and the Asteroids, Ceres, Vesta, Juno, and Pallas; and five in the present day: Neptune, with four Asteroids, Astrea, Hebe, Iris, and Flora—making, with the earth, sixteen primary planets.

II. The primary planets, with secondary bodies or moons attached to some of them, are satellites of the sun, revolving round him at different distances, and in different periods. These, together with comets, constitute the solar universe.

The planets are called inferior and superior, according as their orbits are within or without that of the earth. Mercury and Venus are the inferior planets; Mars, the Asteroids, Jupiter, Saturn, Uranus, and Neptune are the superior planets. A better phrase would be interior and exterior.

III. The respective distances of the planets from the sun may be thus numerically expressed:—

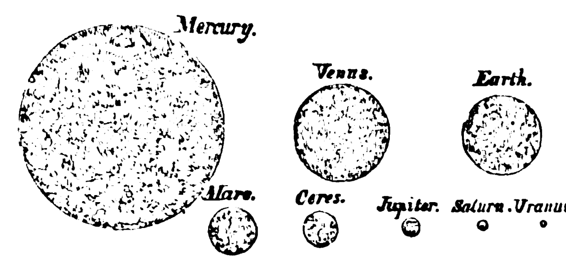
Mercury $\frac{4}{10}$, Venus $\frac{7}{10}$, Earth 1, Mars $1\frac{1}{2}$, Ceres $2\frac{2}{3}$, Jupiter $5\frac{1}{4}$, Saturn $9\frac{1}{2}$, Uranus 19.

IV. The apparent diameter of the sun, as seen from the different planets, varies with their distances, the solar globe dwindling down from a resplendent luminary to a comparatively small orb, yet still a sun to the farthest of his satellites.

The apparent diameter of the sun is 32′ as seen from the earth. From the other planets, it will be:

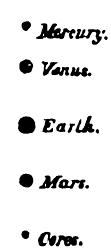
Mercury 80′, Venus 46′, Mars 21′, Ceres 11′, Jupiter 6′, Saturn 3′, Uranus 1′·3.

The comparative size of the great source of light and heat, at each of the planets, may be thus pictorially shown.



V. All the planets are spheroids, more or less flattened at their poles, varying prodigiously in their magnitudes.

Their relative bulk is brought before the eye in the annexed cut.



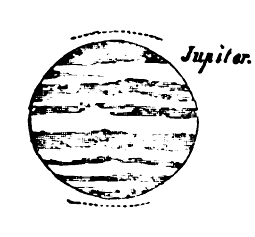
Taking the earth as 1, their comparative volume is numerically as follows:—

Mercury $\frac{1}{23}$, Venus $\frac{4}{5}$, Mars $\frac{1}{5}$, Ceres $\frac{1}{125}$, Jupiter 1300, Saturn 900, Uranus 80.

As seen from the sun their respective apparent diameters will be.—

Mercury 16″, Venus 30″, Earth 17″·2, Moon 4″·6, Mars 10″, Jupiter 37″, Saturn 16″, Uranus 4″.

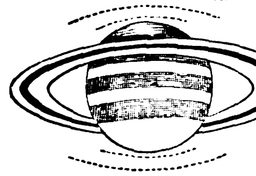
Sir John Herschel gives the following illustration of their relative magnitudes and distances:—"Choose any well-levelled field, or bowling-green; on it place a globe, two feet in diameter; this will represent the sun. Mercury will be represented by a grain of mustard-seed, on the circumference of a circle 164 feet in diameter for its orbit: Venus, a pea, on a circle 284 feet in diameter; the Earth, also a pea, on a circle 430 feet; Mars, a rather large pin's head, on a circle of 654 feet; Juno, Ceres, Vesta, and Pallas, grains of sand, in orbits of from 1000 to 1200 feet; Jupiter, a moderate sized orange, in a circle nearly half a mile across; Saturn, a small orange, on a circle of four-fifths of a mile; and Uranus, a full-sized cherry, or small plum, upon the circumference of a circle more than a mile and a half in diameter."



VI. The solar and planetary orbs vary remarkably in their density. Their weight, compared with that of the earth, represented by 1, is estimated to be:—

Sun 355,000, Mercury $\frac{3}{20}$, Venus $\frac{9}{10}$, Mars $\frac{1}{8}$, Jupiter 338, Saturn 95, Uranus 17.

Saturn.



Their weight, compared with that of a globe of water of the same size, is estimated to be:—

Sun $1\frac{1}{3}$, Mercury $17\frac{7}{10}$, Venus $5\frac{1}{3}$, Earth $4\frac{9}{10}$, Mars $3\frac{3}{10}$, Jupiter $1\frac{1}{10}$, Saturn $\frac{1}{2}$, Uranus 1.

Thus, while the material of Mercury is as heavy as lead, that of Saturn is nearly as light as cork, and would float buoyantly upon the waters, if his globe were launched on an ocean capable of receiving it.

Uranus.

VII. The mean orbital velocity of the planets is as follows, per second:— Mercury, 30 miles; Venus, 23; Earth, 19; Mars, 15; Vesta, 13; Juno, 12; Ceres, 11; Pallas, 11; Jupiter, 8; Saturn, 6; Uranus, 4.

CHAPTER II.

THE SUN.

I. The sun, the centre of the solar system, dispensing light and heat to the planets, and governing their motions, is by far the largest body in the universe whose dimensions have been ascertained. The real diameter of the grand luminary is about 882,000 miles, and the circumference about 2,764,600 miles. A magnitude so vast can only be feebly grasped by the conceptions of the human mind, and requires comparison in order to be appreciated.

The diameter of the sun is equal to $111\frac{1}{2}$ times that of the earth. The circumference embraces a volume of matter about 1,300,000 times larger than our globe, and more than 500 times greater than that of all the planets.

If the centre of the sun occupied the place of the earth's centre, then the solar mass would fill up the whole distance between the earth and the moon, and extend into space nearly as far again beyond it.

Conceiving of the sun as a hollow sphere, perforated, so as to admit of the twinkling through, in a thousand places, of the luminous atmosphere without; and supposing the earth placed at the centre, with the moon at her real distance from it; there would then be exhibited to a spectator on our globe, a universe as extensive as the whole creation was conceived to be in the infancy of astronomy, or as it now appears to the uninstructed eye.

The solar substance is, however, far less dense than the terrestrial, so that if the two bodies were weighed in a balance, the weight of the sun would not exceed that of the earth in proportion to the excess of magnitude, but be only about 355,000 times heavier. While, therefore, it would require $1\frac{1}{4}$ million earths to equal the sun in bulk, it would require but 355,000 to equal him in mass, or in the amount of ponderable matter.

Immense as is the volume of the sun, it is supposed, on good grounds, to be greatly exceeded by that of some of the fixed stars. Dr. Wollaston computes that Sirius, occupying the sun's place, would appear 3·7 times larger, give 13·8 times more light, and consequently be equal to nearly 14 suns in size.

II. That a body of such magnificent dimensions as the sun should apparently fill so small a space in the heavens, argues the enormous distance subsisting between the solar and terrestrial worlds. The sun's mean distance is equal to 12,000 times the diameter of the earth, or about 95,000,000 of miles. This has been determined chiefly by observation of the transits of Venus; and, according to Laplace, it is within $\frac{1}{87}$ of the true distance. The computation involves, therefore, no error of importance.

A steam-boat, making 200 miles a day, would require 1,300 years to describe the distance between the earth and the sun. A locomotive engine travelling at the rate of 20 miles an hour, would require more than 500 years to accomplish the same space; and a cannon-ball, maintaining the full force with which it is discharged, or flying night and day at the rate of 15 miles a minute, would not perform the feat under upwards of eleven years. Yet the earth, if completely surrendered to the solar attraction, would fall upon the sun in 64 days 13 hours; and light visits us from the sun in 8 minutes 13 seconds.

III. The mean distance of the sun from the earth supposes variation, and is the average struck between the two extremes of the greatest and the least. If the earth described a perfect circle in space, with the sun in the centre, the distance of the two bodies from each other would be always the same; but as the earth's orbit is an ellipse or oval, having the sun, not in the centre, but in one of the *foci*, or points around which the ellipse is drawn, it follows that the distance varies. When at its nearest point to the sun, the earth is about 93,000,000 of miles distant, and about 96,000,000 of miles when farthest removed. The difference in the distance is, accurately, 3,202,104 miles. The maximum and the minimum distance are attained respectively at intervals of six months, the former about the end of June, or at the summer solstice, and the latter about the end of December, or at the winter solstice.

When most remote from the earth, the sun is said to be in *apogee;* and when nearest, in *perigee.*

When most remote from the sun, the earth is said to be in *aphelion;* and when nearest, in *perihelion.*

The apparent anomaly of the earth being 3,202,104 miles nearer the sun at midwinter, when the temperature is low, than at midsummer, when it is high, is easily explained. Comparatively, the difference in the distance is trifling, and its effect is overruled by the two following circumstances:—When the earth is farthest from the sun, as in summer, we have the solar day twice as long as in winter, and the sun's rays acting continuously through the lengthened interval, cause a powerful accumulation of heat. Again, at the same season, we have the sun in those signs of the zodiac that are north of the equator, and rising to a greater altitude above the horizon, his rays reach us in a more vertical direction, and acquire their greatest force. Precisely opposite circumstances transpire in winter, and hence we have then the greatest cold, though nearer to the sun than in summer.

The change of distance is recognised by an observed variation in the apparent diameter of the sun. Measured by the heliometer, the greatest apparent diameter is 32′ 35″ on the 31st of December, and the least is 31′ 31″ on the 1st of July, the difference amounting to 1′ 4″.

IV. The sun has two apparent motions in the heavens, diurnal and annual. The apparent diurnal motion, from the point of sunrise to that of sunset, or from east to west, is an optical deception, caused by the real rotation of the earth upon its axis, from west to east. The apparent annual motion, through the signs of the zodiac, from the first point of Aries to the same point again, or from east to west, is also an illusion, caused by the earth's translation in its orbit from west to east.

A familiar illustration of apparent motion, is that of the country on each hand through which a railway-train is passing, which seems to be moving rapidly in an inverse direction,—or that of the banks of a river, as seen from a vessel sailing on its surface.

V. There are two proper motions belonging to the sun,—a change of place, and a rotation upon his own axis. The former, due to the attraction of the different planets, is imperceptible. It consists of a revolution round the common centre of gravity in the system. This does not coincide with the centre of the solar globe, though but very slightly removed from it, and never apart from the solar body. The latter movement is open to observation, the sun accomplishing an axical rotation in a period of 25 days, 9 hours, 56 minutes, following the same direction as the earth, from west to east.

The rate of rotation at the equator of the sun is about 4,530 miles an hour.

VI. The fact and time of the sun's rotation are clearly ascertained by observation of the solar spots. These peculiarities of the disk, though all transient, frequently remain long enough to be identified as the same after a considerable period. They move progressively from the eastern to the western limb of the sun, vanish, and appear again at the eastern edge, thus sensibly demonstrating the solar rotation.

The time apparently occupied by the revolution of a spot from a particular point of the sun's disk to the same point again, is 27 days, 7 hours, and 26 minutes. This exceeds by nearly two days the period stated as that of the sun's rotation. But a spot will really have made more than an entire revolution in the former interval, owing to the motion of the earth in its orbit at the same time; and making the proper allowance for that, the actual period of the solar rotation is reduced to the limits mentioned.

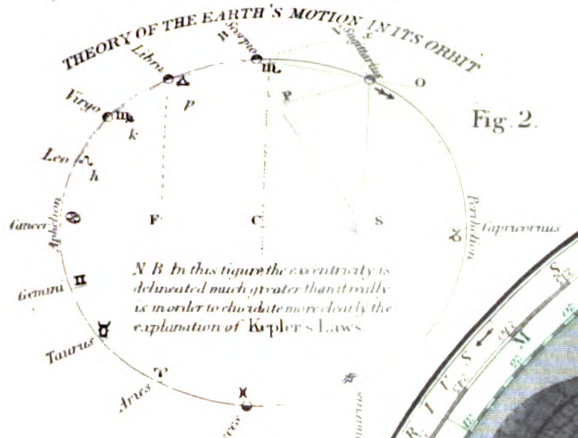
VII. When viewed through a powerful telescope, with coloured glasses interposed to prevent the intense light and heat of the sun from injuring the eye, the unwrinkled and uniformly luminous appearance of the solar surface to the unassisted vision is found to be an illusion. Besides the black patches, or *maculæ,* (dark spots,) often exhibited, a variety of luminous aggregations or lines are seen, brighter than the other parts of the disk, to which the term *faculæ* (little torches) is applied. The dark spots are of all shapes and sizes, or the luminous ridges frequently run in a winding course from one to another. The solar spots are usually observed in a zone parallel to his equator, and about 35° from it, though they are also seen much nearer to the polar regions.

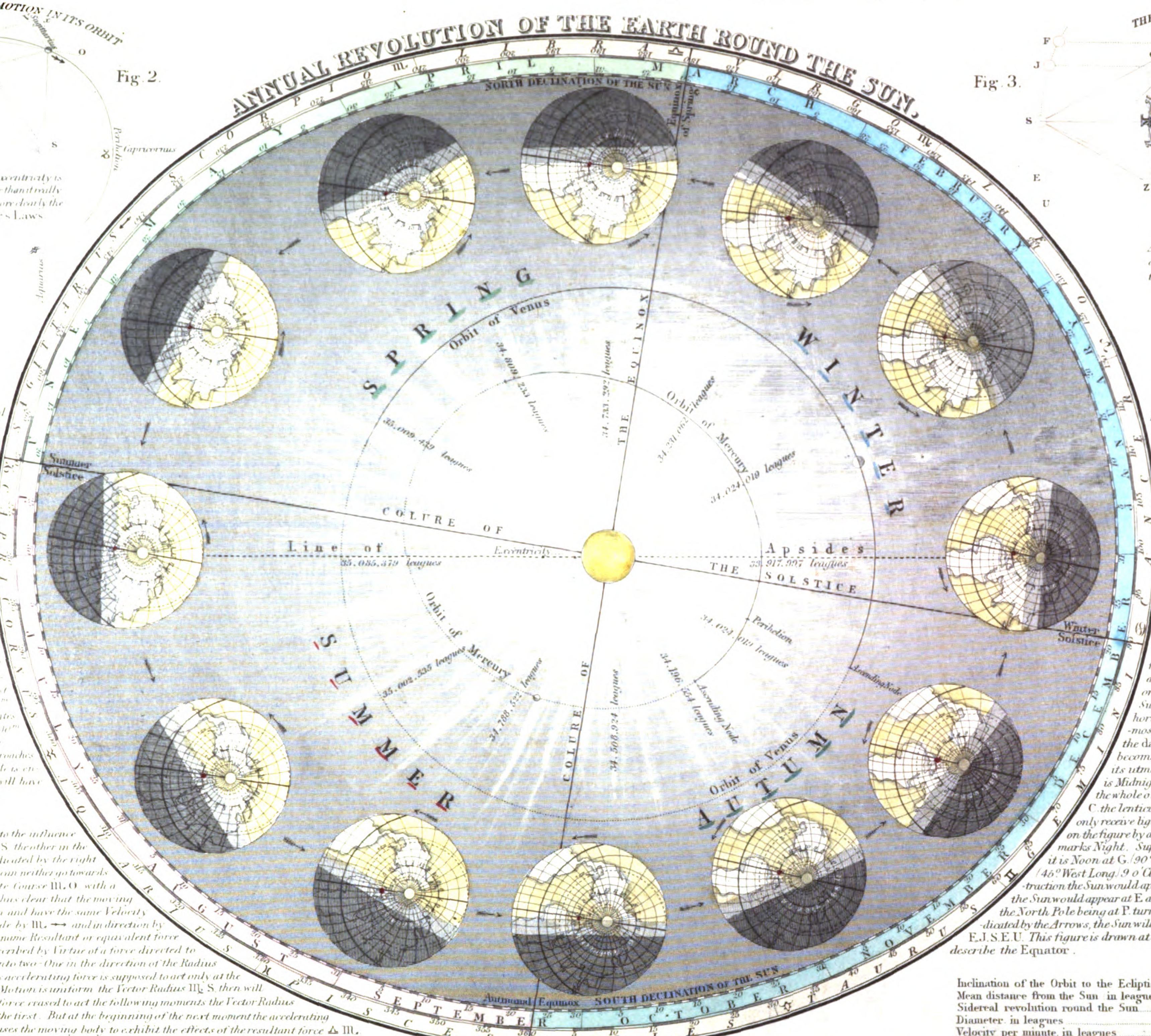
Herschel estimated the diameter of a spot observed by him at upwards of 50,000 miles, more than six times the diameter of the earth. Another, observed June 30, 1830, had a diameter of 23,000 miles. It was nearly circular, and, therefore, included an area of 443,000,000 of square miles. Herschel's large spot was visible to the naked eye. There is respectable testimony to the same fact in other instances. The spots thus seen must have been of enormous dimensions. It has been suggested, that a temporary accumulation of spots will perhaps account for statements made by old authors respecting the solar appearance, which have been referred simply to their fondness for the marvellous. Thus, Plutarch states, that, in the first year of the reign

ANNUAL REVOLUTION OF THE EARTH ROUND THE SUN.

THEORY OF THE EARTH'S MOTION IN ITS ORBIT

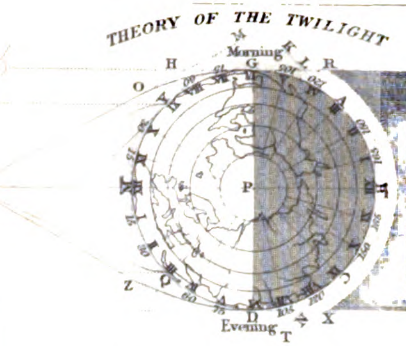
Fig. 2.





THEORY OF THE TWILIGHT

Fig. 3.



Apparent position of the Sun at different hours of the day at the time of the Equinoxes.

Fig. 1.

The Centre Figure represents the Annual Revolution of the Earth round the Sun on its Orbit which is an Ellipse, the excentricity of which is about 583,691 leagues and on the first of each Month. The graduated Circle which at a small distance surrounds the North Pole in each figure of the Earth, shews the Parallel of Great Britain, this Circle is divided into 24 hours.

The figure to the right marks the hour of Sun-rise that to the left the hour of Sun-set. The point ∘ indicates the position of Great Britain with reference to the Sun at the various hours of the Day and Night. for Example, it is 2 o'Clock A.M. on the first of June and the horary Circle shews us that at this time the hour of Sun rise is 4^h 3^m and that of Sun set 7^h 51^m the Night therefore will continue 2^h 3^m longer. Again on the first of December the Sun rises at 7^h 40^m and Sets as the horary Circle indicates at 4^h 4^m the time supposed being 1^h 40^m the day will continue 2^h 24^m longer. At this period of the Year the Earth approaches the Winter Solstice when its North Pole is enveloped in darkness for two Months will have reached the middle of its long Night.

Fig. 2.

Suppose a moving body ♏ subjected to the influence of two forces, One in the direction ♏ S the other in the direction ♏ x the intensity being indicated by the right lines ♏ P and ♏ V the moving body can neither go towards S nor x but must take an intermediate Course ♏ O with a Velocity represented by ♏ ⟶. It is thus clear that the moving body ♏ will take the same direction and have the same Velocity as One force represented in Magnitude by ♏ ⟶ and in direction by ♏ O would have imparted to it. The name Resultant or equivalent force is given to this. When a Curve is described by Virtue of a force directed to a fixed point S, it may be resolved into two - One in the direction of the Radius ♏ S the other of the Curve ♏ △. This accelerating force is supposed to act only at the beginning of each moment while the Motion is uniform the Vector Radius ♏ S then will trace a small triangle ♏ S △. If this force ceased to act the following moments the Vector Radius would trace a fresh triangle equal to the first. But at the beginning of the next moment the accelerating force ♏ k combines with ♏ B and causes the moving body to exhibit the effects of the resultant force △ ♏, the sides of which △ p, △ B represent these forces.

Fig. 3.

For some time after Sun-set the rays still illumine the Atmosphere diffusing themselves through space and Night come on almost insensibly, this is called twilight and the dawn is a similar Phenomenon which precedes Sun rise. The Solar ray S.O. which enters the Atmosphere at O instead of coming out at M will be turned aside refracted or bent more and more as it penetrates the various Strata of Air and will at last reach the Earth describing the Curve O.G. The Observer at G would thus see the Sun much longer at E than he really was visible above the horizon. The effect of the dawn is the reverse of this - let the Earth be represented by A.B.C.D. and G where the Sun rises the horizon at H.G.R. receives light from all parts of the Heavens either directly or by reflection the point A at which the Sun has not actually risen, has above its horizon the lenticular portion of the Atmosphere K.L.R. indirectly illuminated the dawn is most brilliant at K. the tint becoming more feeble until it reaches R. its utmost limit above the horizon at B. it is Midnight, and at D where the Sun is Rising the whole of the horizon is illuminated while at C. the lenticular portions of the Heavens T.N.X. only receive light. The extent of twilight is shewn on the figure by a Zone of lighter shade than that which marks Night. Suppose M the Meridian of London & it is Noon at G. (90° West Long. it is 6 A.M. and at Y. (45° West Long.) 9 o'Clock by the effect of Atmospheric attraction the Sun would appear to be at J. at Q (45° East Long. the Sun would appear at E at 3 o'Clock P.M. Thus as the Earth, the North Pole being at P. turns on its Axis from West to East, as indicated by the Arrows, the Sun will appear to occupy the opposite points F.J.S.E.U. This figure is drawn at the time when the Sun appears to describe the Equator.

	MERCURY	VENUS
Inclination of the Orbit to the Ecliptic	70	3° 23
Mean distance from the Sun in leagues	13.361.000	24.966.000
Sidereal revolution round the Sun	87 days 97	224 days 70
Diameter in leagues	1.130	2.787
Velocity per minute in leagues	653	485
Time of rotation upon its axis	$24^h\ 4^m$	$23^h\ 21^m$

of Augustus, the sun's light was so greatly diminished, that one could look at it with the naked eye without inconvenience.

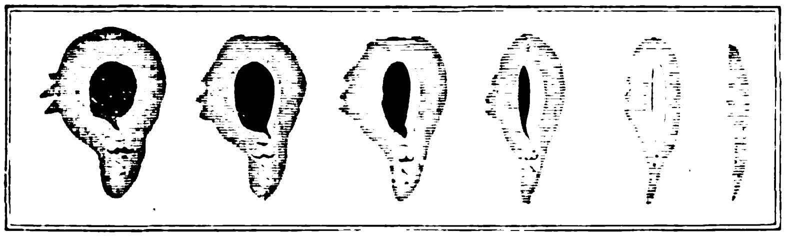
That part of the solar disk not occupied by spots, presents the appearance of a ground finely mottled with minute dark dots or pores, which, attentively watched, are observed to be in a state of constant change.

The solar disk, however, frequently exhibits a comparatively unblemished aspect. From 1650 to 1670 scarcely any spots were to be seen; and this was the case also from 1676 to 1684. But since the beginning of the eighteenth century, scarcely a year has passed in which they have not been visible, and often in great numbers.

VIII. The large black spots on the sun consist of a dark nucleus, surrounded by a band or border less completely dark, called a penumbra. The penumbra usually corresponds in shape to the spot it environs. It presents no apparent gradations of luminosity, but is terminated by distinct edges, beyond which there is a *facula*, or ridge of light, more brilliant than that of the sun's radiant disk.

As a general rule, the solar spots are not long permanent or uniform. They undergo great and rapid changes. Sometimes several small ones unite into a large one, or a large one separates into several smaller. Dr. Wollaston observed one to burst in pieces like a lump of ice when dashed upon a hard surface. Some remain for days, weeks, and months continuously, while others appear and disappear in the course of a few hours. Spots gradually formed are generally gradually dissolved; while those that are rapidly formed as quickly disappear.

IX. The solar rotation causes a spot to alter in its appearance to the eye, as in the illustration. The left-hand figure may be regarded as a spot seen upon the



centre of the solar disk. As the sun rotates, the nucleus is gradually impaired, till it wholly disappears, and only the penumbra is seen, consisting of a single shady line. This so exactly answers to what would take place supposing the spots to be excavations, as naturally to suggest and strongly confirm that opinion.

X. Dr. Wilson, of Glasgow, in the year 1773, proposed the theory now commonly held respecting the constitution of the solar spots. The visible surface of the sun is supposed to be a highly luminous atmosphere, perhaps several thousand miles in thickness. Under this another is conceived to lie, less luminous—a stratum or mass of clouds, throwing back the light of the upper regions, and forming the penumbra of a solar spot. The nucleus itself is considered to be the dense body or real substance of the sun, temporarily exposed through openings in the surrounding atmospheres, occasioned by local agitations from powerful currents. Adopting this view, the *faculæ*, or bright ridges, may be simply grand accumulations, or immense waves of luminous matter, in the exterior atmosphere, heaped up by violent commotions in their neighbourhood. It is further supposed that the currents, or forces, which disturb and rend the cloudy and luminous strata operate from below, though comparatively superficial in their seat, and not emanating from any explosive action within the solar mass. Hence a spot is always surrounded by a *facula*, as if the opening had been caused by an upward current, accumulating the light atmosphere around it.

XI. The sun, then, in its interior physical constitution is not a ball of fire, according to ancient fancies and natural impressions, but, very probably, an opaque, non-luminous body like our own globe; nor are there insuperable difficulties in the way of supposing it the abode of organised beings.

At the visible surface of the solar orb the light and heat must be intense in the extreme, affecting us so powerfully at the distance of so many millions of miles. But two considerations materially abate the difficulty which this fact presents.

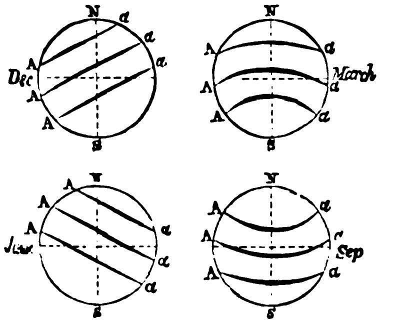
The effect of the sun in producing heat depends upon the solar influence combining with heat in a latent state. Hence, the higher we ascend in the atmosphere, the greater is the cold experienced. Perpetual ice and snow clothe the summits of high mountains, receiving the direct rays of the sun; while in sheltered valleys far below, which only admit their indirect influence, the temperature is often overpowering. Sensible heat is thus generated by the sun's rays, through their combination with caloric, or latent heat. It is physically possible, therefore, for the solid matter of the sun to be so modified, as to be capable of only slightly combining with the rays of the luminous regions above it, and thus for there to be no excessive temperature at its superficies.

Again, the stratum of dense clouds below the vividly resplendent surface of the sun may be so perfectly reflective, as effectually to defend the solar mass from the intense light and heat of the superior regions. That the penumbral clouds, remarks Sir John Herschel, are highly reflective, the fact of their visibility in such a situation can leave no doubt. They may thus act as a screen to the body of the luminary, duly attempering to it the light and heat radiated by the exterior atmosphere.

XII. Galileo first noticed the solar spots in the month of April, 1611, and announced their inconstancy, with other peculiarities, in the following year. About the same period they were observed by Scheiner and Fabricius, but by our own countryman, Harriot, a year previous.

They had probably been discerned before without a telescope, but not understood. An entry from the log of a ship off the African coast, in the year 1590, is given by Hakluyt:—"The 7th (December), at sunset, we saw a great black spot on the sun; and on the 8th, both at rising and setting, we saw the like, the spot appearing about the size of a shilling."

XIII. The apparent motion of the spots across the solar surface varies in its direction through the year, but the same course is invariably pursued year after year. Sometimes they appear to describe straight lines, and then curves, as represented in the diagram.



N, S, the north and south poles of the sun; A the points where the spots appear upon the disk; *a* the points where they appear to leave it.

At the beginning of December the course seems to be in straight lines from A to *a*; at the beginning of March it assumes the form of the curves in the figure; at the beginning of June straight lines again seem to be described, but with an inclination precisely contrary to that seen six months before; and at the beginning of September the curvature re-appears, but with the convex side towards the south pole of the sun. The same phenomena, in the same order, are repeated every year.

The above appearances are entirely optical. They result from the motion of the earth round the sun, and from the uniform rotation of the latter upon an axis inclined to the plane of the earth's orbit. The following is an illustration of the effect:—Take a common terrestrial globe, with the pole inclined about seven degrees from the zenith, to represent the sun. Let it revolve, and a spectator then walk round it, keeping his eye in the plane of the wooden horizon, and the circles of latitude will alternately appear straight lines and curves, varying in their inclination, as seen from his different positions.

XIV. However glorious the appearance, vast the dimensions, and sublime the general vocation of the solar orb, balancing the planets in their spheres by the force of attraction, it is the detail of daily life that shows us the utility and importance of the luminary. The sun discloses the features of the landscape, and by the light and heat evolved the vegetation upon its surface is elaborated, furnishing a supply of food to man and beast. Ripe seeds have never been obtained from plants kept in darkness, and plants transferred to it from the open air become pale and blanched; from which it may be inferred that the presence of light is essential to the perfectability of the vegetable kingdom. By the solar influence, also, the aqueous particles are exhaled from the ocean, rivers, lakes, and moist earth, from which we have clouds and rain, and the winds are set in motion, preserving the atmosphere in a healthy state. Nor could any of the processes which now go on upon the earth, essential to the maintenance of animal life, be conducted without the action of the sun. Yet how it is that a body should keep up an indefinite generation of light and heat, supplying the planetary system bounteously with these elements, not, as far as we know, receiving any itself, is a problem which, in its present state, chemical science cannot solve.

The direct light of the sun has been estimated to be equal to that of 5570 candles of moderate size, placed at the distance of one foot from the object. It is 300,000 times greater than that of the moon.

Such is the power of the solar rays, that some of the men employed at the Plymouth Breakwater had their caps burnt in a diving-bell, 30 feet beneath the water, from sitting under the focal point of the convex glasses in the upper part of the machine.

XV. An interesting and, within the tropics, a very definite phenomenon accompanies the sun, called the zodiacal light, from its path lying obliquely in the zodiac. It is a kind of glow, or beam of light, somewhat analogous to a comet's tail, rounded at the vertex, with its base towards the sun, usually of a pure rose tint, through which the faintest stars are seen. In our climate it may be observed soon after sunset on a clear evening in March and April, and before sunrise in September and October; but never with that distinctness with which it appears in equatorial regions.

Keppler noticed the zodiacal light; Descartes regularly treated of it about the year 1530; but it did not attract much attention until described by the elder Cassini in 1683. Humboldt had several distinct views of it at Caraccas.

Some suppose the zodiacal light to be a solar atmosphere, or attributable to it, receiving its form, that of a long and narrow ellipse, only the half of which we see, from the rotation of the sun on its axis. Sir John Herschel conceives that it may be the denser part of that medium, which we have reason to believe resists the motion of comets, loaded perhaps with the tails of millions, which have been stripped of them in their approach to the sun. M. Arago is disposed to identify the phenomenon as the nebulous body producing the November meteors, or shooting stars, so commonly observed in that month.

XVI. Besides the proper motions mentioned as belonging to the sun, it has been supposed that the solar body has a progressive motion in space, by which it is advancing towards a point in the heavens in the constellation Hercules. This idea of the elder Herschel wants verification. Physical considerations, however, render it in the highest degree probable that the sun has such a motion in some direction or other. If so, it follows that all the planets, besides their movements of revolution and rotation, are accompanying the central luminary in a grand procession through space.

CHAPTER III.

MERCURY.

I. Mercury is the smallest planet in the system with the exception of the asteroids. Its diameter is estimated at 3140 miles. But it is the most compact celestial body with which we are acquainted, or has the greatest quantity of ponderable matter within the same limits.

The density of Mercury is concluded to be fourteen times that of water, or more than equal to that of lead. A ball of lead, therefore, 3140 miles in diameter, would not balance the orb if the two were placed in scales against each other. It would require twenty millions of such bodies in size to equal the sun in volume, but only two millions to equal him in weight.

II. The planet, as far as we know, is the nearest body to the sun; revolving round him at a mean distance of nearly 37,000,000 miles, accomplishing one revolution in a period of a little less than 88 days. This is the length of the year of Mercury, equal to about three of our months. If the seasons follow in the same proportion, they will each consist of only three of our weeks.

The planet has an extremely rapid motion in space, at the rate of more than 100,000 miles an hour. This originated the name, from the active messenger of the gods. On account, too, of this mobility, chemists adopt his symbol to denote quicksilver.

III. The period of the planet's rotation upon its axis is 24 hours, 5 minutes, and 28 seconds, which makes its day about ten minutes longer than ours.

IV. To Mercury the sun will occupy seven times more space in the heavens than he does to us, on account of his greater proximity, and the planet will receive seven times the amount of light and heat.

The presumed effect, as that of water constantly boiling at the surface, or any excessive temperature prevailing, need not follow. The solar influence may be modified by conditions of the planet adapted to that end. The icy tops of the Himalayas are nearer to the sun than the parched and burning plains of Hindûstan.

V. Owing to nestling near the sun, Mercury is usually lost in the solar blaze, and is never in a dark part of the heavens at the time of his greatest elongation.

The distance of a planet from the sun as seen from the earth, measured in degrees, is called its elongation. If at any time we draw a line from the earth to the sun, and another from the earth to Mercury, the two lines will never form a larger angle than 29°. This is Mercury's greatest elongation.

VI. Proximity to the sun, an excessively rapid rate of revolution, a peculiar quick scintillation, together with the smallness of the planet's mass, render it a very difficult object to catch and examine. It may be best seen about an hour and three-quarters before sunrise in autumn, and after sunset in spring, but very clear weather and a good eye are required.

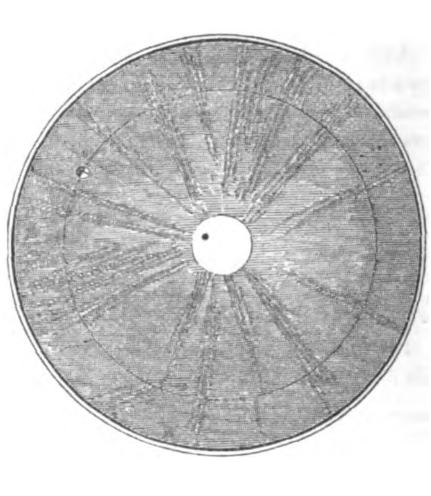
Copernicus never caught sight of Mercury; and Delambre only twice with the naked eye. It redounds, therefore, not a little to the credit of the ancients that they recognised this body as a planet, and so accurately described it. Cicero states, that "it is never further distant from the sun than the space of one sign, sometimes preceding, sometimes coming after him."

VII. Some astronomers attribute a dense atmosphere to Mercury, and irregularities of outline, supposed to indicate high mountains. But such conclusions are premature. A certain and interesting circumstance is the existence of phases, similar to those periodically exhibited by our moon, which satisfactorily proves that the planet does not shine by virtue of its own inherent light, but by light reflected from the sun.

When Mercury is most distant from the sun, his illuminated portion has nearly the form of a semicircle. When he is passing round on the opposite side of the sun to that at which the earth is situated, the bright portion becomes more than a semicircle, and assumes the form called gibbous.

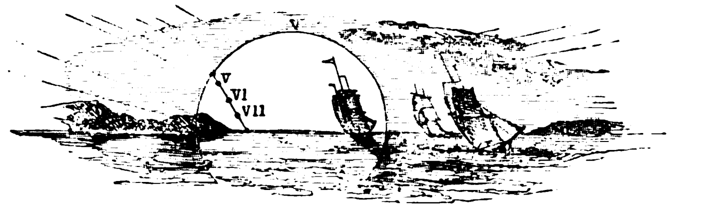
When he emerges from the sun he is again a semicircle, which gradually diminishes to a crescent as he proceeds in his orbit, and approaches the earth.

VIII. This evidence that the planet does not shine by inherent light, is corroborated by the opaque appearance presented during a transit over the solar disk, which also shows its spherical form.



IX. A transit occurs when Mercury is between the earth and the sun, on a straight line joining the centres of the two bodies. Passing between that orb of splendour and the earth, the planet appears upon the solar disk as a small, round, black speck to the eye of the observer. The illustration gives the appearance. The first-recorded transit was observed by Gassendi, Nov. 6, 1631, and the following have since occurred:—

1644, Nov. 6.	1697, Nov. 2.	1753, May 5.	1799, May 7.
1651, Nov. 2.	1707, May 5.	1756, Nov. 6.	1802, Nov. 8.
1661, May 3.	1710, Nov. 6.	1769, Nov. 9.	1815, Nov. 11.
1664, Nov. 4.	1723, Nov. 9.	1776, Nov. 2.	1822, Nov. 4.
1674, May 6.	1736, Nov. 10.	1782, Nov. 12.	1832, May 5
1677, Nov. 7.	1740, Nov. 2.	1786, May 3.	1835, Nov. 7.
1690, Nov. 9.	1743, Nov. 4.	1789, Nov. 5.	1845, May 8.



The annexed cut represents the last transit, which was visible in England under favourable circumstances. It marks the gradual advance of the planet over the disk of the sun, in the direction indicated, at V. VI. VII., P.M. The contact of the two bodies ceased at 9 minutes before 11, and was, of course, invisible in this country, the sun setting with Mercury as a speck upon his face. The remaining transits of the present century will be as follows:—

1848, Nov. 9.	1868, Nov. 4.	1881, Nov. 7.	1894, Nov. 10.
1861, Nov. 11.	1878, May 6.	1891, May 9.	

It will be observed that each of these recorded transits have occurred either in November or May, a circumstance which may be easily explained. Every three months Mercury accomplishes a revolution round the sun, comes between the sun and the earth, and would appear transiting the solar surface if his path coincided in its plane with that of the earth. But this is not the case. The planet's orbit is partly above and partly below that of the earth, cutting it at two opposite points. These points of intersection are called the ascending and descending nodes; and it is only when the planet is in one of them, and on a line passing through the centres of the earth and the sun, that a transit can take place. Mercury's ascending node is in the 16th degree of Taurus; the descending node is in the 16th degree of Scorpio; and as the earth passes these points in November and May, the transits of the planet occur, and must, for ages, in one of these months.

X. The calculation of a transit is obtained by finding such complete revolutions of Mercury and the earth as shall be to each other in the ratio of their periodical times, or as 87·969 days, the period of the former, is to 365·256, the period of the latter. By doing this, we have as the result:—

7 Periodical revolutions of the earth equal to 29 of Mercury.
13 Periodical revolutions of the earth equal to 54 of Mercury.
33 Periodical revolutions of the earth equal to 137 of Mercury.
46 Periodical revolutions of the earth equal to 191 of Mercury.

Hence transits of Mercury may occur at the same node after intervals of 7, 13, 33, 46, &c. years. Upon the same principle transits of Venus are calculated, and eclipses of the sun and moon, which are an identical class of phenomena.

CHAPTER IV.

VENUS.

I. Venus, the most brilliant star in the heavens, and the nearest planet to the earth, is rather smaller than our globe, having a diameter of 7700 miles.

II. She is the second member of the system in point of distance from the sun, revolving round him at a mean interval of 68,000,000 of miles, accomplishing a revolution in 224 days, 16 hours, and 49 minutes, moving at the rate of 80,000 miles an hour. Thus the year of the planet is equal to about 7½ of our months, or 32 weeks.

That the position of Venus is exterior to that of Mercury, is clearly proved by the fact that she sometimes eclipses him, an instance of which occurred May 17th, 1737. It is also shown by her wider departure from the sun, to the angular distance of 48°, as seen from the earth, rather more than half the space from the horizon to the zenith, and 19° farther than Mercury.

That the position of Venus is interior to that of the earth, appears from the phenomena of her transits, when she is seen upon the disk of the sun, and is consequently between him and us. This is also evidenced by the planet never being visible at midnight, and never seen rising in the east while the sun was setting in the west; or in other words, in opposition to the luminary, which would be the case if our globe occupied a place between the two.

III. Nearer to the sun than ourselves, Venus receives nearly double the proportion of light and heat, and has the solar disk in her heavens appearing nearly twice as large as it does to us.

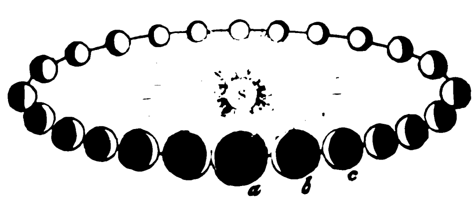
IV. Venus rotates upon her axis in 23 hours, 21 minutes, 7 seconds, which makes her day about 35 minutes shorter than ours.

The diurnal rotation was first ascertained by the elder Cassini, from observation of spots on the planet's face. He determined also the period within a minute of what it was afterwards established by Schroeter.

V. Alternately, Venus is a morning and evening star, remaining visible for about three hours after sunset, and as long before sunrise, at the time of her greatest elongations.

As a morning star the Greeks denominated the planet Phosphorus (light-bringer); and as "Lucifer, son of the morning," she is referred to by the prophet Isaiah. As an evening star she was styled Hesperus and Vesper. The ancients supposed these to be two distinct bodies. Pythagoras is said to have been the first to proclaim the contrary, a fact which, however obvious now, required sagacity and reflection to determine.

VI. The planet exhibits the various lunar phases as seen through a telescope, only that she never appears absolutely full; for when the whole of her enlightened side is towards us, in her superior conjunction, the solar rays interfere with her splendour. The diagram represents the appearance of Venus in her orbit moving in the direction of the letters *a*, *b*, *c*.



Soon after her inferior conjunction, when she passes between the earth and the sun, we behold Venus as a morning star, rising a little before the sun, exhibiting a fine silver crescent, an elegant telescopic object. She gradually gains upon the luminary, rises more and more before him, till her greatest angular distance westward is attained, when she appears a semicircle. Proceeding to her superior conjunction, she apparently returns to the sun, rises later and later, appears gibbous, and then nearly full. On the east of the sun Venus becomes an evening star, visible for a short time after his setting. Passing to her eastern elongation, she sets later every night, and her appearance is gradually reduced to a semicircle; after which, returning to the sun, she becomes a crescent, sets with him, and is invisible, the unenlightened half of the orb being towards us. In a few days the phenomena of the morning star are repeated.

Copernicus predicted the discovery of the phases of Venus, confident of the truth of his theory, of which these appearances are the necessary result. This observation was one of the first-fruits of the telescope in the hands of Galileo.

VII. Venus occupies about 290 days in passing from one conjunction to another, or appears to keep on the same side of the sun, and is a morning or evening star for that length of time. This seems an anomaly, as it is a longer period than she takes in accomplishing an entire circuit.

The fact is readily understood, when we consider that the earth is going round the sun at the same time with the planet, though at a slower pace. Venus accomplishes about 1° 36′ of angular motion per day; the earth about 59′; so that the planet gains upon the earth only at the rate of 37′ a day. But obviously both bodies will appear to keep on the same side of the sun, until Venus has gained half of her orbit in advance of the earth, or 180°, which will require about 290 days to effect. Thus 37, the difference of their daily rate, × 290 = 10730′ = 180° nearly.

VIII. The distance between Venus and our globe varies greatly. At her inferior conjunction, she is 26,000,000 of miles from the earth; but at her superior conjunction, upwards of 160,000,000 of miles. Hence her apparent diameter varies.

The apparent, or observed diameter of the planet, when nearest the earth, is 6⅓ times greater than when most remote, and the surface of her disk is nearly 41 times greater.

If Venus, when nearest the earth, presented her illuminated side entirely to us, she would shine like a small brilliant moon in the heavens. As it is, however, the planet has been observed to project a visible shadow in the night, and has often been seen by the naked eye in the day time during eclipses of the sun.

IX. Venus, like Mercury, transits the solar disk under the same conditions, and then appears denuded of her radiance, a small dark spot upon his face.

X. If the orbit of the planet lay exactly in the plane of that of the earth, she would be seen to pass centrally over the sun's disk, at every inferior conjunction. But one half of the orbit of Venus is 3½° above the path of the earth, and the other half as far below it. She passes then either a very little above or below the sun at her inferior conjunctions, except these occur when she is at one of her nodes, or the points where the two orbits intersect. This happens very rarely.

8	periodical revolutions	of the earth	are equal to	13	of Venus
235	"	"	"	382	"
243	"	"	"	395	"
251	"	"	"	408	"

consequently, a transit of Venus may happen at the same node after an interval of 8 years; but if it does not take place then, it cannot in less than 235 years.

The ascending node of Venus is at present in the 14th degree of Gemini; the descending node is in the 14th degree of Sagittarius; and as the earth is in the same longitude in December and June, transits only can occur in those months for many centuries to come.

The first transit of the planet ever known to have been seen by the human eye, was observed by our countryman Horrox, at an obscure village near Liverpool, on Sunday, December 4, 1639. Venus was then at her ascending node; and reckoning 235 years forwards, we have the date of the next transit at the same node, in December of the year 1874. After an interval of 8 years, another will occur at the same node, or in December, 1882. Reckoning forwards 235 and 8 years, we have the date of the two following transits at the same point, December 11, 2117, and December 8, 2125.

The second transit observed, when Venus was at her opposite or descending node, took place in June, 1761; and after an interval of 8 years, another took place at the same node, in June, 1769. Reckoning forwards intervals of 235 and 8 years, we have the time given for the next transits at the same point, June 8, 2004; June 6, 2012; June 11, 2247; and June 9, 2255.

The rarity of the phenomenon, and its importance in physical astronomy, as the best means for determining the distance and volume of the sun, upon which an exact knowledge of almost all the elements of the solar system depends, render a transit of Venus an event of extraordinary interest. Hence the different national expeditions despatched to various parts of the globe to observe the last in 1769, among which was that of Captain Cook to Otaheite. The next, in 1874, will excite more attention than any natural phenomenon that has yet marked the history of the globe.

XI. The phenomena of the seasons, which depend upon the inclination of the axis of a planet to the plane of its orbit, are peculiar in the case of Venus. Her axis seems inclined at least 75° to her orbit, and as the declination of the sun on each side of the equator is equal to the inclination of the axis, her tropics are only 15° from her poles, and her polar circles at the same distance from her equator. Owing to the sun changing his declination so much more at Venus than at the earth, she has never a vertical sun at the same place for two days in succession, and has seldom a forenoon and afternoon of equal length. The variation of her seasons is so frequent, that she has two winters summers, springs, and autumns, in each of her annual revolutions.

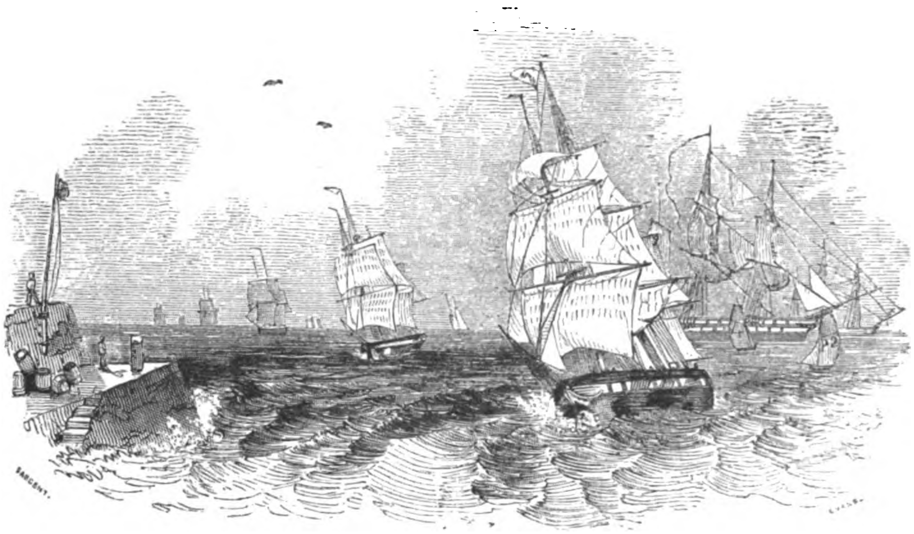
XII. Respecting the physical constitution of Venus, the matter of the planet is supposed to be somewhat denser than that of the earth. A considerable atmosphere is inferred from a penumbral light around the dark body of the planet during her transits, and from a faint radiance observed to stretch beyond her directly illuminated hemisphere. In the upper figure of the annexed cut, the dotted line marks the boundary of the direct light of the sun, beyond which, the projections show the twilight, caused by atmospheric reflection. Spots, variable and fleeting, as in the

B

second figure, have also been noticed, indicating an atmosphere charged with clouds and vapours. Superficial irregularities in the form of high mountains are attributed to Venus, on the ground of the edge of her enlightened part appearing shaded, her corners being sometimes obtuse, and presenting a luminous point apparently detached from the planet, as in the lower figure. Schroeter regarded this last as the summit of a vast mountain illuminated by the sun after he had ceased to be visible to the rest of that hemisphere.

Upon the whole, it may be deemed highly probable that Venus has mountains, but the estimates given of their elevation are very uncertain. According to Schroeter, who devoted ten years to the careful observation of this planet, they rise to the following enormous heights, 10, 11, 18, and 22 miles, or five times the height of the loftiest peaks of the Himalaya.

XIII. An attendant of Venus, or satellite, like our own moon, has been repeatedly affirmed to exist. The appearances which have led to this opinion are supposed by others to have been misconceived, as no satellite was seen with the planet on the sun's disk, at the carefully watched transits of 1761 and 1769. The point remains undecided.



CHAPTER V.

THE EARTH.

I. The earth, which, to the eye of its inhabitants, appears an immense plain, stretching out to an indefinite extent in all directions, is shown to be of a spherical form by a variety of circumstances appealing to our reason and our senses.

Observing from the sea-shore on a clear day a ship leaving it in any direction, it appears as if gradually sinking in the ocean, first the hull or body of the vessel disappearing, then the rigging, and then the top of the masts vanishing from sight. A passenger on board of the ship also, first observes the coast to sink below the horizon, then the buildings, and lastly the tall spires of the city he is leaving. Approaching the shore, the vessel, to an observer on land, seems as if gradually rising from the ocean, the masts and sails first appearing, and then the hull. These appearances arise from the convexity of the water between the eye and the object; for if the surface of the sea were a dead level, the largest objects would be visible the longest.

The terrestrial shadow on the moon during an eclipse is always of a circular shape, evidencing the globular form of the object projecting it.

Upon the heart of the ocean, or in the midst of an extensive plain, the boundary of vision is a well-defined circle, and this circular horizon is a certain indication of the circular figure of the body to which it relates.

Navigators proceeding in the same general direction, east or west, have arrived at the same point from whence they started. This enterprise, now so common, was first undertaken by Ferdinand Magellan, who sailed westerly from Seville, in Spain, August 10, 1519, passed the extremity of the South American continent, entered the Pacific, reached the Philippine islands, where he was killed in a skirmish, but one of his ships arrived at St. Lucar, near Seville, September 7, 1522.

Voyages of circumnavigation demonstrate the convexity of the earth, east or west, or that its form must be either globular or cylindrical. The convexity of the surface, north and south, is shown by the gradual declination and rise of the north and south circumpolar stars as the equator is approached and receded from, which proves the figure of the earth not to be that of a cylinder but of a sphere.

II. Though spherical, like the sister planets whose round disks are defined by the telescope, yet the earth is not a perfect sphere, a body whose circumference is everywhere at an equal distance from the centre. It is more convex within the tropics than towards the poles, the equatorial diameter being longer than the polar; so that its general shape is that of an oblate spheroid, a ball that bulges out in the middle and is flattened at the two opposite sides.

This proposition of Newton, the result alone of theory, has been amply confirmed by accurate measurements conducted by the most eminent mathematicians in various places, from the equator to the polar circle. He conceived that the velocity of the earth's daily rotation upon its axis being the greatest at the equator, the consequent greater action there of the centrifugal force would produce a bulging out of the surface in the equatorial regions, and a flattening at the poles. This is demonstrated by the fact, that the length of a degree, derived from the heavens or an arc of the meridian, increases with the latitude; being least near the equator, and greatest near the poles:

Places of Observation.	Latitude.	Length of a degree in Eng. miles.	Observers.
Peru	Equator	68·732 . . .	Bouguer.
United States .	39° 12′ 0″ . . .	68·896 . . .	Mason and Dixon.
Rome	42 59 0 . . .	68·998 . . .	Boscovich and Lemaire.
France . . .	44 50 0 . . .	69·054 . . .	Delambre and Mechain.
England . . .	51 29 44 . . .	69·146 . . .	Mudge.
Sweden . . .	66 20 10 . . .	69·292 . . .	Svanberg.

A degree of latitude is nine-sixteenths of a mile longer at the arctic circle than at the equator.

III. The diameter of the earth is ascertained by these measurements to be as follows:

	Feet.	Miles.
Equatorial, or greater diameter	= 41,847,426 =	7925·648
Polar, or lesser diameter	= 41,707,620 =	7899·170
Difference of diameters, or polar compression .	= 139,806 =	26·478

The mean diameter is, therefore, about 7912 miles. According to a determination of the French academy, the diameter is accurately 7912 miles, from the 45th degree of north latitude to the opposite degree of south latitude. It is considered very improbable that there can be any error in the above estimates to the extent of 5 miles. The equatorial circumference is a little less than 25,000 miles, accurately 24,899.

To illustrate the very trifling proportion which subsists between the inequalities of the earth's surface and its entire volume, we may suppose an artificial ball 18 inches in diameter to represent our globe, when the proper proportionate elevation to be assigned to its highest mountains would be $\frac{1}{80}$th of an inch.

IV. Two principal motions belong to our planet; one of rotation upon its axis, called its diurnal motion, producing the succession of day and night; and another of progression in space, or revolution round the sun, called its annual motion, causing the vicissitude of the seasons. Both these motions are to be understood of the whole earth, its interior substance, its superficial masses of land and water, the surrounding atmosphere, and the clouds in suspension in it; and both motions are in the same direction from west to east.

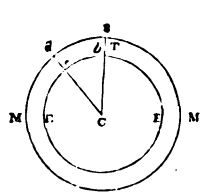
V. The exact time occupied by the diurnal rotation is 23 hours, 56 minutes, and 4·09 seconds. This forms a sidereal day; so called, because in that time the stars appear to complete one revolution round the earth. A star which is on the meridian of a place at a given period, will be on the meridian again after that interval. But as while the earth rotates upon its axis it is moving in its orbit round the sun, it will require 24 hours upon an average through the year, for the sun to pass from the meridian of a place to the same meridian again. This forms a solar day, longer than a sidereal; and consequently, in the course of the earth's annual revolution round the sun, while we have 365 of the former we have 366 of the latter, or that number of complete rotations of the earth upon its axis. Hence the well-known fact, that, in travelling round the globe, a person finds, on arriving at the point whence he set out, that he has gained or lost a day in his reckoning of time, according as he has travelled east or west, as compared with the reckoning of those who have remained at rest.

The earth's motion upon its axis is perfectly uniform and equable. Sidereal days, therefore, are always of the same length, every rotation being accomplished in the same time; but the motion of our planet in its orbit being unequal, sometimes faster, sometimes slower, solar days vary in length at different times of the year. Hence the hour shown by a well-regulated clock and a true sun-dial is scarcely ever the same; the difference between them, sometimes amounting to 16¼ minutes, being called the equation of time. About the 21st of December, the solar day is half a minute longer, and about the 21st of September nearly as much shorter than 24 hours; which is an average of all the solar days throughout the year.

The rotation of the earth upon its axis is not susceptible of ocular evidence like that which the observation of spots upon the sun, and some of the planets, affords of the same fact in relation to those bodies. Nevertheless, the truth of the doctrine is established by various considerations.

Either the globe revolves upon an axis every 24 hours, or the whole universe, including the sun, moon, comets, and fixed stars, accomplishes a revolution round the earth in the same time. No third opinion upon the subject can possibly be held. In the latter case it is evident, from the distance of the celestial bodies, that their diurnal revolution around our planet must involve a rate of motion that is utterly inconceivable. The sun must travel at the rate of 400,000 miles a minute, the nearer stars with the velocity of upwards of 1,000,000,000 of miles a second, and the more distant with a rapidity which no numbers can express. It is absurd to suppose this, when the end to be gained requires only our little globe to revolve upon itself.

But something like demonstrative proof of the fact may be adduced. If the earth rotates, the summit of a high tower, having a larger circle of rotation to describe in the same time than the base, must obviously move with greater rapidity; a stone, therefore, dropped from the summit, leaving it with the greater momentum, will move faster through the whole of its descent than the base, and reach the ground a little in advance, or easterly, of the foot of the perpendicular, the direction of the earth's rotation. Owing to the small height of buildings suitable for the purpose, this is a very difficult matter to test; but experiments have been conducted with this result, in 1804, in St. Michael's Tower, at Hamburg, and, in 1805, in a coal-pit at Schlebusch, in the county of Mark. Let the circle E be the equatorial circumference of the earth, the line T a tower perpendicular to c the centre, the circle M will then be the circumference described by the summit of the tower s, in the course of one rotation of the earth upon its axis. If we suppose the base of the tower *b* to pass to *c*, the summit s will in the same time pass to *a*, and this being the larger arc., it follows that the summit must travel faster than the base. If then the earth rotates eastward, a ball dropped from the summit will leave it with its momentum, and move faster eastward through the whole of its descent than the base. The result will be that it will deviate a little from the plumb-line, and fall a little to the east of *c*.



Again: a pendulum of a given length, which makes 86,535 vibrations in a day at London, will make only 86,400 in the same time if transported to the equator. This shows that the force of gravity which produces its oscillations must be least where the movement is the slowest, or less at the equator than at London. Now assuming the earth's rotation, its equatorial regions, where the circle of the circumference is the greatest, must revolve with greater velocity than those which are situated towards the poles; consequently, the tendency to fly off from the centre is greater there, which proportionably neutralises the force of gravity and accounts for the unequal action of the pendulum.

At the equator, the rate of the rotation is about 1042 miles an hour, or 17 miles a minute; at 30° of north latitude it is 14 miles a minute; at 45°, or about the centre of France, it is 11.

VI. The annual motion of the earth, or its orbital movement round the sun, occupies a period of 365 days, 5 hours, 48 minutes, 49·7 seconds. This forms the solar year, or the period which the sun appears to take, through the actual procession of our planet, in passing from a particular point of the ecliptic, say the first point of Aries, where the ecliptic and the equator intersect, to the same point again. It is also called the tropical year, because the interval occupied by the sun in visiting the tropics and returning to the equator. The sidereal year, or the space of time which the sun takes in apparently passing from any fixed star till it returns to it again, is 365 days, 6 hours, 9 minutes, 9·7 seconds; rather more than 20 minutes longer than the tropical year, which is due to a slow annual displacement of the equinoctial points.

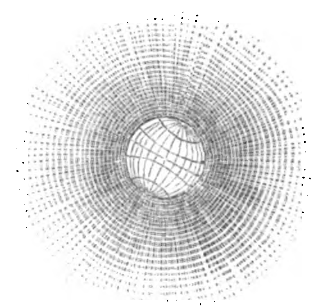
As the mean distance of the earth from the sun is 95,000,000 of miles, the diameter of the orbit is 190,000,000 of miles, and its linear extent near 600,000,000 of miles. This enormous distance is traversed at the rate of 68,000 miles an hour, or 19 miles in a second. This is the mean velocity for the year: but in January the earth travels at the rate of 69,600 miles an hour; which is more than 3000 miles an hour its rate of motion in July, when it is only 66,400 miles an hour. This results from the second law of Keppler.

Hipparchus, two thousand years ago, was the first who closely approximated to the true length of the solar or tropical year. His determination of 365 days, 5 hours, 55 minutes, 12 seconds, exhibits a value but slightly in excess of the truth.

The earth's motion of translation in space, like that of its rotation, is imperceptible by us, resembling that we experience in calmly floating down a stream, when surrounding stationary objects appear to be in movement, and our senses are lulled into complete forgetfulness of our own progression. It appeals not to the eye, as in the case of the other planets, which are seen to be constantly changing their place; but besides the evidence of strong probability in its favour, it has received sensible confirmation from the discovery of the aberration of the stars.

VII. In its annual revolution round the sun, the axis of the earth, inclined 23½° from a line perpendicular to the plane of the orbit, maintains invariably the same position, causing the phenomena of the seasons.

VIII. An atmosphere, the region of the winds, lightning, and meteoric corruscations, upon which respiring beings depend for vitality, surrounds our globe, and is one of its most important attributes; chiefly interesting to the astronomer, on account of its effect in displaying to us the heavenly bodies and diffusing the rays of light in every direction around us. The extent of this wonderful and benign envelope is not precisely known; but its density diminishes as we ascend from the surface, and, at a very inconsiderable elevation, it becomes so rare as to interfere with the functions of existence. The diagram represents the engirdling atmosphere of our planet, various strata of air resting upon it, the upper pressing upon the lower, and causing the interior to be more dense than the exterior strata.



IX. The density of the earth is $4\frac{9}{10}$ that of water, so that our globe would counterpoise $4\frac{9}{10}$ globes, of the same size, composed of materials of the same specific gravity as water. Yet, abandoned to the solar attraction, it would require 64 days, 13 hours, to fall upon the sun.

X. The varying intensity of the force of gravity at the surface of the earth, as shown by the unequal action of the pendulum, which vibrates slower at the equator than in other places, is as 1 at the equator to $1\frac{1}{194}$ at the poles. A body, therefore, weighing 194 pounds at the equator, would weigh 195 pounds at the north-pole.

XI. The place of the earth in the system is a favoured one, where nearly all the planets are visible to the naked eye. While they appear in our heavens, Jupiter, Venus, and occasionally Mars, shining with great splendour, our planet returns the compliment, exhibiting to Venus, at the time of her inferior conjunction, when she is nearest to us, a full orb resplendent through her whole night.

CHAPTER VI.

THE MOON.

I. Next to the sun, the moon is the most remarkable and important of the heavenly bodies to the inhabitants of the earth, and with this unfailing attendant of our globe, the scheme of satellites in the system appears to commence.

With the exception of Mars and the Asteroids, the planets exterior to the earth have secondary bodies, or moons, attached to them, compensating for that diminution of direct solar light which arises from their vast distance from its source. The number of these bodies appears to be proportioned to the wants of their primaries. Jupiter, at five times the earth's distance from the sun, has four; Saturn, at ten times the distance, has seven; and Uranus, at nearly twice the distance of Saturn, has five or six discovered, and may have a numerous train invisible to us, through the immensity of the interval. Peculiar unknown circumstances may account for the exceptive case of Mars. That of the asteroids may be excluded from notice, their whole character being anomalous. Apart from these cases, the law of satellites, commencing with the earth, applies to the rest of the system exterior to it.

II. The diameter of the moon is only 2160 miles. Her mean distance from the earth is under 238,000 miles,—through which she would fall in 4 days and about 20 hours, if surrendered to the force of terrestrial attraction.

The surface of the satellite is $\frac{1}{13}$ that of the earth, and her volume $\frac{1}{49}$, and $\frac{1}{70000000}$ that of the sun.

The distance of the moon from the earth is about $\frac{1}{400}$ that of the sun. It is owing to this proximity that the small lunar orb is so conspicuous in our heavens. An astronomer at the sun would never see it apart from the earth by an angle greater than 10′. The following are singular coincidences:

	Miles.	
Diameter of the moon .	2,160 × 110 =	237,600 average mean distance from the earth.
Diameter of the sun . .	870,320 × 110 =	95,735,200 average mean distance from the earth.
Diameter of the earth .	7,912 × 110 =	870,320 estimated diameter of the sun.

III. Besides accompanying the earth in an annual revolution round the sun, the moon revolves round the earth in an elliptical orbit from west to east.

This motion is very observable. Notice the moon's place with reference to a neighbouring star on any clear night, to the westward of her. The next night she will have increased her distance by about 13° to the east; and so on every night, until from an opposite quarter of the heavens she approaches the star again, having completed one of her revolutions round the earth.

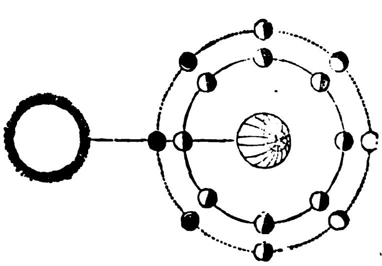
IV. The moon moves in her orbit round the earth at the rate of about 2290 miles an hour, and accomplishes the journey in 27 days, 7 hours, 43 minutes, 11 seconds. This is called her periodic or sidereal revolution, because in that period she completes her circuit, and returns to the same place in relation to the stars. But the time included between one new moon and another, is 29 days, 12 hours, 44 minutes, 2 seconds. This is called a synodic revolution, because the interval occupied by the moon in returning again to the same position with respect to the sun and the earth.

The time between one phase of the moon and the same phase again, or a synodic revolution, is longer than one complete orbital course, because, during the lunar tour, the earth is advancing all the while in the same direction in its orbit, so that the extra 2½ days are required by the moon to fetch up the progress made by the earth, and return to the same conjunction with it and the sun.

The moon performs near 13 revolutions round the earth, during one revolution of the earth round the sun.

The famous Metonic cycle, called after the discoverer, Meton, an Athenian mathematician, adopted by the Greeks in the year B.C. 432, closely approximated lunar and solar periods. It consisted of 6940 days, supposed to be equal to 19 solar years, and 235 lunations; which is the case within a few hours.

V. The varying appearances or phases of the moon in the course of a lunation have been viewed with admiration by mankind in all ages, and have furnished uncultivated nations with an obvious standard in the measurement of time. They result from the revolution of the moon round the earth, and prove that she does not shine by any light of her own; for in that case, being globular, the satellite would always appear a round full orb like the sun.



The diagram exhibits the lunar phases; the earth the central body; the moon along the inner circle in eight different parts of her orbit, receiving the light of the sun; the outer circle showing the appearances presented to a spectator on the earth in each station of the lunar globe.

When between the earth and the sun, or in conjunction, the moon is lost to view, her dark side being turned towards us. It is then new moon. Advancing in her orbit, she alternately appears a crescent, a semicircle, and full; after which the same phases are exhibited in inverse order, till she returns to conjunction, and is again invisible. The plate, "The Phases and Movements of the Moon," represents these changes of aspect upon a large scale, with the requisite explanations.

The two points of the lunar orbit where the moon is new and full, or in conjunction and opposition to the sun, are named syzygies—a compound of two Greek words, signifying yoked together; the two intermediate points are called quadratures, being the first and last quarters; the four other points are the first, second, third, and last octants, each marking an advance of 45°, one-eighth of the orbit.

The lunar crescent has its convex side towards the sun, but the direction of the crescent changes, that of the waning moon being towards the east, and the new moon towards the west. The two extremities of the crescent are called horns, or cusps, (*cuspis*, a point.) When the moon is a crescent to us, the earth is about full to her, and consequently reflects the greatest amount of light to the lunar surface. This, under favourable circumstances, has the effect of rendering the dark part of the satellite feebly visible. Hence the popular remark, of the new moon appearing with the old one in her arms.

VI. The orbit of the moon is inclined to that of the earth, or the ecliptic, at an angle of about 5°. In consequence of a revolution round our globe while accompanying it round the sun, the lunar path is exceedingly involved and irregular, consisting of a series of peculiar curves, always concave towards the sun, termed epicycloids, or circles rolling upon the circumference of another, like the wheel of a carriage upon a convex road. Fig. 3. Plate, "Phases and Movements of the Moon."

VII. Besides an orbital course, the moon rotates on an axis exactly in the time that she performs her revolution around the earth. If this were not the case, every part of the lunar surface would be presented to the view of the inhabitants of our world in the course of a synodical revolution; but the same side of the satellite, or very nearly so, is constantly turned to the earth, owing to her rotation coinciding in its time with that of revolution. The same law applies to the satellites of Jupiter.

Suppose a person to walk in a circle round a tree, keeping his face turned towards it, he will see completely round the horizon in the circuit, and must of course turn round upon himself.

It follows from the coincidence of the moon's period of rotation and revolution, that to one half of the lunar world the earth is never visible.

It follows also, that the moon rotating in nearly 30 days, has the presence of the sun for near 15 days successively, alternating with the same period of absence, or a day and night, each of that length. But the night of the two lunar hemispheres is widely different. That part of the moon which is always turned from us, is then left to the feeble illumination of the stars, while the side always turned towards us, has, in the absence of the sun, our own globe, as an orb of extraordinary splendour, appearing 13 times larger than the moon to ourselves. Thus, while to one of the lunar hemispheres there is alternately a fortnight's light and a fortnight's darkness, to the other there is a fortnight's solar illumination alternately with the same period of earth-light.

Judging from analogy, the consequences of near 15 days of continuous exposure to the solar influence, and the same interval of continuous deprivation, will be winter and summer of the fiercest description once a month.

VIII. The differences are slight as to the lunar surface presented to us, so as not to affect the statement as a general truth, that the same side of the moon is always turned to us. Small portions of disk on the eastern and western, the northern and southern edges, appear and disappear, as if the orb actually oscillated in space. These are termed librations (*libra*, a balance), the former being in latitude, and the latter in longitude.

The librations are caused by the moon's orbital motion being irregular, alternately accelerated and retarded, while that on her axis is uniform; the effect of which is, alternately to extend a little and diminish the sides of the exhibited surface

IX. The moon appears either to have no atmosphere at all, or one so extremely rare and small, as to be incompatible, according to our apprehensions, with any form of organised existence.

This is inferred from the equable brightness of the disk, and from the planets, when being occulted, passed over and hidden by the moon, suffering no diminution of light and distortion of figure, just before occultation, as the effect of being seen through the lunar atmosphere. Therefore common terrestrial phenomena, thunder and lightning, rain, hail, and snow, seas and lakes, or water at all, it is difficult to conceive of, in relation to the lunar globe as at present constituted.

X. To the naked eye, large and variously-shaded patches appear upon the lunar face, and when viewed through a telescope, the surface of the orb presents a wonderful and interesting aspect, not only diversified, but excessively torn and rugged. Looking at the crescent moon, the boundary of the light and dark parts is a line notched and broken, (as in the cut,) indicating an unevenness of surface. Small shining points appear in the dark part, which are gradually joined to the illuminated portion as the moon waxes; plainly lofty peaks and summits catching the sun's rays before the lower adjacent regions. Elevated ridges of various shape are distinctly observable, casting shadows in a direction opposite to that of the sun, and these shadows are seen to shorten as the sun's light becomes more direct. Mountain scenery, plains, chasms, and enormous depressions, belong as truly to the satellite as to the earth; but the irregularities seem to be of a wilder character, the mountains are more precipitous, and have some peculiar and unique features.

Selenography (a description of the moon) has been attentively studied in modern times, and we have now large and accurate maps of the moon's visible hemisphere. In the Selenographic map the lunar surface is carefully delineated. The names of prominent appearances are given, now generally adopted from Hevelius and Riccioli. The principal peculiarities may be ranged in the following groups:

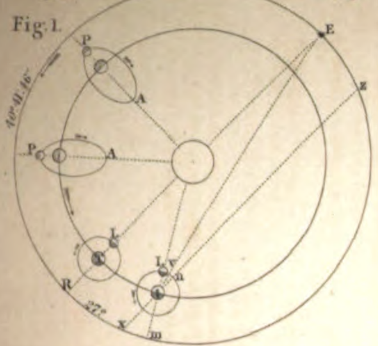
Large irregular tracts appear in some parts, dusky and dark in appearance, but in others luminous, and variously shaded. These were formerly supposed to be seas, from water reflecting less light than land. Hence their names, *Mare Tranquillatis*, *Mare Imbrium*, *Oceanus Procellarum*, &c., which are still retained, though there is probably no fluid akin to water upon the lunar surface. (Map. Division i. ii.) The tracts in question seem to be vast flat regions, variously depressed below the general level, containing enormous cavities similar to what our ocean beds would exhibit, upon the dissipation of their waters.

Isolated mountains, of a conical or sugar-loaf form, springing out of plains, are not uncommon. Of these, Pico, is one of the best examples. (Map. Division ii. 46.) It attains an estimated elevation of 7,000 feet, and has a more abrupt ascent than any

PHASES AND MOVEMENTS OF THE MOON.

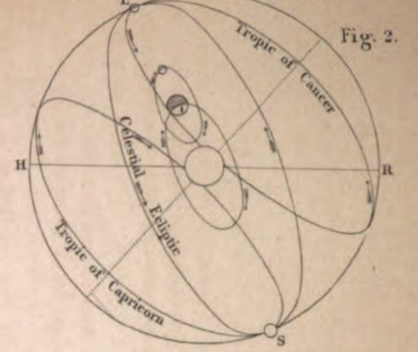
TIME OF THE MOON'S REVOLUTIONS

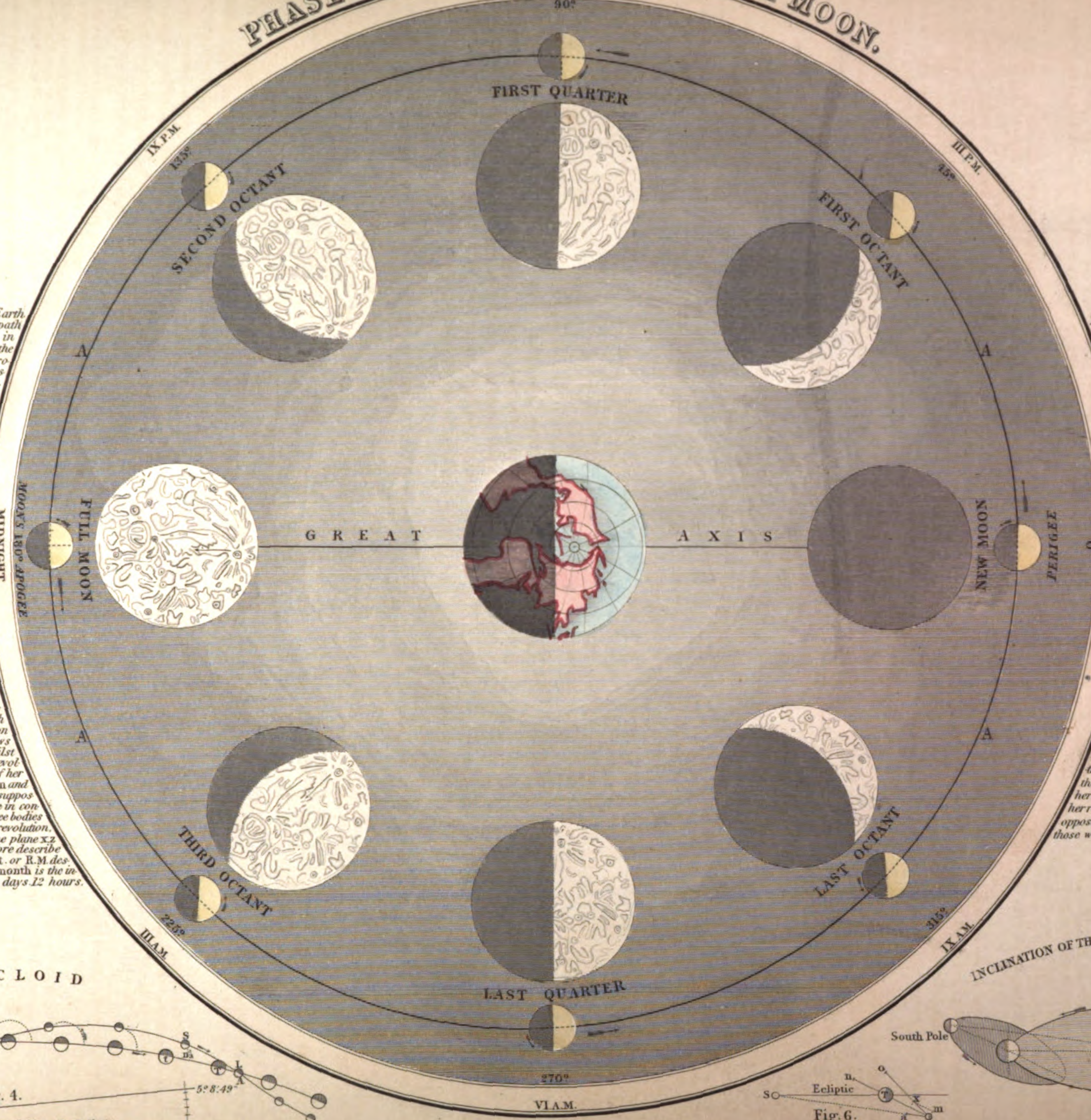
Fig. 1.



DIURNAL MOTION OF THE MOON

Fig. 2.





The central figure represents the Moons phases around the Earth placed in the centre. the elliptical line A.A.A.A. indicates the path of the Moon revolving from west to east. at eight points in her orbit. The Moon is shown of her exact relative size to the Earth. her distance is however about ten times greater in proportion within the lunar orbit the Moons phases are represented on an enlarged disk in order to show the principal spots. The Moon is the satellite of the Earth. that is. whilst the Earth performs its annual revolution round the Sun. the Moon accompanies the Earth revolving also around it. The Moon's orbit is an ellipse the Earth occupying one of the foci. its excentricity is about 4730 leagues. the mean distance being about 86000 leagues. From the figure of her orbit the Moon is sometimes nearer than at others: the point at which she is nearest is called - Perigee (fig. 1. P.) that at which she is farthest - Apogee (fig. 1. A.) The Perigee and Apogee advance every year about 40° 41'. 46" from west to east. The plane of the lunar orbit makes an angle of 5° 8'. 49" with the ecliptic (fig. 4.) The planes of the two orbits are cut by a line passing through the centre of the Earth. the two points where this line meets the Moons orbit are the Nodes, - one. the ascending node. when the Moon rises above the ecliptic towards the north the other. the descending node. when she sinks below it towards the south. (see fig. 5.) The nodes advance every year about 19° 20'. 29" in an opposite direction to her orbicular motion. Let the Moon (L. fig. 6.) be at a point of her orbit L.n. below the ecliptic. advancing towards her ascending node. the Suns attraction will be in the direction L.S. the intensity of this force being represented by the line L.a. it may be decomposed into two forces - one. L.T. towards the centre of the Earth. the other. L.m. towards the plane of the ecliptic. the action of these two forces would give the Moon an intermediate direction. L.x.o. and cause her to cross sooner the plane of the ecliptic. The arc described above the horizon by the Moon in summer appears much smaller than that described by her in winter: it is thus explained - on the night of the winter solstice (21st or 22nd December) the Earth T. fig. 2. sees the Sun at S. on the tropic of Capricorn & the Moon at L. on the tropic of Cancer. the line of our horizon H.R. shows that the arc described above it by the Sun is very small. whilst that described by the Moon is very extended. One complete revolution of the Moon round the Earth. that is. from one point of her orbit to the same point again. is called a Periodical revolution and is performed in 27 days. 7 hours. 43 minutes. 4½ seconds. Now supposing the Moon L. fig. 1. at the beginning of her revolution. to be in conjunction i.e. between the Sun and the Earth. & that these three bodies and a star E. are on the same line R.E. - at the end of her revolution. the Earth having advanced in its orbit. she will be at n in the plane x.z parallel to R.E. to be again in conjunction she must therefore describe on the arc n. L. a number of degrees equal to the arc T. t. or R.M. described by the Earth. The Synodical revolution or Lunar month is the interval from one conjunction to another. a period of 29 days. 12 hours. 44 minutes. 3 seconds.

The Moon revolving round the Earth and accompanying it in its annual revolution round the Sun. describes a peculiar curve in the heavens termed an Epicycloid. This curve is formed of 12 arcs and one third nearly. fig. 3. A.C. Let the Earth. T. advance an 8th part of 30 degrees to t. the Moon which was at first at L. will have described round the Earth the arc n. S. or. an 8th part of a lunation. & at the same time accompanying the Earth in its progress. will have traced in the heavens the portion of the Epicycloid L.S. It is by a combination of the movements previously noticed that the Moon's phases or. the various aspects under which she is seen from the Earth are caused. The central figure illustrates these changes of the Moons appearance - thus. when in conjunction. i.e. between the Sun and the Earth. she is not visible because her dark side is turned towards us and she reaches the meridian at noon. it is then New Moon. rather less than four days after. the Moon which has reached the meridian ¾ of an hour later each day. is perceived as a slender crescent with its points towards the east. she is then 45° distant from the point of conjunction. at her first Octant when only a fourth part of her illuminated surface is seen from the Earth as marked at m.o. she then reaches the meridian at 3 o'clock in the afternoon. Arrived at 90° the point of conjunction. half of her disk is visible. she is then said to be in her first quarter & reaches the meridian at 6 in the evening. At 135° is her second Octant when ¾ of her disk are visible. she then reaches the meridian at 9 in the evening. At 180° from the first point in her orbit. she will be again on the same line. in opposition with the Sun. & will present to the Earth the whole of her illuminated disk: reaching the meridian at midnight it is then full Moon. Passing from this point in her orbit the Moon begins to wane & three or four days after at 225° is in her third Octant. reaching the meridian at 3 in the morning & turning towards the Earth ¾ of her disk as in her second Octant. thus exhibiting in her decline appearances analogous to those in the earlier part of her revolution. The two points in the Moon's orbit where she is in opposition or in conjunction with the Sun are named - Syzygies. and those where she is in her first and last quarters - Quadratures.

LUNAR EPICYCLOID

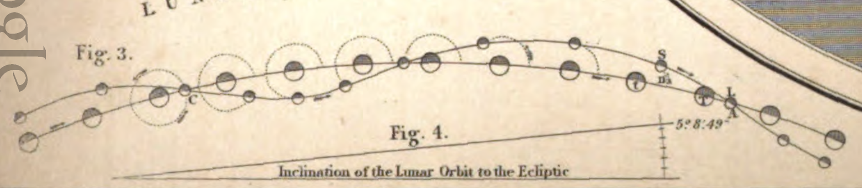


Fig. 3.

Fig. 4.

Inclination of the Lunar Orbit to the Ecliptic

INCLINATION OF THE ORBIT. ECLIPSES. MOVEMENT OF THE NODES &c.

Fig. 5.

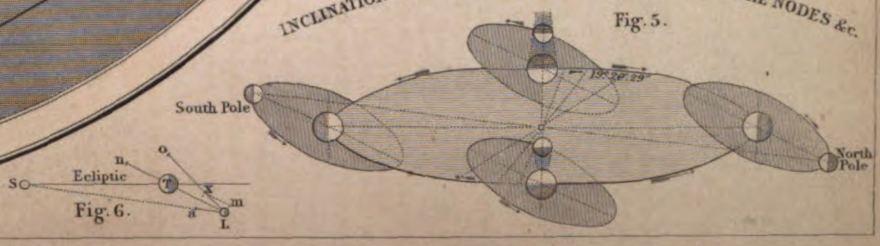


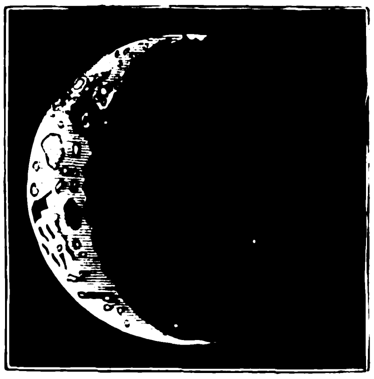
Fig. 6.

Drawn & Engraved by J. Dower. Pentonville. London.

analogous rock on the earth, such as the Peter Botte mountain in the Mauritius, or Mount Egmont in New Zealand.

Chains of mountains, sloping on one side and precipitous on the other, a feature belonging to all the grand terrestrial chains, are not wanting in the lunar world. Some of these appear on the rim of the moon, but the most distinct ridge is the Apennines, on the north of the *Mare Imbrium*. (Map. Div. ii.) The chain extends from north-east to south-west, and presents peaks, estimated from their shadows to rise to the height of 20,000 feet.

Circular or crateriform mountains are the most common and extraordinary objects of the lunar globe. They occur in the form of huge ring fences, encircling plains which vary in diameter from 40 to 120 miles, from which rises a conical central hill. The earth has no analogous annular ranges. They occur also more numerously upon a smaller scale, occupying nearly two-fifths of the moon's visible surface, and displaying a true type of volcanic craters. The most imposing specimens are Plato, Copernicus, Aristarchus, Keppler, and Tycho. (Map. Div. ii. 54, 12, 32, 13; iii. 35.) Streaky radiations of light appear issuing from the craters, and extending over large spaces, as if the highly illuminated summits of ridges were composed of successive depositions of ejected matter.



Aristarchus has been thought to be a volcano in action at the present era. Herschel saw luminosities on the dark body of the new moon, at or near the centre of this spot. They were intense enough to be seen with the naked eye in 1794. Cassini, Captain Kater, and Captain Smyth, have noticed the same appearance in the same region. The cut represents the object as seen by the latter, December 22, 1835, resembling a star far within the unenlightened disk of the moon. During the eclipse of the sun in July, 1842, a scintillation, or fiery protuberance, was observed on the edge of the moon's black disk, which vanished before the eclipse was over. We may not be warranted to deem these appearances instances of volcanic explosion, but the proof is indubitable of the surface of the moon having been disturbed in the past by volcanic action.

Dr. Scoresby thus describes the appearance of the moon as seen in the great telescope of Lord Rosse:—"It appeared like a globe of molten silver, and every object of the extent of a hundred yards was quite visible. Edifices, therefore, of the size of York Minster, or even of the ruins of Whitby Abbey, might be easily perceived, if they had existed. But there was no appearance of anything of that nature; neither was there any indication of the existence of water or of an atmosphere. There was a vast number of extinct volcanoes, several miles in breadth; through one of them there was a line in continuance of one, about 150 miles in length, which ran in a straight direction like a railway. The general appearance, however, was like one vast ruin of nature; and many of the pieces of rock, driven out of the volcanoes, appeared to be laid at various distances."

XI. The lunar light is considered to be 300,000 times weaker than that of the sun, and as far as experiment has gone, its rays, collected by the aid of powerful glasses, when the moon was full, and on the meridian, have produced no effect whatever upon the most delicate thermometers.

CHAPTER VII.

MARS.

I. Mars is the first planet whose orbit is exterior to that of the earth, being at the mean distance of 142,000,000 of miles from the sun.

The exterior position of Mars in relation to our globe is clearly shown by his never appearing horned like Mercury and Venus, never having been known to transit the sun's disk, and sometimes being in direct opposition to the sun, coming to the meridian at midnight, or rising when the sun sets, and setting when the sun rises.

II. The distance between the orbits of the Earth and Mars is thus somewhat less than 50,000,000 of miles, but the actual space between the two bodies varies prodigiously.

When Mars has the earth directly between him and the sun, he is nearest to us, or at the distance just named; but when the planet and the earth are on opposite sides of the sun, his distance is increased by the whole diameter of the earth's orbit, and the space of 240,000,000 of miles is between them.

Hence the diameter of Mars, as seen from the earth, varies from 4″ to 18″, according as he is more or less remote, and his brightness also, sometimes rivalling that of Jupiter, at other times presenting a faint hazy appearance. Baron Zach states, that in August, 1719, the planet being nearest the earth, and in perihelion, or nearest the sun, its splendour was so great as to alarm the popular mind, being mistaken for a new object in the skies.

III. Mars revolves round the sun in 686 days, 23½ hours, the length of his year, nearly equal to two of ours. His period of rotation is 24 hours, 39 minutes, 21 seconds; and consequently he has very nearly the same intervals of day and night as we have. His axis is inclined to the plane of his orbit, at an angle of about 30¼°; and hence his seasons must be very similar to those of the earth.

The rate of the annual revolution is about 54,000 miles an hour. The planet appears to accomplish about half a degree per day, passing through one sign of the zodiac in rather less than 60 days. Were his course stopped, he would fall to the sun in 121 days, 10 hours.

IV. The true diameter of Mars is computed at 4100 miles; rather more than half that of the earth. His form is spheroidal, having a greater degree of oblateness than our own globe.

Sir W. Herschel determined the polar diameter to be one-sixteenth less than the equatorial. There is the difference of 26 miles in the length of the polar and equatorial diameters of the earth, and 240 miles in the case of Mars.

V. The planet has been long known in the heavens by a ruddy appearance; and hence its name, derived from the heathen god, presiding over war and bloodshed. The red colour of Mars is attributed by some to a very dense and extensive atmosphere, similar to our own in the yellow and red rays of light penetrating it more easily than the blue and violet. Others, as Sir John Herschel, consider the effect to be due to the geology of the planet; its general soil being thus coloured, like the red sandstone districts of the earth, but more decidedly.

The aspect of Mars presented a different appearance in the course of the year, 1845. Instead of the fiery hue, observed from time immemorial, the planet lost all trace of redness, and put on a decidedly white aspect, with the exception of a moderately broad equatorial belt, vying with Jupiter in brightness and apparent magnitude. This novel appearance seems to point to atmospheric changes.

VI. Examined through a telescope, Mars exhibits a variety of spots, some of which are fluctuating as though cloud-land, while others are permanent, and appear to be seas and continents, their geographical lines of demarcation being often beautifully distinct. The annexed view of the planet was taken by Sir John Herschel, at Slough, August 16, 1830. The dark parts are seas, which were of a greenish hue, resembling the colour of our own. A luminous zone at the pole is supposed to be produced by the reflection of the sun's light from frozen regions. It changes in luminosity and magnitude with the summer and winter seasons of the planet, and alternately appears and vanishes at the other pole. It is least after long exposure to the sun, and greatest when just emerging from the long night of the polar winter.

VII. Of all the planets, Mars exhibits the most points of accordance with the earth, and has been not unaptly styled our "celestial cousin-german." Both have nearly equal intervals of day and night, and the same succession of seasons, though of different length. Both have atmospheres, seas, continents, and polar ice and snow. But Mars has no lunar attendant as yet discovered, and consequently the ocean there is nearly tideless. To his inhabitants our globe will appear a beautiful object at night, and exhibit, under sufficient instrumental power, an appearance of which the cut gives a rough representation at one stage of its rotation.

CHAPTER VIII.

THE ASTEROIDS.

I. The present century opened with the discovery of four small planets, Vesta, Juno, Ceres, and Pallas, situate between Mars and Jupiter, called asteroids, (the appearance of stars,) because of their stellar aspect under telescopic examination.

The order of their discovery, with the names of their discoverers, is as follows:

Ceres . . . January 1, 1801, by M. Piazzi, of Palermo, in Sicily.
Pallas . . . March 28, 1802, by M. Olbers, of Bremen, in Saxony.
Juno . . . September 2, 1804, by M. Harding, of Lilienthal, in Hanover.
Vesta . . . March 29, 1807, by M. Olbers, of Bremen.

These bodies are sometimes styled planetoids, as more expressive of their character, and extra-zodiacal planets, because their orbits are not confined within the zodiac like those of other planets. They are exclusively telescopic objects, and require the very best instruments to be caught, with the exception of Vesta, which, under favourable circumstances, has been seen by the naked eye.

II. Vesta, the first of the group, following the order of succession in the system, is at the mean distance of 225,000,000 of miles from the sun, and performs a revolution in 1325 days, somewhat more than $3\frac{1}{2}$ years.

The planet is much brighter than its compeers, and appears like a star of the fourth or fifth magnitude.

III. Juno is at the mean distance of 254,000,000 of miles, and accomplishes an orbital revolution in 4 years, 128 days.

Juno has a very eccentric orbit, varying in her distance from the sun to the extent of 130,000,000 of miles. This eccentricity has a remarkable effect upon her motion, for she goes through that half of her orbit which is nearest the sun, in nearly half the time that she travels through the remainder. The planet has a reddish colour, and appears like a star of the eighth magnitude.

IV. Ceres, the next in order, revolves about the sun in about $4\frac{3}{5}$ years, at the mean distance of 263,000,000 of miles.

The telescope reveals Ceres as a ruddy star of the eighth magnitude, under circumstances which leave the impression of an extensive atmosphere.

V. Pallas is at nearly the same mean distance from the sun as Ceres, and has nearly the same period of revolution.

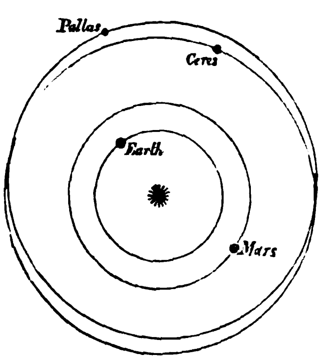
VI. The discovery of the asteroids was not an accidental circumstance, but the result of a search conducted upon the presumption that the harmony of the solar system required the presence of a planetary body between Mars and Jupiter. It was observed, that the distance between the orbits of Mars and the earth is about double that between those of the earth and Venus, or 50,000,000 of miles; whereas between the orbits of Mars and Jupiter there is the tremendous interval of 349,000,000 of miles, nearly $2\frac{1}{2}$ times the whole distance of the former from the sun. Astronomers, therefore, became thoroughly imbued with the notion that an undiscovered planet existed in the gap; and commencing an active search of the heavens, the asteroids were met with in the vacancy.

VII. This planetary family presents the following anomalies:

The dimensions of the asteroids, though not accurately ascertained, are very inferior to those of the older planets. The computed diameter of Vesta is only 250 miles, and Pallas is supposed to be much smaller.

There is but a very trifling difference in their mean distances from the sun, and in their periods of revolution.

Their orbits are much more eccentric than those of the other planets, and they actually cross each other, (as represented in the Diagram, in relation to Ceres and Pallas,) while the path of Vesta cuts that of the other three at two opposite points. There is thus a possibility of collision between these bodies; a contingency to which none of the other planets can be subject, without an entire derangement of the solar universe.



VIII. On the ground of these peculiarities, it has been surmised that these four small bodies have diverged from a common node, and therefore originally formed a single large planet which some mighty convulsion shattered. This bold hypothesis, first started by Olbers, has received a very general sanction. It obtains evidence from the powerful explosive forces in action in the interior of our own globe, to which its volcanic vents act as safety-valves; from the phenomena of meteoric showers, respecting which we have no supposition better than that they are *debris* which the earth encounters in its orbit, fusing upon contact with its atmosphere.

IX. In 1846, M. Encke, of Dresden, discovered a fifth asteroid, which has received the name of Astræa; and in 1847, a sixth, which has been designated Hebe. In August, 1847, also, a seventh asteroid was discovered at Mr. Bishop's observatory in the Regent's-park, and shortly afterwards, an eighth, to which the names of Iris and Flora have been given.

CHAPTER IX.

JUPITER.

I. Jupiter, the largest of the planets, is also the most brilliant, with the exception of Venus; whom, however, he sometimes fully equals in brightness, when nearest to the earth, notwithstanding his vastly more remote position. His mean distance from the sun is more than seven times that of Venus, and five times that of the earth, amounting to 495,000,000 of miles. He revolves around the central orb in about 4332 days, nearly equal to a period of twelve years, compassing about 3,000,000,000 of miles in space, at the rate of 29,000 miles an hour.

Jupiter travels over 30° 20′ 32″ of the zodiac in a year, rather more than a whole sign. Nothing can be easier therefore than to trace his course. On whatever night he is observed in a certain constellation of the zodiac, he will be found a year afterwards equally advanced in the constellation following.

II. The diameter of this planet is upwards of eleven times that of the earth, amounting to 89,069 miles. His bulk is 1400 times greater, but his density is so far inferior, but little heavier than water, that the quantity of matter included in his enormous volume is only about 331 times that of the earth.

While two globes of granite of equal dimensions with the earth would be required to balance it, Jupiter would only require a globe of wood of the same magnitude as his own. The force of gravity at his surface is about eight times that at the surface of the earth.

Were the orbital motion arrested, Jupiter would occupy a period of 765 days 15 hours in falling to the sun.

III. While the year of Jupiter is equal to nearly twelve of ours, his day is not half so long, a rotation upon his axis being performed in 9 hours, 55 minutes, 49 seconds, involving a rate of motion which is 25 times as rapid as the rotatory motion of the earth, or about 26,000 miles an hour at his equator.

The immense velocity of the axical rotation has proportionably modified the form of the planet. The compression at the poles is sufficiently great to be sensibly perceived with the telescope. The polar diameter is less by 6000 miles than the equatorial; more than three-quarters of the whole diameter of the earth.

IV. Owing to his greater distance, the sun will appear to Jupiter only $\frac{1}{27}$ of the size which he does to us, affording but $\frac{1}{27}$ of the amount of light and heat. But the swifter rotation upon his axis compensates in some degree for this deficiency, by rendering the period during which the direct solar influence is suspended a much shorter interval than with us. A night and day of five hours' duration alternate with each other.

V. The axis of Jupiter being perpendicular, or nearly so, to the plane of his orbit, there is no change of seasons, and no difference in the length of the days and nights.

Of course the seasons differ at different parallels of latitude; but the same place has constantly the same season, whatever it may be. It is perpetual summer at the equator, and winter at the poles; but there is the same length of day and night at each. This obviously beneficent arrangement is due to the position of the planet's axis; for had it been inclined like that of the earth, there would have been alternately six years night and winter at his poles.

VI. The telescopic appearance of Jupiter usually presents a series of zones or belts, surrounding the body of the planet in a direction parallel to his equator, being generally parallel to each other. They sometimes remain for two or three months without undergoing any change, and at other times alter their appearance in the course of an hour. They vary not only in breadth but in number, from one to seven or eight; but more usually three are observable. Bright and dark spots are also frequently seen in the belts, which appear and vanish with them.

The belts of Jupiter were first observed at Naples by the Jesuits Zappi and Bartoli, about the year 1633.

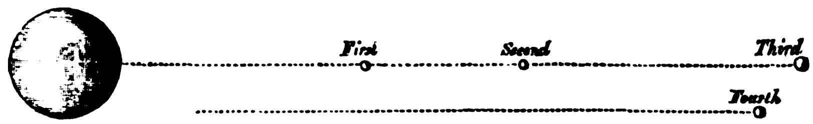
By some these appearances have been supposed to be the effect of great changes on the surface of the planet; but the more probable opinion is, that they are caused by atmospheric fluctuations. It is conceived that clouds and vapours floating in the atmosphere, which reflect more light than the body of the planet, being thrown into parallel strata by the rapidity of its diurnal motion, form the luminous zones, through the interstices of which its opaque body appears, constituting the dark belts.

VII. Jupiter is attended by four satellites or moons, quite invisible to the naked eye, but easily seen with a telescope magnifying thirty times, or with a much lower power, in a pure condition of the atmosphere.

Their first discoverer was Galileo, on the night of January 7, 1610. He called them the Medicean stars, in honour of his patrons the Medici. Till then it had been commonly urged as an argument in favour of the revolution of the heavens round the earth, that our planet was the most dignified body in the universe, having an attendant moon; a notion which the discovery soon exploded.

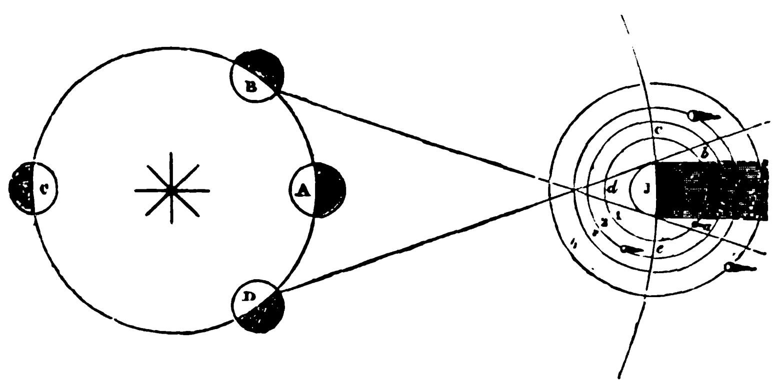
VIII. The moons of Jupiter revolve around him at different distances, and rotate upon their axes respectively in the time of one orbital revolution. They are named after their relative position to him, first, second, third, and fourth; which, with their comparative magnitudes, the following figure expresses. They are all larger than our own moon, except the second, their united bulk being equal to thirteen of our moons. Their elements are as follows:

Satellite.	Diameter in Miles.	Distance from Jupiter.	Time of Revolution.	Duration of Eclipse.
1	2508	260,000	1d. 18h. 28m.	2 hours.
2	2068	420,000	3 13 14	3 „
3	3377	670,000	7 3 43	3½ „
4	2890	1,180,000	16 16 32	5 „



IX. The satellites of Jupiter, in revolving round their primary, pass between him and the sun, in which case there is a solar eclipse to that part of the planet upon which their shadows are projected; a phenomenon which may be seen from the earth with the aid of a good telescope. They pass also between the planet and the earth, and are then sometimes seen as spots upon his illuminated disk. They are occulted likewise by passing directly behind his orb; and lastly, all the satellites are eclipsed in every revolution, by entering the shadow of Jupiter, with the exception of the fourth, which sometimes escapes, because of the greater inclination of its orbit.

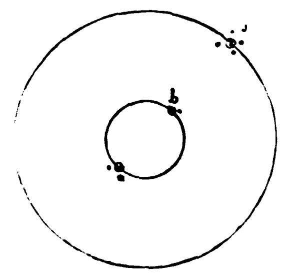
The entrance of a satellite into the planet's shadow, is called an *immersion*; the coming out, an *emersion*. The immersion and emersion of the first satellite, and generally of the second, can never be both seen from the earth, owing to their nearness to Jupiter.



At A, B, C, D, the earth appears in its orbit; and at J, Jupiter surrounded by his satellites, whose orbits are marked 1, 2, 3, 4. At *a* the first satellite is shown entering his shadow, while *b* is the point of emergence from it. Now from the earth at D, the immersion at *a* will be visible, but not the emersion at *b*, because of the interposing body of the planet. So, for the same reason, from the earth at B, the emersion will be visible, but not the immersion. From the earth at A, the satellite has its greatest eastern and western elongations at *c* and *e*, and appears upon the disk of Jupiter at *d*.

X. These eclipses furnish a ready means for ascertaining the longitude of places, or the difference of meridians on the earth, especially those of the first satellite, on account of their more rapid recurrence. For this purpose, the times of immersion and emersion are calculated for the meridian of Greenwich, and inserted in the Nautical Almanack, equally facilitating the movements of the traveller in an unknown country, and the mariner. At sea, however, this method of finding the longitude is often difficult and impossible, owing to the unsteadiness of the observer's station, and hence more convenient and accurate modes have largely superseded it in navigation.

The earth revolves on its axis at the rate of 15 degrees in an hour, which is one degree in four minutes of time. If, then, an observer finds the time of immersion or emersion of any one of the satellites to occur an hour later than the time given for Greenwich, as obtained from the Almanack, he may be sure that he is 15 degrees west of that meridian; or, if an hour earlier, that he is 15 degrees east. Faster time shows that he is east, and slower that he is west; and the difference of time gives the distance east or west, at the rate of one degree to four minutes. A good telescope, and a watch beating seconds or half seconds are required.



XI. It was from observation of the eclipses of Jupiter's satellites that the interesting discovery of the progressive motion of light was made. Repeated experiments have shown, that when the earth is at *b* in the diagram, or nearest to Jupiter, J, the eclipses are seen sooner than when at *a*, or farthest from him. The times are sooner or later than as calculated from the laws of their own movements, owing to the variations of the earth's distance. This would not be the case if light were propagated instantaneously. But the fact that time is required for it to fly over the increased distance, equal to the whole diameter of the earth's orbit, determines its progressive motion, and the rate of its transmission.

The discovery was made by the Danish astronomer, Roemer, in the year 1675.

The diameter of the earth's orbit is 190,000,000 of miles. Hence the difference of time between the calculated period for the eclipses of the satellites and their observation, in the two positions of the earth, gives the time for light to compass that distance. This is 16¼ minutes; so that light has a velocity of 12 millions of miles a minute, or 190,000 miles a second.

XII. The system of Jupiter exhibits upon a small scale a picture of the solar universe. The satellites are governed in their revolution round him by the laws which govern the planets in their revolution round the sun. Their orbits also are elliptical, and their motion in them from west to east, as in the case of the superior bodies.

CHAPTER X.

SATURN.

I. The most singular body in the system in point of architecture, Saturn, is nearly twice the distance of Jupiter from the sun, or at the mean distance of about 900,000,000 miles. He performs his revolution in 10,759 solar days, somewhat less than 29½ of our years, moving at the rate of 22,072 miles an hour.

The mean daily motion of Saturn among the stars is only about 2′, the thirtieth part of a degree. At a mean rate, therefore, he is about 2½ years in passing over one sign of the zodiac.

The planet would fall to the sun in 1901 days, equal to 5 years, 76 days, if his orbital revolution were arrested.

II. Saturn rotates upon his axis in 10 hours, 29 minutes, the length of his day. The axis is inclined about 29° to the plane of the orbit, which renders the intervals of light and darkness of unequal length, and produces seasonal changes.

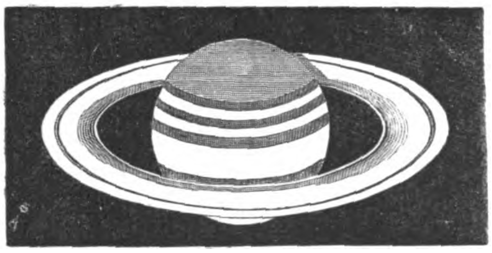
For above seven years at a time the poles of the planet are immersed in wintry darkness, not receiving any direct rays from the sun.

III. Next to Jupiter, the apparently diminutive orb of Saturn is by far the largest of the planets, having a diameter of 76,068 miles, and a bulk equal to near a thousand times that of the earth. The rapid axical whirl of the planet has had the effect of flattening its form at the poles. The polar diameter is less by 6700 miles than the equatorial, or in the proportion of 11 to 12. This is a greater degree of oblateness than belongs to Jupiter, though the axical rotation is less rapid, an effect due to a less dense material.

The density of Saturn is not quite half that of water, and little more than that of cork.

The north polar region of the planet is much more flattened than the south, and the diameter is not the greatest at the equator, but at the parallel of 45° from it. This peculiarity of form is supposed to be due to the attraction of the rings of Saturn. His surface also exhibits bright and dark belts, as in the case of Jupiter.

IV. Never hailed by us from any point nearer than 800,000,000 miles, Saturn shines to the naked eye with a pale, feeble, yet steady light, but becomes one of the most fascinating objects in the heavens as seen with the telescope. The body of the planet is encompassed with an inner and outer ring, of which the wooden horizon of an artificial globe, removed to a little distance from it, may be taken as a rough representation.



Galileo was the first who noticed the extraordinary form of Saturn, in the year 1610, which he supposed to be made up of three stars. Huygens, with a more perfect telescope, resolved the appearance into a ring. Herschel discovered two rings; and from Captain Kater's observations in 1825, the outer ring appears to be subdivided into several others.

The ball of Saturn, it has been recently found, is not in the centre of the rings, but a little to the west of it. Struve's measurements of these appendages are as follows:

Exterior diameter of exterior ring	176,418 miles.
Interior diameter of exterior ring	155,272 „
Exterior diameter of interior ring	151,690 „
Interior diameter of interior ring	117,339 „
Interval between the inner ring and Saturn .	19,090 „
Interval between the rings	1,791 „
Thickness of the rings not more than . . .	100 „

V. The outer ring has a width of 10,573 miles; the inner of 17,175 miles; and the entire width of the double ring, including the interval, is 29,539 miles. The rings project shadows upon the surface of the planet, and are consequently opaque bodies, receiving also a projection of the planet's shadows. Both have a motion of rotation accomplished in 10 hours, 29 minutes, 17 seconds. The centrifugal force hereby engendered balances the attraction of the planet, and prevents their precipitation to its surface.

VI. The plane of the rings is inclined to that of the orbit of Saturn in an angle of 28°. In consequence of this obliquity of position they appear to us of an elongated oval form, of very variable ellipticity, sometimes reduced to a straight line, according to the respective positions of Saturn and the earth.

From their most open appearance the rings gradually contract to an almost imperceptible line, or to entire disparition, unless the mightiest telescopic power is used, and then expand again till the former shape is regained. These are the phases of Saturn.

Alternately one of the surfaces of the rings is presented to us, and then the other.

The rings are reduced to a straight line, in appearance intersecting the disk of the planet, and projecting on each side, when the earth is in their plane. This happens every 15 years, or twice in every revolution of Saturn round the sun.

When the planet is in either of the first six signs of the zodiac, the sun shines on the south side of the rings; and when in either of the last six signs, upon their north side.

The rings are most open when the planet is in 19° of Gemini or of Sagittarius; and least so when in 19° of Pisces or of Virgo.

At present the northern side of the rings is presented to us. They will disappear Dec. 1847, and the southern side be seen to the greatest advantage, the rings most expanded, April 1855.

VII. In addition to these remarkable appendages, Saturn is attended by seven satellites revolving round him in periods varying from less than 1 to 79 days, and at distances ranging from half the distance of our moon from us to 2,000,000 of miles.

The first satellite discovered was by Huygens, being the sixth in point of distance. Though not the largest it is the brightest, and commonly called the Huygenian satellite and Saturn's guard.

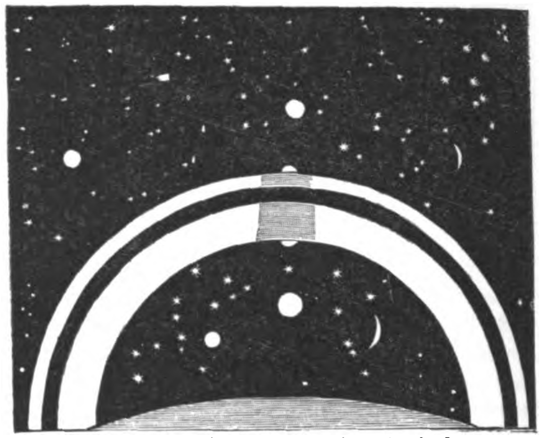
Four others were discovered by Cassini; the third, fourth, fifth, and seventh in the order of distance from the planet. The last is the largest, supposed to be nearly equal to Mars in size.

Two more were discovered by Herschel, the first and second as to position, which require the most powerful and finished instruments to be caught.

The following table exhibits an approximation to their elements which are not known with precision:

Satellites in order from the planet.	Time of Revolution.	Mean distance from Saturn in Miles.	Discoverer and Date.
1	0d. 22h. 38m.	120,000	W. Herschel, 1789.
2	1 8 53	150,000	W. Herschel, 1789.
3	1 21 18	190,000	D. Cassini, 1684.
4	2 17 45	243,000	D. Cassini, 1684.
5	4 12 25	340,000	D. Cassini, 1684.
6	15 22 41	788,000	C. Huygens, 1655.
7	79 7 55	2,297,000	D. Cassini, 1671.

VIII. The sun as seen from the surface of Saturn will only appear to be rather more than 3′ in diameter, affording about one-ninetieth part of the heat and light which the earth enjoys. But the sun returns more than twice as soon to the meridian of any place on the Saturnian globe, owing to the planet's quick rotation on its axis; while, as a farther compensation, a plentiful supply of reflected light is afforded by means of the satellites and rings, equal to that of a thousand of our full moons. The nearest satellite will present a disk nearly ten times as large as that of our lunar world, and in little more than 22 hours will exhibit the various phases which the moon takes a month to assume. At 30° from the poles the rings will be seen as the segment of a circle above the horizon. They will be seen at a higher elevation from lower latitudes; and from the equatorial regions will appear stretching across the heavens near the zenith, with the planet's shadow resting upon them.



CHAPTER XI.

URANUS.

I. Uranus, the Georgium Sidus, Georgian, or Herschel, names applied to the same planet, is an addition to our system in modern times, having been discovered by Herschel at Bath, on the 13th of March, 1781.

The planet was observed three times by Flamstead, once by Bradley, once by Mayer, eleven times by Lemonnier, but supposed to be one of the stars. With a telescope of small magnifying power it appears like a star of the 6th or 7th magnitude. On a very clear night, when the moon is absent, it may be seen by a practised eye without a telescope.

II. The planet is at the mean distance of 1,800,000,000 miles from the sun, and accomplishes an orbital course around the centre of light in 84 years, journeying at the rate of 16,000 miles an hour.

Surrendered to the solar attraction, Uranus would not fall to the sun under 5425 days, or nearly 15 years.

The proportion of light and heat received from the sun is about $\frac{1}{368}$ that enjoyed by the earth; but this illumination would be equal to that of 300 of our full moons.

An inhabitant of Uranus may have a distinct view of Saturn, and just catch a glimpse of Jupiter, but the other interior planets are all invisible.

III. Insignificant as the planet appears, it has a diameter of 35,000 miles, and is eighty times the magnitude of the earth.

IV. Uranus is attended by six satellites, which offer two remarkable peculiarities. They revolve round him nearly at right angles to the plane of his orbit, and in a direction from east to west, which is contrary to the order of the signs. The satellites of this planet, and the two innermost moons of Saturn, are the most difficult objects in the system to get a sight of.

CHAPTER XII.

NEPTUNE.

Previous to the discovery of Uranus, it had been conjectured by astronomers that certain perturbations in the motions of Jupiter and Saturn, which could not otherwise be explained, might be due to the action of some unknown planet exterior to them. In like manner astronomers have been for some time aware that the motions of Uranus could not be accounted for by the action of the known planets; and M. Leverrier, after examining the theory of this remote wanderer with great care, ascertained that the irregularities arose from an unknown body, whose exact position and diameter he determined by calculation. This remarkable theoretic conclusion was verified on the night of September 23rd, 1846, by M. Galle, at Berlin, the planet being found in the position and with the diameter announced by Leverrier; one of the noblest achievements of modern times. It has since been repeatedly and carefully observed by astronomers. A fortnight before the discovery, Sir John Herschel remarked, on resigning the chair of the British Association, at Southampton, Sept. 10, that the last twelvemonth had added a new planet (Astræa) to our list, and proceeded to observe, "it has done more—it has given us the probable prospect of the discovery of another. We see it as Columbus saw America from the shores of Spain. Its movements have been felt, trembling along the far-reaching line of our analysis, with a certainty hardly inferior to that of ocular demonstration."

The new planet, according to M. Arago, is at the astounding distance of 1,250,000,000 of leagues from the sun, about 3,125,000,000 of miles. Its volume is about 230 times that of the earth. Thus, during the year 1846, the bounds of our solar system have been nearly doubled. The planet has received the name of Neptune with the general consent of European astronomers. The existence of a satellite and a ring seems conclusive from recent observations.

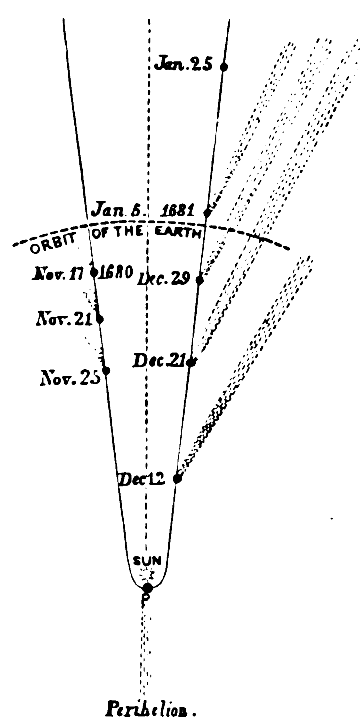
CHAPTER XIII.

COMETS.

I. Besides the planets with their satellites, which may be considered as the regular members of the solar system, there are other bodies, called comets, some of which have their orbits included within its visible bounds, while others appear within it during only a small part of their course, accomplishing the rest in regions of remote and unknown invisibility.

The word comet, from the Greek, signifying *hair*, alludes to a kind of nebulosity, or haze, which often surrounds their nuclei. Their frequent appearance presents a definite bright point, or nucleus—a luminous envelope, or the hair—and a stream of light, formerly called the beard when preceding the nucleus, and the tail when following it, but now universally known by the latter term. No importance is now attached to these features; but all bodies are considered comets which have a motion of their own, and describe extremely elliptical orbits.

II. Comets differ from planetary bodies in their configuration, which varies from a simple spherical luminosity to an irregular wisp-like shape; in the form of their orbits, which are immensely elongated ellipses, only one end of which lies within the visible limits of the solar system; in their motion, which is often retrograde, or from east to west; and in their paths, which are extra-zodiacal, cutting the ecliptic in every direction, some being even perpendicular to it, traversing the heavens in all parts.



The diagram represents a part of the path of the comet of 1680, which was described in about two months, at an average velocity of 800,000 miles an hour. It had the three features of nucleus, hair, and tail. The tail was computed to extend upwards of 123,000,000 of miles at its greatest length; and in two days an extent of 60,000,000 of miles was emitted from the nucleus. At its perihelion, or nearest approach to the sun, it was not more than 144,000 miles apart from his surface; and in three minutes it would have closed with his mass, if the projectile force had been suspended.

The diagram shows the direction of the luminous train, or tail, away from the sun, following the nucleus when approaching the sun, and preceding it afterwards; acquiring, also, its greatest extent, after passing the point of perihelion. If the tail is vaporisation caused by intense heat acting upon the body of the comet, this accounts for its greatest length after the perihelion, just as the earth attains its highest temperature after the summer solstice, though the daily supply of solar influence is then actually diminishing. According to Newton, an observer of this object, it must have been heated to a degree 2,000 times greater than that of red-hot iron in passing round the sun. The comet is shown in its perihelion passage merely for the sake of illustration, as then it was completely lost in the solar blaze.

This comet is supposed to be identified with the cometary appearances B.C. 34, about the time of Cæsar's death, A.D. 531, in the reign of Justinian, and A.D. 1106, in the reign of Henry II. Between these periods, and between the last and 1680, there is the interval of 575 years, which Newton supposed to be its periodic time. If this be correct, it will return in the year 2255.

III. Comets with nucleus, hair, and tail, have a remarkable, and sometimes a terrific aspect. The nuclei often shine with a very vivacious light, but are of small diameter. On the contrary, their trains have stretched over 90° or 100°, reaching to the zenith, while the nucleus has been below the horizon, compassing an extent of 150,000,000 of miles. Some have more than one train, as that of 1744, which had six. The appearance of comets is not only diverse from each other, some seeming to be mere patches of cloud without any condensation, but the appearance of the same object alters considerably in its periods of revolution. Astronomers discard such circumstances as those of shape, size, and brilliancy being similar in identifying two cometary appearances as apparitions of the same body, and attend only to the elements of the path being accordant.

IV. The periodic time of several comets has been calculated, and supposed to be as follows:—

Year of Comet.	Period.	Authority.
1680	575 years	Newton.
1682	75½ "	Halley.
1807	1543 "	Bessel.
1811	3383 "	Bessel.
——	2988 "	Argelander.
1815	72-77 "	Bessel and others.
1819, second comet	5½ "	Encke.
1819, fourth comet	3½ "	Encke.
1812	66-76 "	Encke.
1822, second comet	1550 "	Encke.
1822, third comet	1817 "	Rumker.
1825, fourth comet	556 "	Hansen.
1826	6¾ "	Biela.

Three of these calculations have been verified.

V. To Halley the grand discovery is due, that comets revolve about the sun in elliptical orbits that return into themselves, announcing the periodic time of the one which appeared in 1682, whose return he predicted would take place in the year 1758, after an interval of 76 years.

The event answered to the prediction. The comet was first seen in the neighbourhood of Dresden, on Christmas-day, 1758, by George Palitzch, with an eight feet telescope, and afterwards at Paris, Leipzic, Cadiz, and Lisbon.

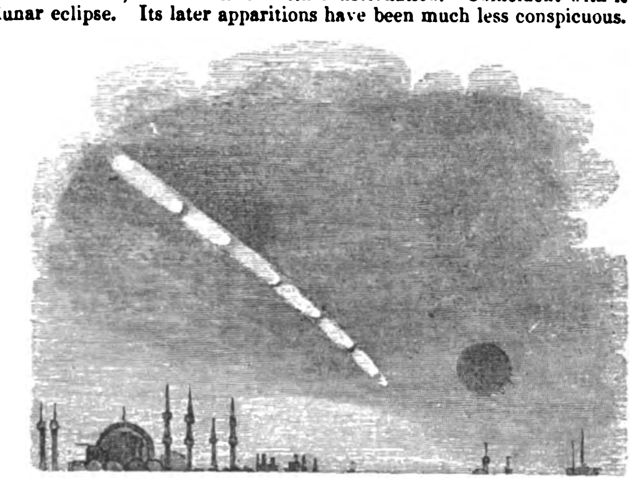
Another of its periodic times brings us to the year 1835, and on the 5th of August in that year the comet was seen at Rome, and passed its perihelion, November 16.

At its perihelion Halley's comet is only 55,700,000 miles from the sun; at its aphelion, it is 3,371,700,000 miles. Its mean distance is 1,713,700,000 miles, which is less than that of the planet Uranus.

There is reason to regard the following cometary appearances as apparitions of the same body.

Years of comets	1155	1230	1305	1380	1456	1531	1607	1682	1758	1835
Intervals between them	75	75	75	76	75	76	75	76	77	

Halley's comet has undergone remarkable changes in appearance. In 1456 it passed near the earth, with a tail extending over 60°, in the form of a sword or sabre. Phranza describes its aspect, as seen from Constantinople, of which the Turks had just become masters, whom it filled with consternation. Coincident with it there was a full lunar eclipse. Its later apparitions have been much less conspicuous.



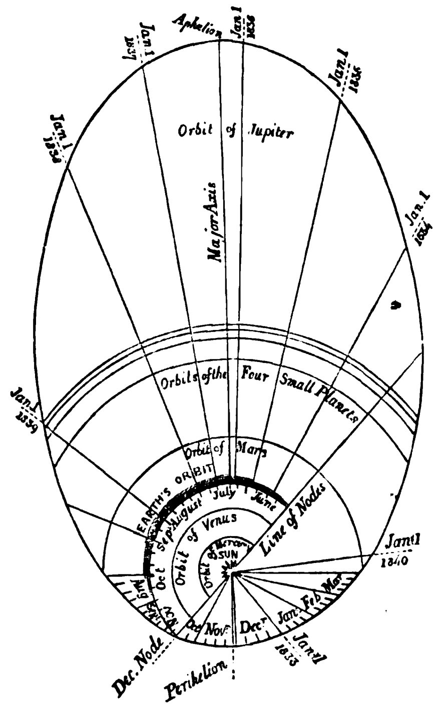
VI. The Encke comet, called after the astronomer who determined the dimensions of its orbit and its periodic time, performs its revolution round the sun in about 1203 days, or $3\frac{3}{10}$ years. It passes within the orbit of Mercury at its perihelion, and accomplishes its aphelion between that of Jupiter and the asteroids, being 358,000,000 of miles farther from the sun in the one case than in the other. It has no nucleus, or tail, but resembles a globular patch of vapour, is scarcely perceptible, and seems to be increasing in dimness.

C

VII. The third comet with whose elements we are well acquainted, called after M. Biela, of Josephstadt, who determined them, performs its revolution in 2,461 days, or about $6\frac{3}{4}$ years. Its aphelion is beyond the orbit of Jupiter; its perihelion within that of Venus.

The path of this comet passes very near to that of the earth, so near, indeed, that when the centre of the comet, which has altogether a diameter of 42,280 miles, is at the point nearest to the earth's path, it is included in the nebulous atmosphere of the comet. If, then, the earth were at the same time in that part of its orbit, the two would be in actual contact.

This collision was apprehended by many in the year 1832. It was calculated, that a little before midnight, October 29, the comet would pass the earth's orbit very near where the earth itself would be on the morning of November 30; and had the comet been delayed by any perturbation till the latter period, contact would have taken place. But a month intervened, and the two bodies were never nearer than 60,000,000 of miles.



VIII. In passing among and near the planets, comets are liable to be deflected from their courses, and in some cases to have their orbits entirely changed. Jupiter especially has been a repeated stumbling-block to them, but no derangement of the motions of his satellites has ever ensued from the *rencontre*.

Previous to the return of Halley's comet in 1758, it was calculated, that 618 days more would be required for it to return to perihelion than on the preceding revolution, from the action of Saturn and Jupiter. The event answered to the calculation.

The comet of 1770, moving in a moderate ellipse, in the periodic time of $5\frac{1}{2}$ years, as determined by Lexell, afterwards got entangled in the system of Jupiter, and has not since been heard of, having been deflected into a remoter path by the action of the planet.

IX. Among the more remarkable of these objects, one appeared in December, 1743, and remained visible during the spring of 1744, shining with great brightness, and eventually presenting a train with six branches curving in the same direction. Another came into view in the autumn of 1811, with a tail extending 123,000,000 of miles by a breadth of 15,000,000, which, according to the calculation of Bessel, will not repeat its visit till the year 5194! A third suddenly burst upon our gaze in the spring of 1843, when travelling away from the sun, a comet of the very largest class, but was not so distinctly seen here as in southern latitudes.

X. Respecting the physical constitution of comets, we know nothing farther than that they are most probably entirely gaseous, simple aggregations of vapour. The following considerations warrant this idea:—

Lexell's lost comet of 1770 passed through the system of Jupiter without disturbing it, when, had it been $\frac{1}{80}$ of one of the satellites in mass, derangement must have been produced. It came also so near to our own globe, that, had it been $\frac{1}{5000}$ of the earth in mass, it would have appreciably shortened the length of our year.

Sir John Herschel, in 1832, saw a group of stars of the sixteenth magnitude, through the very centre of Biela's comet.

XI. Though quite in the dark respecting the office of these members of our system, we may dismiss as idle imaginations their supposed influence through contact with them in producing great physical changes, such as the deluge of Noah, the depression of a part of Western Asia, and the origin of the telescopic planets from a comet-stricken orb. The possibility of collision between our globe and one of these erratic objects is very admissible; but probably the only consequence would be some effect upon the temperature, with peculiar atmospheric phenomena, without any disturbance transpiring in the planetary constitution of the earth.

XII. A third comet, of short period, was discovered by Faye, Nov. 22nd, 1843, at the Paris Observatory, which accomplishes its revolution in rather more than seven years. The last few years have been remarkable for the number of comets observed.

CHAPTER XIV.

AEROLITES.

I. Mankind, in all ages and countries, have been familiar with the appearance of transient luminosities in the heavens at night, popularly called "shooting stars," from their resemblance to a star falling from its sphere. These meteorites vary in apparent magnitude, brilliancy, velocity, elevation, and the extent of space described by them.

Out of 98 appearances observed by Brandes in the year 1823, in the neighbourhood of Breslau, the computed heights were:—

4 under 15 miles.	13 from 70 to 90 miles.
15 from 15 to 30 miles.	6 above 90 miles.
22 „ 30 to 45	5 from 140 to 460 miles.
33 „ 45 to 70.	

II. Luminosities of a far more striking kind, though of much rarer occurrence, have repeatedly been observed giving out an intense light and hissing noise during their progress, a loud explosion attending their termination.

In 1676, a luminous body passed over Italy about two hours after sunset, coming from the Adriatic, and crossing the country in the direction of Rimini and Leghorn, at which latter place a loud report was heard, disappearing towards Corsica.

In 1718, a similar object was seen all over England, at the computed distance of about 60 miles above the surface, with a brightness so intense as to efface the lustre of the moon and stars, the sound of an explosion being heard in Devon and Cornwall.

On the night of Sept. 25, 1846, about 10 o'clock, a magnificent meteorite was observed from different parts of the kingdom, travelling in a north-westerly direction across the heavens, leaving behind it a fiery train. The light, of a lurid bluish tinge, was so powerful, that for half a minute there seemed to be a transition from darkness to daylight.

III. The actual descent of heavy bodies to the earth from surrounding space is a well-established fact. To these bodies the term aërolites is applied, signifying atmospheric stones.

At Ennisheim, on the Rhine, a stone of 260 lbs. weight fell in the year 1492.

In 1627, Gassendi observed a similar event near Nice, and examined the mass of 59 lbs.

In 1790, a complete shower of stones fell in France, of various sizes.

In 1795, a stone weighing 56 lbs. fell near Wold Cottage, in Yorkshire, a loud explosion being heard.

In 1803, another shower took place in France, of nearly 3,000 stones, which were examined, some of which weighed $17\frac{1}{2}$ lbs. The above are only a few of many cases of the same nature.

IV. Aërolites, examined immediately after their descent, are always found to be intensely hot. They are uniformly composed of the same substances, and nearly in the same proportions, whether falling in India or in England, viz., silica, magnesia, iron, nickel, sulphur, and zinc. These are substances native to the earth; but it is a remarkable fact, that they are never found natively combined as in the case of the meteoric stones.

V. In various countries, large metallic masses have been met with, lying completely insulated and half buried in the earth, of identical composition with the known aërolites, leaving no doubt as to their common origin.

An immense mass of malleable iron mixed with nickel was discovered by Pallas, at a considerable height on a mountain of slate in Siberia.

A similar block, computed to weigh 13 tons, lies on the plain of Otumba, in the district of Buenos Ayres, of which a specimen weighing 1,400 lbs. is in the British Museum.

In the province of Bahia, in Brazil, there is another block weighing six tons.

VI. These remarkable bodies have been supposed to be concretions formed in the atmosphere from particles in it; but their size, and the fact that their ingredients have never been found in the atmosphere, analyzed at the sea level and on the tops of high mountains, renders the hypothesis inadmissible. They have been also considered projections from lunar volcanoes. But the supposition of a body, or bodies, in the system circulating round the sun, which, encountering the earth in its orbit, are drawn towards it by attraction, and become ignited upon entering the atmosphere, in consequence of their rapid motion, is the most probable theory; and is, perhaps, the true explanation of the phenomena of shooting stars, aërolites, and the November meteoric displays.

Sir Humphrey Davy advocated the opinion of meteorites being solid bodies moving in space; and states, that the heat produced by the compression of the most rarefied air from their velocity must be sufficient to ignite their mass. Some, no doubt, are completely dissipated in the atmosphere; others may pass by us horizontally as brilliant lights re-entering the depth of space; while others fall to the earth without being completely fused.

VII. Resplendent showers of stars are mentioned in old chronicles, but have been assigned to the ancient love of the marvellous, till confirmed by analogous exhibitions in modern times. What is most remarkable is, that these grander and more extensive meteoric displays have usually been witnessed in the month of November, and at about the same period of the month.

On November 13, 1799, the Moravian missionaries in Greenland—Humboldt and Bonpland, in South America—the Franciscan monks near the entrance of the Orinoco, and Mr. Elliott at sea, between Cape Florida and the West Indies, observed this magnificent phenomenon. It continued from about three o'clock in the morning until after daybreak, the meteors falling towards the earth as thick as hail.

In 1814 and 1819, similar stellar showers were observed in Canada; and during the autumn of 1818, in the North Sea.

On November 13, 1831, the same event occurred upon a great scale, and was seen off the coast of Spain, and in the Ohio country.

At the same time, in 1832, another exhibition was witnessed from the Red Sea, westward to the Atlantic, and from Switzerland to the Mauritius.

VIII. The most astonishing and awful spectacle of this class took place November 13, 1833, and was observed from the longitude of 61° in the Atlantic Ocean, to that of 100° in Central Mexico, and from the latitude of the North American lakes to the West Indies. It was not seen anywhere in Europe, or in South America, or in any part of the Pacific Ocean; but within the area named, from a little before midnight, in a very clear state of the firmament, there was an incessant play of meteors in the sky, till the full break of day rendered them invisible.

The remarkable fact was established upon this occasion, that the meteoric shower proceeded from one point of the heavens, to the south-east of the zenith, near the star γ Leonis. None of the luminosities started directly from this point; but, traced backwards, they converged towards it as to a common focus (represented by the Diagram). The point remained stationary with respect to the stars, and was thus independent of the earth's rotation. It was computed to be not less than 2,238 miles above the earth's surface.

IX. The periodicity of the occurrence appearing to be established, it has been anxiously watched for in the November of succeeding years, and though no rival scene to the preceding has been witnessed, yet extraordinary flights of shooting stars have appeared at the periodic time.

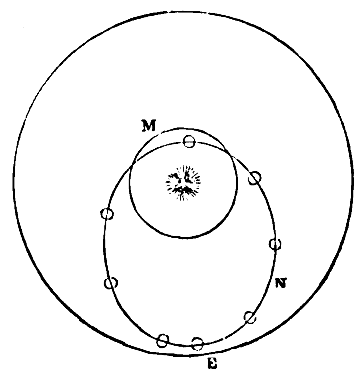
On November 13, 1834, they were seen in Europe and America, more abundant than usual.

On November 12 and 13, 1836, the following results were obtained in France:—

Places.	Meteors.	Places.	Meteors.
Paris, at the Observatory	170	Von Altimarl	75
Dieppe	36	Anjou	49
Arras	27	Rochefort	23
Strasburg	85	Havre	300

On November 12, 1837, many falling stars were seen in England, but at 10 o'clock dark clouds prevented further observation. In November, 1838, they were frequent at Vienna.

X. Professor Olmstead, of Yale College, an eye-witness of the imposing scene of 1833, after carefully collecting and comparing facts, came to the conclusion, that the meteors "emanated from a nebulous body, which was then pursuing its way along with the earth around the sun; that this body continues to revolve around the sun in an elliptical orbit, but little inclined to the plane of the ecliptic, and having its aphelion near to the orbit of the earth; and finally, that the body has a period of nearly six months, and that its perihelion is a little below the orbit of Mercury." The diagram represents at E the orbit of the earth, at M that of Mercury, and at N that of the supposed nebula, particles of which, when the two bodies periodically approximate, are attracted towards the earth, and fused upon entering our atmosphere by their concurrent velocities, causing the appearance of a meteoric shower. However doubtful this particular theory, the fact seems indisputable, that, besides planets, satellites, and comets, the system contains unknown bodies in circulation round the sun, which the earth encounters in its orbital revolution, and hence the preceding phenomena.



CELESTIAL AND TERRESTRIAL PHENOMENA.

CHAPTER I.

SOLAR ECLIPSES.

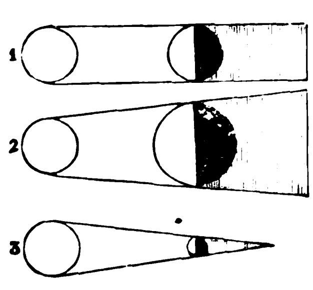
I. An eclipse of the sun is caused by the dark body of the moon passing directly between the earth and the sun, intercepting his light.

This is, properly speaking, an occultation of the solar orb by the moon, which deprives certain portions of the earth's surface of his light, thereby eclipsing those portions.

If the sun and moon had been of equal magnitude, the moon's shadow would be cylindrical and of unlimited length, as fig. 1.

If the moon had been of greater magnitude than the sun, her shadow would then resemble a truncated cone, of indefinite extent, as fig. 2.

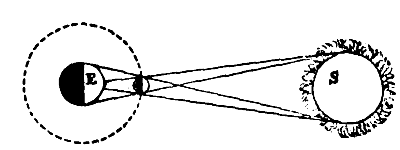
The moon being immensely inferior to the sun, her shadow hence converges to a point, as fig. 3.



II. When the sun is at his greatest distance from the earth, and the moon at her least, her shadow is sufficiently long to reach the earth, and extend about 19,000 miles beyond it. If, then, the moon comes in a direct line between the sun and the earth, the dark shadow of the moon will fall upon the earth, covering a circular area, within which there will be a total eclipse of the sun. But besides the dark shadow of the moon, or *umbra*, there is another fainter shadow, or *penumbra*, much more extensive, caused by the moon hiding a part only of the sun's disk, to all places within which the eclipse is more or less partial.

Lines drawn to the earth, as in the diagram, from the upper and lower limbs of the sun and moon, define the *umbra*, the moon's dark conical shadow.

Lines drawn to the earth, along opposite edges of the sun and moon, define the *penumbra*, or fainter shadow.



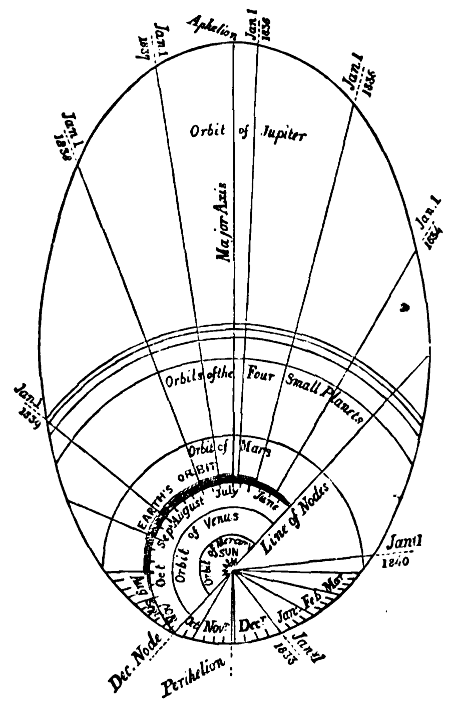
The dark shadow of the moon can never cover more of the earth's surface than an area of about 175 miles in diameter, where the eclipse is total; but in consequence of the earth's motion, this area becomes a continuous belt, as the shadow sweeps over the terrestrial superfices. No total eclipse, therefore, can last longer to any part of the world than 7 minutes 58 seconds.

The fainter shadow covers an area of about 4000 miles in diameter; and the eclipse becomes less extensive within it with the distance from the area where it is total.

As a general rule, subject to many modifications, it may be observed, that places

VII. The third comet with whose elements we are well acquainted, called after M. Biela, of Josephstadt, who determined them, performs its revolution in 2,461 days, or about 6¾ years. Its aphelion is beyond the orbit of Jupiter; its perihelion within that of Venus.

The path of this comet passes very near to that of the earth, so near, indeed, that when the centre of the comet, which has altogether a diameter of 42,280 miles, is at the point nearest to the earth's path, it is included in the nebulous atmosphere of the comet. If, then, the earth were at the same time in that part of its orbit, the two would be in actual contact.



This collision was apprehended by many in the year 1832. It was calculated, that a little before midnight, October 29, the comet would pass the earth's orbit very near where the earth itself would be on the morning of November 30; and had the comet been delayed by any perturbation till the latter period, contact would have taken place. But a month intervened, and the two bodies were never nearer than 60,000,000 of miles.

VIII. In passing among and near the planets, comets are liable to be deflected from their courses, and in some cases to have their orbits entirely changed. Jupiter especially has been a repeated stumbling-block to them, but no derangement of the motions of his satellites has ever ensued from the *rencontre*.

Previous to the return of Halley's comet in 1758, it was calculated, that 618 days more would be required for it to return to perihelion than on the preceding revolution, from the action of Saturn and Jupiter. The event answered to the calculation.

The comet of 1770, moving in a moderate ellipse, in the periodic time of 5½ years, as determined by Lexell, afterwards got entangled in the system of Jupiter, and has not since been heard of, having been deflected into a remoter path by the action of the planet.

IX. Among the more remarkable of these objects, one appeared in December, 1743, and remained visible during the spring of 1744, shining with great brightness, and eventually presenting a train with six branches curving in the same direction. Another came into view in the autumn of 1811, with a tail extending 123,000,000 of miles by a breadth of 15,000,000, which, according to the calculation of Bessel, will not repeat its visit till the year 5194! A third suddenly burst upon our gaze in the spring of 1843, when travelling away from the sun, a comet of the very largest class, but was not so distinctly seen here as in southern latitudes.

X. Respecting the physical constitution of comets, we know nothing farther than that they are most probably entirely gaseous, simple aggregations of vapour. The following considerations warrant this idea:—

Lexell's lost comet of 1770 passed through the system of Jupiter without disturbing it, when, had it been $\frac{1}{10}$ of one of the satellites in mass, derangement must have been produced. It came also so near to our own globe, that, had it been $\frac{1}{5000}$ of the earth in mass, it would have appreciably shortened the length of our year.

Sir John Herschel, in 1832, saw a group of stars of the sixteenth magnitude, through the very centre of Biela's comet.

XI. Though quite in the dark respecting the office of these members of our system, we may dismiss as idle imaginations their supposed influence through contact with them in producing great physical changes, such as the deluge of Noah, the depression of a part of Western Asia, and the origin of the telescopic planets from a comet-stricken orb. The possibility of collision between our globe and one of these erratic objects is very admissible; but probably the only consequence would be some effect upon the temperature, with peculiar atmospheric phenomena, without any disturbance transpiring in the planetary constitution of the earth.

XII. A third comet, of short period, was discovered by Faye, Nov. 22nd, 1843, at the Paris Observatory, which accomplishes its revolution in rather more than seven years. The last few years have been remarkable for the number of comets observed.

CHAPTER XIV.

AEROLITES.

I. Mankind, in all ages and countries, have been familiar with the appearance of transient luminosities in the heavens at night, popularly called "shooting stars," from their resemblance to a star falling from its sphere. These meteorites vary in apparent magnitude, brilliancy, velocity, elevation, and the extent of space described by them.

Out of 98 appearances observed by Brandes in the year 1823, in the neighbourhood of Breslau, the computed heights were:—

4 under 15 miles.	13 from 70 to 90 miles.
15 from 15 to 30 miles.	6 above 90 miles.
22 „ 30 to 45	5 from 140 to 460 miles.
33 „ 45 to 70.	

II. Luminosities of a far more striking kind, though of much rarer occurrence, have repeatedly been observed giving out an intense light and hissing noise during their progress, a loud explosion attending their termination.

In 1676, a luminous body passed over Italy about two hours after sunset, coming from the Adriatic, and crossing the country in the direction of Rimini and Leghorn, at which latter place a loud report was heard, disappearing towards Corsica.

In 1718, a similar object was seen all over England, at the computed distance of about 60 miles above the surface, with a brightness so intense as to efface the lustre of the moon and stars, the sound of an explosion being heard in Devon and Cornwall.

On the night of Sept. 25, 1846, about 10 o'clock, a magnificent meteorite was observed from different parts of the kingdom, travelling in a north-westerly direction across the heavens, leaving behind it a fiery train. The light, of a lurid bluish tinge, was so powerful, that for half a minute there seemed to be a transition from darkness to daylight.

III. The actual descent of heavy bodies to the earth from surrounding space is a well-established fact. To these bodies the term aërolites is applied, signifying atmospheric stones.

At Ennisheim, on the Rhine, a stone of 260 lbs. weight fell in the year 1492.

In 1627, Gassendi observed a similar event near Nice, and examined the mass of 59 lbs.

In 1790, a complete shower of stones fell in France, of various sizes.

In 1795, a stone weighing 56 lbs. fell near Wold Cottage, in Yorkshire, a loud explosion being heard.

In 1803, another shower took place in France, of nearly 3,000 stones, which were examined, some of which weighed 17½ lbs. The above are only a few of many cases of the same nature.

IV. Aërolites, examined immediately after their descent, are always found to be intensely hot. They are uniformly composed of the same substances, and nearly in the same proportions, whether falling in India or in England, viz., silica, magnesia, iron, nickel, sulphur, and zinc. These are substances native to the earth; but it is a remarkable fact, that they are never found natively combined as in the case of the meteoric stones.

V. In various countries, large metallic masses have been met with, lying completely insulated and half buried in the earth, of identical composition with the known aërolites, leaving no doubt as to their common origin.

An immense mass of malleable iron mixed with nickel was discovered by Pallas, at a considerable height on a mountain of slate in Siberia.

A similar block, computed to weigh 13 tons, lies on the plain of Otumba, in the district of Buenos Ayres, of which a specimen weighing 1,400 lbs. is in the British Museum.

In the province of Bahia, in Brazil, there is another block weighing six tons.

VI. These remarkable bodies have been supposed to be concretions formed in the atmosphere from particles in it; but their size, and the fact that their ingredients have never been found in the atmosphere, analyzed at the sea level and on the tops of high mountains, renders the hypothesis inadmissible. They have been also considered projections from lunar volcanoes. But the supposition of a body, or bodies, in the system circulating round the sun, which, encountering the earth in its orbit, are drawn towards it by attraction, and become ignited upon entering the atmosphere, in consequence of their rapid motion, is the most probable theory; and is, perhaps, the true explanation of the phenomena of shooting stars, aërolites, and the November meteoric displays.

Sir Humphrey Davy advocated the opinion of meteorites being solid bodies moving in space; and states, that the heat produced by the compression of the most rarefied air from their velocity must be sufficient to ignite their mass. Some, no doubt, are completely dissipated in the atmosphere; others may pass by us horizontally as brilliant lights re-entering the depth of space; while others fall to the earth without being completely fused.

VII. Resplendent showers of stars are mentioned in old chronicles, but have been assigned to the ancient love of the marvellous, till confirmed by analogous exhibitions in modern times. What is most remarkable is, that these grander and more extensive meteoric displays have usually been witnessed in the month of November, and at about the same period of the month.

On November 13, 1799, the Moravian missionaries in Greenland—Humboldt and Bonpland, in South America—the Franciscan monks near the entrance of the Orinoco, and Mr. Elliott at sea, between Cape Florida and the West Indies, observed this magnificent phenomenon. It continued from about three o'clock in the morning until after daybreak, the meteors falling towards the earth as thick as hail.

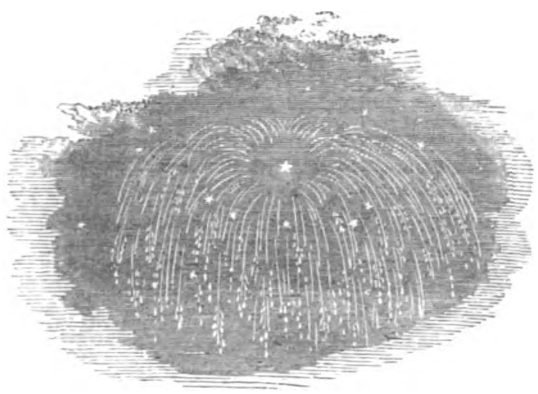
In 1814 and 1819, similar stellar showers were observed in Canada; and during the autumn of 1818, in the North Sea.

On November 13, 1831, the same event occurred upon a great scale, and was seen off the coast of Spain, and in the Ohio country.

At the same time, in 1832, another exhibition was witnessed from the Red Sea, westward to the Atlantic, and from Switzerland to the Mauritius.

VIII. The most astonishing and awful spectacle of this class took place November 13, 1833, and was observed from the longitude of 61° in the Atlantic Ocean, to that of 100° in Central Mexico, and from the latitude of the North American lakes to the West Indies. It was not seen anywhere in Europe, or in South America, or in any part of the Pacific Ocean; but within the area named, from a little before midnight, in a very clear state of the firmament, there was an incessant play of meteors in the sky, till the full break of day rendered them invisible.

The remarkable fact was established upon this occasion, that the meteoric shower proceeded from one point of the heavens, to the south-east of the zenith, near the star γ Leonis. None of the luminosities started directly from this point; but, traced backwards, they converged towards it as to a common focus (represented by the Diagram). The point remained stationary with respect to the stars, and was thus independent of the earth's rotation. It was computed to be not less than 2,238 miles above the earth's surface.



IX. The periodicity of the occurrence appearing to be established, it has been anxiously watched for in the November of succeeding years, and though no rival scene to the preceding has been witnessed, yet extraordinary flights of shooting stars have appeared at the periodic time.

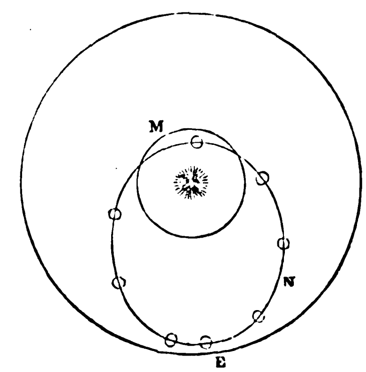
On November 13, 1834, they were seen in Europe and America, more abundant than usual.

On November 12 and 13, 1836, the following results were obtained in France:—

Places.	Meteors.	Places.	Meteors.
Paris, at the Observatory	170	Von Altimarl	75
Dieppe	36	Anjou	49
Arras	27	Rochefort	23
Strasburg	85	Havre	300

On November 12, 1837, many falling stars were seen in England, but at 10 o'clock dark clouds prevented further observation. In November, 1838, they were frequent at Vienna.

X. Professor Olmstead, of Yale College, an eye-witness of the imposing scene of 1833, after carefully collecting and comparing facts, came to the conclusion, that the meteors "emanated from a nebulous body, which was then pursuing its way along with the earth around the sun; that this body continues to revolve around the sun in an elliptical orbit, but little inclined to the plane of the ecliptic, and having its aphelion near to the orbit of the earth; and finally, that the body has a period of nearly six months, and that its perihelion is a little below the orbit of Mercury." The diagram represents at E the orbit of the earth, at M that of Mercury, and at N that of the supposed nebula, particles of which, when the two bodies periodically approximate, are attracted towards the earth, and fused upon entering our atmosphere by their concurrent velocities, causing the appearance of a meteoric shower. However doubtful this particular theory, the fact seems indisputable, that, besides planets, satellites, and comets, the system contains unknown bodies in circulation round the sun, which the earth encounters in its orbital revolution, and hence the preceding phenomena.



CELESTIAL AND TERRESTRIAL PHENOMENA.

CHAPTER I.

SOLAR ECLIPSES.

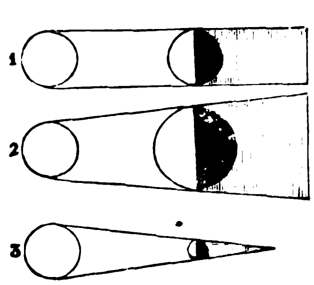
I. An eclipse of the sun is caused by the dark body of the moon passing directly between the earth and the sun, intercepting his light.

This is, properly speaking, an occultation of the solar orb by the moon, which deprives certain portions of the earth's surface of his light, thereby eclipsing those portions.

If the sun and moon had been of equal magnitude, the moon's shadow would be cylindrical and of unlimited length, as fig. 1.

If the moon had been of greater magnitude than the sun, her shadow would then resemble a truncated cone, of indefinite extent, as fig. 2.

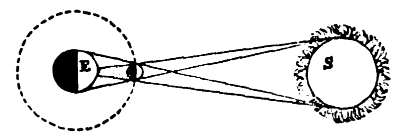
The moon being immensely inferior to the sun, her shadow hence converges to a point, as fig. 3.



II. When the sun is at his greatest distance from the earth, and the moon at her least, her shadow is sufficiently long to reach the earth, and extend about 19,000 miles beyond it. If, then, the moon comes in a direct line between the sun and the earth, the dark shadow of the moon will fall upon the earth, covering a circular area, within which there will be a total eclipse of the sun. But besides the dark shadow of the moon, or *umbra*, there is another fainter shadow, or *penumbra*, much more extensive, caused by the moon hiding a part only of the sun's disk, to all places within which the eclipse is more or less partial.

Lines drawn to the earth, as in the diagram, from the upper and lower limbs of the sun and moon, define the *umbra*, the moon's dark conical shadow.

Lines drawn to the earth, along opposite edges of the sun and moon, define the *penumbra*, or fainter shadow.



The dark shadow of the moon can never cover more of the earth's surface than an area of about 175 miles in diameter, where the eclipse is total; but in consequence of the earth's motion, this area becomes a continuous belt, as the shadow sweeps over the terrestrial superfices. No total eclipse, therefore, can last longer to any part of the world than 7 minutes 58 seconds.

The fainter shadow covers an area of about 4000 miles in diameter; and the eclipse becomes less extensive within it with the distance from the area where it is total.

As a general rule, subject to many modifications, it may be observed, that places from 200 to 250 miles from the central point of a total eclipse, will have the sun 11 digits eclipsed; from thence to 500 miles, 10 digits; and 1 digit less for every additional 250 miles. A digit is the twelfth part of the solar or lunar disk.

III. When the sun is at his least distance from the earth, and the moon at her greatest, the lunar shadow will not reach the earth's surface by 20,000 miles; and it will fall short of it also when the sun and moon are at their mean distances. In either case, when the moon is directly between the earth and the sun, the moon will be unable to cover the entire face of the luminary, and it will be seen surrounding her dark body in the form of a ring, constituting an annular eclipse.

The greatest possible duration of an annular eclipse is 12 minutes, 24 seconds. This is a somewhat rare phenomenon. The last that was visible in this country occurred October 9, 1847. It was annular to the south of Ireland; to the south of England, below a line drawn from Gloucester to Canterbury; and to part of the north of France. In this country the weather was not favourable for observation.

IV. As the moon passes in every revolution between the sun and the earth, at the time of new moon, there would be a solar eclipse every month, if the plane of her orbit coincided with that of the earth. But the moon's orbit ascends and descends to an angle of 5° in relation to the earth's, crossing it at two opposite points, or her nodes, and she must be at or near one of these, when between the earth and the sun, for a solar eclipse to transpire. If not at or near one of her nodes, when in conjunction with the sun and the earth, she is either a little above or below a direct line from the one to the other, and her shadow is projected in space a little above or below the earth.

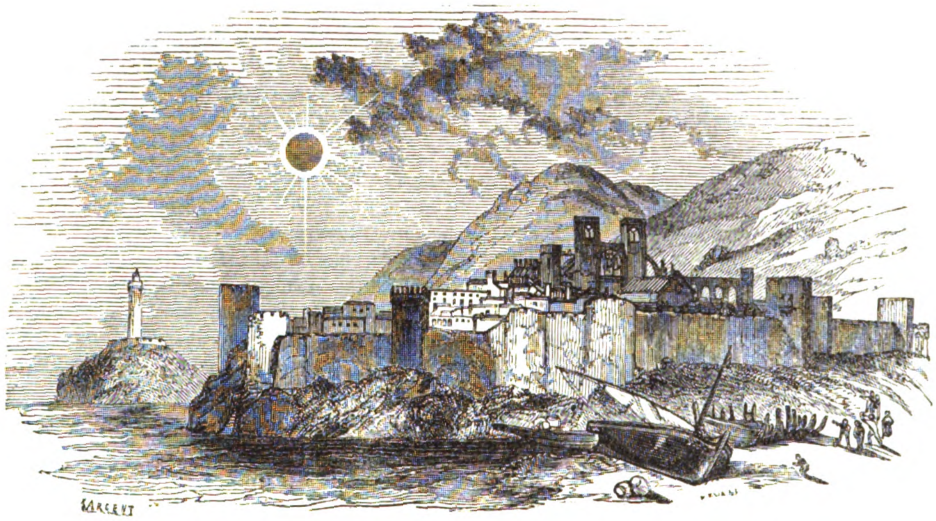
The moon must either be in one of her nodes at the time of conjunction, or within the mean distance of about $16\frac{1}{2}$° on either side of it, for solar eclipses to occur. These are the ecliptic limits, amounting to 33° for each node.

The moon's nodes retrograde at the rate of $19\frac{1}{2}$° every year, returning to the same points after 223 lunations, or about 6585 days, equal to nearly 18 years, 11 days, when the sun, moon, and earth, are again found in the same position with respect to each other. This grand cycle was discovered by the Chaldeans, and, comparing cycle with cycle, their eclipses will nearly correspond for the earth generally, in number, order, and magnitude, amounting to about 70 in each, of which 29 will be lunar, and 41 solar.

The eclipses visible in this country during the present century, in which more than half the solar surface will be impaired, are given in the following table, the time and the number of digits being calculated for the middle of England:—

Years.	Day and Hour.	Digits Eclipsed.	Years.	Day and Hour.	Digits Eclipsed.
1851 . .	July 28 2 P.M. . . .	9° 43′	1870 . .	Dec. 22 11 A.M. . . .	9° 36′
1858 . .	March 15 11 A.M. . . .	11 30	1874 . .	Oct. 10 9 A.M. . . .	6 18
1860 . .	July 18 2 P.M. . . .	9 12	1887 . .	Aug. 19 3 A.M. . . .	11 58
1865 . .	Oct. 19 4 P.M. . . .	7 36	1900 . .	May 28 3 A.M. . . .	8 0
1867 . .	March 6 $8\frac{1}{2}$ A.M. . . .	8 42			

V. The opportunity to view a full solar eclipse but rarely occurs. The appearance which nature puts on is strange and mournful. The light and temperature are considerably affected, the former frequently to such a degree that the brighter stars become visible.

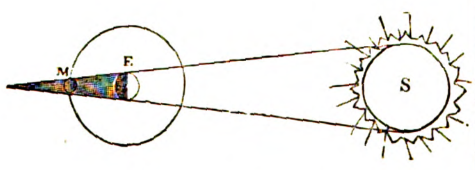


Annular Eclipse.

CHAPTER II.

LUNAR ECLIPSES.

I. Eclipses of the moon are caused by the opaque body of the earth intercepting the solar light, and take place when the moon is full, or in opposition. She then sometimes passes through the earth's shadow and suffers a total obscuration, as represented in the annexed figure.



The earth being so much smaller than the sun deflects a shadow which converges to a point.

The length of the shadow varies with the earth's distance from the sun, but extends at all times to nearly four times the moon's distance from us, or at a mean to 850,000 miles.

The breadth of the shadow, at the distance of the moon, varies also, but can always more than twice comprehend her orb, having a mean diameter of about 5700 miles.

While the earth may eclipse the moon, its shadow, and that of each of the primary planets, always converges to a point before it reaches any other planet, so that not one of the primary planets can eclipse another.

II. A lunar eclipse, like a solar one, would occur every month, at the time the moon is full, or in opposition, but for the inclination of her orbit to that of the earth. Owing to this she escapes the terrestrial shadow by passing above or below it, except when at or near one of her nodes, while in opposition.

If the moon is exactly at the node at the time of opposition, she passes centrally through the earth's shadow and is totally eclipsed. If within 6° of the node, she passes through the shadow, though not centrally, and is also totally eclipsed. If more than 6° and under 12° from the node, she dips only a part of her orb in the shadow, and the eclipse is more or less partial. If just more than 12°, she touches the shadow, and passes it without an eclipse. These are her ecliptic limits, amounting at a mean to 21° about each node.

III. A lunar eclipse cannot last longer than $5\frac{1}{2}$ hours, which includes the time from her first entering the earth's *penumbra* to her quitting it. She cannot remain in the earth's *umbra*, or be partially and totally eclipsed, more than $3\frac{3}{4}$ hours; and she cannot be wholly immersed in it, or be totally eclipsed, more than $1\frac{3}{4}$ hour.

IV. The ecliptic limits of the moon being less than those of the sun, there are not so many lunar as solar eclipses, the ratio being nearly that of two to three; but at any given place, more lunar than solar eclipses will be seen, because an eclipse of the sun can be visible to only a portion of the earth's enlightened hemisphere, while one of the moon may be seen by half the globe.

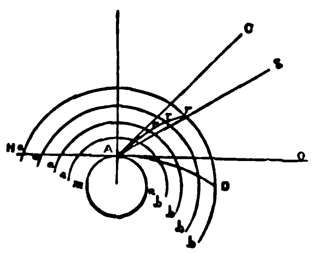
There cannot be fewer than two eclipses in a year, in which case they will be both solar, as in the year 1839. There are sometimes six; there cannot be more than seven; the usual number is four, two of the sun and two of the moon, as in the present year, 1847.

V. The lunar globe, during an eclipse, is not hid from view, owing to the inflexion of the rays of light from the terrestrial atmosphere. The peculiar colour then assumed by the moon, often that of a dark copper and even blood-red hue, arises from the red rays, which have the greatest momentum, principally reaching her.

CHAPTER III.

THE SUN AND MOON AT THE HORIZON.

I. The atmosphere surrounding the earth not being a medium of uniform density, the rays of light from any celestial object are refracted or bent from a straight course in passing through it, and as the density increases with the lower elevation of the atmosphere, the rays of light deviate more and more from a right line towards a curve, in passing to the eye of an observer.



Let *ab, ab, ab, ab*, be strata, or layers of the atmosphere, increasing in density towards *m n*, the surface of the earth. A ray of light from the star S, will be refracted or bent, so as to move in the curve r r r A; and as an object is seen in the direction of the ray that meets the eye, the star which is actually at S will seem to be at C, to a spectator at A. Owing to refraction, which always acts in a vertical direction, objects appear elevated above their real place, and hence a body at D below the horizon H O will be seen as if at O.

The refractive power of the atmosphere was known to Ptolemy, but Tycho Brahe was the first who attempted an estimate of its value, and systematically applied it to correct the observed altitude of the sun, moon, and stars.

II. In the zenith there is no refraction, and a celestial object there is seen in its true position, as if there were no atmosphere. Halfway between the zenith and the horizon, or at the altitude of 45°, the refraction amounts to only $\frac{1}{60}$ of a degree; but at the horizon it is equal to 33′, which is rather more than the greatest apparent diameter of either the sun or moon.

III. Hence it follows, that all the heavenly bodies, except when in the zenith, appear higher than they really are, and are seen for a short time before they rise to the horizon, and also after they have sunk below it. When the sun or the moon's lower limb appears just resting on the horizon, the entire body of either luminary is actually below it, and would be quite concealed by the convexity of the earth, but for the upward bending of the rays in their passage through the air.

It was in consequence of refraction, that, April 20, 1837, the moon appeared to rise eclipsed before the sun had set, which also occurred September 20, 1717. But for refraction, the phenomenon could not possibly have happened, for the three bodies would not have been in a line.

The effect of refraction may be familiarly illustrated by plunging a stick partially into a river, or other collection of water. The stick appears perfectly straight as usual while held upright, because in that position there is no refraction; but let it be inclined, and it appears bent, refraction then taking place.

Or, let any small object, as a piece of money, be placed in an empty basin, as near the centre as possible, and retire to such a distance as just to lose sight of the object. Let water then be poured into the basin, and the object will appear in view. Upon again retiring till it is just no longer seen, and more water being added, the object will again be visible.

The edge of the basin may be supposed to represent the horizon; the water, the atmosphere; and the piece of money, the sun, which is thus made to appear by the power of refraction, when otherwise it would be invisible.

IV. One obvious effect of refraction is to shorten the duration of night and darkness by prolonging the apparent stay of the sun and moon above the horizon. At some periods of the year, the sun appears 5 minutes longer, morning and evening, and about 3¼ minutes longer, as the mean for every morning and evening through the year, than he would do if there were no refraction.

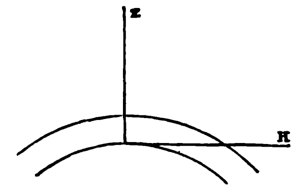
V. Viewed at the horizon from the summit of a mountain, or an eminence by the sea, the sun and moon are often distinctly observed to have a compressed or oval shape. This arises from the unequal refraction of the rays of light proceeding from their upper and lower limbs.

The lower regions of the atmosphere being the densest, have the greatest refractive power. Hence the rays of light from the lower limbs are bent more than those from the upper. The apparent vertical diameter of the sun or moon is thereby diminished, while the apparent horizontal diameter is scarcely affected, as refraction acts only in a vertical direction. They appear, therefore, to lose their circular form, and put on a compressed shape.

The vertical diameter of the solar disk at the horizon, has been found, by micrometrical measurements, to be four, five, and even six minutes of a degree less than the horizontal.

VI. The solar glory at the horizon can be borne by the naked eye without inconvenience, but his meridian splendour is oppressive and intolerable to the unprotected vision. This is due to the absorbent property of the atmosphere, to the rays of light having to pass through a much larger extent of it, and to the medium being much more dense in the one case than in the other.

Rays of light passing from H, the horizon, will embrace a much greater portion of the atmosphere included between the two arcs than rays proceeding from Z, the zenith. Consequently, as the air is an absorbent, a much less quantity will reach the eye from the sun at the horizon than in other positions. It is computed that the solar light, in the circumstances named, is diminished 1300 times from its meridian strength.



VII. At the horizon the sun and moon appear much larger than in other situations, though then, according to the laws of optics, they should appear smaller, being farther away from the eye by the earth's semi-diameter, than if in the zenith. This effect may be due in part to refraction, but is chiefly an optical illusion, caused by the intervening landscape over which they are seen, as, when measured by an instrument, their apparent diameters are not increased at all.

CHAPTER IV.

THE HARVEST MOON AND THE HUNTER'S MOON.

I. The progress of the moon in her orbit from west to east being about 13° daily, she rises at the mean rate of nearly 50 minutes later every day than on that preceding. But in places of considerable latitude, as our own country, this general rule is departed from, especially about the time of harvest, when the full moon rises for several nights only about 20 minutes later than the one preceding. The benefit thus conferred upon the husbandman, in having a greater share of natural light, when employed in reaping and garnering the fruits of the earth, has acquired for the moon, under these circumstances, the title of the harvest moon.

At and near the equator, the moon rises with nearly the equal daily difference of 48¾ minutes throughout the year, and consequently there the harvest moon is unknown.

II. The fact of the moon rising in northern latitudes with different intervals between the times of rising, which is also true of corresponding latitudes in the southern hemisphere, is due to the different angles which her orbit makes with the horizon, some parts of it lying less oblique to the horizon than others. When the angle, or obliquity, is small, a larger portion of the moon's orbit, or of the ecliptic, rises in equal times than when the angle or obliquity is greater.

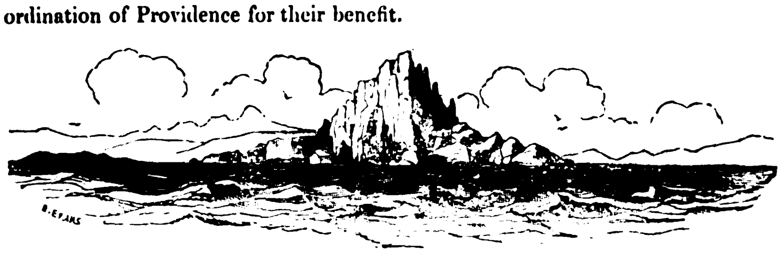
In the latitude of London, for instance, those parts of the moon's orbit, or of the ecliptic, which at their rising make the smallest angle with the horizon, are the signs Pisces and Aries. As much of them rises in two hours as the moon goes through in six days. Hence it follows, that, while the moon is in these signs, she differs but two hours in rising for six days together, or, one day with another, she rises about twenty minutes later every day than on the preceding.

III. As the moon passes through Pisces and Aries every month, it follows that her rising for a week together at nearly the same time is a monthly phenomenon; but it is only in the autumnal months, September and October, that she rises with so little variation as a full moon, and it is her appearance, and the season, that renders the event remarkable. The former is the harvest, and the latter the hunter's moon.

The moon can never be full but when she is opposite to the sun. For the moon then to be full in Pisces and Aries, the sun must be in the opposite signs, Virgo and Libra; and the sun is never in those signs except in our autumnal months.

While in northern latitudes the autumnal full moons are in Pisces and Aries, in corresponding southern latitudes it is just the reverse, because the seasons are so. There, Virgo and Libra rise at as small angles with the horizon as Pisces and Aries do with us; and hence, south of the equator, the harvest moons occur as regularly, but at an opposite period of the year.

IV. The phenomenon of the harvest moon was observed by agriculturists long before it engaged the attention of astronomers, and regarded as a special ordination of Providence for their benefit.



form of the earth, and the unequal attraction of the sun and moon on the unequal masses of matter at the equator and the poles, producing a slow reeling motion of the earth's axis from east to west, and the recession westward of the equinoctial points.

CHAPTER IX.

OBLIQUITY OF THE ECLIPTIC.

I. The obliquity of the ecliptic is the distance between the equinoctial and either tropic measured on a meridian; or it may be defined to be the angle which the plane of the equator makes with the plane of the earth's orbit. The inclination of these planes to each other, upon which the unequal length of day and night, and the succession of the seasons depend, is subject to a very small annual reduction, the tendency of which is to bring the two planes to coincide—that of the equator with the ecliptic.

II. This diminution in the obliquity of the ecliptic is due chiefly to the action of the planets on the earth, principally of Jupiter and Venus, by which the plane of its orbit is drawn nearer to the equinoctial, so that the tropics are not so far distant from it, and the sun does not come so far north of the equator in summer, nor decline so far south in winter, as he must have done several thousand years ago, by nearly a degree.

The amount of the obliquity of the ecliptic has been carefully observed in different ages, with the following results:—

	Date.	Obliquity.		Date.	Obliquity.
Eratosthenes	230 B.C.	23° 51′ 20″	Cassini	1655 A.D.	23° 29′ 15″
Ptolemy	140 A.D.	23 48 45	Flamstead	1690	23 29 0
Albategnius	880	23 35 0	Roemer	1706	23 28 41
Arzachel	1104	23 33 30	Bradley	1750	23 28 18
Ulug Beg	1463	23 30 17	Maskelyne	1800	23 27 56·5
Keppler	1627	23 30 30	Airy	1840	23 27 36·5

Thus in two thousand years, the ecliptic has decreased its angle by only 23′ 43″·5, and is still decreasing it, but the annual amount is almost imperceptible.

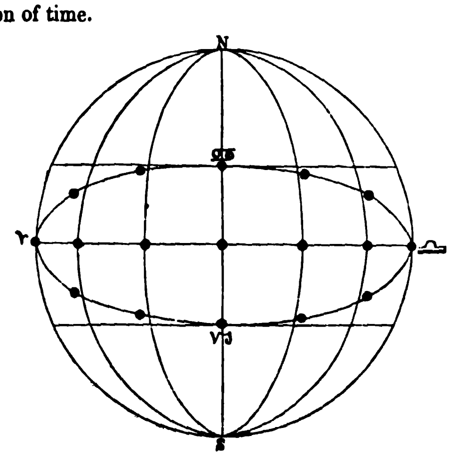
III. However small the rate of diminution in the obliquity of the ecliptic, it is obvious, that if it proceeded without check, the plane of the earth's orbit and that of the equator would at last coincide, the sun be always in the equinoctial, and our seasons be exchanged for a perpetual spring, the days and nights being always equal to each other. It has been found, however, from the theory of gravitation, that the reduction of the obliquity will at length cease, and an increase set in; the action of Jupiter and Venus upon the earth producing an inverse effect, to decrease and again increase, thus oscillating between definite and restricted limits, under control of regular planetary perturbations.

CHAPTER X.

EQUATION OF TIME.

I. It has been already observed, that the intervals between two successive arrivals of the sun on the meridian, are not the same at all times of the year, but sometimes greater, and sometimes less, than 24 hours, as shown by a well-regulated clock. Hence the distinction between apparent or solar time, shown by the sun-dial, and true, or mean, or equinoctial time, given by a clock adjusted by an imaginary sun, supposed to move in the plane of the equator with an equable mean motion. The difference between them, which sometimes amounts to 16¼ minutes, is called the equation of time.

The following figure represents the difference between solar, ecliptic, or apparent time, and mean, equinoctial, or clock time. It will be seen that from Aries to Cancer, the sun in the ecliptic comes to the meridian before the equinoctial sun; from Cancer to Libra after it; from Libra to Capricorn before it; and from Capricorn to Aries after it. Thus, from December 25 to April 16, and from June 16 to September 1, the clock is faster than the sun-dial; from April 16 to June 16, and from September 1 to December 25, the sun-dial is faster than the clock.



II. The following table shows the equation of time at noon, or the interval between the apparent and true noon, or the days on which a clock keeping good time will be an even number of minutes faster or slower than the sun's noon, as shown by a correct sun-dial:

F FAST, S SLOW, MINUTES.

Days.	Min.	Days.	Min.	Days.	Min.	Days.	Min.	Days.	Min.	Days.	Min.
January 2 F	4	March 9	11	May 1	3	August 21	3	October 4	11	Dec. 10	7
4	5	12	10	15	4	25	2	7	12	12	6
6	6	16	9	30	3	29	1	11	13	14	5
8	7	19	8	June 5	2	Sept. 1	0	15	14	17	4
11	8	23	7	11	1	4 S	1	20	15	19	3
13	9	26	6	16	0	7	2	28	16	21	2
16	10	29	5	20 F	1	10	3	Nov. 16	15	23	1
19	11	April 1	4	25	2	13	4	21	14	25	0
22	12	5	3	30	3	16	5	25	13	27 F	1
27	13	8	2	July 5	4	19	6	28	12	29	2
Feb. 1	14	12	1	11	5	22	7	Dec. 1	11	30	3
21	14	16	0	22	6	24	8	3	10		
28	13	20 S	1	31	5	27	9	6	9		
March 5	12	25	2	August 16	4	30	10	8	8		

CHAPTER XI.

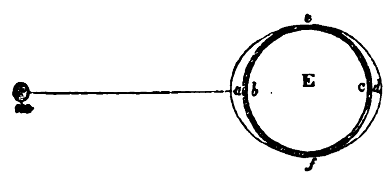
TIDES.

I. The periodical flux and reflux of the waters of the ocean, an important auxiliary to navigation, and to the health of cities visited by the tidal wave, depends upon an astronomical cause, the attractive influence of the sun and moon. The general theory of the tides is very simple in its principle, but complicated in its details by the geographical distribution of land and sea.

The ocean rises, or flows, as it is called, gradually, about six hours; it remains stationary about a quarter of an hour; it then retires, or ebbs, during another six hours, to flow again after a brief repose.

II. The moon is the most potent agent in the production of the tides, owing to her proximity to us. Twice every day, or in the interval between successive returns of the moon to the meridian of a place, which is 24 hours, 50½ minutes, the sea flows and ebbs, but much less towards the poles than within the tropics, the latter zone being more directly exposed to the lunar attraction.

If the earth were surrounded by a uniform mantle of water subject to no external influence, it would uniformly maintain the same level, and lie upon its surface in the form of the shaded zone in the diagram. But let us see what, according to the law of gravitation, will be the effect of the presence of a body like the moon, and is actually exhibited by tidal phenomena.



The attraction of gravitation has reference to all matter, solids and fluids, but may be expected to produce its greatest effect upon the liquid form of it, so susceptible of mobility, yielding to the slightest impression.

Suppose *m* the moon, then, as the force of attraction varies with the distance of the attracting body from the point attracted, it follows, that the particles of water at *a* will be more powerfully acted upon by the moon than those at *e* and *f*, or than the particles of land at the bottom of the water at *b*, these being at a greater distance. The waters, therefore, are drawn towards the point directly opposite the moon by the force of her attraction, and bulge out as in the diagram.

High water is thus produced at *a*, and it is also caused at the same time in the opposite hemisphere at *d*, for the same reasons. The particles of land at *c*, and the earth's centre E, will be more powerfully drawn towards the moon than the waters at *d*, being nearer, and recede from them, producing the same effect as though they receded or rose up from the centre of the earth.

High water is thus produced at *a* and *d*, and as the ocean cannot rise in one place without being correspondingly depressed at another, it is then low water at *e* and *f*.

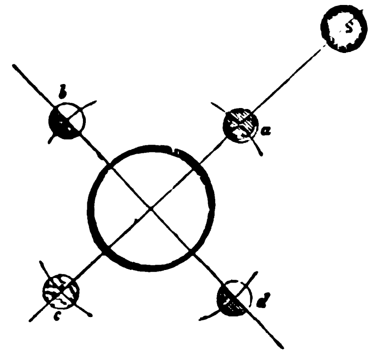
III. The rise of the tide, or high water at any given point, is thus caused by the point in question being in the direct line of the lunar attraction, or the moon passing the superior or inferior meridian of its position, that which cuts the zenith and the nadir. The ebb of the tide, or low water, is caused by the moon being 90° from the zenith and nadir of the place, on a circle which cuts the meridian at right angles, or appearing in the horizon.

As the moon is a month in completing a circuit round the earth, there would only be two tides of flood and ebb every month, if the earth reposed upon its axis. But the diurnal rotation brings the moon daily to the superior and inferior meridian of every part of the globe, producing two daily seasons of high and low water.

It is found, however, by observation, that the time of high water is not precisely coincident with the moon passing the meridian, but about three hours afterwards. The explanation is, that the moon acts with considerable force for some time after she has passed the meridian, and owing to the impulse given to the waters of the ocean they continue to ascend, reaching their maximum elevation when the lunar influence is on the wane.

IV. The attraction of the sun operates in producing the tides, but is feebler than that of the moon, calculated to be about three times less, owing to his greater distance. Sometimes the two bodies act in conjunction, and sometimes in opposition, causing high and low tides.

Let S be the sun, and *a*, *b*, *c*, *d*, the moon in four parts of her orbit.



When the moon is at *b* and *d*, her action and that of the sun are in opposite directions, and to some extent counteract each other. This happens twice a month, when the moon is in quadrature, and then occur the lowest or neap tides.

When the moon is at *a*, as it is new moon, she unites her influence with that of the sun; and this is the case also when she is at *c* or full, for while the sun attracts the waters on the side nearest to him, the moon attracts the earth from them, and while the moon attracts the waters on the side nearest to her, the sun attracts the earth towards him. Hence in these positions of the moon, new and full, we have the highest or spring tides.

But the greatest spring tides are not exactly coincident with the full and change of the moon, nor are the least neap tides coincident with her quadratures. The former occur about 1½ days after the new and full moons; and the latter about 1½ days after her first and third quarters. This is for the same reason that high water occurs after the moon's coming to the meridian.

In addition to this, the highest floods and the lowest ebbs occur at the new and full moon near the equinoxes in March and September, when the moon is in perigee, or nearest the earth.

V. Such is the general theory of those fluctuations to which the waters of the ocean are subject, as far as they depend upon astronomical causes. The actual phenomena, however, are greatly complicated by the varying action of the winds, by oceanic currents, by the inequalities that mark the bed of the sea, and more especially by the irregular intermingling of immense masses of dry land with the waters.

Supposing the earth completely covered with water, the tides would flow from east to west, that being the direction which the moon appears to pursue daily in consequence of our diurnal rotation from west to east. But continents and islands arrest and divert the tidal waves from this course, and peninsulas, headlands, and narrow channels, introduce further complexity, so that to different places the tides flow in different directions, rise to very varying heights, and happen at all distances of the moon from the meridian, or at all hours of the lunar day.

VI. Lakes have no tides, owing to their dimensions being so small, that the moon's attraction is equal to every part, and does not therefore disturb the equilibrium of their waters. Some narrow seas also, as the Mediterranean and the Baltic, undergo very trifling changes of level for the same reason, and because their entrances are so contracted that they cannot receive a sufficient efflux from the tidal waves of the outlying oceans sensibly to raise their surfaces.

CHAPTER XII.

LATITUDE AND LONGITUDE.

I. The latitude of a place on the earth's surface or its distance north or south from the equator, measured on its own meridian, is readily found by taking the elevation of the pole above the horizon, for it is always equal to that elevation.

To mariners and travellers in the northern hemisphere, the polar star is a useful auxiliary in finding the latitude, being about 1° 32′ from the true polar point in the heavens. The navigator, therefore, applies his quadrant to this star, ascertains its altitude, makes the necessary allowance for the polar aberration, and thus obtains his latitude.

At Quito, nearly on the equator, the pole star is scarcely visible, being in the horizon of the spectator. As we proceed northwards from this or any other point, its elevation increases, amounting at Greenwich to 51° 28′ 40″, the latitude of the place.

II. The longitude of a place on the earth's surface, or its distance east or west from any fixed station, the meridian of Greenwich being adopted by English astronomers and geographers, is a more difficult problem. The distance is at once ascertained, if we know the time at our own station, and at the place from which we want to compute our distance, for the difference of an hour earlier or later shows that we are 15° to the west or east of it; and so on proportionably. The whole question of the longitude resolves itself into knowing the difference of time, and to obtain this various methods are adopted.

The exact times at which solar and lunar eclipses, and the eclipses of Jupiter's satellites occur at a given meridian, as that of Greenwich, are calculated and announced several years in advance, and by observing the phenomena, and comparing the hour at the place of observation with that given in the tables, the traveller or mariner arrives at the difference of time, and from thence deduces his longitude.

Again—Lunar distances, or the distances of the moon from particular stars, are calculated beforehand, and set down in the tables according to Greenwich time. If, then, the mariner finds a particular star registered in the "Nautical Almanack" as at such a lunar distance at a certain hour at Greenwich, he observes the hour when this lunar distance occurs, as seen from his ship, and thus obtains the difference of time, and from thence his longitude.

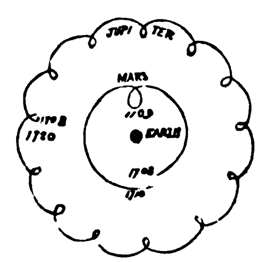
III. The preceding methods are imperfect, because a day or two before and after the change the moon is invisible. Fogs and clouds also may completely obscure the sky; and the rolling of a vessel in boisterous weather renders correct observation often impossible. Hence chronometers, constructed upon the principle of ordinary watches, but fitted up with extreme care, and furnished with a compensator, are now commonly carried out as an additional means of finding the longitude. At the moment of departure the chronometer is set exactly to the time of the meridian of Greenwich, or any other given station, and when accurate time-keepers, as such instruments are made, the mariner has only to take the hour of the place he is in, to compare it with that given by the chronometer as the hour at Greenwich, and he obtains the difference of time, and consequently his longitude.

CHAPTER XIII.

MOTIONS OF THE PLANETS.

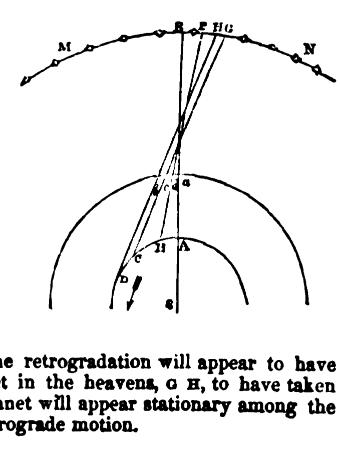
I. The real motions of the planets, or as seen from the sun, are in elliptical orbits from west to east. Their apparent motions, or as seen from the earth, are sometimes direct and sometimes retrograde, or from west to east and from east to west, describing paths the most vexed and unsystematic, spiral loops, complicated curves, and angular movements.

The paths of Jupiter and Mars, at the intervals stated, as observed from the earth, were as roughly represented in the diagram.



II. A planet's motion is said to be direct when to a spectator on the earth it appears to go forwards in the zodiac, according to the order of the signs;—to be stationary, when it appears for some time in the same point of the heavens;—and to be retrograde, when it seems to go backward in the zodiac, contrary to the order of the signs. These apparent irregularities result from the combined prosecution of direct and regular paths on the part of the earth and the planets, but with different velocities.

Let S be the sun; A, B, C, D, part of the earth's orbit in the direction of the arrow; *a*, *d*, *c*, *b*, part of the orbit of a superior planet; M, N, an arc of the celestial sphere.



When the earth is at A, and the planet at *a*, a terrestrial spectator will see it projected to a place in the heavens at E. The angular motion of a superior planet being slower than that of an inferior, when the earth is at B, the planet may be supposed to be at *d*, and its place will be projected in the heavens at F, thus apparently retrograding in the sphere from E to F, while accomplishing the direct movement from *a* to *d*. The next movement of the earth, B, C, and of the planet *d*, *c*, will produce a further retrogradation of the latter in the heavens from F to G. But when the earth has arrived at D, and the planet at *b*, the retrogradation will appear to have ceased, and the direct movement of the planet in the heavens, G H, to have taken place. As both proceed in their orbits, the planet will appear stationary among the stars, then to have a direct, and afterwards a retrograde motion.

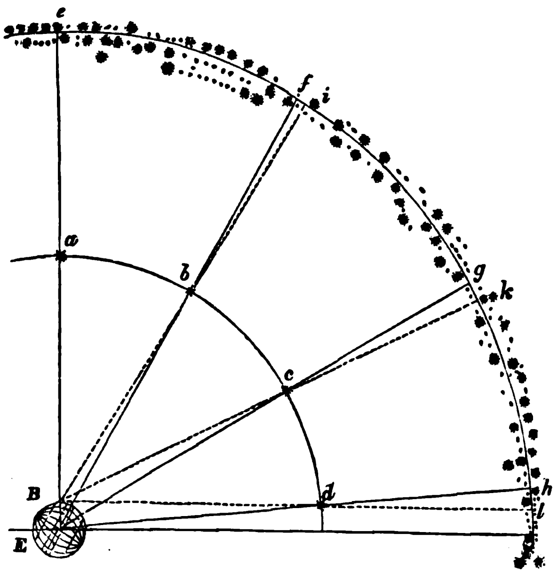
III. Assuming the earth to be the centre of the universe, the foundation principle of the old astronomy, the motions of the planets defied the efforts of all theorists to reduce them into harmony with orderly paths; but their direct, stationary, and retrograde aspects, are resolved into appearances simply, by their common revolution round the sun in connexion with the earth.

CHAPTER XIV.

PARALLAX.

I. Parallax, signifying a change of place, is a change of apparent position of any celestial object, or it is the difference between the true and apparent place of the heavenly bodies.

II. The apparent place of a celestial object is that point of the heavens in which it is seen from the surface of the earth. Its true place is that point of the heavens in which it would be seen from the centre. The difference between the two points is the parallax of the object.



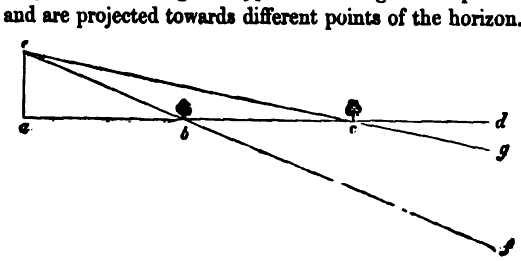
All astronomical observations are referred to the centre of the earth as a general station; and as a heavenly body can only be viewed from the surface, a correction is made for its position, termed a reduction for the centre.

Let E be the earth, and B a position on the surface. From B the heavenly bodies, *a*, *b*, *c*, *d*, will be viewed in the direction of the dotted lines, and be projected respectively to *e*, *i*, *k*, *l*. But these bodies, seen from the centre, would be projected to *e*, *f*, *g*, *h*, which would be their true places. The angles formed by the two lines at *b*, *c*, *d*, are the parallactic angles, and *f*, *i*, *g*, *k* and *h*, *l*, show respectively the parallax.

Hence it follows, that an object in the zenith has no parallax at all, is seen in its true place, in a straight line with the centre of the earth; and that the parallax diminishes in proportion as an object reaches the zenith.

It follows, also, that the true place of a heavenly body not in the zenith is somewhat higher than the apparent place; and hence, in obtaining the true altitude of the sun and moon, to find his latitude at sea, the mariner must add the parallax to the apparent altitude.

III. Parallax, in a more general sense, is the change of apparent situation of an object, produced by a real change of place on the part of the observer. We are familiar every day with this effect; for as we walk or journey, the trees, houses, and hedgerows upon which we gaze, appear to change their place in relation to each other, and are projected towards different points of the horizon.



A spectator at *a*, having two trees before him in the direct line *a*, *b*, *c*, will see both trees projected towards the point *d*. But if he shifts his position to *e*, the nearest tree will be seen in the direction *f*, and the farthest in the direction *g*; and by measuring the base line *a*, *e*, and the respective angles subtended, the distance of the trees from the points of observation, by the rules of trigonometry, is readily obtained.

Now two spectators, at two remote stations on the surface of the earth, observing the sun or the moon, at the same instant, will see either body projected to different points in the sphere of the fixed stars, and by determining accurately the precise quantity of their parallaxes, or the amount of their apparent displacement, their respective distance from the earth, by trigonometrical principles, may be ascertained.

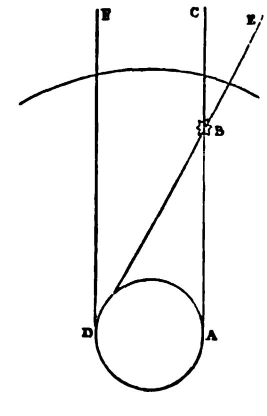
The mean horizontal parallax of the moon can be taken without any difficulty, as it amounts to nearly 1°; but as the greater the distance of any body from the earth the less is its parallax, that of the sun is so exceedingly small as to require the nicest observation, aided by the rare phenomenon of a transit of Venus, to be ascertained with any precision. By the common consent of astronomers it has been settled at the minute quantity of about 0° 0′ 8″·6.

IV. The principles of parallax are important; for when it has been accurately found in relation to any heavenly body, the real distance of the body from the earth follows; and that element obtained, we have only then to measure its apparent diameter, to find its magnitude.

CHAPTER XV.

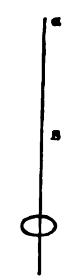
ABERRATION.

I. The aberration of the stars is their apparent motion in a small ellipse, an optical illusion, arising from the earth's revolution in its orbit, and the progressive transmission of light. The phenomenon and its cause are the discoveries of Bradley, who made them while attentively observing a particular star, γ Draconis, in the hope of detecting some parallax, or apparent change of place, arising from its being viewed from opposite points of the earth's orbit, separated from each other by its entire diameter, or 190,000,000 miles. He found no parallax of the star, but discovered the aberration.



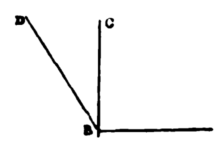
Suppose the circle A D the orbit of the earth, and B the star γ Draconis. When the earth is at A, the star will be seen in the direction B C; but when the earth is at D, if there were any sensible parallax, the star would be seen in the direction B E. The observed appearance, however, was that of the star seen from A in the direction C, appearing from D in the direction F. Thus the apparent change of place was opposite to what would have been the result of parallax, caused by the earth's motion alone.

The next diagram represents the apparent annual course of γ Draconis, and other stars similarly situated, near the zenith. Suppose the line *a* bent overhead, B being the zenith, and *a* the pole. The ellipse is the apparent annual movement of the star, the transverse diameter of which is about 40″.



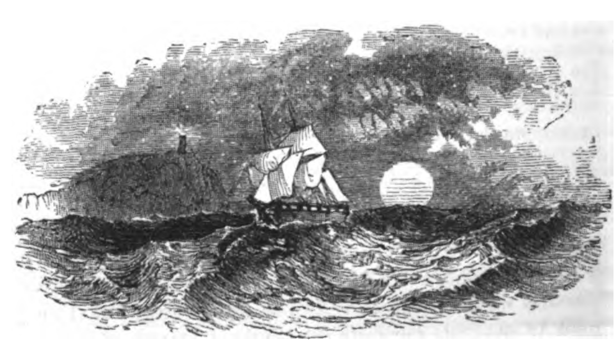
II. To this apparent motion the term aberration is applied, but not with strict accuracy, as the movement is not irregular but uniform. It long foiled sagacity to discover the cause of this effect, but at length it was satisfactorily explained to result from the progressive motion of light combined with that of the earth in its orbit.

Let an observer be supposed to move from A to B in the same time that a ray of light passes from C to B. The impression of the ray of light meeting the eye at B, owing to the combined motions, will be exactly similar to what it would have been if the eye had been at rest at B, and the molecule of light had come to it in the direction D B. The star, therefore, from which the ray of light proceeds, whose real place is at C, will appear in the direction D to the observer at B.



A precisely similar effect takes place when a person moves rapidly through a perpendicular shower of rain. If he stood still, the drops would fall upon his hat; but, owing to his motion, they beat against his face, as though they fell obliquely, and not from the zenith. Now, as an object is seen in the direction in which the rays of light impinge upon the eye, a star in the zenith will appear at a little distance from it to a spectator carried along with the earth in its orbit.

III. The aberration of the stars is a fact of great importance, as it is the only sensible evidence we have of the earth's translation in space. With its discovery the locomotion of our planet became a demonstration.



THE SIDEREAL HEAVENS.

CHAPTER I.

THE FIXED STARS.

I. Under the denomination of fixed stars, those celestial bodies are included, which, while partaking in the apparent diurnal revolution of the sphere, seem to maintain invariably the same positions in relation to each other.

The denomination is, strictly speaking, inaccurate, for many of the stars have their own proper motions; but they are so exceedingly slow and small that their detection and estimate belong to the refinements of astronomy, so that for all general purposes the received phrase is sufficiently correct.

II. The apparent immobility of these bodies renders them of immense service to mankind, as celestial guide-posts to the traveller in the desert, where there are no land-marks to direct his way, and to the mariner at sea to find his longitude.

For this latter purpose, nine conspicuous stars are chiefly used, conveniently situated in relation to the moon's path in the heavens :—*a* Arietis, Aldebaran, Pollux, Regulus, Spica Virginis, Antares, Altair, Fomalhaut, and Markab. Their lunar distances, at certain hours of the day for several years to come, are calculated for the meridian of Greenwich, and by comparison of his own observations with the tables, the seaman finds his distance from that meridian.

III. The fixed stars are divided into classes according to their magnitudes, ranging from the first down to the sixteenth; but all after the sixth magnitude are invisible to the naked eye.

Within reach of a practised eye, there are in both hemispheres, about the following number of stars:

First magnitude	20 stars	Fourth magnitude . . .	500 stars
Second	70 „	Fifth	690 „
Third	220 „	Sixth	1,500 „
			—Total 3,000.

IV. The stars have, however, no appreciable magnitude at all, remaining mere points of light, without any apparent diameter, under the mightiest telescopic power. They vary simply in brightness, and appear much brighter when viewed through a telescope; and hence it would be more proper to compare them with each other by brightness, not by magnitude.

V. To facilitate reference to the heavens, the stars are arranged in constellations, or groups; a convenient practice, analogous to the civil divisions of the globe into countries and states. The arrangement has, however, been more the work of fancy than of judgment. The stars have been grouped into outlines of men, animals, and dragons, to which the particular stellar clusters have no natural resemblance; and hence we have constellations involved, and running into each other in the most irregular manner.

The formation of the constellations has been the work of different periods, but the greater part were produced in very ancient times. Aratus, a Cilician from Eudoxus, B.C. 370, a cotemporary of Plato, enumerated 45 as then in use, all of which are now depicted on our celestial globes, the 12 zodiacal, with 20 in the northern, and 13 in the southern hemisphere.

Ptolemy gives the next enumeration, which includes the preceding, and three additional, one northern and two southern constellations, making 48.

Large accessions have since been made, maritime discovery having led to a full acquaintance with the southern heavens, of which the Greeks and Romans had only a partial knowledge. Lacaille, in 1751, went to the Cape of Good Hope to catalogue the southern stars, and form them into constellations; and by Hevelius and others, some stars of the northern hemisphere, not included in the ancient groups, have been formed into new ones.

VI. Prominent stars in the heavens received from the Greek and Arabian astronomers particular names, which are still popularly retained—as Sirius, Arcturus, Rigel, Capella, Markab, &c.; but in scientific works the stars in each constellation are denoted, according to their brightness, by Bayer's characters, consisting of the letters of the Greek and Roman alphabets, and of numerals.

Thus α designates the most brilliant star of a group, β the next, γ the third, δ the fourth, &c. When these are exhausted the Roman letters *a*, *b*, *c*, *d*, &c., are used; and when these fail, the numerals 1, 2, 3, 4, &c., are employed.

The relative brightness of the stars of a particular group, and not of the heavens in general, is thus indicated. Hence γ, Virginis, is equal in brightness to α, Aquarii.

VII. This nomenclature of the stars was first proposed by John Bayer, of Augsburg, in Suabia, in the year 1603, and has been generally followed.

CHAPTER II.

ZODIACAL CONSTELLATIONS.

I. The constellations in the zodiac are twelve in number. In the following table the number of the stars in each is given, and the principal are mentioned with their magnitude. The right ascensions and declinations refer to the middle of the several constellations. The name Aratus signifies merely that they are in his list:

CONSTELLATIONS.	AUTHOR	NO. OF STARS.	PRINCIPAL STARS.	MAGNITUDE.	RT. ASC.	DEC.
Aries, the Ram	Aratus.	66	*a* Arietis. Sheratan.	2·3	34	18 N.
Taurus, the Bull	„	141	Aldebaran, Pleiades, Hyades.	1	62	18 „
Gemini, the Twins	„	85	Castor, Pollux.	1·2	106	25 „
Cancer, the Crab	„	83	Acubens.	3	128	20 „
Leo, the Lion	„	95	Regulus, Denebola.	1·2	155	15 „
Virgo, the Virgin	„	110	Spica Virginis.	1	192	3 „
Libra, the Balance	„	51	Zubenich Meli.	2	225	15 S.
Scorpio, the Scorpion	„	44	Antares.	1	242	26 „
Sagittarius, the Archer	„	69	... ...	... ...	285	32 „
Capricornus, the Goat	„	51	... ...	... ...	312	20 „
Aquarius, the Water-Bearer	„	108	Scheat.	3	332	9 „
Pisces, the Fishes	„	113	... ...	... ...	5	10 N.

II. Aries has two conspicuous stars in the head of the ram, about 4° apart They are the nautical star α Arietis, called Hamal by the Arabs, of the second magnitude, and Sheratan of the third. Bright stars in pairs, but one brighter than the other, are common. Owing to the precession of the equinoxes, as before stated, the constellation Aries is now in the sign Taurus, while the constellation Pisces is in the sign Aries; but 2,000 years ago, the zodiacal asterisms and signs corresponded. Hence some ancient representations depict the equinoctial colure intersecting the stellar ram.

III. Taurus, one of the finest of the zodiacal asterisms, is just rising in the east, when Aries is 27° high. It includes Aldebaran, a star of the first magnitude, forming with the Hyades the letter V on the face of the bull, and the well-known cluster of the Pleiades on the shoulder.

CONSTELLATIONS.	AUTHOR.	NO. OF STARS.	PRINCIPAL STARS.	MAGNITUDE.	RT. ASC.	DEC.
*Phœnix	Bayer.	13	...	...	10	50 S.
*Apparatus Sculptoris, the Sculptor's Apparatus	Lacaille.	12	...	...	5	32 ,,
Eridanus Fluvius, the River Po	Aratus.	84	Achernas.	1	60	30 ,,
*Hydrus, the Water Snake	Bayer.	10	...	...	33	70 ,,
Cetus, the Whale	Aratus.	97	Menkar, Mira.	2·2	25	12 ,,
Fornax Chemica, the Chemist's Furnace	Lacaille.	14	...	...	42	30 ,,
*Horologium, the Clock	,,	12	...	...	40	57 ,,
*Rheticulus Rhomboidialus, the Rhomboidal Net	,,	10	...	...	60	62 ,,
*Xiphias Dorado, the Sword Fish	Bayer.	7	...	...	75	62 ,,
*Celapraxitels, the Engraver's Tools	Lacaille.	16	...	...	68	42 ,,
Lepus, the Hare	Aratus.	19	...	...	80	20 ,,
Columba Noachi, Noah's Dove	Halley.	10	Phaet.	2	85	35 ,,
Orion	Aratus.	78	Betelgeux, Rigel, Bellatrix, Saiph.	1·1·2·3	82	0
Argo Navis, the Ship Argo	,,	64	Canopus, Miaplacidus, Naos.	1·1·2	115	50 S.
Canis Major, the Great Dog	,,	31	Sirius, Mirzam.	1·2	100	24 ,,
Equuleus Pictoris, the Painter's Easel	Lacaille.	8	...	...	80	55 ,,
Monoceros, the Unicorn	Hevelius.	31	...	...	110	2 ,,
Canis Minor, the Little Dog	Ptolemy.	14	Procyon, Gomelza.	1·2	112	5 N.
*Chamæleon	Bayer.	10	...	...	165	78 S.
Pyxis Nautica, the Mariner's Compass	Lacaille.	4	...	...	132	30 ,,
*Piscis Volans, the Flying Fish	Bayer.	8	...	...	127	68 ,,
Hydra, the Serpent	Aratus.	60	Cor Hydræ.	1	139	10 ,,
Sextans, the Sextant	Hevelius.	41	...	...	155	0
*Robur Carolinum, the Oak of Charles II.	Halley.	12	...	...	159	60 S.
Antlia Pneumatica, the Air-pump	Lacaille.	3	...	...	150	35 ,,
Crater, the Cup	Aratus.	31	Alker.	3	168	15 ,,
Corvus, the Crow	,,	9	Algorab.	3	183	18 ,,
*Crux, the Cross	Royer.	6	...	...	183	60 ,,
Apis Musca, the Southern Fly	Bayer.	4	...	...	185	68 ,,
*Avis Indica, the Bird of Paradise	,,	11	...	...	245	76 ,,
*Circinus, the Compass	Lacaille.	4	...	...	220	64 ,,
Centaurus, the Centaur	Aratus.	35	...	...	195	48 ,,
Lupus, the Wolf	,,	24	...	...	230	45 ,,
Norma, vel Quadra Euclidis, Euclid's Square	Lacaille.	12	...	...	242	45 ,,
*Triangulum Australis, the Southern Triangle	Bayer.	5	...	...	238	65 ,,
*Ara, the Altar	Aratus.	9	...	...	256	64 ,,
*Telescopium, the Telescope	Lacaille.	9	...	...	278	53 ,,
Corona Australis, the Southern Crown	Ptolemy.	12	...	...	278	40 ,,
*Pavo, the Peacock	Bayer.	14	...	...	302	68 ,,
*Indus, the Indian	,,	12	...	...	315	55 ,,
Microscopium, the Microscope	Lacaille.	10	...	...	310	37 ,,
*Octans Hadliensis, Hadley's Octant	,,	43	...	...	310	80 ,,
*Grus, the Crane	Bayer.	14	...	...	330	47 ,,
Toucan, the American Goose	,,	9	...	...	359	66 ,,
Piscis Australis, the Southern Fish	Aratus.	24	Fomalhaut.	1	335	32 ,,
*Mons Mensa, the Table Mountain	Lacaille.	30	...	...	76	72 ,,

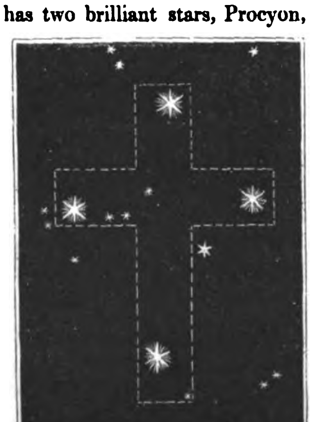
Those marked * are not visible in the latitude of London.

The parallelogram is intersected in the middle by three stars of the second magnitude, in a straight line about 3° in length, running from north-west to south-east. These form the belt of Orion, otherwise called the Three Kings. The uppermost, or most northern star of the belt, called Mintika, being less than ½° S. of the equinoctial, is almost exactly vertical to the equator.

South of the belt there is another row of stars in an oblique direction, of the fourth and fifth magnitude, forming the sword of Orion.

The belt and sword are popularly called the Yard and Ell, because a line joining the three stars of the former is 3° in length, and is divided by the central star into two equal parts like a yard-stick, and because the stars of the latter form a line which is 1¼ the length of the yard.

III. Canis Major, on the south-east of Orion, contains one star of the first magnitude, four of the second, and two of the third, the former, Sirius, glowing in our winter hemisphere with a lustre unequalled by any other star in the firmament, being apparently the largest and nearest of the stellar orbs. Canis Minor, east of Orion and north of Canis Major, has two brilliant stars, Procyon, of the first magnitude, and Gomelza, of the second, on the S.E., about 4° distant.



Procyon is a Greek compound, signifying *ante canis*, or "before the dog," referring to its rising above the horizon before Sirius, the dog-star.

IV. Of all the southern constellations, the Cross, invisible in our latitude, is the most interesting to the mariner on account of the sacred emblem to which it has been referred, and also its real use in navigation. It consists of four bright stars, so disposed as readily to admit of the cruciform configuration assigned to them. The three lower are immersed in the Milky Way. The upper and the lower are the Pointers to the south pole.

CHAPTER V.

NUMBER OF THE STARS.

I. By adding together the numbers given in the preceding tables, the sum will be found to be 1016 stars in the zodiacal constellations, 1456 in those of the northern, 1995 in those of the southern hemisphere,—making a grand total of 3467. These are not all visible to the naked eye, but they are those whose declination and right ascension have been accurately determined, and inserted chiefly in Flamstead's catalogue. Taking the whole heavens, there are not more than 3000 which can be reached by the keenest eye without instrumental aid, and consequently not more than 1500 from the same station.

On gazing at the heavens, the impression made upon the mind is that of a much larger number of stars being visible to the eye than that stated above. But their disorderly position, with their twinkling, completely deceives the sight. The impression is soon corrected by an attempt to count them.

The twinkling of the stars arises from the molecules of the atmosphere constantly undergoing sudden compressions and dilatations, which produce changes in its refractive power, and consequent changes in the direction of the rays of light, apparently every moment displacing the stars. From the tops of high mountains the scintillation is less, from the greater rarity of the atmosphere.

II. Directing a telescope to the heavens almost indifferently, a multitude of stars, invisible to the eye, is revealed, realising the common optical impression of their infinite number. Every increase of instrumental power increases the catalogue of stars in every asterism.

The undermentioned constellations, in different catalogues, stand as follows:

	Ptolemy.	Tycho Brahe.	Hevelius.	Flamstead.	Bode.
Aries	18 stars.	21 stars.	27 stars.	66 stars.	148 stars.
Ursa Major . .	35 ,,	56 ,,	73 ,,	87 ,,	338 ,,
Boötes . . .	23 ,,	28 ,,	52 ,,	54 ,,	319 ,,
Leo	35 ,,	40 ,,	50 ,,	95 ,,	337 ,,
Virgo . . .	32 ,,	39 ,,	50 ,,	110 ,,	411 ,,
Taurus . . .	44 ,,	43 ,,	51 ,,	141 ,,	394 ,,

The extreme number of visible stars in Orion is not more than 60, but Galileo found 80 in the belt with his imperfect instrument, and 500 in another part within the compass of one or two degrees; upwards of 2000 have been counted within the trapezium, or unequal square of Orion.

Examining the Milky Way with his telescope, Herschel counted no less than 588 stars in the same field of view; and in a space of the zone not more extensive than 10° long by 2½° wide, he computed that there could not be less than 258,000.

III. Professor Bessel, of Konigsberg, observed in three years between 30,000 and 40,000 stars included within a zone of 15° on each side of the equator. This same zone was parcelled out among twenty-four observers for examination, at the recommendation of the Berlin Academy, each confining himself to 15° of right ascension, and surveying it in minute detail. Professor Inghirami, of Florence, took the eighteenth division, comprehended between right ascension 255° and 270°, and determined the positions of 75,000 stars in it. Upon the whole, it is estimated that there are not fewer than 100,000,000 of stars within the range of the telescope.

CHAPTER VI.

DISTANCE AND MAGNITUDE OF THE STARS.

I. Upon the principle of an annual parallax, astronomers have attempted with great assiduity to approximate at least to the nearest of the fixed stars, but not until very recently with any success.

For this purpose it is necessary to employ the longest measure that astronomy can use, or the whole diameter of the earth's orbit, amounting to 190,000,000 miles. This being taken as a base line, and the angular bearing from us of some star being observed at intervals of six months, when the earth has actually shifted its place from one end of the base line to the other, the grand question to be solved is, the change in the angular bearing of the star, if any, and its amount, occasioned by this vast shift of the post of observation. Till lately, not the smallest appreciable quantity of parallax, or apparent change of position, could be detected with the most perfect instruments, so that instead of any angle being formed by a star, when viewed from points 190,000,000 miles apart, the star appeared in the same point of the heavens during the earth's annual course round the sun, and the same straight line in both cases would describe its direction.

II. Dr. Bradley made a series of observations on γ Draconis, a star which, when on the meridian, is nearly in the zenith of London, but could only infer that its annual parallax did not amount to 1″, or to $\frac{1}{3600}$ of a degree, otherwise it must have been detected by his instruments. For the same purpose, a zenith-micrometer was erected a few years ago at Greenwich to observe the same star, but no parallax could be discovered.

Supposing the parallax of the star to be exactly 1″, then knowing the length of the base line, 190,000,000 miles, any schoolboy may compute the distance. As the sine of the star's parallax 1″ : is to radius, or 90° :: so is the semi-diameter of the earth's orbit, or 95,000,000 miles to the distance of the star; or as 0·0000048481368. nat. sine of 1″ : is to 1·0000000000000, nat. sine of 90° :: so is 95,000,000, semi-diameter of earth's orbit : to 19,000,000,000,000 star's distance. But the star had not this amount of parallax, and consequently was more than 19 billions of miles distant.

III. In order to discover an annual parallax, Professor Bessel took the star 61 Cygni in hand, in 1834, and continued observations upon it through four years, which commonly amounted to sixteen every night. He ascertained its parallax to be 0″.3136, somewhat less than one-third of 1″, which gives it a distance of 657,700 semi-diameters of the earth's orbit, or nearly 62½ billions of miles.

Light, which flies to us in 8 minutes from the sun, would require more than 10 years to dart across this space. A single hair placed before the eye of a spectator at that distance would hide from view the whole solar system.

61 Cygni is a star of the 5th mag. in the right wing of the Swan, passing the meridian near the zenith.

IV. Respecting the magnitude of the stars, we have nothing whatever to guide us beyond the fact of their visibility when so vastly remote. From experiments upon the light of Sirius, it is inferred, that regarding the star at the least supposable distance, it must be equal to two of our suns, and is, in all probability, vastly greater.

CHAPTER VII.

LOST, NEW, AND TEMPORARY STARS.

I. In a number of instances, stars whose places have been registered in the catalogues, have subsequently disappeared, and have not since been recovered. Losses of this kind may no doubt be apparent only, there having been a mistaken entry; but in many cases, stars whose positions have been marked with precision, are no longer to be found.

Montanari observed in 1664 two stars of the 2nd mag. in the stern and yard of the ship Argo, but in 1668 he could not obtain the least glimpse of them.

55 Herculis in Flamstead's catalogue, of the 5th mag., was particularly observed by Herschel in 1781 and 1782, but nine years afterwards it was gone, and has not since been seen.

In 1828, Sir John Herschel missed a star in Virgo, inserted in Baron Zach's catalogue, and has never been able to perceive it.

II. Some stars, on the other hand, appear to be new, as no entry of them occurs in the catalogues of former observers, who have registered objects of inferior magnitude in their vicinity, and would scarcely have omitted these had they been present.

A star in the head of Cepheus, one in Gemini, another in Equuleus, a fourth in Sexstantis, a remarkable one between β and δ Hydræ, a sixth in Hercules, and several others, are not in Flamstead's catalogue, and are probably new. Since 1826 a star has appeared in the great nebula of Orion.

III. Temporary stars are those which appear in the heavens and vanish, after shining with more or less lustre for a time, of which there are several well-authenticated cases on record.

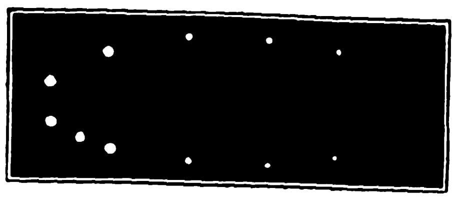
Instances of stellar apparition occurred in the years 389, 945, and 1264 of our era; but the most remarkable appeared in 1572, which had Tycho Brahe, Cornelius Gemma, and Keppler for its observers.

The star was seen by Cornelius Gemma on November 9th, and by Tycho on the 11th. The Dane was walking across the fields home, about 10 o'clock at night, when he first observed it, and he met with a group of peasants gazing at the object. It shone with great brilliancy, so as to cause Tycho's staff to deflect a shadow. It continued visible eighteen months, remained unaltered in its place in the heavens, exhibited no sensible parallax, which plainly fixed its position in the region of the fixed stars. Before it vanished, in March 1574, the star gradually waned in lustre, and changed in colour from a white to a yellow hue, afterwards had a fiery tinge, like Mars, and became livid, like Saturn. It appeared in Cassiopeia, immediately under the scabellum, or chair, of the lady, forming an irregular square with the three principal stars of the constellation, (as in the diagram.) The largest star is the stranger; above it to the left is Caph; the upper star to the right is Schedis; the lower is γ Cassiopeiæ; together composing a trapezium.

Another temporary star appeared in 1604, in which year Saturn, Mars, and Jupiter were in conjunction, an event which attracted general attention. It was first noticed, September 30, by Keppler's scholars, near Jupiter, far surpassing the planet in magnitude, and equal to Venus in splendour. Owing to unfavourable weather at Prague, Keppler himself did not obtain a view of it till October 8. It appeared in Serpentarius, had no parallax, exhibited various colours, and finally vanished after an apparition of twelve months.

A third example of a temporary star, in Cygnus, was witnessed by Hevelius and Don Anthelme, in 1670, which continued two years.

IV. Lost, new, and temporary stars, are among the mysteries of the universe. In relation to the latter, Laplace and others have conceived that they are bodies hid from terrestrial gaze by their remoteness, which some vast conflagration brings into sudden and transient visibility. The idea has, however, been started, that they are subject to a periodical translation from the depths of space, moving in immensely elliptical orbits, (as in the diagram,) at one extremity of which they become visible to us, and then retire from view. The temporary stars of 945, 1264, and 1574, are also supposed to have been returns of the same stars, on the ground of the close accordance of the intervals between them.



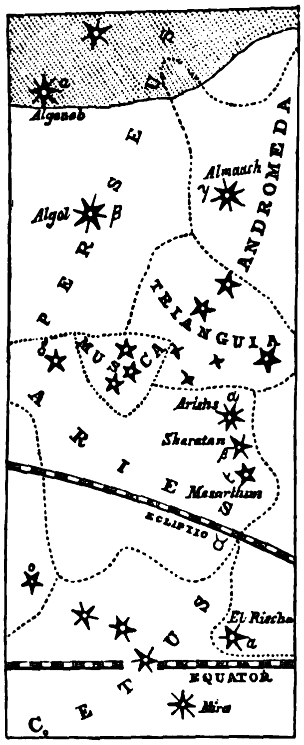
From 945 to 1264 = 319 years. | From 1264 to 1572 = 308 years.

The temporary stars of these years all appeared in Cassiopeia, and if the hypothesis be correct, another apparition may be expected towards the close of the present century. But it labours under the difficulty of no change of place having been observed during their visibility.

CHAPTER VIII.

VERSATILE STARS.

I. Stars whose light undergoes periodical mutations, regularly waxing and waning, form the class called versatile or variable. Some fade away into complete obscurity for a time, while others merely have their brightness reduced without being hid from view.



Algol, a variation of *Al-ghúl*, the monster or demon, the name of the star β Persei, in the head of Medusa, is one of the most remarkable of this class. Montari first observed its variableness; Maraldi, in 1694, ascertained the amount; and Mr. Goodricke, of York, in 1782, accurately fixed the period of its changes. Algol, at the brightest, is a star of the second magnitude. It continues so 2 days, 14 hours. Then its light suddenly diminishes, and in 3½ hours it is reduced to the fourth magnitude. It remains at the feeblest a little more than 15 minutes. It then begins to increase, and in 3½ hours more is restored to its former aspect, thus going through its changes in 2 days, 20 hours, 48 minutes. The star may be clearly seen on any fine evening from August, through the winter months, to May.

ο Ceti, otherwise called Stella Mira, the "wonderful star," is another extraordinary object of the same class, in the middle of the Whale's neck, first noticed by Fabricius, in 1596. Its general phases are, that of a star of the second magnitude for about 14 days, diminishing during 3 months, passing entirely out of sight, remaining invisible about 5 months, again coming into view, and gaining in 3 months more its maximum brightness. Its cycle of change occupies 331 days, 10 hours, 19 minutes; but its period of invisibility is sometimes longer, and it does not always return to the same degree of brightness. The relative positions of Algol and Stella Mira are indicated in the cut.

II. About twenty stars are ascertained to be versatile, but a much greater number are suspected to belong to the class. The following contains the more prominent in our hemisphere, with their amount of change, and periods of variation:

Stars.	Periods.	Diff. of Mag.	Authority.
ο Ceti (Mira)	331 d. 10 h. 19 min.	2 to 0	Herschel, W.
β Persei (Algol) . . .	2 20 48	2 to 4	Goodricke.
η Antinoi	7 4 15	3 to 5	Pigot.
χ Cygni	396 21 0	6 to 10	
γ Hydræ	490 0 0	3 to 10	
ψ Leonis	Several years.	6 to 0	
κ Sagittarii	Ditto.	3 to 6	
18 Leonis	311 23 0	5 to 10	
δ Cephei	5 8 30	3 to 5	Goodricke & Pigot.
β Lyræ (Sheliak) . . .	6 10 34	3 to 5	Goodricke & others.
α Herculis (Ras Algethi)	60 6 0	3 to 4	Herschel, W.

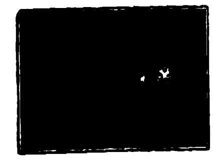
III. These singular appearances are accounted for, by supposing a rotating body to have one of its hemispheres less luminous than the other, or non-luminous, which upon being presented to us in the course of rotation, produces the periodical decay of light, or absolute invisibility, observable.

CHAPTER IX.

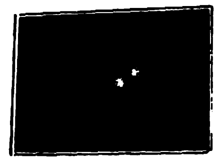
MULTIPLE STARS.

I. Upon directing a telescope of considerable power to the heavens, stars which appear to be single objects to the naked eye are found to be compound, consisting of two or more individuals. In the northern hemisphere alone, and within 15° S. of the equator, the number of stars whose multiple character has been determined, cannot be rated at less than 6000.

II. Binary stars, or combinations of two, are the most numerous, of which Castor, η Coronæ, Rigel, Polaris, Mirac, γ Leonis, γ Virginis, ξ Ursæ Majoris, α Herculis, 36 Andromedæ, λ Ophinchi, and π Aquilæ, are examples.


Castor.

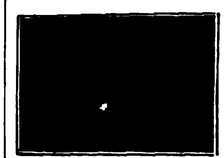
Castor, or α Geminorum, is the most northerly of the two bright stars in the head of the Twins. It easily separates into two constituents, of the third and fourth magnitudes, at present about 3″ apart.


η Coronæ.

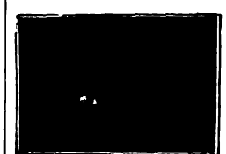
η Coronæ, half-way between the club of Boötes and the Northern Crown, is not separable but with the most powerful instruments, and under favourable circumstances. Herschel discovered its compound character in 1781, since which time its constituents have completed more than one revolution round each other.


β Rigel.

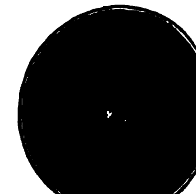
Rigel, or β Orionis, the well-known star in the right foot of Orion, whence the name from the Arabic, *Rijl-al-jauzá*, the Giant's leg, consists of one large and brilliant object, with a minute companion.


Polaris.

Polaris, the pole-star, resolves into two of very unequal size, one appearing a mere point in comparison with the other.

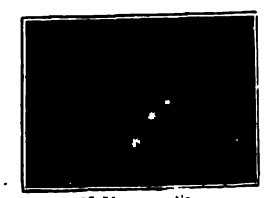

ε Bootis.

Mirac, or ε Boötis, on the herdsman's left hip, about 10° N. E. of Arcturus, is one of the loveliest objects in the heavens, owing to the distinct and strongly contrasted colours of the two stars composing it, one being a pale orange, and the other a sea-green. Hence Struve calls this star *pulcherima*.


γ Leonis.

γ Leonis, about 7½° N.E. of Regulus, is another striking double star.

III. Triple stars, or combinations of three individuals, are not uncommon. Eleven sets of bright triple stars are specified by Struve in a very small space of the heavens.


Π Monocerotis.

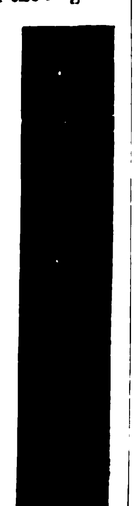
Π Monocerotis, in the unicorn's right fore-foot, is a triplicate discovered by Herschel in 1781. ξ Libræ is another example of a ternary system.

IV. Quadruple stars, combinations of four individuals, consisting of two double stars, have also been detected, and even combinations of five individuals, constituting quintuple.


ε Lyræ.

ε Lyræ is an example, an irregular looking star, visible to the naked eye, 1½° N.E. of Vega in the Lyræ. It separates into two stars with the slightest optical aid. Each of these becomes binary under a higher power; and between the pairs are three small stars forming a curve to the south, as in the diagram, constituting a septuple system.

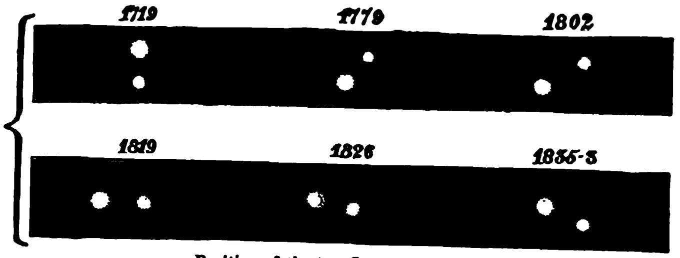
V. With reference to the compound stars, it was at first supposed that no mutual connection subsisted between their constituents, but that they appeared double and triple, owing to one star lying at an immense distance behind another, and nearly upon the same straight line with the eye. The effect of beholding the two stars represented in the lower part of the diagram, upon nearly the same straight line, is shown by the immediately contiguous stars in the upper part. But this explanation is rendered untenable by the excessive prevalence of the multiple arrangement, and by evidence of the real connection of respective constituents.



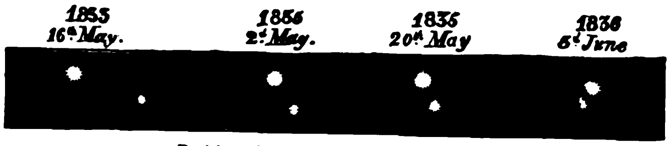
VI. The components of the binary stars, closely watched through a series of years, are found to change their respective positions, and to repeat the same cycle of change, thus demonstrating their real relation and systematic union.

The relative positions of the two stars of Castor, at the periods named; and of the two stars respectively which compose γ Virginis, and ξ Ursæ Majoris, are shown in the annexed cuts. This is unquestionable evidence of orbital motion, the revolution of suns around suns, each probably attended by a train of planets, the smaller moving around the greater, or both around a common centre of gravity.

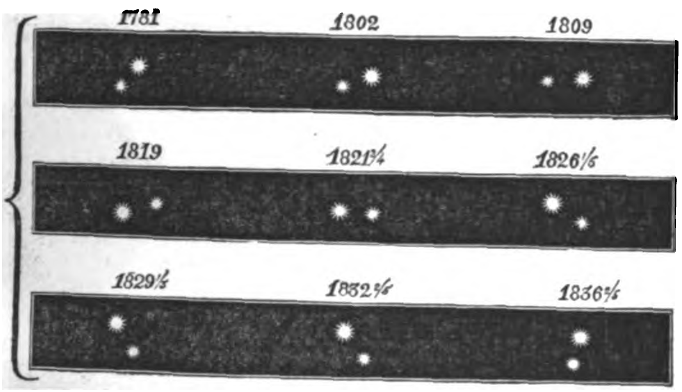
In consequence of their proper motion, the constituents of a binary star appear to vary their distance from each other, as in the cut representing γ Virginis, where the component stars seem gradually to have approximated. The two stars of Castor are likewise now apparently approaching each other, and will appear to close, so as to require the finest telescopes to be capable of showing otherwise than a single object, their respective motions again opening as it were a breach between them.



Position of the two Stars of Castor.



Position of the two Stars of γ Virginis.



Position of the two Stars of ξ Ursæ Majoris.

From the observations that have been made upon the binary stars, their periods of revolution are known in some instances, as a complete one has been performed by η Coronæ, while in other cases, the observed change in the angles of position has supplied data for approximate calculation, of which the annexed table contains the result:—

	Yrs.		Yrs.		Yrs.
ζ Herculis	35	γ Virginis	150	μ Draconis	600
γ Coronæ	40	α Geminorum (Castor)	240	49 Serpentis	610
η Coronæ	44	127 Virginis	240	12 Lyncis	680
ζ Cancri	60	36 Andromedæ	250	η Cassiopeiæ	700
ξ Ursæ Majoris	65	4 Aquarii	300	ζ Aquarii	750
η Ophiuchi	80	ε Arietis	400	ε Boötis (Mirac)	980
ω Leonis	82	μ_2 Boötis	460	γ Leonis	1000
τ Ophiuchi	83	37 Pegasi	500	5 Lyræ	1000
λ Ophiuchi	86	61 Cygni	5.4	ε Lyræ	2000
51 Libræ	100	σ Coronæ	560	δ Herculis	2046
ξ Boötis	120	ι Leonis	580	65 Piscium	3067

VII. The multiple stars thus appear to be respectively schemes of suns revolving about a common centre, under control of laws of gravitation like those which prevail in the solar system, each constituent having probably its planets with their satellites, at a distance from the orbs they attend parallel to that of our satellites from their primaries, and of our planets from the sun, but crowded by their vast remoteness into a space which a grain of sand will cover.

CHAPTER X.

COLOUR OF THE STARS.

I. To the naked eye the stars vary sensibly in their hues, and are known to have undergone remarkable changes of colour.

Sirius, Lyra, Spica Virginis, Bellatrix, Altair, and Vega, are white stars; Procyon and Capella, are orange; Aldebaran, Antares, Arcturus, Rigel, Pollux, and Betelgeux, are red.

But Sirius, now intensely white, was anciently a red star, a change of colour inverse to that which the planet Mars exhibited recently, from red to white. γ Leonis and γ Delphini have perceptibly changed colour within the last half century.

II. The constituents of a binary or multiple system, though in many cases of the same complexion and intensity, often exhibit the curious and beautiful phenomenon of contrasted colours or complementary tints.

Of 596 binary stars, Struve gives the following analysis:

Pairs of the same colour and intensity	375
Pairs of the same colour, but of different intensity	101
Pairs of totally different colours	120
	596

III. White, red, blue, green, yellow, and violet-coloured stars are common in the multiple systems. The white are estimated at 2½ times the number of the red, and the red at twice the number of the blue.

Struve gives the following list of blue attendants upon different coloured principals:

Pairs, consisting of a blue and a white principal star	53
" " " a light yellow principal star	52
" " " a yellow or red principal star	52
" " " a green principal star	16

It is impossible to conceive adequately of the varied illumination of two suns, a red and a green, or a yellow and a blue one, afforded to a planet revolving around either of them, as both together may be above its horizon; or the effect of a green or red daylight alone, following another tint, as one of the suns only come to be present to it.

IV. While insulated red stars of a colour as deep as blood occur in the heavens, as well as white and yellow stars, it has been noticed, that no case has yet been met with of a green, blue, or violet-coloured star, unassociated with a companion orb.

CHAPTER XI.

CLUSTERS OF STARS. NEBULÆ.

I. A number of stars apparently closely compressed together, forming distinct groups and clusters, are found in various parts of the heavens, some of the individuals of which are visible to the naked eye, while in other cases only a general haze is discernible, caused by the aggregation. Every increase of telescopic power resolves these clusters into a greater number of components.

The Pleiades furnish a familiar example. Six or seven stars are presented to the naked eye, but a moderate telescope easily distinguishes about 40 individuals. Keppler counted 32; De la Hire, 64; Hook, 78; Rheita, 118.

The Hyades in the head of Taurus appear to consist of 5 stars, but between 30 and 40 are easily counted with a telescope.

Presepe, gleaming as a speck of light in the sombre districts of Cancer, is a congeries of minute stars, some of which the commonest instrument unfolds. Galileo counted 36.

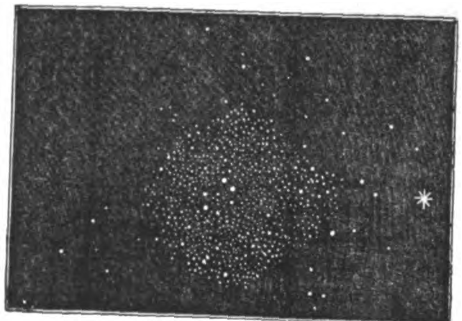
Coma Berenices is a more diffused group of larger stars.

The existence of these clusters shows, that the stars in particular regions of the heavens have been subject to particular laws of aggregation.

II. The term nebula, signifying a cloud or mist, denotes an identical class of objects, which appear isolated patches of luminous matter to the naked eye, or through common telescopes, but are resolved into clusters of stars by instruments of greater power, the individuals of which are to be reckoned by thousands and tens of thousands.

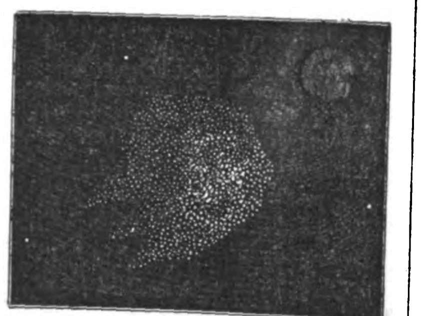
There are hundreds of such clusters of various shapes, the globular or roundish form predominating, of which the annexed representations are specimens:

Fig. 1. A nebula in the sword-handle of Perseus, a grouping of an immense number of stars, difficult to separate, with a central circlet of brighter individuals.



1. Nebula in Perseus.

Fig. 2. A nebula in Canes Venatici, discovered by Messier in 1784, and resolved by Herschel into a stellar cluster of about 5′ or 6′ in diameter.



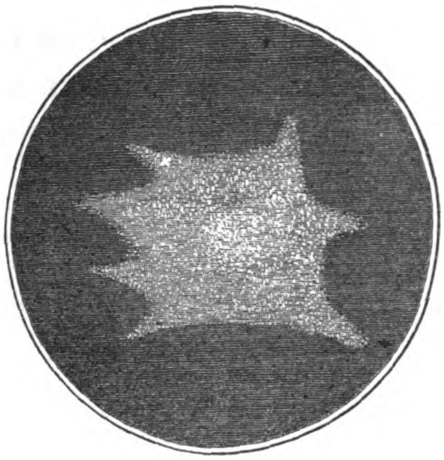
2. Nebula in Canes Venatici.

Fig. 3. A nebula in Pegasus, found by Maraldi in 1745, observed by Messier in 1764, and separated into constituents by Herschel in 1783.

3. Nebula in Pegasus.

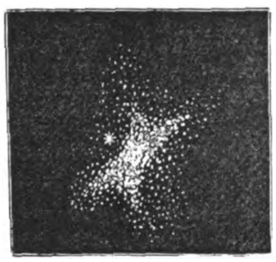
Fig. 4. A nebula in Hercules, about 22° due W. of Vega, which appears to the naked eye when the sky is serene and the moon absent. With a common telescope, it seems a faint cometary body, but with higher power it becomes a magnificent assemblage of stars, showing great central condensation and splendour.

Besides globular, there are clusters of oval and fantastic outline.



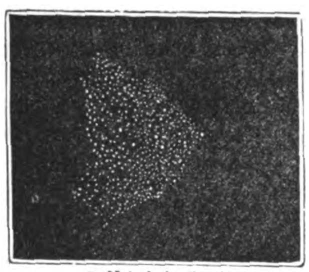
4. Nebula in Hercules.

Fig. 5. A nebula of the southern hemisphere, the 30 Doradus, sketched at Paramatta, by Mr. Dunlop, resembling a knot formed by a bunch of ribbons.



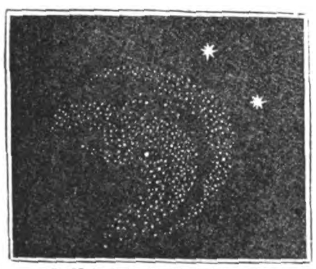
5. Nebula 30 Doradus.

Fig. 6. A nebula in the Twins, angular-shaped, discovered by Herschel in 1783.



6. Nebula in Gemini.

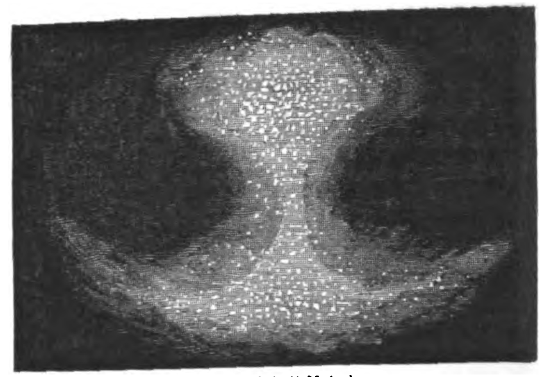
Fig. 7. A nebula in Scutum Sobieski, on the shield, discovered by Kirch in 1681, resembling the form of a distant flight of wild fowl.



7. Nebula in Sobieski's Shield.

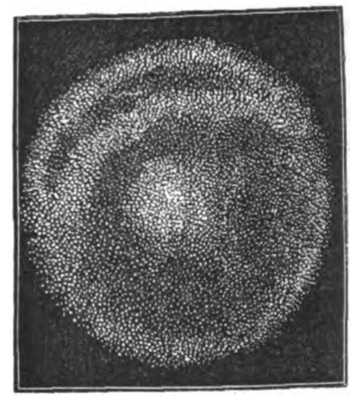
III. In areas of the heavens not exceeding $\frac{1}{10}$ of the lunar diameter, there are thus schemes of stars, each constituting as rich a firmament as that immediately around us. But besides resolved nebulæ, or those whose stellar constitution is known, there are others lying on the extreme verge of observation, which appear to want only a sufficient increase of instrumental power to be discriminated as great systems of stars.

Fig. 1. A nebula in Vulpecula et Anser, on the breast of the Fox. It has the shape of a dumb-bell or hour-glass, composed of the two connected dense hemispheres, and hence called the dumb-bell nebula. No other form parallel to this has been found.



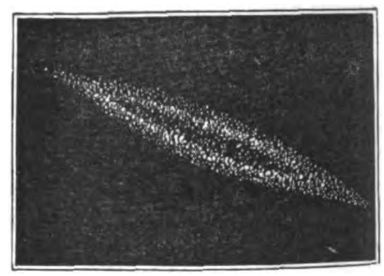
1. Dumb-bell Nebula.

Fig. 2. A nebula in Canes Venatici, called the halo nebula from its shape, and the ghost of the planet Saturn, as seen with his rings in a vertical position. There is a bright central nucleus, and an annulus split through part of its circumference, a *fac-simile* of our divided Milky Way.



2. Halo Nebula.

Fig. 3. A nebula in Andromeda, of an elongated form, supposed to be an immense ring like the Milky Way, which appears elongated, owing to lying oblique to our line of vision.



3. Elongated Nebula.

The dumb-bell and halo nebulæ have been resolved by Lord Rosse's telescope.

IV. Nebulæ, properly so called, have till very recently appeared to be quite of a different character to the classes noticed, suggesting no idea of stars, but seeming to be simply portions of luminous matter, extending over immense regions of space, in various stages of condensation.

A well-known object of this class is in the middle of the sword of Orion, and may be picked up by a good eye on a favourable night. As it subtends nearly an angle of 10′, and considering it to be at the distance of a star of the 8th mag., it has been computed to be more than 3,000,000,000,000,000,000, or three trillions of times the size of our sun. Its appearance has been compared to that of a curdling liquid, or a surface strewed over with flocks of wool, or to the breaking up of a mackerel sky, when the clouds of which it consists begin to assume a cirrous appearance.

Great Nebula of Orion.

Upon the extraordinary character of this and kindred nebulæ, the presumption was built of the existence of immense masses of phosphorescent and luminous matter in the regions of the universe, the rude material of new worlds and systems, in process of elaboration, from it. This theory, however, is now quite untenable, as the great nebula of Orion, hitherto the strangest and most incomprehensible of these objects, has been resolved into stars by Lord Rosse's telescope.

V. The nebulæ, therefore, of all classes are probably sidereal firmaments, each as expansive as that of which the farthest verge of the Milky Way may be deemed the outward boundary, but compressed by their immeasurable remoteness into a space, which at the largest, to the naked eye, a snow-flake will utterly conceal.

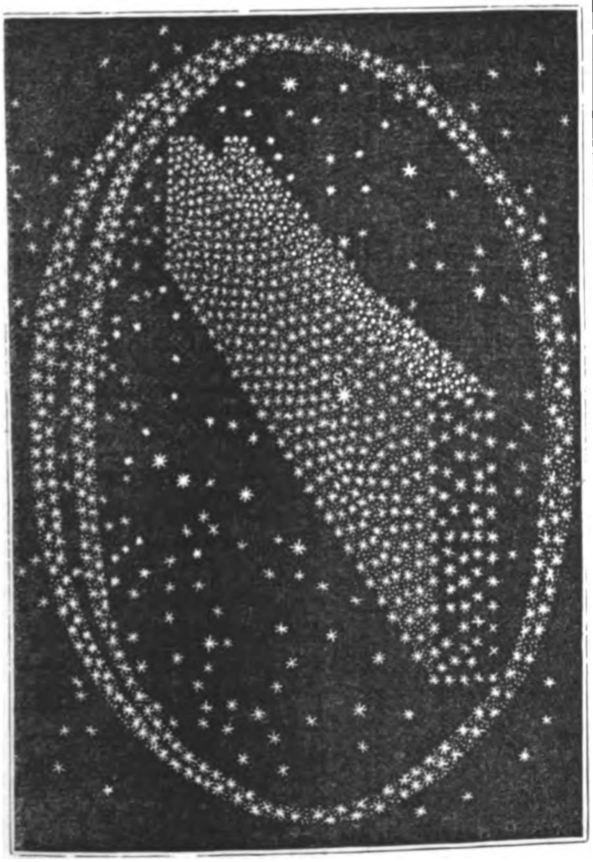
CHAPTER XII.

THE MILKY WAY.

I. The Galaxy, Via Lactea, or Milky Way, is the name given to the only real and sensible circle in the heavens, on account of its colour and appearance. It forms nearly a complete circle of the sphere, but coincides neither with the ecliptic, the equinoctial, nor with the colures, in its direction. It varies in breadth from 4° to 20°; and in brightness, being much more brilliant in the southern than in the northern hemisphere, particularly in the neighbourhood of the Cross. This has led to the surmise, that we are eccentrically situated in relation to it, being much nearer to those parts that are about the Cross than to those that are diametrically opposite. Though more or less visible at all seasons of the year, the Milky Way is seen to the best advantage in the months of August, September, and October, the latter part of July, and the beginning of November.

Traced along its course, it passes from the head of Cepheus about 30° from the north pole, through Cassiopeia, nearly covering Perseus, over part of Auriga, and crosses the ecliptic between the feet of Gemini and the horns of Taurus. Thence it proceeds over the equinoctial, through Monoceros, the middle of the ship Argo, Robur Carolinum, Crux, coming within 20° of the south pole. It then takes a northerly direction, assuming a double path, dividing into two branches, before leaving the southern hemisphere. The eastern branch streams over the bow of Sagittarius, the shield of Sobieski, the feet of Antinous, through Aquila, to Cygnus. The western branch passes over the tail of Scorpio, the right side of Serpentarius, Taurus Poniatowski, to the neck of Cygnus. The two branches then unite, after remaining distinct for about 150°, and pass on to Cepheus, the point from whence we started.

II. The ancients imagined this silvery zone to be composed of stars. The impression was confirmed upon the application of the telescope to it, but no idea was entertained of its profound depths, and multitudinous objects, till it was gauged and examined by the large reflecting telescopes of Schroeter and Herschel. It is constituted entirely of stars, "scattered by millions, like glittering dust, on the black ground of the general heavens," the average magnitude of the stars being about the tenth or eleventh, removed from each other, if not by equal distances, yet by spaces proportionate to that of the nearest star from ourselves.



III. This wonderful and lucid tract is now considered to be a nebula, or scheme of stars, of which our sun is one of the members. Its particular form is supposed to be that of a layer or stratum, bifurcated or divided into two principal branches at one of its extremities, the thickness of the stratum being very small in comparison with the length and breadth.—This is represented in the diagram, the letter s indicating the place of our solar system.—The exterior bifurcated ring exhibits the effect of the stars of the stratum being viewed in the direction of its length and breadth, precisely the appearance of the Milky Way, the remaining scattered stars representing those seen in the direction of the thickness of the stratum, comparatively of small extent. It is open to observation, that there is a crowding together of stars towards that perfect conglomeration of them to the naked eye, which forms the Milky Way, while more apart from it they appear diffused and insulated.

CHAPTER XIII.

TO KNOW THE HEAVENS.

I. When a few particular stars have been recognised, they may serve as starting points, and by alignment, or drawing imaginary lines from them, other stars may be detected, and thus a general knowledge of firmamental objects be acquired.

The alignment rule to find the Pole-star, by an imaginary line drawn through the two well-known Pointers of the Great Bear, need only be mentioned for the sake of stating, that it may serve as a rough scale of measurement, to take the distance between the Pointers at 5°, and between them and the Pole-star at 29°.

A line projected from the Pole-star, perpendicular to that passing through it from the Pointers, in a direction opposite to that of the Great Bear, leads to Capella, at the distance of 44°. Capella may also be found by projecting a line through the two northern stars in the square of Ursa Major, from the smaller to the larger, and continuing it about 50°.

A line projected from the first star in the triangle of Ursa Major next the square to the Pole-star, and carried on, leads to Schedir and the bright group of Cassiopeia, at nearly an equal distance on the opposite side of the pole. When Ursa Major is at its lowest position below the pole, Cassiopeia is near the zenith, and *vice-versâ*.

A line projected from the Pole-star through the last star in the triangle of Ursa Major, and carried onwards about 30°, leads to Arcturus. The Pole-star and Arcturus make nearly a right angle with Vega in the Lyre.

A line drawn through the side of the square of Ursa Major, opposite to the Pointers, and continued southwards, leads to Regulus.

A line projected from the Pole-star, through the middle star in the triangle of Ursa Major, leads to Spica Virginis at the distance of 70°. Regulus, Arcturus, and Spica make a large triangle.

A line from Regulus through Spica, continued 45° further eastward, passes below Antares.

A line drawn through the belt of Orion leads northerly to Aldebaran, and southerly to Sirius.

A line drawn from Sirius, perpendicular to another joining that star and Orion's Belt, leads to Procyon.

A magnifient equilateral triangle is formed by Sirius, Procyon, and Betelgeux, as well as a right-angled one by Betelgeux, Procyon, and Pollux. Castor may be known by its connection with Pollux, as the northern star of the pair.

A line drawn from Castor through Pollux, and continued about three times the distance between them, or 15°, reaches Presepe in Cancer.

A line projected from Orion's Belt to Aldebaran, and carried to somewhat more than the same distance beyond, hits the head of Medusa, and reaches the remarkable versatile star Algol.

Algol, with Algenib in the side of Perseus, and Almaac in the foot of Andromeda, forms a triangle, with the open part towards Cassiopeia.

A line drawn from Orion's Belt, passing below Aldebaran, hits *a* Arietis, the principal star in Aries, and carried onwards, reaches Alpherat in Andromeda; and still continued, leads to Scheat in Pegasus.

Alpherat and Scheat, 14° apart, form the northern side of the "great square of Pegasus;" Markab 13° S. of Scheat, and Algenib 14° S. of Alpherat, form the southern side.

Algenib in Pegasus, and 14° N. Alpherat in Andromeda, and from thence 30° N. Caph in Cassiopeia, are important stars, for a line produced through them, terminates at the pole. They are therefore called the "Three Guides." They are situated on the equinoctial colure, or first meridian of the heavens, and serve to point out the position of that great circle of the sphere from which the right ascension of all the heavenly bodies is measured. Caph is especially of use to the mariner and surveyor. The Pole-star not being exactly at the true polar point of the heavens, but 1½° from it on that side which is *towards* Caph, the position of the latter becomes important, as it always shows on which side of the polar point the Pole-star is.

II. It must not be forgotten by the student, that in consequence of the apparent diurnal revolution of the sphere, the stars, while preserving their relative positions and distances, will have the imaginary lines joining them perpetually varying their direction; being sometimes horizontal, sometimes inclined, and sometimes vertical, after the manner in which the Diagram on page 29 represents Ursa Minor swinging round the polar point.

III. The following are the north circumpolar constellations and principal stars; those within the circle of perpetual apparition, never setting and rising at the latitude of London.

Ursa Minor, Ursa Major, Lynx, Cameleopardalis, head of Auriga including Capella, head and body of Perseus including Algenib and Algol, feet and arm of Andromeda including Almaac, Cassiopeia, Cepheus, Lacerta, body of Cygnus including Deneb, part of Lyra including Vega, Draco, feet of Hercules, head and arm of Boötes, the northern hound Asterion and part of the southern including Cor Caroli.

IV. The annexed tabular statement gives the apparent approximate time of culmination of principal stars visible at London, on the first day of every month through the year. The time is reckoned from noon to noon. Subtracting the hours to the meridian from the time of culmination, and adding them to it, gives the time of rising and setting. The point in the horizon of rising and setting is also expressed.

STARS.	RT. ASC.	DEC.	CONST.	MAG.	TIME OF CULMINATION. Jan. h. m.	Feb. h. m.	Mar. h. m.	April h. m.	May h. m.	June h. m.	July h. m.	Au . h. m.	Sept. h. m.	Oct. h. m.	Nov. h. m.	Dec. h. m.	POINTS OF Rising.	Hours to Mer.	Setting.
Almaac	28	41° N.	Andromeda.	2	5 12	3 56	1 12	23 14	21 23	19 21	17 17	15 13	13 17	11 30	9 33	7 30	N.E. ½ N.	8¾	N.W. ½ N.
Algenib	1	14 „	Pegasus.	2	5 17	3 5	1 17	23 19	21 28	19 26	17 22	15 18	13 22	11 34	9 38	7 35	E.N.E.	7½	W.N.W.
Schedir	10	60 „	Cassiopeia.	3	5 44	3 32	1 43	23 46	21 55	19 53	17 49	15 44	13 28	12 0	10 5	8 1	CIRCUMPOLAR.		
Arietis	28	22 „	Aries.	2	7 10	4 58	3 9	1 16	23 21	21 19	19 15	17 10	15 15	13 27	11 31	9 28	E.N.E.by E.	8¼	N.W. by W.
Aldebaran	67	16 „	Taurus.	1	9 38	7 26	5 38	3 44	1 53	23 47	21 43	19 39	17 43	15 55	13 59	11 56	E.N.E.	7½	W.N.W.
Capella	76	46 „	Auriga.	1	10 16	8 4	6 16	4 22	2 31	0 29	22 21	20 18	18 21	16 33	14 37	12 34	CIRCUMPOLAR.		
Rigel	76	8 S.	Orion.	1	10 18	8 6	6 18	4 24	2 33	0 31	22 23	20 20	18 23	16 35	14 40	12 35	E. by S. ½ S.	5½	W. by S. ½ S.
Betelgeux	86	7 N.	Orion.	1	10 58	8 46	6 57	5 4	3 13	1 11	23 3	20 58	19 2	17 15	15 19	13 15	E. by N.	6¾	W. by N.
Sirius	100	16 S.	Canis Major.	1	11 49	9 38	7 49	5 55	4 4	2 2	23 54	21 50	19 54	18 6	16 10	14 7	E.S.E. ½ S.	4¾	W.S.W. ½ S.
Procyon	113	6 N.	Canis Minor.	1	12 42	10 30	8 41	6 48	4 57	2 55	0 46	22 42	20 47	18 59	17 3	14 59	E. ½ N.	6½	W. ½ N.
Pollux	114	29 „	Gemini.	2	12 47	10 35	8 46	6 53	5 2	2 59	0 51	22 47	20 51	19 3	17 7	15 4	N.E. ½ N.	9	N.W. ½ N.
Regulus	150	13 „	Leo.	1	15 11	12 59	11 10	9 17	7 26	5 23	3 15	1 15	23 15	21 27	19 31	17 28	E.N.E.	7¼	W.N.W.
Dubhe	165	63 „	Ursa Major.	1	16 4	13 51	12 3	10 10	8 19	6 17	4 14	2 9	0 13	22 21	20 25	18 21	CIRCUMPOLAR.		
Denebola	176	16 „	Leo.	2	16 51	14 39	12 51	10 57	9 6	7 4	4 56	2 56	1 0	23 8	21 12	19 9	E.N.E. ½ N.	7½	W.N.W. ½ N.
Cor Caroli	193	40 ..	Canes Venat.	3	17 59	15 47	13 58	12 5	10 14	8 12	6 5	4 8	2 8	0 16	22 20	20 16	CIRCUMPOLAR.		
Spica	200	10 S.	Virginis.	1	18 27	16 15	14 26	12 33	10 42	8 40	6 34	4 35	2 35	0 44	22 48	20 44	E. by S. ½ S.	5	W. by S. ½ S.
Arcturus	212	20 N.	Boötes.	1	19 18	17 6	15 18	13 24	11 33	9 31	7 27	5 23	3 27	1 36	23 39	21 36	N.E. by E.	7¾	N.W. by W.
Antares	245	26 S.	Scorpio.	1	21 29	19 17	17 28	15 35	13 44	11 42	9 38	7 34	5 38	3 48	1 54	23 47	S.E.	3½	S. W.
Vega	280	39 N.	Lyra.	1	23 41	21 29	19 40	17 47	15 56	13 54	11 50	9 45	7 49	6 2	4 6	2 2	CIRCUMPOLAR.		
Altair	295	9 „	Aquila.	1	0 55	22 40	20 51	18 58	17 7	15 5	13 1	10 56	9 1	7 13	5 17	3 13	E. by N. ½ N.	6¾	W. by N. ½ N.
Deneb	310	45 „	Cygnus.	1	1 49	23 33	21 44	19 51	18 0	15 58	13 54	11 50	9 54	8 6	6 10	4 7	CIRCUMPOLAR.		
Fomalhaut	342	31 S.	Piscis Aust.	1	4 1	1 45	0 1	22 3	20 12	18 10	16 6	14 2	12 6	10 18	8 22	6 19	S.E. by S.	2½	S.W. by S.

This table, calculated for the year 1845, requires a minute to be subtracted annually to the year 1849, when the time will again suit within a few seconds, owing to the extra day in leap year. The same rule applies to the next epoch, from 1849 to 1853, and so on, till the differing seconds amount to a minute.

V. The annexed four maps are intended to serve as guides to find the stars.

These maps may be supposed to represent the heavens at the hour named. The dotted circle crossing the graduated meridian line at 41°, is the circle of perpetual apparition, the stars within that circle being visible at all times from the meridian of Greenwich.

The maps may, by a little calculation, be made to represent the aspect of the heavens at other times than is named; for instance, reckoning backwards, and allowing a difference of about twenty minutes for every five days, or four minutes for every twenty-four hours, we find that on the 21st of January, at 40 minutes past 1 o'clock in the morning, the stars will appear as they are represented in the map for March, and so on for every other month, following the same reckoning for every day in the year.

TABLE SHOWING THE HOUR AND DAY WHEN THE STARS OCCUPY THE POSITION INDICATED IN THE MAP.

Map for March.

		hr.	m.			hr.	m.			hr.	m.
January	21	1	40	February	21	11	40	March	23	9	40
	26	1	20		26	11	20		28	9	20
February	1	1	0	March	3	11	0	April	2	9	0
	6	12	40		8	10	40		7	7	40
	11	12	20		13	10	20		12	7	20
	16	12	0		18	10	0		17	7	0

Map for June.

		hr.	m.			hr.	m.			hr.	m.
April	22	2	0	May	27	11	40	June	26	9	40
	27	1	40	June	1	11	20	July	1	9	20
May	2	1	20		6	11	0		6	9	0
	7	1	0		11	10	40		11	8	40
	12	12	40		16	10	20		16	8	20
	17	12	20		21	10	0		21	8	0
	22	12	0								

Map for Septembrr.

		hr.	m.			hr.	m.			hr.	m.
July	26	1	40	August	30	11	20	October	4	9	0
	31	1	20	September	4	11	0		9	8	20
August	5	1	0		9	10	40		14	8	20
	10	12	40		14	10	20		19	8	0
	15	12	20		19	10	0		24	7	40
	20	12	0		24	9	40		29	7	20
	25	11	40		29	9	20				

Map for December.

		hr.	m.			hr.	m.			hr.	m.
November	3	1	20	December	3	11	20	January	3	9	20
	8	1	0		8	11	0		8	9	0
	13	12	40		13	10	40		13	8	40
	18	12	20		18	10	20		18	8	20
	23	12	0		23	10	0		23	8	0
	28	11	40		28	9	40		28	7	40

VI. The celestial planisphere represents the whole heavens lying between 70° of north and south declination, not as the surface of a concave sphere, but of a concave cylinder, and spread out so as to form a plain surface. By finding any given day of the month at the bottom of the map, then, the sign and degree corresponding to it on the scale immediately above, gives the sun's place in the ecliptic. Thus—over August 10 there are four signs and seventeen degrees, which is the sun's place in the ecliptic at noon on that day—17° in the sign Leo.

SUPPLEMENTAL NOTICES.

While the preceding pages have been passing through the press, some discoveries and observations have transpired, a brief summary of which may here be introduced.

On the 25th of April, 1848, a *new planet* was discovered by Mr. Graham at Markree, making the ninth asteroid. Its name has not been authoritatively settled, nor its elements determined. The other eight members of the asteroid family appear to occur as follows with respect to mean distance from the sun, Flora, the nearest, having a period of revolution of about 3¼ years—Flora, Iris, Vesta, Hebe, Astræa, Juno, Ceres, Pallas.

About the same time, Mr. Hind, of Mr. Bishop's Observatory in the Regent's Park, announced the appearance of a *new star* in the constellation Ophiuchus. It became distinctly visible to the naked eye, but has been observed to be of variable magnitude. No observation of a star in the same position has been previously recorded, on a line joining η and 20 Ophiuchi; but the new star seen by Keppler, as already noticed (chap. vii.), which vanished after a brief apparition, appeared in the same constellation, though some degrees distant from the place occupied by the stranger. Captain Smyth, the author of the Bedford Catalogue in 1844, in noticing Keppler's famous object, remarked—"such reports call for attention to the prospect of re-appearance."

On May 8 and 10, 1795, the astronomer Lalande observed what he supposed to be the same fixed star, but as the observations were found discordant, he concluded that errors of right ascension and polar distance had been committed, and only entered the observation of May 10 in the *Histoire Céleste*, rejecting the first, and printing the last with the points signifying doubt. The star, now missing from the heavens, has been ranked as a *lost star;* but singularly enough, by tracing back the orbit of Neptune, it is found, that the newly-discovered planet was the object seen by Lalande, whose two days' different results are at once explained by the planetary character of the body. The periodic time of Neptune is now supposed to be nearly 166 years.

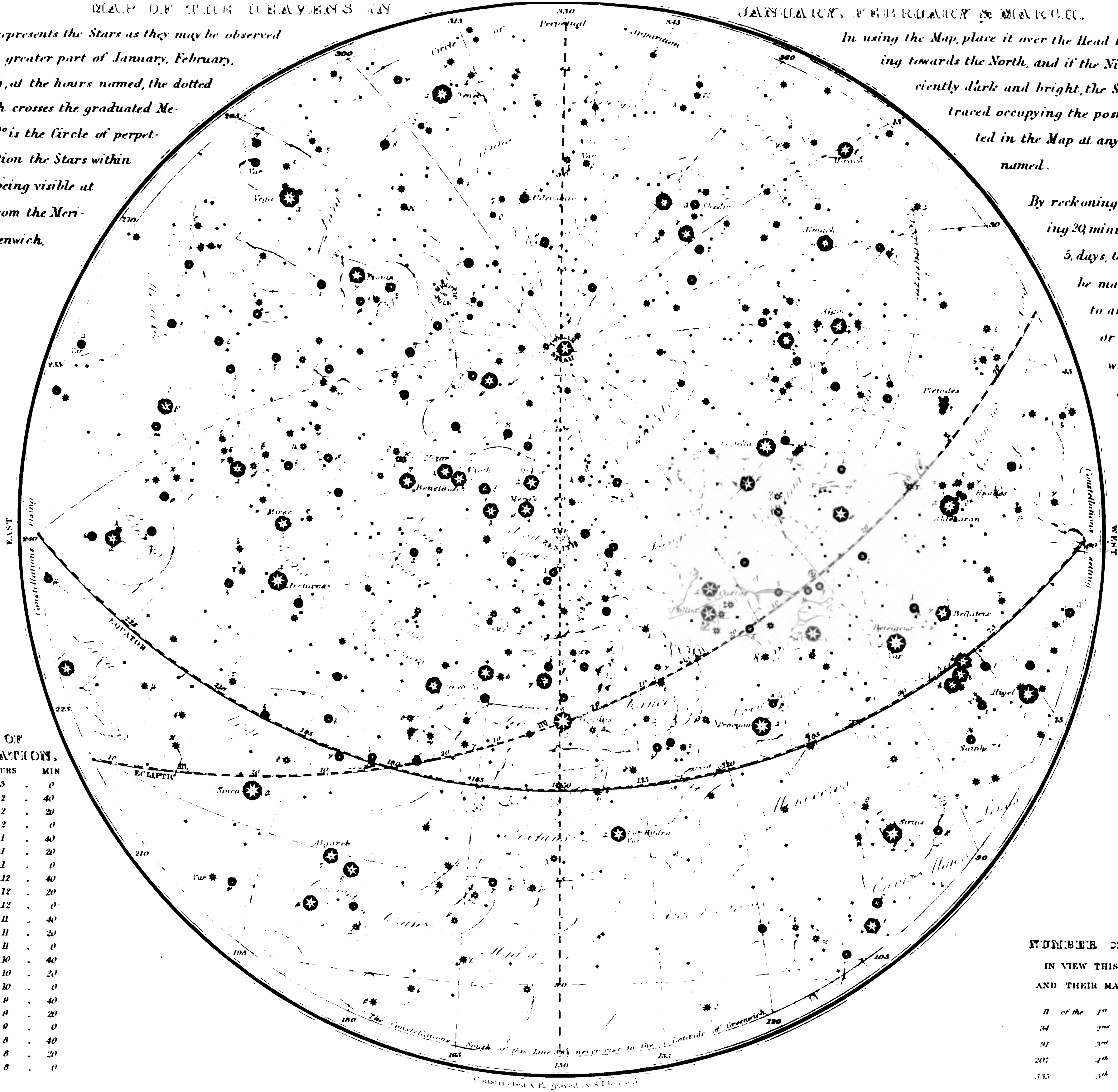
In a pamphlet, entitled "On the Expected Return of the Great Comet of 1264 and 1556, by J. R. Hind," London, May, 1848, that intelligent astronomer conceives that there is a "very high probability" in favour of the identity of the comets of those eras, and also of another apparition of the same body occurring about the present year. This is not offered as a prediction, because of the confessedly uncertain nature of the data within reach, the vague descriptions of the old chroniclers, but simply as a reasonable hypothesis. Should it prove to be correct, the comet will have a periodic time of about 291½ or 292 years, be in its aphelion at a distance of 8,300,000,000 of miles from the sun, in perihelion at a distance of less than 48,000,000 of miles, and have an orbit the minor axis of which is 1,260,000,000 of miles broad.

MAP OF THE HEAVENS IN JANUARY, FEBRUARY & MARCH.

This Map represents the Stars as they may be observed during the greater part of January, February, and March, at the hours named, the dotted Circle which crosses the graduated Meridian at 41° is the Circle of perpetual apparition the Stars within that Circle being visible at all times from the Meridian of Greenwich.

In using the Map, place it over the Head the top pointing towards the North, and if the Night be sufficiently dark and bright, the Stars may be traced occupying the position indicated in the Map at any of the times named.

By reckoning back allowing 20 minutes for every 5 days, the Map may be made to apply to any other day or hour during which the Stars are visible.

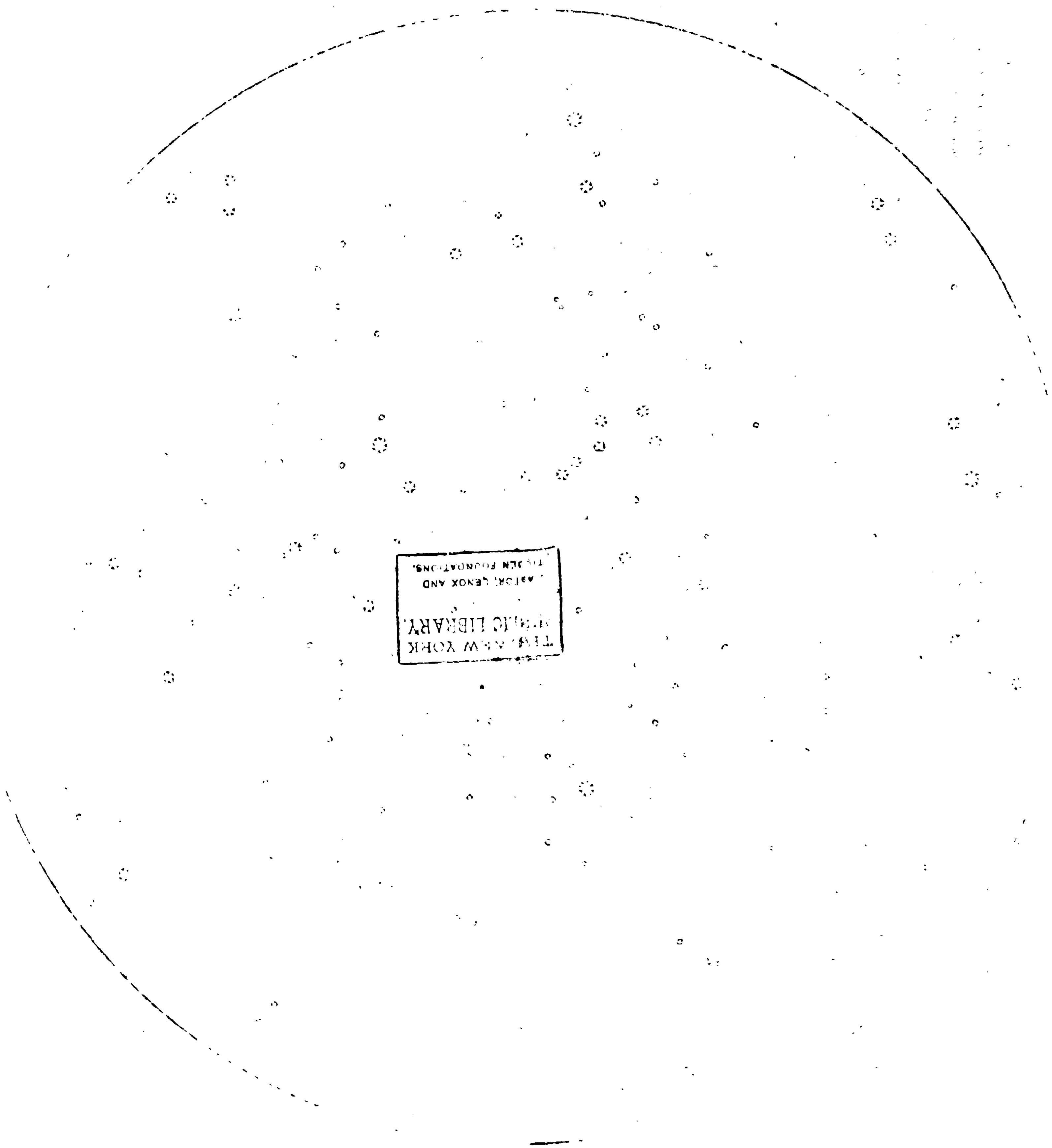


TIME OF OBSERVATION,

	DAY	HOURS	MIN.
Jan.y	1st	3	0
	6th	2	40
	11th	2	20
	16th	2	0
	21st	1	40
	26th	1	20
Feb.y	1st	1	0
	6th	12	40
	11th	12	20
	16th	12	0
	21st	11	40
	26th	11	20
March	3rd	11	0
	8th	10	40
	13th	10	20
	18th	10	0
	23rd	9	40
	28th	9	20
April	2nd	9	0
	7th	8	40
	12th	8	20
	17th	8	0

NUMBER OF STARS IN VIEW THIS MONTH AND THEIR MAGNITUDES

11	of the	1st
34		2nd
91		3rd
207		4th
335		5th

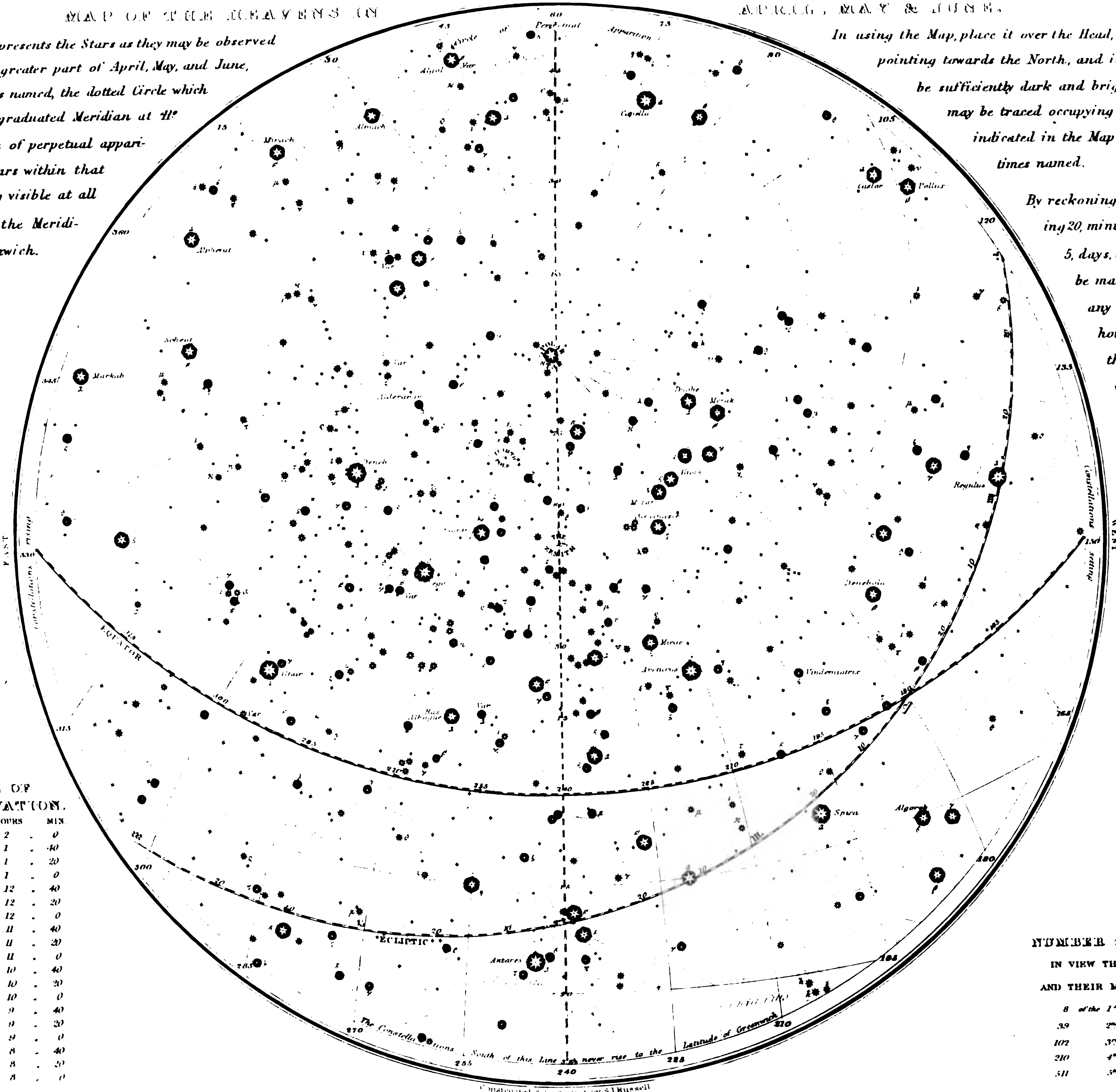


MAP OF THE HEAVENS IN APRIL, MAY & JUNE.

This Map represents the Stars as they may be observed during the greater part of April, May, and June, at the hours named, the dotted Circle which crosses the graduated Meridian at 41° is the Circle of perpetual apparition, the Stars within that Circle being visible at all times from the Meridian of Greenwich.

In using the Map, place it over the Head, the top pointing towards the North, and if the Night be sufficiently dark and bright, the Stars may be traced occupying the position indicated in the Map at day of the times named.

By reckoning back allowing 20 minutes for every 5 days, the Map may be made to apply to any other day or hour during which the Stars are visible.



TIME OF OBSERVATION.

	DAY	HOURS	MIN
April	22nd	2	0
	27th	1	40
May	2nd	1	20
	7th	1	0
	12th	12	40
	17th	12	20
	22nd	12	0
	27th	11	40
June	1st	11	20
	6th	11	0
	11th	10	40
	16th	10	20
	21st	10	0
	26th	9	40
July	1st	9	20
	6th	9	0
	11th	8	40
	16th	8	20
	21st	8	0

NUMBER OF STARS IN VIEW THIS MONTH AND THEIR MAGNITUDES

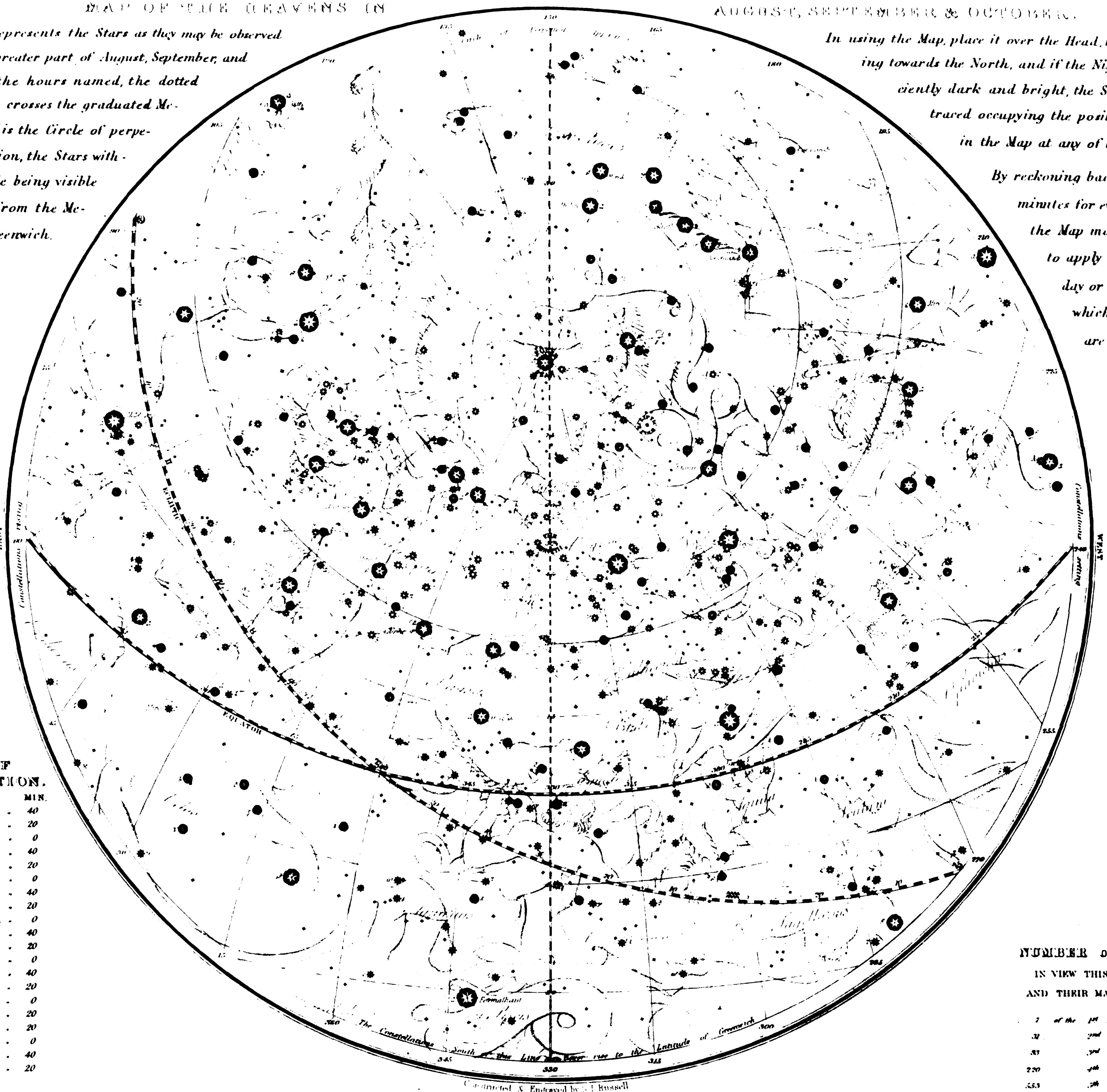
8	of the 1st	
39	2nd	
102	3rd	
210	4th	
511	5th	

MAP OF THE HEAVENS IN AUGUST, SEPTEMBER & OCTOBER.

This Map, represents the Stars as they may be observed during the greater part of August, September, and October, at the hours named, the dotted Circle which crosses the graduated Meridian at 41° is the Circle of perpetual apparition, the Stars within that Circle being visible at all times from the Meridian of Greenwich.

In using the Map, place it over the Head, the top pointing towards the North, and if the Night be sufficiently dark and bright, the Stars may be traced occupying the position indicated in the Map at any of the times nam'd.

By reckoning back allowing 20 minutes for every 5 days, the Map may be made to apply to any other day or hour during which the Stars are visible.



TIME OF OBSERVATION.

	DAY	HOURS	MIN.
July	26th	1	40
	31st	1	20
Augt	5th	1	0
	10th	12	40
	15th	12	20
	20th	12	0
	25th	11	40
	30th	11	20
Septr	4th	11	0
	9th	10	40
	14th	10	20
	19th	10	0
	24th	9	40
	29th	9	20
Octr	4th	9	0
	9th	8	20
	14th	8	20
	19th	8	0
	24th	7	40
	29th	7	20

NUMBER OF STARS IN VIEW THIS MONTH AND THEIR MAGNITUDES

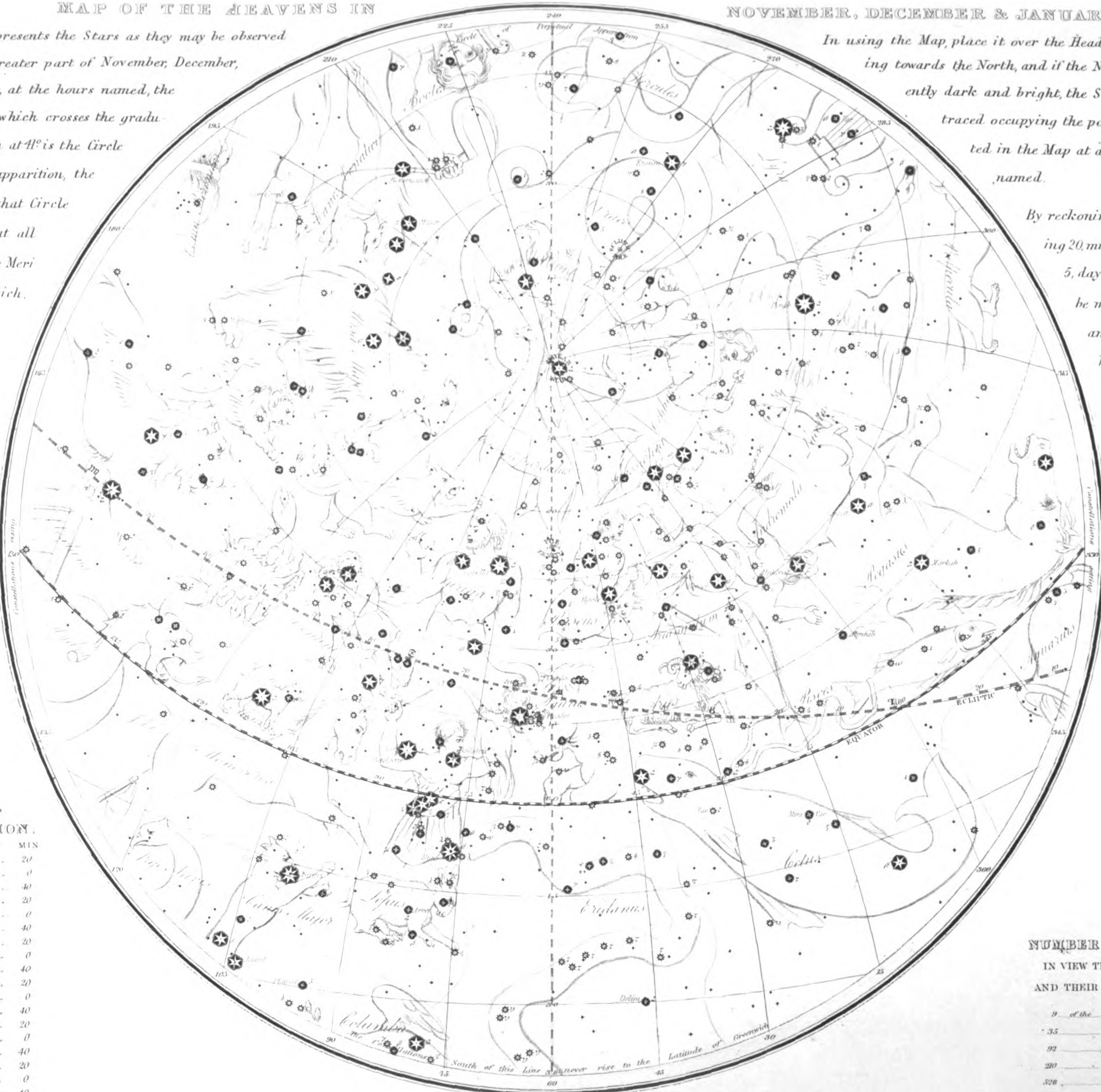
1	of the	1st
31		2nd
83		3rd
220		4th
553		5th

MAP OF THE HEAVENS IN NOVEMBER, DECEMBER & JANUARY.

This Map represents the Stars as they may be observed during the greater part of November, December, and January, at the hours named, the dotted Circle which crosses the graduated Meridian at 41° is the Circle of perpetual apparition, the Stars within that Circle being visible at all times from the Meridian of Greenwich.

In using the Map, place it over the Head, the top pointing towards the North, and if the Night be sufficiently dark and bright, the Stars may be traced occupying the position indicated in the Map at any of the times named.

By reckoning back allowing 20 minutes for every 5 days, the Map may be made to apply to any other day or hour during which the Stars are visible



Constructed & Engraved by S. I. Russell.

TIME OF OBSERVATION.

	DAY	HOURS	MIN
Novr.	3rd	1	20
	8th	1	0
	13th	12	40
	18th	12	20
	23rd	12	0
	28th	11	40
Decr.	3rd	11	20
	8th	11	0
	13th	10	40
	18th	10	20
	23rd	10	0
	28th	9	40
Jany.	3rd	9	20
	8th	9	0
	13th	8	40
	18th	8	20
	23rd	8	0
	28th	7	40

NUMBER OF STARS IN VIEW THIS MONTH AND THEIR MAGNITUDES

9	of the 1st
35	2nd
92	3rd
210	4th
528	5th

PHYSICAL GEOGRAPHY.

INTRODUCTION.

I. Physical or Natural Geography treats of the general features of the terrestrial superficies; the arrangement of the inorganic matter of the globe, and the distribution of organic life; the phenomena of the atmosphere, and its relation to the varied animal and vegetable productions with which the earth is replenished. The limits of this department of science are not strictly defined. The connection is so direct and intimate with the domains of Astronomy, Geology, Botany, and Zoology, that a trespass upon them is unavoidable in prosecuting this branch of physical inquiry.

II. The surface of our planet consists of unequal portions of land and water. The area of the dry to that of the fluid is as 1 to $2\frac{4}{5}$ according to Humboldt, as 100 to 270 according to Rigaud, or as 100 to 284 following other estimates. The fluid portion of the surface thus vastly predominates, occupying nearly three-fourths of the entire area of the globe. The ancients, whose geographical knowledge was very limited, considered the ocean to be much less extensive than the land. Their poetical expression of the "ocean stream" was probably founded upon this idea. In the middle ages, the sea was supposed to occupy about one-seventh of the terrestrial surface. Columbus seized upon this opinion with ardour, as favouring his hypothesis, that a westerly sail across the Atlantic would bring him to an undiscovered shore.

III. The solid and fluid portions of the surface are very unequally distributed; land predominating in the northern, and occurring in comparatively insignificant force in the southern hemisphere. The proportion of known land to the entire area of different latitudinal zones, is exhibited in the following table:

LAND—NORTHERN HEMISPHERE.		LAND—SOUTHERN HEMISPHERE.	
Arctic Zone	0·400	Antarctic Zone	Unknown.
Temperate Zone	0·559	Temperate Zone	0·075
Torrid Zone	0·297	Torrid Zone	0·312
Total	0·441	Total	0·163

Its superficial extent in square miles is as follows:

LAND—NORTHERN HEMISPHERE.		LAND—SOUTHERN HEMISPHERE.	
Arctic Zone	3,252,589	Antarctic Zone	Unknown.
Temperate Zone	28,531,631	Temperate Zone	3,828,036
Torrid Zone	11,628,440	Torrid Zone	12,215,735
Total	43,412,660	Total	16,043,771

If we suppose the quantity of land in the northern hemisphere to be represented by 16, the amount in the southern will be scarcely equal to 5.

IV. Considering the globe to be divided, not in the line of the equator, but in that of the meridian of Teneriffe, the quantity of land and water in the two divisions is still very unequal, land predominating in the eastern half, while the western is specially oceanic. But if we take London to be the centre of a hemisphere, and its antipodes near a small island to the south-east of New Zealand, called Antipodes Island, to be the centre of the other, the inequality in the distribution of the components of the surface will strikingly appear. The first hemisphere will include nearly all the superficial land, and the other, excepting New Holland, a part of South America, and some islands will be oceanic.

V. There are no considerable antipodal surfaces of land, except where Chili and Patagonia oppose the eastern part of China; and the volcanic islands of Sumatra, &c., oppose the volcanic mountains of Quito. The great tract of New Holland is opposite to the deep centre of the Atlantic. Only about $\frac{1}{27}$th part of the present continents and islands has land opposed to it. The line of 16° west longitude, and 164° east longitude, is the meridian of least land. It passes by Kamschatka, the west side of New Caledonia, near the west side of New Zealand, and the west coast of Africa, near Madeira, Teneriffe, and the Cape de Verde islands. On this line it is almost all sea.

VI. The preponderance of land in the northern hemisphere indicates the superior intensity of the causes of elevation in northern latitudes at a remote geological epoch.

VII. Large continuous masses of land are termed continents, a Latin derivative signifying *connexion*. There are two grand examples: the Eastern Continent, which includes Asia, Africa, and Europe, otherwise styled the Old World, from its being the only one known to Europeans previously to the close of the fifteenth century; and the Western Continent, or the New World, which includes North and South America. The terms eastern and western refer to the meridian of the Ferro isles, from which longitude was formerly reckoned.

The rank of a continent has been assigned by some geographers to New Holland; but it is so far inferior in extent to either of the other masses, as to be more correctly placed in the class of islands. New Holland, however, with the innumerable islands of the Pacific and Indian oceans, ranks after Europe, Asia, Africa, and America, as a fifth great division of the globe, under the title of Oceania.

On many maps of the world, constructed in the interval between the discovery of the southern seas, and their navigation by Captain Cook, an immense continent figures, stretching out from the south pole, and filling the Antarctic regions, under the name of *Terra Australis Incognita*. Though no evidence of its existence could be adduced, yet speculative geographers firmly clung to the conviction of its reality, on the ground that an imaginary law of equipoise required such a continent in the southern hemisphere, to balance the great mass of land in the northern. The last formal advocate of a great habitable world in that region, Alexander Dalrymple, in 1772, sought to induce the Government to patronise an expedition, to be conducted by himself, stipulating that he should be allowed to retain for five years all the countries discovered in the southern ocean, between the longitudes 0° and 60° west of Greenwich. The researches of Captain Cook, who reached the high latitude of 71° 15′ S., encountering only some small islands, banished the dream of a *Terra Australis*, abounding in accessible mineral wealth, capable of sustaining vegetable life, and providing a new home for the human race. Yet it still remained an open question, whether there were not immense tracts of land lying between his limits and the south pole, or nothing but a frozen ocean. This question has recently been determined in favour of the former supposition, by separate expeditions under the auspices of the French, American, and British Governments. But it has not been positively ascertained that the respective coasts discovered are continuous, so as to form what may be called an Antarctic Continent.

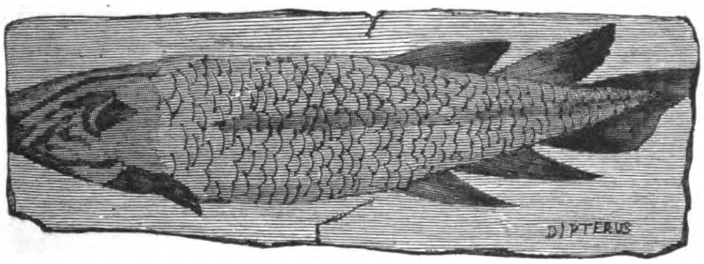
In the opposite hemisphere, Greenland may be the projection of an arctic continent, extending round the north polar point.

VIII. Smaller portions of land, surrounded by water, are termed Islands. They are true continents in miniature, as the great masses are everywhere engirdled by the ocean. A considerable number of islands closely clustered, is called an Archipelago. Semi-islands are portions of land cut off from an adjoining shore at high water, appearing in connection with it upon the retreat of the tide. A home example occurs off the coast of Northumberland, in Holy Island, the Lindisfarne of the Saxons, which is accessible at low water to vehicles of all kinds from the main shore across the Fenham Flats.

IX. A part of a continent running out into the sea, so as to be nearly insulated, being connected with the main land by a small portion of its own circumference, or a narrow neck, is named a Peninsula, signifying almost an island, as Italy, Spain, and the Morea. The peninsular form is a very common feature of the land; and almost all peninsulas follow a southerly direction. This rule applies to Scandinavia, Spain, Italy, Greece, Africa, Arabia, India, Malacca, Cambodia, Corea, and Kamschatka, in the eastern hemisphere; and in the western, to South America, California, Florida, Alaska, and Greenland. The

II. SECONDARY.

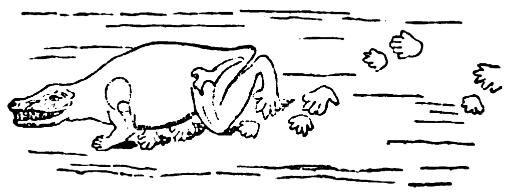
3. Old Red Sandstone, or Devonian system, largely developed in the west of England, and upon an immense scale in Scotland, occupying also vast areas of southern Russia, Siberia, and Tartary, and occurring on the southern flanks of the Himalaya mountains, and in various parts of the western world. The system is named in reference to its eminently arenaceous character, and predominant colour, a dark brick-red varying to a cream yellow, arising from iron oxide. *Organic remains.*—Plants, a few unimportant examples. Ichthyolites, or fossil fishes, belonging to the vertebrated order, are the characteristic fossils. The tails are heterocercal, or unequally lobed, as in the shark. Several genera, as the Dipterus, (double-winged,) have the vertical fins on the back and under the tail double.



4. Carboniferous system, embracing the mountain limestone and the coal measures, abundant in Great Britain and the United States; one main cause of their commercial greatness, but proportionably more extensive in the British islands than in other parts of the globe. The system is locally developed in France, Belgium, Saxony, Bohemia, Westphalia, on the north of the Carpathians, in Russia, Syria, the basin of the Indus, in China, and New Holland. *Organic remains.*—Zoophytes, molluscs, and fishes in abundance, with some crustaceans, in several instances of fresh-water origin. The mountain limestone is sometimes called the encrinal limestone, from whole masses of rock being almost wholly composed of the articulated stems of encrinites. Plants of many races, and generally of terrestrial growth, coniferæ, stems of sigillariæ, stigmariæ, and calamites of great size, with the foliage of arborescent ferns, like those within the tropics, in profusion, are the characteristic fossils.

Tropical Fern.

5. New Red Sandstone system, consisting of variously-coloured marls, sandstones, and magnesian limestones, with masses of rock salt, hence sometimes called Poikilitic, (variegated,) and Saliferous, (salt-yielding;) appears largely in midland England, in central Europe, and composes many of the river-valleys of the United States. The upper portion of the series, as exhibited in France and Germany, is there recognised as a separate system under the name of Triassic, as consisting of three principal groups; the lower portion, comprising the magnesian limestone, has been recently



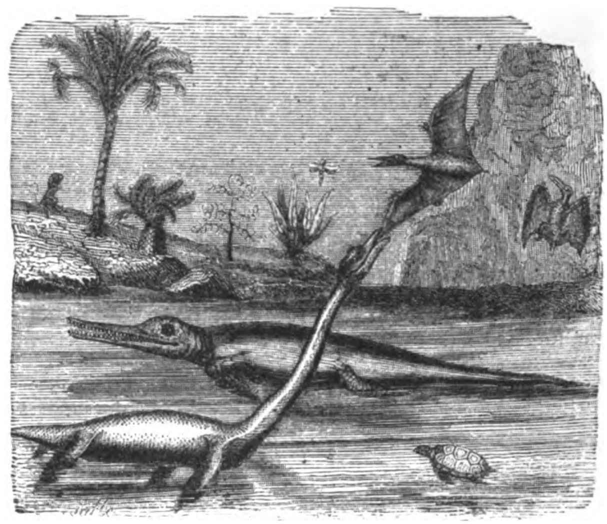
Labyrinthodon (restored).

styled the Permian system, in allusion to the locality where it is exhibited upon a grand scale, the ancient kingdom of Permia. This district extends about 700 miles from north to south, and nearly 400 from east to west, between the Ural mountains and the river Volga. *Organic remains.*—Plants, terrestrial and marine, with fishes, common to the carboniferous period, but in several instances peculiar; reptiles, the earliest instance of their occurrence, saurians and lizards, among which are frogs of enormous dimensions, as the labyrinthodon, a generic name referring to the labyrinthine, or intricate inflections of the teeth; Ichnolites, (foot-prints on stone,) of

Tracks of the Chirotherium.

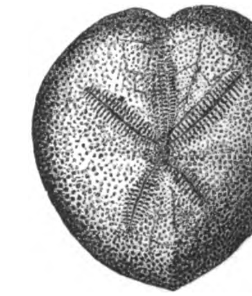
which some are called *sauroidichnites*, the supposed traces of reptiles, as those of the Chirotherium, so named from the impressions resembling the human hand in shape; others *ornithichnites*, the supposed tracks of birds; and others, *tetrapodichnites*, the supposed footsteps of an unknown four-footed animal.

6. Oolitic system, comprising the lias group and the Wealden formation, a collection of clays and limestones of various shades, the latter containing small calcareous globules, resembling the roe or eggs of a fish, and hence the name of the system, oolite, (egg-stone,) from the Greek. It occupies an extensive area of England; appears in various parts of Europe, but no true representatives are said to have been observed in America. *Organic remains.*—The most remarkable are those of marine saurians, the Ichthyosaurus, (fish-lizard,) the Plesiosaurus, (akin to the lizard,) with crocodilians of extant species; the Pterodactile, (wing-fingered reptile,) a flying saurian; the Megalosaurus, (great saurian,) a gigantic carnivorous terrestrial lizard; the Iguanadon, a huge herbivarous reptile, allied to the living Iguana; and Marsupial relics, allied to the opossum, the earliest type of mammalian organisation.



Restorations of Saurians, &c.

7. Cretaceous system, a scheme of deposits which comprises green sands, chalk marl, provincially called gault, and chalk, with chert modules and layers of flints, entitled after the Latin name of the prominent mineral, *Creta* (chalk.) It is conspicuous in the eastern and southern counties of England, spreads over wide areas of France and Germany, and occurs abundantly in North America. *Organic remains.*—Few examples of land organisms; plants, rare and nearly all referable to marine types; sponges, zoophytes, star-fishes, shells, and achinites abundant, as the *spatangus cor-anguinum*, heart-shaped achinite; vertebrated fishes; and the mososaurus (lizard of the Meuse,) named from the place where it was first discovered, an aquatic reptile.

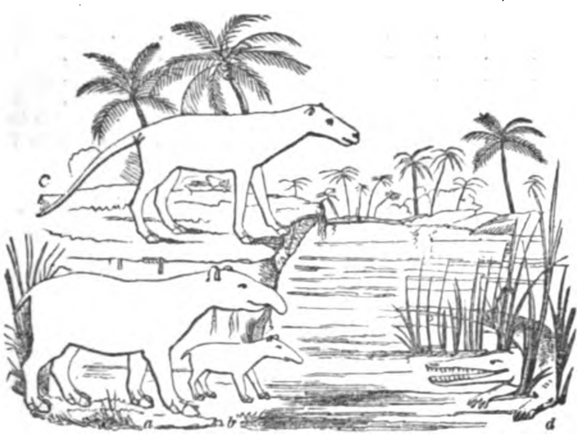


Spatangus cor-anguinum.

III. TERTIARY.

8. The Tertiary system, consisting of loosely aggregated beds of marine and fresh-water origin, occupies more than half the surface of Europe, and forms the site of three of its capitals—London, Paris, and Vienna. There are three principal groups:

1. The Eocene, (dawn of recent,) or lower tertiaries. 2. The Miocene, (less recent,) or middle tertiaries. 3. The Pliocene, (more recent,) or newer tertiaries. The nomenclature refers to the approach which the imbedded fossils make to existing nature. A fourth group is sometimes added, the Pleistocene, (most recent,) embracing the superficial accumulations of gravel, sand, and erratic blocks. *Organic remains.*—Plants, few marine, but the fresh-water beds have yielded cycadeæ, coniferæ, palms, poplars, willows, elms, chestnuts, sycamores, &c.: Fishes, mostly of extinct species; Molluscs, in great abundance, many belonging to living species; Reptiles, genuine crocodiles, serpents, tortoises, turtles, and prototypes of the frog tribe; Birds, referable



Animals of Paris Basin.

a Palæotherium magnum. *b* Palæotherium minus.
c Anoplotherium commune. *d* Crocodile.

to the genera, buzzard, owl, quail, woodcock, sea-lark, curlew, pelican, albatross; Mammalia, belonging to various orders.—*Pachydermata*, (thick-skinned,) palæotherium, anoplotherium, mastodon, elephant, hippopotamus, rhinoceros, horse, boar, tapir, &c.—*Quadrumana*, (four-handed,) monkey tribe.—*Carnivora*, (flesh devourers,) bear, hyena, fox, dog, seal, cat, weasel, &c.—*Rodentia*, (gnawers,) beaver, rat, hare, squirrel, &c. *Ruminantia*, (cud-chewers,) stag, deer, elk, antelope.—*Cetacea*, (whales.)—*Edentata*, (toothless animals, or with only molar teeth,) megatherium, glyptodon, mytodon, related to the existing diminutive sloths.

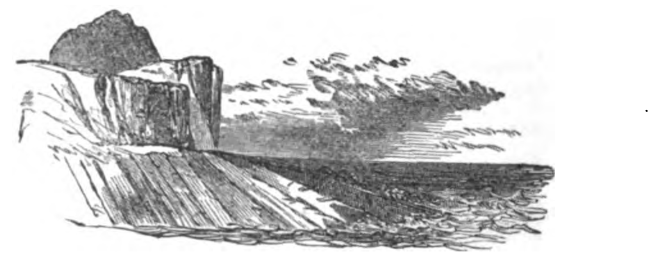
XI. The order of succession in the metamorphic and aqueous rocks, which has been stated ascendingly, is invariably maintained, that is, while many members of a group, and entire systems may be wanting, wherever they do occur, they are found to occupy the same relative position. Thus, if the old red sandstone is at the surface, the carboniferous system is not the under-lying formation. Chalk beds are never found below the coal measures, or the coal measures below rocks of clay-slate; but either chalk or coal may occur immediately above the slate, the intermediate formations being absent.

XII. The igneous rocks, plutonic and volcanic, exhibit generally amorphous, or irregular masses, without divisional structure, but broken by fissures, the summits being dome-shaped, globular, or deeply serrated ridges, in the form of needles, as the Aiguille de Dru in the valley of Chamouni. The metamorphic and aqueous rocks, on the contrary, are disposed in the form of beds, layers, or

Peter Botte Mountain, Mauritius.

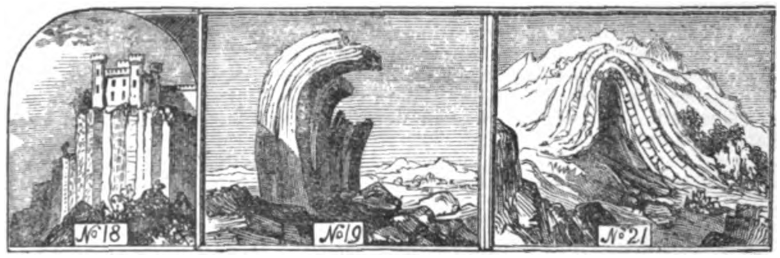
strata, both horizontal and inclined at all angles to the horizon. The plains and low portions of the earth are occupied almost universally by stratified rocks. They appear also in elevated districts, and on the flanks of mountainous regions. Strata vary in thickness from a few inches to many yards and fathoms.

Had the rocks of deposition been formed in quiet waters, and kept free from disturbing forces, the position of strata would have been uniformly horizontal. But this has not been the case, and consequently strata are generally found to dip to some point of the horizon, as represented in the cut. It is clear that this inclination of the strata is due to an elevating cause which acted subsequent to deposition.



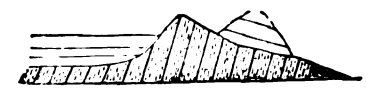
Inclined Strata.

Sometimes the strata have been lifted into a vertical position, or variously curved

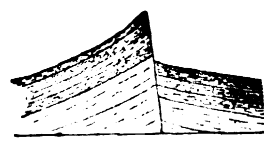


and contorted by the disturbing force. An example of vertical strata is given, or nearly so, from the rock on which Powis Castle is built; of curved strata, from one of the western islands of Scotland; and of contorted strata from the banks of the Wye. (Figs. 18, 19, 21.)

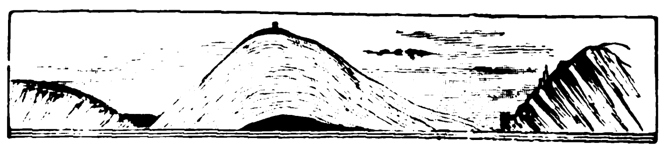
Frequently horizontal beds appear divided by the inclined, which latter were plainly elevated before the deposition of the former; or horizontal beds rest upon a highly inclined stratified base, while a series inclines in a different direction. In such cases, of which an illustration is given, the stratification is said to be unconformable, or discordant.



Strata very commonly present examples of interrupted continuity, cracks and fissures occurring, varying in breadth from a few inches to many feet and yards. These are termed faults, the divided parts often exhibiting a change of level. But instead of being simple fractures, faults are sometimes open fissures, and chasms filled with angular dispersed fragments from the rocks above, or with igneous products injected from below.



XIII. The general conclusion obviously indicated by the preceding facts is, that the rocks of fusion, or the unstratified masses, which constitute the basis of the crust of the earth, have been repeatedly erupted through and into the stratified formations, at different epochs of critical action among the subterranean agencies of heat. Hence the various dislocations of the stratified rocks, their disturbed and inclined positions, their upheaval above the deep in which they were deposited, and frequent elevation along the flanks and on the crests of high mountain ranges, which commonly have igneous masses for their nuclei or axes. The force exerted by the elastic vapours which the earth encloses in the elevation of mountains, however vast, immeasurably yields to the power indicated in the upheaval of the general surface of the land to its far inferior altitude.



Section of Crich Hill, Derbyshire.—Arched Strata.

CHAPTER II.

CONTINENTAL MASSES.

I. The great eastern continent extends through upwards of two hundred degrees of longitude, from Cape Verde, the most westerly point of Africa, 17° 33′ W, to Tschuktschi-noss, or East Cape, the eastern extremity of Asia, 190° E. It embraces upwards of a hundred degrees of latitude, from Cape Taimura, otherwise called Severo Vostochni-noss, or North East Cape, in Siberia, 78° 16′ N., to Cape Lagullas, east of the Cape of Good Hope, 34° 50′ S.

The greatest northern and southern stretches of the land are made under nearly the same meridians. Compare the northern extremity of Europe, North Cape, with the southern point of Africa, Cape Lagullas: the northern and southern extremities of Asia, Cape Taimura and the peninsula of Malacca.

II. The superficial area of this mass of land is estimated at about 33,000,000 of English square miles. It has a maritime coast line of more than 50,000 miles; and attains its greatest elevation in central Asia, reaching to the enormous height of nearly five and a half miles above the level of the sea, the culminating point of the globe. Its greatest depression is the shore of the Dead Sea, which, at the water level, according to barometrical and trigonometrical measurements, is upwards of 1300 feet in perpendicular depth below the highest houses in Jaffa on the Mediterranean.

Of the three divisions of the continent, Europe comprises somewhat less than one-eighth of its entire area; Africa more than a third; and Asia more than half. Africa is more than three times, and Asia more than four times the size of Europe.

The longest straight line that can be drawn on the solid superficies of our planet, extends from Cape Verde to the western side of Behring's Strait, a distance of about 11,000 miles.

III. The south-western member of the continent, Africa, is in many respects diverse from the other portions. Externally, a comparatively unbroken coast-line; and internally, deficient water communication, with the preponderance of sandy deserts, mark the contrast. Asia and Europe exhibit repeated examples of deeply indented shores; and both are plentifully supplied with great river systems, and fertile soil.

Some remarkable structural correspondences between Asia and Europe have been pointed out by M. Boué. Each has a large central protuberance, or nucleus, bifurcated at its extremities, the spine of the respective masses.

The Himalayans of Asia and the Alps of Europe follow the same general direction. Granitoid rocks and crystalline schists compose the central parts of the chains; and the same recent sedimentary formations are found on their flanks. The narrow gorges opened by nature, which admit of the passage of the chains, and serve as thoroughfares for commerce, have precisely similar features, and are only more formidable in the case of the Himalayans. The great tertiary and alluvial valley north of the Alps, answers to Turkestan and Mongolia. Piedmont and the plain of Lombardy are a miniature likeness of the basins of the Indus and the Ganges. "Delhi," says Boué, "is Milan, Calcutta reminds us of Venice, while Bombay is the counterpart of Genoa." The vast igneous district of Hindostan has its correspondent in the volcanic zone of Italy.

The southern peninsulas of the two regions are obvious analogues, Spain and Arabia, Italy and Hindostan, the Morea and Malacca.

IV. The inferior western continent extends through upwards of a hundred and thirty degrees of longitude, from the most easterly projection of South America, below Cape St. Roque, in Brazil, 35° W., to Cape Prince of Wales, the most westerly point of North America, in Behring's Strait, 168° W. It embraces upwards of a hundred and twenty degrees of latitude, from Point Barrow in the Arctic Ocean, 72° N., to the Straits of Magellan, 54° S.

The superficial area is computed to be about 14,000,000 square miles. The sea-coast has a linear extent of 32,000 miles. The greatest elevation is rather more than $4\frac{3}{4}$ miles above the level of the sea, but nearly 3000 feet below the culminating point of the eastern continent. The longest line that can be traced passes from Point Barrow along the Rocky mountains and the Cordilleras of the Andes to the Straits of Magellan, a distance of about 10,000 miles.

V. A striking dissimilarity appears in the general contour of the two continents. In the eastern, the prevailing direction of the land is from west to east, or more correctly from south-west to north-east: in the western, it is perfectly opposite, being from north-north-west to south-south-east. The forces that raised the two masses seem to have acted at right angles to each other, in the direction of the equator in the case of the old world, and of the meridian in the instance of the new.

This statement must be somewhat modified, if we regard south-eastern Asia as prolonged through the Indian and Pacific Oceans by a subaqueous continent, of which the large tracts of New Holland, New Zealand, New Guinea, Borneo, and the innumerable islands of those regions are the table lands and mountain summits.

VI. The western continent exhibits a simpler outline than the eastern. Its maritime coast has a less proportion of irregularities or indentations, no interruption of consequence occurring on the side towards the Pacific, except at California. The eastern sea-board of South America is also comparatively entire.

Of all the divisions of the globe, Europe has the most highly developed outline, being deeply invaded at all accessible points by the ocean in the form of inland seas, bays, and gulfs. This is strikingly shown by comparing the extent of their respective areas and coast lines.

	Area in square miles.	Linear miles of coast.
Europe	3,900,000	17,000
Asia	17,500,000	35,000
Africa	11,870,000	16,000
America	14,000,000	32,000

Thus, the proportion of square miles of surface to one mile of coast is in the case of Europe 229, America 437, Asia 500, and Africa 741. The figures in the table are rough approximations.

VII. Granite appears to be the base or skeleton of both continents, but while it occurs at a great elevation in the old world, forming some of the highest points of the Alps, it occupies a subordinate position among the rocks of the American mountain chains. Humboldt states that he never saw it at a greater height above the sea than 11,500 feet, and that a person might travel for years among the Andes of Peru and Quito without meeting with it at all. The superior and predominant formations of the Cordilleras are immense amorphous masses of porphyritic, basaltic, and trachytic rocks, for the most part of comparatively recent date. These volcanic products constitute a great portion of the chain, and form the loftiest summits of the new world, while in the eastern continent they occur in inferior force and never at great elevations.

From the extensive development of volcanic activity in the Andes, the newness of some of the formations, the frequency of earthquakes, and the recent rise of the western coast of Chili three or four feet above its former level, it has been inferred, that those mountains, though superior to most in elevation, are among the last that have been upheaved.

VIII. The two continents have some points of resemblance. Both terminate pyramidally towards the south. Their limits to the north have nearly the same latitude, that of 70° generally, except part of the northern Asiatic coast, which exceeds it; and an important member of each is almost isolated, a narrow isthmus connecting Africa with Asia, and uniting the Americas.

Descending to detail, we find the northerly projection of the peninsula of Jutland in Europe, repeated in the peninsula of Yucatan in central America, the only important exceptions to the southerly directions of peninsulas.

The remarkable crevices, or fiords, of the Norwegian shore, are repeated on the coast of southern Chili and western Patagonia.

IX. Comparing the two sides of the Atlantic basin, a mutual adaptation to unite may be observed in the advancing and retreating configuration of the land masses. Thus the great convexity of western Africa is opposite to the indentation of the Gulf of Mexico; and the convexity of the Brazilian shore is opposite to the indentation of the Gulf of Guinea.

The bold conception has been entertained from this peculiar outline, that the two continents once formed an undivided territory, which some great convulsion separated, creating the Atlantic valley into which the ocean poured.

X. The mean height of continents, or their elevation above the level of the sea, supposing the respective masses to be equally distributed, is a subject investigated by Humboldt with somewhat surprising results. He finds the mean height to depend, not so much on the longitudinal mountain chains—"those culminating points or domes which attract the curiosity of the vulgar"—as on the gentle but extensive and compact swellings of the plains, and the development of the table lands. Thus it is calculated, that the Pyrenees would produce upon the whole of Europe scarcely the effect of 6 feet, and the Alps about 22 feet, while the plateau of Spain, of inferior elvation but more compact, would produce an effect of 76 feet. If the vast range of the Andes were pulverised, and spread equably over the eastern plain of South America, its effect would be to raise the surface only about 518 feet. Omitting Africa, which is comparatively unknown, the final results obtained are, an elevation above the level of the sea, for Europe of 670 feet, North America 750 feet, South America 1130 feet, and Asia 1150 feet, or a mean elevation for the whole of 920 feet.

CHAPTER III.

ISLAND MASSES.

I. Islands rarely occur solitarily, surrounded by a wide expanse of ocean, but usually form groups and archipelagoes contiguous to some main shore.

Solitary isles are commonly small and of volcanic origin. Ascension Island is an example, 1450 miles from the coast of Africa, 680 from St. Helena, and 520 from the nearest point of land, the island of St. Matthew. St. Helena is another example, 1800 miles from the coast of Brazil, and 1200 from the shore of Africa, its nearest neighbour being Ascension Island. Both are volcanic formations. Rockall, a singular granite block, occurs in the north Atlantic, only a hundred yards in circumference, 290 miles from the mainland of Scotland, 260 from the north coast of Ireland, and 184 from any other land.

M. Balbi classifies a few islands placed at no great distance from one another, or a principal island surrounded by others of smaller size, as a group; and several islands, varying in their extent and distance, but in the same general locality, as an archipelago. Groups and archipelagoes have frequently detached or outlying members, which are sometimes called Sporades, or "scattered islands."

II. Some islands are simple accretions of sand, deposited by the ocean, just rising above high-water mark. Others are tracts, more or less extensive, having the same general appearances as the continents, with mountains, plains, lakes, rivers, and variable climates, being identical in geological structure with adjacent continental masses.

This affinity appears in the case of southern England and northern France. The crystalline mountains of Sardinia and Corsica, are related to the maritime Alps. Some members of the Greek Archipelago correspond to the ancient chain of Olympus and Pelion. The secondary system of the Peloponnesus appears in the isle of Crete, while Cyprus and Rhodes are geologically connected with the coast of Asia Minor. The same relationship exists between the island of Trinidad and the coast chain of Cumana; the isles of the Gulf of St. Lawrence and the adjoining continent; the Japanese islands and the deposits of Kamtschatka.

III. It is obvious, from geographical position and geological character, that such islands are continental extensions, mountain chains, and high table lands connected with the main shore, the intermediate portions, at a lower level, being submerged. In a variety of instances, appearances indicate the visible junction of continental and contiguous island masses at a former period, which violent oceanic invasions have interrupted.

It can hardly be doubted that England has in this manner been detached from the main land of Europe, the sea cutting its way through an isthmus connecting it with France, and forming the present Straits of Dover.

The West Indian islands, and those of the Indian Archipelago, seem to have been rendered insular by incursions of the ocean.

IV. A vast number of islands are volcanic, either at present the scenes of fiery convulsion, or proclaiming the past activity of the tremendous element by their igneous masses and crateriform outlines. Though widely distributed, from the island of Jan Mayen, in latitude 72°, the most northern volcanic country known to the south polar lands, they are principally found in the Indian and Pacific oceans, forming three great zones, each extending several thousand miles. The formation of new islands by submarine volcanic action is a phenomenon of the present era. Some of these remarkable creations have either entirely disappeared by subsidence, or remain as shoals slightly depressed below the surface of the ocean, while others have continued permanent.

There are well authenticated records of new volcanic islands, in the following localities:

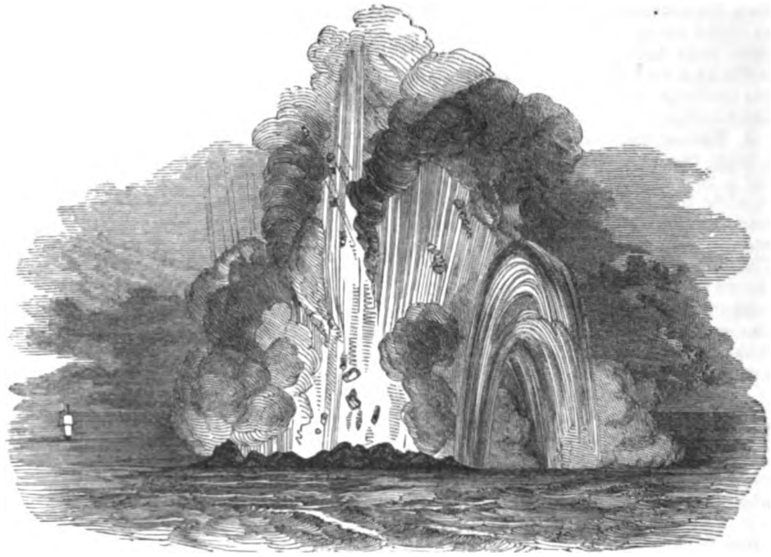
Grecian Archipelago.—In the Gulf of Santorin, one of the Cyclades, the small island of Palaia Kameni was thrown up rather more than two centuries before the Christian era. A second appeared in the year 1573, called the Little Kameni, and a third was formed in the years 1707 and 1709, called the New Kameni. They consist of lava, scoriæ, and pumice, with strata raised from the bed of the sea.

The Azores.—New islands appeared in connection with this group in 1538, 1587, and 1720; but the best known example occurred in 1811, when the temporary island of Sabrina rose off the coast of St. Michael. It attained the height of 300 feet, was about a mile in circumference, but gradually subsided, and wholly disappeared by the close of February, 1812. In 1813, there was 500 feet of water at the spot.

Coast of Iceland.—Seventy miles from Cape Reykiawas, the island of Nyöe, or New Island, was erupted in 1783, and formally claimed by the court of Denmark; but in a few months the sea regained possession of the site.

Aleutian Isles.—A new island was added to this group in the year 1806, upwards of four geographical miles in circumference; and a second appeared in 1814, which rose to the height of 3000 feet, then slightly subsiding. Both have since remained firm.

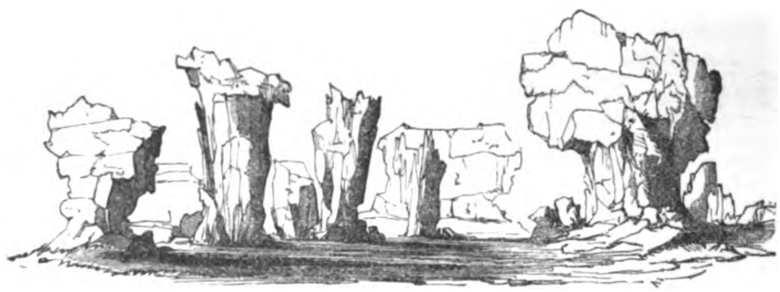
Coast of Sicily.—Thirty miles north-east of Pantellaria, in July 1831, a column of water was seen rising from the sea like a water-spout, followed by dense steam, and an island, which gained the height of 200 feet, and a circumference of three miles. Towards the close of the year, Hotham or Graham Island, as it was called, gradually subsided, and sank beneath the waves, forming a dangerous shoal.



Hotham Island.

V. Coralline islands, among the most interesting and wonderful operations of nature, are the work of organic beings, which exist in inappreciable numbers, chiefly in the tropical seas, the Indian and Pacific oceans. They consist of the agglutinated skeletons of departed races of polypi, composed of carbonate of lime, secreted from the ocean, cemented into hard calcareous rock, and, within a certain range, of the living organisms, adding by their growth to the superstructure.

The coral insects cannot exist if left dry, or at a greater depth than from 25 to 30 fathoms. All the coral above the surface of the water is dead, and has been washed up, sometimes in huge blocks, by the stormy swell of the ocean, which has tremendous power in the Pacific. All the coral likewise is dead below the depth mentioned; and



Coral Blocks.

the fact of its occurrence hundreds of feet below the limit within which the polypi can live, with the general phenomena of the formations, is beautifully explained by Mr. Darwin's theory, that the foundations upon which the coral insects originally began to build have been in course of subsidence. This view is confirmed by the circumstance, that the lines of volcanic activity in the Indian and Pacific Oceans, or the areas of elevation, are in general remote from the spaces occupied by the coral-working insects, the supposed areas of subsidence.

VI. Coralline formations are distributed into the four great classes of Lagoon-islands, to which their Indian name of atolls is generally applied, encircling-reefs, barrier-reefs, and fringing-reefs.

1. Lagoon-islands, or atolls, consist of a belt of coral enclosing a lagoon, or vacant space of the ocean. The coral above the surface of the water is usually under a quarter of a mile in breadth, and so low, that it would not be perceptible at a very small distance, but for its vegetable clothing of cocoa-nuts and palms. The lagoons themselves, or enclosed spaces, vary in extent from a few square miles to enormous areas. Bow atoll is 30 by 6 miles across; Rimsky atoll, 54 by 20; Suadiva atoll, 44 by 34; and one of the Maldiva atolls is 88 miles long by from 10 to 20 broad. The atolls are variously circular, oval, and irregular in shape. They occur solitary and in groups, but usually in elongated archipelagoes. Dangerous archipelago, east of the Society Islands, is an assemblage of 80 atolls, mostly circular, subject to strong currents and squalls. The Low Archipelago, to the north, is an ellipse, 840 miles in its longer, and 420 in its shorter axis. The Caroline Archipelago, north of New Guinea, comprises 60 groups of atolls, about 1000 miles in length. Between the extreme limits of the Carolinas west, and those of the Low Archipelago east, there is a linear space of ocean extending upwards of 4000 miles, in which the islands are for the most part atoll-formed.

2. Encircling reefs differ only from the atolls in having one or more islands within the central expanse. The coral belt is commonly at the distance of two or three miles

from the enclosed shore. Otaheite, the principal of the Society group, is a fine example, an island rising in mountains 7000 feet high, surrounded by a lagoon, like an enormous moat, from half a mile to three miles broad, which is separated from the out-lying ocean by a reef of coral. The coral, both in the case of atolls and encircling reefs, has openings or channels in its circuit, by which ships enter the lagoons, where they find excellent harbourage.

3. Barrier reefs extend in straight lines in front of the shores of a continent, or of a large island, frequently at a considerable distance from the land. New Caledonia has a reef of this kind 400 miles long; but the grandest example of coral formation existing is the great Australian reef. Externally, it starts up with little inclination from a fathomless ocean, stretches upwards of 1000 miles along the coast, varies in breadth from 200 yards to a mile, and in distance from the shore from 20 to 70 miles. There are transverse openings by which vessels enter the interior ocean, which is everywhere safely navigable. "The long ocean swell," remarks an observer, "being suddenly impeded by this barrier, lifted itself in one great continuous ridge of deep blue water, which, curling over, fell on the edge of the reef in an unbroken cataract of dazzling white foam. Each line of breaker runs often one or two miles in length, with not a perceptible gap in its continuity. There was a simple grandeur and display of power and beauty in this scene that rose even to sublimity. The unbroken roar of the surf, with its regular pulsation of thunder, as each succeeding swell fell first on the outer edge of the reef, was almost deafening, yet so deep-toned as not to interfere with the slightest nearer and sharper sound. Both the sound and sight were such as to impress the spectator with the consciousness of standing in the presence of an overwhelming majesty and power."

4. Fringe reefs are mere ribands of coral enclosing no lagoons but immediately lining the shore.

VII. In a few instances, islands have been registered as existing in certain parts of the ocean which subsequent navigators have failed to find. Saxenburg Island, and Isla Grande, both placed in the South Atlantic, are examples. Either the precise localities have not been visited, owing to inaccurate entries of latitude and longitude, so that the problem of their existence remains to be solved, or the supposed discoverers were deceived by the land-like appearance presented by low clouds and icebergs. A singular incident occurred during the recent Antarctic expedition of Sir James Clark Ross. This was the sudden appearance of what seemed to be an island, in a spot occupied a few hours before by an iceberg, upwards of a hundred feet high, the whole of the summit being perfectly free from snow. It seems that the berg had turned over unperceived from the ships, exposing to view a new surface covered with earth and stones, the mass still slightly oscillating from the effect of its capsize.

Dean's Island.

CHAPTER IV.

MOUNTAINS AND VALLEYS.

I. Mountains, to which we are largely indebted for sublime and savage, or beautiful and picturesque scenery, are the loftier protuberances of our planet, those of the first class reaching the height of 10,000 feet and upwards above the level of the sea, those of the second class ranging between that height and 4000 feet, those of the third class varying from thence to 2000 feet, the inferior elevations being styled hills and slopes.

The Himalayans, Andes, Caucasus, Alps, Atlas, Pyrenees, &c., belong to the first class: the Carpathians, Apennines, Ural, Scandinavian mountains, and some of the Scottish Highlands, &c., belong to the second; the Cumbrian and Cambrian chains, &c., belong to the third; the Malvern Hills, Peak of Derbyshire, &c., to the fourth.

The optical impression made by the elevations of the surface is that of the earth being an irregular body, and not a sphere. But the highest mountain known, rising to 28,000 feet, is only about $\frac{1}{5000}$th part of the earth's greatest circumference, and $\frac{1}{1500}$th of its axis. A grain less than $\frac{1}{20}$th of an inch in thickness would therefore represent it upon an artificial globe of twenty-one feet in circumference.

II. Though nothing appears at first sight more arbitrary and unsystematic than the contour of mountains, there is everywhere a certain general correspondence between their external aspect and internal structure. The productions of the animal and vegetable kingdoms vary with the climate, but the mineral masses present everywhere distinctive peculiarities of natural configuration.

M. Boué remarks, that while blunt cones with craters indicate volcanoes, a series of peaks like a saw denotes dolomites, a form of the magnesian limestone; rounded heads like the tops of nails characterise calcareous rocks; triangular points, slates or quartziferous schists; needles, crystalline schists; capricious twistings and crumplings, serpentines and trachytes; pyramidal forms, phonolites; thin and dark-looking walls intimate the presence of basalts or traps; rocks broken up by the weather into roundish masses are granites or grits.

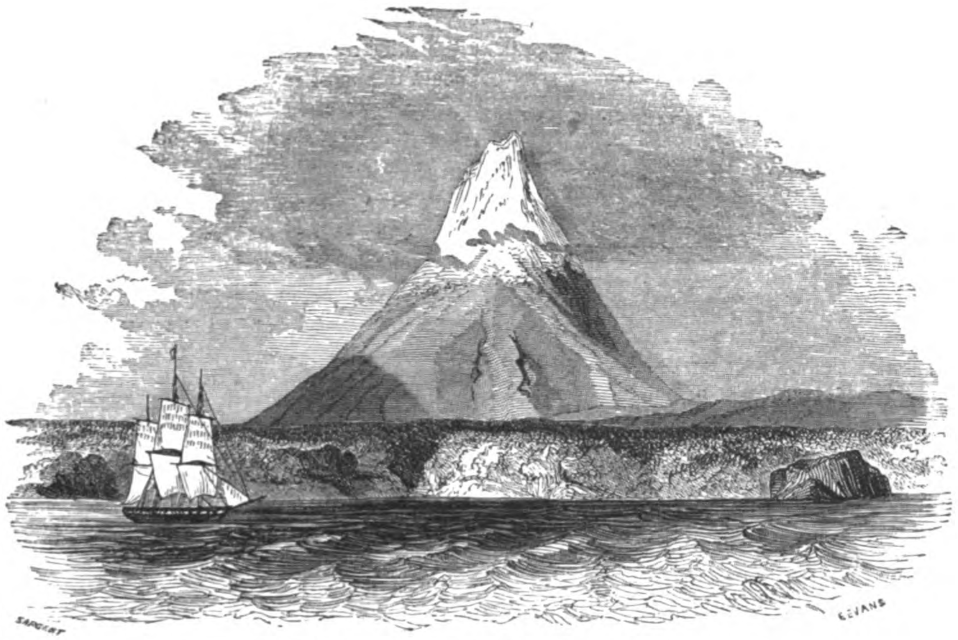
III. The elevation of several remarkable localities, with some of the highest altitudes reached by man, is stated in the following list:

	Feet.
Culminating point of the globe, Dhawalagiri, in Nepaul	28,000
Culminating point of the western continent, Novada Sorata, Bolivia	25,250
Ascent of Gay Lussac at Paris, in 1804, being the greatest height ever attained by a balloon	22,900
Highest flight of the condor of the Andes	21,000
Highest point reached by Humboldt on Chimboraco, in 1820	19,500
Manering Pass in the Himalaya, crossed by Capt. Gerard	18,612
Culminating point of the Caucasus, Mount Elbrouz	17,796
Bushes seen in the Himalaya	17,000
Mines of Potosi	16,080
Highest pass of the Andes, in Bolivia	16,000
Good crops of wheat raised in Chinese Tartary	16,000
Highest snow line of the Himalaya	16,500
Highest snow line of the Andes	15,800
Manasa Lake in Thibet	15,000
Thick woods of pines in the Himalaya, and birch trees of a large size	14,000
Highest habitation of man in the Old World, table land of Thibet	13,600
Highest inhabited spot on the Andes, farm of Antisana	13,435
Potosi, great square of the city	13,314
Milum Temple, near the source of the Ganges	13,000
Titicaca Lake	13,000
Culminating point of the Antarctic lands, Mount Erebus, a volcano, supposed to be	12,400
Poplars found by Gerard in the Himalaya, 12 feet in girth	12,000
Cuzco, ancient capital of Peru	11,380
Highest European Pass, that of Mont Cervin, Pennine Alps	11,100
Riobamba Pass, Andes	10,800
Highest growth of Peruvian bark	9,590
Quito, city	9,540
Pass of Sta Maria, house, highest permanent habitation of Europe	9,272
Mine of Real del Monte, in Mexico	9,120
Greatest height of the peach, apricot, and walnut, growing luxuriantly in the Himalaya	9,000
Highest carriage-road of Europe, across Mont Stelvio, Rhætian Alps	8,850
Santa Fe de Bogota, Columbia	8,650
Pass of the Grimsel, Bernese Alps	8,400
Quito, plains	8,000
Hospice, St. Bernard	7,965
Mexico, city	7,470
Mexico, plains	7,000
Hospice, St. Gothard	6,808
Highest village of Europe, Soglio in the Grisons	6,714
Source of the Loire	4,593
Culminating point of Great Britain, Ben Nevis, Inverness-shire	4,368
Plain of Ispahan, Persia	4,140
Culminating point of England and Wales, Snowdon	3,571
Culminating point of Ireland, Gurrane Tual (Magillicuddy Reeks), Kerry	3,440
Palace of the Escurial, Spain	3,264
Culminating point of England, Sca-Fell, Cumberland	3,166
Carmel, Syria	2,160
Longwood House, residence of Bonaparte, St. Helena	2,000
Rock of Gibraltar	1,439
Great Pyramid, Egypt	576
Folkstone Turnpike, Kent	575
Vienna	522
St. Paul's, London	360

IV. Mountains seldom occur completely free and insulated, that is, in plains remote from other masses. The examples are chiefly volcanic, as Mount Egmont in New Zealand. They are not often found in groups with no connection apparent between their bases. The common arrangement is for a series of neighbouring mountains to run into each other, forming parallel ridges, a number of which constitute a grand chain. The central ridge has usually the boldest development and the highest elevation; and the extremities of a chain are generally low heights, its culminating points being towards the centre. Secondary lines of mountains branch off from the main chains at various angles.

From its frequent occurrence, it seems to be a general law, for chains of mountains to have very steep declivities on one side, and very gradual slopes on the other. The Alps descend much more abruptly towards Italy than towards Switzerland. The Pyrenees are steeper towards the south than towards the north, and so is the Sierra Morena, while the mountains of the Asturias are just the reverse. The Scandinavian system is steepest towards the west and north-west; and while the Ghauts of Hindoostan have long and gentle slopes in one direction, they are precipitous on the opposite side. The Andes present a steeper face towards the Pacific Ocean than towards the main land of America.

The judgment formed from popular observation, respecting the steepness of declivities, is often most erroneous. "In the whole range of the Alps there is not a single rock which has 1600 feet of perpendicular height, or a vertical slope of 90°. The declivity of Mont Blanc towards the Allée Blanche, precipitous as it seems, does not amount to 45°; and the mean inclination of the Peak of Teneriffe, according to Baron



Mount Egmont in New Zealand (Extinct Volcano.)

Humboldt, is only 12° 30′. The Silla of Caraccas, which rises precipitously from the Caribbean Sea, at an angle of 53° 28′, to the height of between six and seven thousand feet, is a majestic instance of the nearest approach to perpendicularity of any great height yet known."

V. Chains of mountains, though making many curves and angles, generally correspond in their prevailing direction, to the line of greatest length in the continent or district in which they are situated.

The chain of the Andes, prolonged in North America, under different denominations, and with frequent interruptions, extends through the longest line of the western continent, from south-east to north-west, over a linear space of upwards of 10,000 miles.

The chain which, with only a few breaks, stretches from the south-west coast of Europe to the north-east coast of Asia, comprising the Pyrenees, Alps, Balkan, Taurus, Caucasus, Hindoo-Koosh, Himalayans, &c., traverses the eastern continent in the line of its greatest extent.

The course of secondary chains, as the Apennines in Italy, the Dovre-field in Scandinavia, the Ghauts in Hindostan, &c., correspond with the greatest length of those peninsulas.

VI. Chains parallel in their course, or having identity of general direction, though remote from each other, being separated by arms of the sea, straits, or valleys, by igneous deposits, secondary or tertiary basins, exhibit correspondences in geological structure.

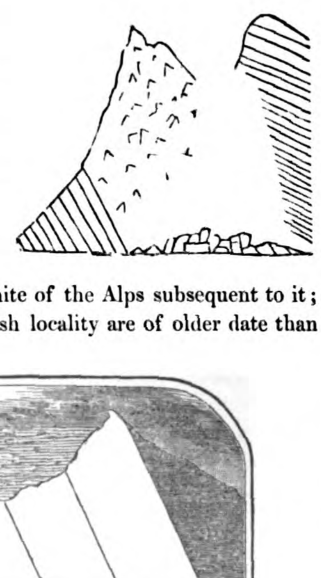
A group of parallel chains whose direction is west to east nearly, comprising the coast chain of New Granada, the Parima in South America, the range probably of Central Africa, the main chain of the Alps, the Balkan, Taurus, Hindoo-Koosh, Himalaya, Thian-Chan (Celestial Mountains), &c., closely resemble each other in geological constitution.

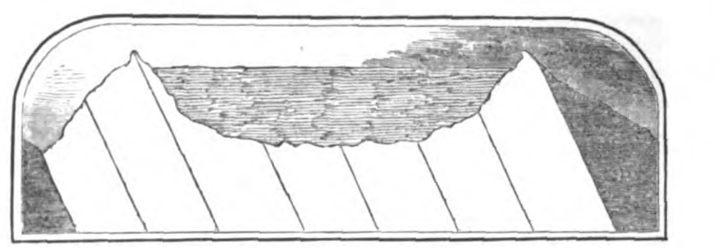
A group of parallel chains whose direction is north to south nearly, comprising ridges in the north of England, part of the Norwegian Mountains, banks of the Middle Rhine, Central France, the Ural, the Western Altai, ranges east of the Yenessei and the Lena, Cordilleras in new Mexico, Bolivia, and Chili, consist of similar ancient and transition formations, igneous deposits, metaliferous veins, and some dependent secondary strata.

VII. Those mountain chains which run in the direction of the parallels of latitude, or from east to west, are found to mark much more striking differences, not only in the flora and fauna of the globe, but among nations, than those which follow the direction of the meridians, or from north to south.

M. Boué remarks, that the immense meridional wall of the Scandinavian Alps has been no barrier to the occupancy of the country on both its sides by people connected by descent; and that in both Americas, where the meridional direction characterises all the chief chains, there is only one copper-coloured race, although the continent stretches through more climateric zones than Europe or Africa, or than Asia and Australia united. On the other hand, the comparatively feeble latitudinal barrier dividing England from Scotland, and the inferior elevations of the Highlands, have for centuries hindered the fusion of the Anglo-Saxons and the Celts, notwithstanding the close intercourse promoted by a high civilization. In like manner, the Spaniards differ more from the French than from the Portuguese, the Italians more from the Germans than the Spaniards, the Turks more from the Arabs than the Persians, &c.

VIII. The contemporaneity of parallel chains is invested with a high degree of probability; and data exist by which the relative age of different mountain systems may be estimated. The structure of a part of the Alps is exhibited in the annexed section, which shows beds belonging to the upper secondary strata uplifted and turned back by the intruding granite. The section following represents similarly recent strata, reposing horizontally on the granite rocks of Charnwood Forest, in Leicestershire. It follows that the granite of Charnwood was elevated before the deposition of the strata, and the granite of the Alps subsequent to it; and consequently the granite rocks of the English locality are of older date than





those of the Alpine. From such indications, the distinguished French geologist, Elie de Beaumont, has ranged the mountains of Europe into twelve grand distinctive systems, according to their age; which, beginning with the oldest, are as follows:

1. System of Westmoreland, comprising also mountains in North Wales and in Cornwall, the ridges of the Hundsruck, of the Eifel, and others in Nassau, with the Scandinavian Alps.
2. System of the Ballons in the Vosges, and of the Bocage in Calvados, to which belong hills in the south of Ireland and in Devonshire, elevations near Magdeburg, and probably the older part of the Hartz.
3. System of the north of England, running from the frontier of Scotland to the Midland Counties, almost direct from north to south.
4. System of the Netherlands and of South Wales, extending from Aix-la-Chapelle, traceable in an unbroken line westward to St. Bride's Bay in Pembrokeshire.
5. System of the Rhine, chiefly developed between Basle and Mayence, including a declivity of the Vosges on one side of the river, and the Black Forest on the other.
6. System of the south-west coast of Brittany, of La Vendée, of Morvan, of the Böhmerwaldgebirge, and of the Thuringerwald—the Bohemian and Thuringian forests.
7. System of the Erzgebirge, the Côte d'Or, the Mont Pilas, and the Cevennes, a closely connected group of elevations, stretching from the banks of the Elbe to the south of France.
8. System of Monte Viso; a series of ridges including the French Alps, and the south-west point of the Jura of Antibes and Nice, of which Monte Viso is the chief elevation.
9. System of the Pyrenees, to which portions of the Apennines belong, some parts of the mountains of Croatia, Dalmatia, Bosnia, Greece, and of the Carpathian range.

10. System of Corsica and Sardinia, with which the cliffs of the Loire and the Allier are classed, many chains of the Apennines, others in Istria, and Servia.

11. System of the Western Alps, stretching from Monte Rosa through Savoy and Dauphiny, in a direction from north-north-east to south-south-west, comprising the loftiest peaks of Europe near its intersection with the great chain running easterly towards Austria.

12. Principal chain of the Alps, running nearly from west to east, with the subordinate ridges on the northern side, which are parallel to it.

IX. The following Table states the length of principal mountain chains, with the heights of their culminating points:

Name.	Length in miles.	Culminating Points.	Height in feet.
Pyrenees, from the Mediterranean to the Bay of Biscay	225	Pic Nethou (Maladetta)	11,168
Apennines, from the maritime Alps west of Genoa to the southern extremity of Italy	800	Monte Corno	9,523
Alps, from Mont Blanc to the frontiers of Hungary beyond Gratz and Laybach	450	Mont Blanc	15,750
Scandinavian system, taking successively the names of Thulian, Dovre-field, and Koelen Mountains	900	Sneehætten	8,122
Caucasus, from the Black Sea to the Caspian, belonging equally to Europe and Asia	700	Elbrouz	17,796
Ural, common to Europe and Asia, from the Arctic Ocean to the river Ural, where it flows from east to West	1250	Deneskin Kamen	5387
Altai, forming the southern boundary of Siberia, from the affluents of the Irtish to the lake Baikal	884	Bieloukha	11,063
Thian-Chan, from the intersection with the Bolor to the centre of Mongolia	1464	—	20,000?
Kouenlun, the northern boundary of Thibet, from the Bolor chain to the sources of the Yellow River	1600	Karakorum	18,000
Himalayans, from the frontiers of China Proper, including the Hindoo-Koosh or Indian Caucasus, and the Persian Elbruz, to the south-western extremity of the Caspian Sea	2800	Dhawalagiri	28,000
Bolor-tagh, a meridional chain, prolonged from the Punjaub in lat. 32½° across the Himalaya and the Kouenlun to lat. 45½°	800	Tutucan-Moutcani	20,480
Atlas, from Cape Gher, on the shore of the Atlantic, to the Gulf of Sidra, on the Mediterranean	2000	Miltsin	11,400
Andes, from Cape Horn to the Isthmus of Panama	4550	Novada Sorata	25,250
Rocky Mountains of North America, including the Sea Alps of California and of the north-west coast	3000	Mount St. Elias	17,860

X. Humboldt has established the very remarkable law, that in a part of Asia there is a predominance of auriferous and platiniferous deposits in the mountain chains which have a meridional direction—a law which he had observed in reference to the auriferous alluvions in the American Andes, in the Southern Alleghanies, and in the mountains of Brazil.

XI. Chains of mountains are variously intersected by valleys, which form two leading classes, termed longitudinal and transverse, from their position in relation to the course of the main elevations. The longitudinal valleys separate parallel ridges of a chain, and follow its general direction; the transverse valleys cut the ridges at right angles to it.

The canton of the Valais is a longitudinal valley, the most considerable in Switzerland, lying between the ranges of the Pennine and Bernese Alps. It extends nearly a hundred miles in length, the breadth of the base varying from a quarter of a mile to three miles, the grand heights of the Jungfrau, Finster Aar Horn, Monte Rosa, &c., forming the side walls. The transverse valleys admit chiefly of high mountain chains being crossed. In such elevated sites they are narrow and frightful gorges, styled passes and gates, because of communication being maintained through them. The passes of the Caucasus, those of the Andes, and of the Himalaya, are scenes of great magnificence—often of appalling gloom and peril. The sides of the valleys of Chota and Cutaco in the Cordilleras are 4875 and 4225 feet in perpendicular height, the breadth not exceeding 2600 feet. So deep and inclosed are the defiles of the Himalaya, that Sir A. Burnes for a considerable time could not obtain a single observation of the pole-star while journeying through them.

XI. Both longitudinal and transverse valleys, but more commonly the latter, have very often written on their opposing sides a plain record of their origin. They exhibit not only a continuation of the same strata, but salient and re-entering points so exactly corresponding as to proclaim their formation by the breakage of the general mass during its upheaval. Hence they are styled Valleys of Dislocation. Sometimes there has been upheaval without fracture, but with more effect at particular points, causing intervening depressions, which are termed Valleys of Undulation, of which an example is given from the Jura Mountains. Valleys of Denudation are those which appear to have been formed by the action of water upon soft and practicable strata; but there is little doubt that most valleys, from the grand rents of mountain ranges to the wide and gently sweeping hollows of the general surface, are mainly due to internal causes of disturbance, their physiognomy being subsequently modified by atmospheric and aqueous agencies.

Jura.

XIII. A great depression, embracing many thousands of square leagues, marks the surface of Western Asia, of which the Caspian Sea and Lake Aral form the lowest part, but which extends far into the interior of the continent, and is supposed to be intimately connected with the upheaval of the Caucasus, the Hindoo-Koosh, and the plateau of Persia. By operations directed by the Imperial Academy of Sciences of St. Petersburgh, which terminated October 23, 1837, it was ascertained that the Caspian is 83·6 English feet below the level of the Black Sea.

CHAPTER V.

PLATEAUS AND TABLE-LANDS.

I. An extensive mass of elevated land, with comparatively level sites, comes under the denomination of plateau or table-land. It may have various undulations of hill and vale, be traversed by mountain ridges, and serve as a platform for lofty peaks. But its prevailing character is that of a highly raised region on which there is a considerable area of plain surface, styled table-land from its aspect and height; the whole presenting either gradual slopes or abrupt acclivities, and sometimes terrace-shaped sides to the adjoining lowlands.

II. The principal plateaus, with their comparative mean heights, are as follows:

Plateaus of	Feet.
Spain	2240
Mysore	2944
Persia	4000
Gobi	4000
Popayan	5760
Abyssinia (Lake Tzana or Dembea)	6110
S. Africa (Orange River)	6400
Abyssinia (Axum, ancient capital)	7091
Mexico	7475
Santa Fe de Bogota	8700
Quito	9536
Bolivia (Lake Titicaca)	13,000

III. The plateau of Bolivia, or Upper Peru, remarkable for its elevation, stretches along the top of the main mass of the Andes, between the gigantic mountain knots of Cuzco and Potosi north and south, and between the Cordillera Real and the Cordillera of the Coast, east and west. The serrated ridges and smoking cones of these boundaries rise to nearly double the height of the enclosed area.—(Nevado de Chuquibamba, 21,000 feet; Gualatieri, 22,000; Nevado de Illimani, 24,200; Nevado de Sorata, 25,260.) The territory of which these are the enormous ramparts exhibits a varied surface, and extends 500 miles long by from 30 to 60 broad, comprising 150,000 square miles, upwards of twice the size of England and Wales. The lake Titicaca is about twenty times as large as the lake of Geneva, covering a surface of 4000 square miles. One of its islets, of the same name, was held sacred by the old inhabitants, and the Incas built upon it a temple of the sun; but colossal ruins in various directions are supposed to be the remains of a people anterior to their empire. Section—Map of South America.

IV. Less elevated and less extensive is the table-land of Quito, 200 miles long by 30 broad, but not less grandly situated, engirdled by magnificent heights.—(Pichincha, 15,922 feet; Cotopaxi, 18,880; Antisana, 19,137; Cayamba, 19,630, remarkable for being traversed by the equator; Chimborazo, 21,420.) "From the terrace of the government palace," says Humboldt, speaking of the city of Quito, "there is one of the most enchanting prospects that human eye ever witnessed, or nature ever exhibited. Looking to the south, and glancing along towards the north, eleven mountains covered with perpetual snow present themselves, their bases apparently resting on the verdant hills that surround the city and their heads piercing the blue arch of heaven, while the clouds hover midway down them or seem to crouch at their feet." A peculiar and somewhat awful interest belongs to this district, if the supposition be correct that a portion of it is but the dome of an enormous vault, which has been hollowed by the action of the neighbouring volcanoes. Section—Map of South America.

V. The plateau regions of central Asia are the most extensive on the face of the globe; but more properly, the great upheaval of central Asia might be considered as forming one vast plateau, comprising different systems of table lands. Between the chains of the Thian-chan and the Kuen-lun mountains, and stretching from thence in a north-east direction to the extremity of Chinese Mongolia, is the vast district called Gobi, signifying in the Mongolian language "a naked desert," of which the Chinese denominations, Shamo, the "Sea of Sand," and Han-hai, "the Dry Sea," are the equivalents. Its mean elevation is given in the table at 4000 feet, which is the altitude of that part of it traversed by caravans of tea, about double that of the plateau of Spain; for while towards the wall of China it rises to 5800 feet, it sinks to 2400 in the central region. The length is given at about 2000 miles, with a breadth of from 200 to 300, including an area more than two and a half times that of France. Shingle, yellow sand, and gravel, form the surface, mostly overgrown with rank grass, except in the middle, where there is a belt of naked sand 20 miles across, shifting with the wind.

VI. The other principal plateaus mentioned in the table may be more briefly noticed.

Santa Fe de Bogota.—The upland plain, the site of this capital, has a perfectly level surface enclosed by a barrier of rocks. It lies along the eastern Cordillera of New Granada, at a greater height than the hospice of St. Bernard.

Mexico.—The whole interior of Mexico is occupied by a plateau, about 360 miles broad in the latitude of the city, the site of numerous lakes and extensive plains, and a platform for the colossal heights of Orizaba, Popocatepetl, Iztaccihuatl, and Nevado de Toluca, which are clothed with perennial snow.

Abyssinia and South Africa.—The central region of southern Africa appears to be an immense table land, probably of no great elevation in general, supposed to extend continuously north of the equator, terminating in the high lands of Abyssinia.

Popayan.—The elevated land occupied by the city, once the capital of New Granada, is formed by the main trunk of the Andes, which sends up in its vicinity the peaks of Purace (17,035 feet) and Nevado de Huila (17,900).

Persia.—The plateau of Iran leaves only a very narrow border of lowland along the Persian Gulf, the Indian Ocean, and the Caspian Sea. The site of Ispahan is higher than the mean elevation given; that of Teheran a trifling degree lower.

Mysore.—The table land of Mysore, in southern India, lies between the angle formed by the meeting of the eastern and western Ghauts.

Spain.—The whole central part of the peninsula consists of a series of lofty plains, divided from each other, and from the maritime lowlands, by parallel mountain chains. The plateau comprises 93,000 square miles, nearly equal to half the peninsula. Madrid is 2220 feet above the level of the Mediterranean.

VII. Parts of the plateau region of central Asia, not included in the preceding table, while more extensive, exceed the elevation of the loftiest Andean table lands; but the country has not been much explored, owing to natural difficulties, and the jealousy of oriental governments respecting the intrusion of strangers.

1. The great space between the Kuen-lun and Himalaya chains, upwards of 1300 miles long by from 350 to 400 broad, occupied by the Thibets, is a district of various but generally considerable elevation, called the Plateau of Great Tartary. At a house of the Dalai-lama, near the margin of the two lakes Manasa and Rawana-hrada, Captain Webb makes the height 14,502 feet, thus exceeding that of the high waters of Titicaca by 1600 feet. To behold the lake Manasa, an oval basin, 15 miles by 11 in extent, is deemed by the Hindoos a felicity beyond every other on earth, but prodigious difficulties attend the pilgrimage.

2. The kingdom of Ladak, comprising about 30,000 square miles, stretching along the north flank of the Himalaya, is believed by Mr. Moorcroft to have an average height of 15,845, equal to that of Mont Blanc.

3. The plateau of central Asia is walled in to the west by the Bolor chain, (Cloudy Mountains,) which forms towards the middle the remarkable region of Pamir, a radiating point in the hydrographical system of Asia, long ago correctly described by Marco Polo as a high table land. This district, locally called *Bam-i-duniah*, "Roof of the World," is the source of the Oxus, and forms the water-parting between its basin, that of the Indus, and other principal rivers. "At five o'clock," says Lieut. Wood, Feb. 19, 1838, "in the afternoon, we stood, to use a native expression, upon the *Bam-i-duniah*, or Roof of the World, while before us lay stretched a noble but frozen sheet of water (Lake Sir-i-kol), from whose western end issued the infant river of the Oxus. This fine lake lies in the form of a crescent, about fourteen miles long from east to west, by an average breadth of one mile. On three sides it is bordered by swelling hills, about 500 feet high, while along its southern bank they rise into mountains 3500 feet above the lake, or 19,000 above the sea, and covered with perpetual snow, from which never-failing source the lake is supplied." Mr. Wood found the altitude of the lake 15,600 feet, a little lower than Mont Blanc.

CHAPTER VII.

PLAINS.

I. Plains are discriminated from table-lands by being very little elevated above the sea, in some instances even descending below it. To popular apprehension the term suggests the idea of a perfectly horizontal surface, but geographically it is applied to an extent of country generally level as compared with mountainous districts, however the superfices may gently wave or prominently undulate, be studded with low hills, traversed by valleys, or intersected with deep ravines. Understood in this sense, plains constitute by far the greater portion of the earth's surface, and are the sites of its highest culture, greatest cities, and most numerous population.

The great northern plain of Europe extends through nearly 60° of longitude, from the eastern bank of the Seine to the terraces of the Ural Mountains and the waters of the Caspian Sea, and has, according to accurate measurement, nine times the surface of France. The Waldai plateau in Russia is the only principal interruptions of small dimensions and inferior elevation. This district comprehends part of Northern France, Belgium, Holland, the north of Germany, Denmark, the whole of Prussia and Poland, and the greater part of Russia. Vast areas exhibit a perfectly dead level, scarcely a rise existing, through 1500 miles, from the Carpathians to the Urals. South of the Baltic, the country is so flat that a prevailing north wind will drive the waters of the Stattiner-Haf into the mouth of the Oder, and give the river a backward flow for thirty or forty miles. The sea is only kept out of Holland by means of dykes, and towards the Caspian the surface dips below the ocean level. At Moscow, the highest point of the exclusively European plain, the elevation is only 480 feet. Pasture-land composed of the richest vegetable mould is abundant, but there are wide tracts clothed with natural forests of pine and fir, and immense quantities of waste lands, either covered with heath, or presenting bare sand, or forming swamps and morasses. The western or oceanic coast of Denmark is a continued level of marshland; and through the centre of a swamp as long as England, comprising an area of upwards of 2000 square miles, the river Pripet flows towards the Dnieper.

The great plain of Europe passes continuously round the southern extremity of the Ural Mountains, and joins the vastly more extensive lowland level of Northern Asia, which extends through 120° of longitude to Behring's Strait, between the Arctic Ocean and the Altai range. This region, comprising one-third of the whole of Asia, and surpassing by one-third the surface of the whole of Europe, is so low that at Tobolsk, 550 miles in a straight line from the Arctic Ocean, the lower portion of the town is only 128 feet above its level; and at Yakutsk on the Lena, 560 miles from the sea, the elevation is only 287 feet. At Irkutsk on the Angara, 1400 miles from the ocean in a straight line, the elevation is but 1246 feet; and the basin of the Upper Irtish, 1750 miles from the sea, or nearly 3000 following the course of the river, has been found not much to exceed 1900 feet.

In South America the plains are estimated to be to the mountainous country as four to one. A rise of only a few hundred feet in the waters of the Atlantic would completely submerge the greater part of the enormous area between its coasts and the roots of the Andes.

II. Plains, while possessing certain features in common, have characteristic peculiarities. With a view to illustrate their differences of natural condition they may be considered under their respective local denominations, as landes, heaths, and puszta, steppes, deserts, llanos, selvas, pampas, savannahs or prairies, barrens, and pine-barrens.

III. Landes, heaths, and Puszta.—Plains, for the most part infertile, known by the name of landes, occupy a large portion of the north of Germany, extending from Lower Silesia to the kingdom of Hanover, where they are prominent, and to the extremity of Jutland. They are sandy tracts, sometimes entirely naked, but more generally covered with pine-woods, or coated with the *Erica vulgaris*, which gives them the name of heaths. Fertile districts, swamps, and stagnant pools intermingle with them. In France extensive landes occur between the Gironde and the Pyrenees, vast sandy downs and levels, either wholly barren, or clothed with heath and pines, interspersed with fens and marshes, and at distant intervals with meadows and cultivated fields. The great plains of the Middle Danube, occupying the interior of Hungary, locally called *puszta*, indicate the country to have once been the bed of an inland sea or lake. They consist of tracts of rich black loam, with districts of deep sand, susceptible of cultivation; but for many miles not a tree, shrub, stone, or living creature is to be seen, the monotony of the scene being alone varied by the sand-hillocks shifting with the wind.

IV. Steppes.—The Russian term steppe is applied to the series of extensive plains which occupy south-eastern Europe, and north-western Asia. If the word implies dry and parched, it is only partially applicable to the districts it denotes. The steppes have in fact no uniform character, except that of being great lowland levels. Some are richly cultivated, while others are incapable of cultivation, but from various causes, either an excess of drought or of moisture, or the abundance of salt. Some are barren sands; others are studded with low saline plants;

others are covered with plants of the families of the compositæ and leguminosæ; and others have a luxuriant gramineous clothing, woods intermingling with the pasture lands.

1. The region of the Higher Steppes extends from the river Don along the sea of Azof and the Black Sea to the west of the Dneiper. The surface, not in general more than 200 feet above the level of the sea, exhibits barren ridges, almost treeless plains intervening, covered with coarse rank grass, and capable of producing in abundance all the cerealia.

2. The region of the Lower Steppes lies eastward of the Don, and has the Caucasus, the Caspian Sea, and the river Ural for its other boundaries. Low hills of loose shelly sand, some fertile hollows, patches covered with a saline efflorescence, pools of salt and bitter waters, are its characteristic features.

3. Passing into Asia, the steppes of the Kirghiz hordes stretch from the river Ural around the sea of Aral to a considerable distance eastward of it, comprehending nearly the whole of Turkestan. The surface is much more irregular than that of the preceding region, but in other respects similar.

4. North of Turkestan lies the great plain or steppe of Ischam, called after the river of that name, which runs through its centre and falls into the Irtish. It extends about 700 miles from west to east.

5. Farther north is the steppe of Barabinsk, hardly less extensive than the former, occupying the whole country between the Irtish and the Obi.

6. Vast marshy plains extend between the Obi and the Yenesei, and through Northern Siberia in general, where the ground is perpetually frozen to a great depth, and only superficially thawed in summer. Excluding these tracts the area of the steppes proper is supposed to be about 1,000,000 square miles.

V. Deserts.—The tracts of bare sand, gravel, rocky slabs, flints, and siliceous stones, which form deserts properly so called, condemned to eternal sterility, though not unknown in the New World, are so predominant in the old continent as to form a marked distinction between the two regions. They stretch in a nearly continuous zone of almost irretrievable desolation from the Atlantic Ocean through the north of Africa, and through Central Asia towards the Pacific. Depressions of varying extent occur, called oases, where there are wells and springs, nourishing groves of date-trees, acacias, ferns, and grasses,—fertile spots which serve as resting-places to the caravans that traverse the wilderness.

1. The most important example is the Sahara-bela-ma, "the desert without water," called also the Bahar-bela-ma, "the ocean without water," which, with the Lybian desert, separated from it by the favoured tract of Fezzan, extends 2650 miles through the central parts of northern Africa, by a breadth of from 700 to 1200 miles.

2. In addition, there are the deserts of Arabia, Mesopotamia, Persia, Independent Tartary, Afghanistan, central Asia, with similar districts in southern Africa, and sandy or stony patches in Europe. One of the most remarkable of the latter is the plain of *La Crau*, in the Bouches du Rhone, a department in the south of France. It comprises from 140,000 to 170,000 English acres, entirely composed of shingle, the stones varying in size from that of a pea to that of a pumpkin, as free from any intermixture of soil as the shingle of a sea-beach.

3. In South America, a sandy desert, called Il Gran Chaco, occurs west of the river Paraguay; a true salt desert, under the name of Las Salinas, also lies further west; and a shingle desert extends for 800 miles through eastern Patagonia. In North America, at the head of the affluents of the Missouri, a large tract of sand and gravel has received the name of the American Desert. But the Old World is emphatically the region of deserts, which occupy an extent of its surface considerably exceeding the area of the whole of Europe.

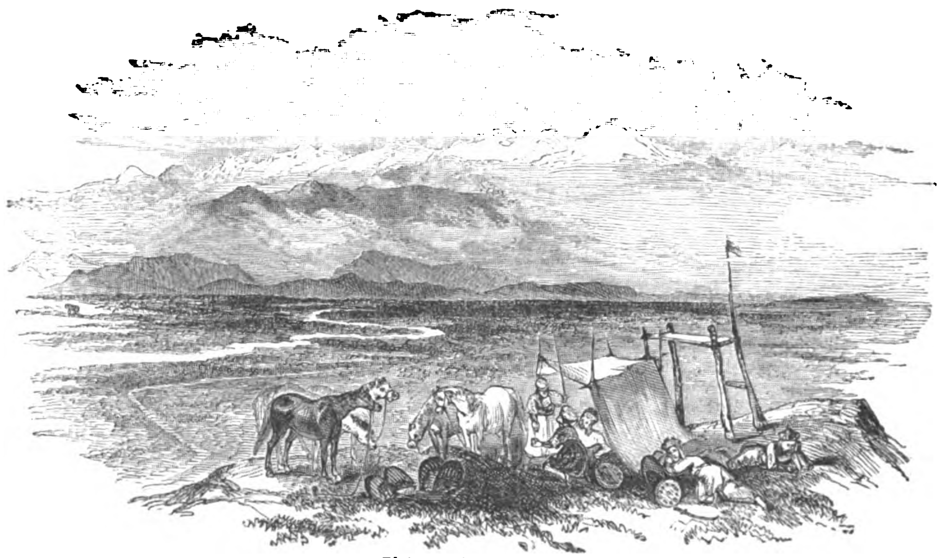
VI. Llanos.—The plains of Venezuela and New Granada in South America, chiefly on the left of the Orinoco, are termed llanos, or level fields. Often in the space of 270 square miles, the surface does not vary a single foot. A gentle wind, or a slight rise of the great river, reverses the current of its tributaries. The llanos are not quite equal to twice the extent of France. They are studded here and there with solitary palms, and undergo remarkable changes in appearance. In the wet season they are inundated for hundreds of square miles; afterwards, upon the subsidence of the waters, they are clothed with beautifully green verdure; and when the season of drought returns, the grass crumbles into dust, and the aspect of a dismal desert meets the eye.

Notwithstanding a very level surface in general, there are two kinds of inequalities in the llanos:—*Bancos*, layers of sandstone or limestone, four or five feet high, which frequently extend for several miles; 2. *Mesas*, vaulted elevations, which rise so gradually as to be imperceptible except by levelling instruments, but serve as water-sheds.

VII. Selvas (forests).—The plains of the river Amazon form another division of the South American lowlands, covered with primeval woods, interspersed with clear grassy spaces and marsh lands. This zone of woods is estimated to comprise upwards of 2,000,000 square miles (as large therefore as Russia in Europe), of which there is nearly 1,000,000 of woodland, the rest being occupied by the waters and the open tracts.

VIII. Pampas.—This Indian term, signifying flats, designates the third great level region of South America, extending about 1800 miles south from the Selvas, and from the Atlantic Ocean to the Andes. It consists of treeless plains, which are in some instances sandy or saline wastes, but mostly immense beds of alluvium, covered with a strong growth of tall grass, lucerne, thistles, with gaudy flowers, presenting also vast lagoons and swamps.

IX. Savannahs or Prairies, Barrens, and Pine-barrens.—The central part of North America, from the Gulf of Mexico to the Arctic Ocean, may be called a continuous plain, estimated to contain 2,430,000 square miles. In the southern part of this tract, on both sides of the Mississippi, but principally on the west, the savannahs or prairies occur, apparently boundless meadows, of which three kinds are noticed. 1. Heathy or bushy prairies, where there are springs, nourishing, besides grass, small shrubs, grape-vines, and an infinite variety of flowers. 2. Dry prairies, the most common, having neither wood nor water, and no vegetation but grass, weeds, and flowers; called also rolling prairies, from their wavy surface. 3. Moist and well-watered prairies, abounding in pools without issue, left by the floodings of the rainy season, producing rank tall grass. The Barrens, or barren grounds, near the Alleghany and Rocky Mountains, resemble the prairies in being grassy and treeless, but are more elevated and dry. The Pine-barrens, situated on the south-coast of the United States, and also in the interior, are monotonous tracts of sand covered with gigantic pine trees.



Plains of Languedoc.

CHAPTER VIII.

FISSURES AND CAVERNS.

I. Deep narrow fissures, yawning chasms, and great chambered cavities, common in mountainous districts, are either monuments of the violent action that has shaped the external envelope of our planet, or of the extensive changes produced by slow erosion operating through a series of ages.

Clefts are frequently the beds of streams, sometimes arched over by a portion of the rock which was not rent by the convulsions that seem to have produced the fissures, forming a kind of natural bridge.

At Iconozo, in South America, on the route from Santa Fe de Bogota to Popayan, a chasm of immense profundity is crossed by a natural arch, 47½ feet in length, 39 in breadth, and 318 above the stream, Summa Paz, which passes through it. Sixty-four feet below this bridge, there is a second, composed of dislodged masses of rock, which have so fallen as to support each other. The dark abyss below is haunted by nocturnal birds, whose doleful cries increase the frightfulness of the spot. Another celebrated curiosity of this kind is the bridge which passes over Cedar Creek in Virginia, at the height of 210 feet above the water.

II. Caverns, properly so called, are perforations open to the daylight at one extremity, with lateral entrances on the sides of mountains, either presenting a single vacuity, or a series of spacious chambers connected by narrow winding passages, which often descend far below the level of the entrance.

In some instances, perforations extend completely through a mountain mass, forming natural shafts and tunnels, so straight as to allow the passage of the daylight through them.

III. True caverns are not found in the older rocks, granite, gneiss, and slate, but vertical fissures of unknown depth are not uncommon. Grand examples of cavern construction occur in ancient and modern volcanic masses. It marks also the gypsum of the new red sandstone system, and the sandstone, but is so characteristic of the mountain limestone, that the rock is sometimes called the "cavern limestone."

Fingal's Cave, in the island of Staffa, off the west coast of Scotland, occurs in pillared basalt, a structure of marvellous grandeur and beauty, to some extent due to the abrading power of the ocean.

In the curious *Grotte des Fromages*, in the basalt rocks at Bertrich-Baden, the softer parts of the basaltic columns have been so worn away, as to make them resemble piles of cheeses, and hence the name.

Surtsheller, an extensive Icelandic cavern, 40 feet high, 50 broad, and 5034 long, is in the immense lava current which has streamed from the Bald Yökul. Such cavities in recent lava currents are referable to the stream meeting an obstruction in its course, causing an overlapping of the persistant matter, and an enclosed hollow, eventually exposed at one extremity by the wearing away or falling in of the crust.

Almost all important caverns, not only in England, but in France, Belgium, Westphalia, Franconia, Wurtemburg, along the Mediterranean shores, in North America and Australia, are in limestone.

IV. From the beds of hard mud which form the floors of many dry caverns, and the streams that still run through others, as in the Peak Cavern at Castleton, it may be inferred that such cavities are due, at least to some extent, to the solvent and mechanical power of water.

Limestone caverns are remarkably characterized by calcareous formations, on the roofs, floors, and sides, caused by the percolation of water containing carbonate of lime held in solution by carbonic acid, which, becoming disengaged, the lime is deposited, originating a variety of wild, fantastic, and beautiful shapes. The depositions depending from the roofs are called stalactites; those formed on the floors from the larger drops of water that have fallen before deposition has taken place, are termed stalagmites. The descending and ascending formations are frequently seen approaching to a junction, and actually united, exhibiting a series of columns.

The localities rich in stalactites are:—1. The Blue John Mine in the Peak, a natural cavern worked as a mine for fluor spar. 2. Macallister's Cave, in the island of Skye. 3. The Woodman's Cave, in the Harz. 4. The celebrated Grotto of Antiparos, in the Greek Archipelago. 5. The extensive cave of Adelsberg, in the neighbourhood of Trieste, accessible for several miles, through which the dark waters of the Peuka flow. 6. The chambered cave of Cacahuamilpa, also several miles in length, in the *tierra caliente*, hot region, of Mexico. 7. Weyer's Cave, in Virginia.

V. Fissures of rocks occur, containing osseous breccia, (a mixture of red loam, pieces of stone, and bones,) and ossiferous caves, where, buried in mud, or covered with calcareous deposits, the separated bones of extinct species of quadrupeds have been found perfectly preserved, but in various conditions, water-worn and gnawed.

The principal of these remarkable sites are:

In England and Wales. 1. Kent's Cavern, near Torquay, in Devon. 2. Fissure

Kent's Cavern, near Torquay.

on Derdham Down, near Bristol. 3. Hutton Hole, in the Mendip Hills. 4. Caves at Oreston, near Plymouth. 5. Cave of Crawley Rocks, near Swansea. 6. Caves of Paviland, on the coast of Glamorganshire. 7. Dream Cavern, near Wirksworth, where nearly the entire skeleton of a rhinoceros was found, enveloped in mud and pebbles. 8. Kirkdale Cave, in Yorkshire, the mouth of which, long choked up with rubbish, and overgrown with grass and bushes, was accidentally discovered by workmen in 1821. Here, under a sheet of stalagmite, was a stratum of mud about a foot thick, in which lay multitudes of bones of the following animals:

Carnivora . . .	Hyæna, felis, bear, wolf, fox, weasel.
Pachydermata . .	Elephant, rhinoceros, hippopotamus, horse.
Ruminantia . . .	Ox, three species of cervus.
Rodentia . . .	Hare, rabbit, water-rat, mouse.
Birds	Raven, pigeon, lark, duck, snipe.

In Germany. 1. Baŭmann's Hole, in the transition limestone of the Harz. 2. Scharzfeld, in magnesian limestone near the Harz. 3. Gailenreuth, Mockas, Zahnloch, Kühloch, in the Jura limestone of Franconia, near the sources of the Maine. 4. Gluchsbrunn, Leibenstein, on the south-western border of the Thuringerwald. 5. Kluterhöhle, Sundwicke, in Westphalia. The animal remains in these caverns are chiefly those of two species of bear, both extinct.

Upon the whole it may be remarked:—1. That into open fissures animals may have fallen while alive, or been drifted into them when dead, by freshwater inundations, or overflowings of the sea. 2. In the German caves, of which, in one case, that of Kühloch, the animal matter has been estimated at no less than 2,500 individuals of the cavern bear, it is likely that these animals retired through a series of ages to die, according to the habits of that tribe of quadrupeds. 3. Other caves, as that of Kirkdale, seem to have served as the den of predacious beasts, hyænas, to which they dragged the carcases of other animals inhabiting the vicinity to prey upon them. The excrement of hyænas, the teeth of young animals of that class, and bones bearing teeth-marks, resembling bones crunched by the living Cape hyæna, support this inference. 4. It is clear that animals once inhabited our northern zone, elephants, rhinoceroses, hyænas, and hippopotami, now exclusively confined to tropical latitudes.

VI. The temperature of caverns, where the roofs are massive and the openings narrow, shows little diversity, being below that of the mean of the surrounding atmosphere; but there are some which exhibit the apparent anomaly of being coated with ice in summer, which melts in winter.

Near Besançon and at Vesoul, in France; near Szelitze, in Upper Hungary; and on the south of the Ural Mountains, there are examples of these summer-produced natural ice-houses. Sir R. Murchison entered one in the latter locality, in exceedingly hot weather, and found solid undripping ice on the roof and sides, while the floor was a mass of hard snow, ice, and frozen earth. In winter, he was informed, that the temperature of the cavern is mild, while the external country is frost-bound.

The summer freezing in these moist caverns is due to vigorous evaporation, withdrawing the warmth from the enclosed air, and producing a degree of cold below the freezing point; while in winter the external atmosphere having little capacity to promote evaporation, no such cold is produced, and the ice formed melts. The effect however depends upon a certain relation subsisting between the external air and the interior of these caves. If their entrances admitted too large a supply of warm air, the temperature of the interior would be increased more than it could be diminished by evaporation; or if they were so narrow that the vapours could not escape sufficiently, the evaporation would go on feebly, the air being saturated. The ice-caverns are therefore rare.

VII. Some caves, situated in volcanic regions, exhale hot and sulphurous vapours, and others are remarkable for the development of irrespirable gas.

The best known of the latter class is the Grotte del Cano, in the neighbourhood of Naples, near the Lago d'Agnano, the bed of which is the crater of an extinct volcano. This is a small cavity, ten feet deep, four broad, and nine high, on the floor of which there is a thin stratum of carbonic acid gas, elaborated by the interior chemical processes going on in that volcanic locality. It takes its name from the dogs which are placed in it by way of experiment.

VIII. Wind caverns are inexplicable phenomena. From a blowing cave in the Alleghany Mountains a hundred feet in diameter, the current of air is so strong as to keep the weeds prostrate to the distance of sixty feet from its mouth. But the most extraordinary example is the great cavern of Ouybe, of unknown extent, in Central Asia. The tempests that rush from it are sometimes so violent as to carry off everything on the road, and throw them into the adjoining lake. The wind, coming from the interior of the earth, is said to be warm in winter, and so dangerous that the caravans often stop for a whole week till the tempests have subsided.

CHAPTER IX.

GLACIAL FORMATIONS.

I. In high northern and southern latitudes, and at certain elevations in all latitudes, snow and ice occur on the surface of the globe as a permanent envelope. The causes of this physical condition, with its details, are reserved for the meteorological section, but some general remarks will here be expedient. In countries which are immediately polar, even on sites that are at the sea level, snow is permanent throughout the year, but at a much lower latitude in the southern than the northern hemisphere. Receding from the poles towards the temperate zones, it maintains firm hold of comparatively inferior elevations, while totally disappearing from the lowlands before the temperature of summer. Equidistant from the poles and the equator, or in latitude 45°, it is only permanent on mountains of considerable altitude, the lowest limit being about 8500 feet. In equatorial districts, the lowest limit of permanence rises to about 16,000 feet.

II. Apart from the regions immediately polar, the principal fields of permanent snow are: in Europe—Iceland, the Scandinavian Mountains, Alps, and Pyrenees; in Asia—the Caucasus, Himalaya (abode of snow), Kouen-lun, and Altai chains; in Africa—the Greater Atlas range; and in America—the Cordilleras.

The requisite data are wanting for an estimate of the extent of surface permanently covered with snow, but the area without the arctic and antarctic circles is comparatively inconsiderable, however locally important. The greatest masses appear to be in the Himalaya Mountains, with the connected ranges. In the Alps, the eternal snow occupies an extensive space, stretching almost continuously at one point, between the upper courses of the Rhone and the Aar, over an area of about 600 square miles. In the Scandinavian peninsula the whole region of permanent snow is computed at 3696 square miles, belonging almost entirely to Norway, remarkable for its snow plains. These are high level tracts, that of Folgefund, a projection on the south-west coast, at an elevation of 5000 feet, extending 30 miles by from 8 to 20, covered with an unbroken stratum of snow estimated at 12 yards in thickness. Out of 40.000 square miles, the supposed area of Iceland, there is an elevated region in the south-eastern quarter, estimated at 3000 square miles, covered with ice and snow.

III. The snows accumulated on the tops and steep declivities of mountains are frequently precipitated by their own weight into the subjacent valleys, rooting up forests in their course, tearing away fragments of rock, filling up beds of streams, diverting them into fresh channels, occasioning destructive floods, and sometimes burying men, cattle, and whole villages fathoms deep beneath the mass. The volume put in motion in the first instance may be small, but dislodged at a high elevation, it increases as it descends to a prodigious magnitude by forcing off other masses in its path. These avalanches, or lavanges, as they are called, are not merely fatal to life and property immediately in their way, but the air suddenly compressed by the velocity of their descent rushes off with the force of a tornado, and plays havoc with every object in the vicinity.

Avalanches are sometimes occasioned by strong gusts of wind after a heavy fall of snow in a calm state of the atmosphere, when the particles, not having acquired consistency, are driven together in vast heaps, which the declivities are not able to support. Sometimes they arise from portions of clammy snow becoming detached during a thaw, which grow in bulk like a rolling snow-ball on their passage from the superior elevations. In other cases, they are due to the melting of the snowy stratum in contact with the ground by the natural heat of the earth, which brings down the whole mass from an inclined base. Hence the three classes of drift, rolling, and sliding avalanches.

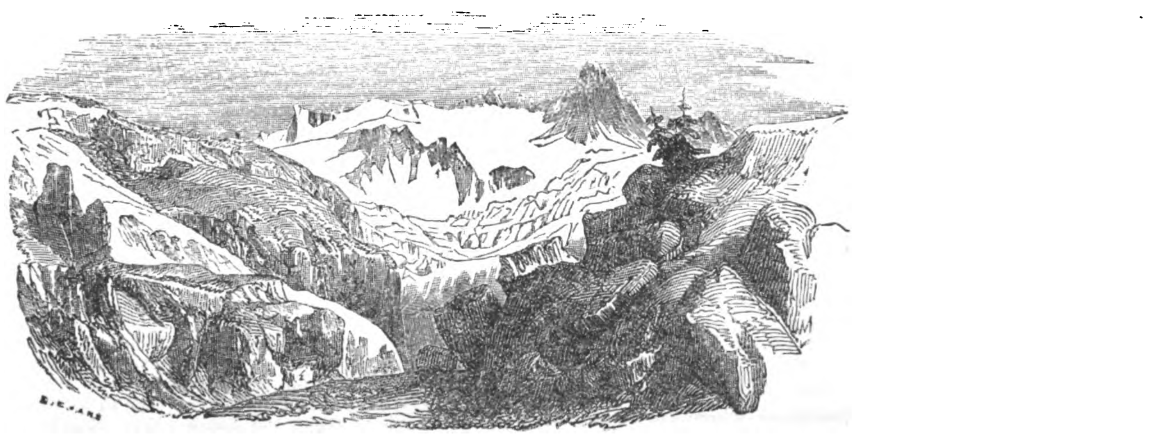
IV. Glaciers. masses of true ice, are remarkable appendages of the snow-fields, as intimately related to them as a stream to its spring, or as an icicle to a snow-covered roof. Their external aspect is that of a frozen torrent, depending upon the flanks of mountains, and extending from the higher summits into the lower valleys. Originating in the regions of eternal frost, they descend below the line of perpetual snow to the warm, cultivated grounds, where, though continually wasted, they are never destroyed, being constantly replenished from the icy world above.

Glacial ice is very different from that produced in a pond or river, less homogeneous and transparent, porous, and full of air-bubbles. The lower part of glaciers contains the most pure and solid ice; the upper part resembles frozen snow, called in French *névé*, and in German, *firn*; but most parts of every mass present an alternation of compact and transparent, with porous and semi-opaque layers.

The lower glacier of the Aar descends to the level of 5,900 feet, or upwards of 1,500 feet below the snow line of the Alps; that of Rosenlaui to 5,100; that of the Great Aletsch to 4,413; that of the Upper Grindelwald to 4,300; and that of the Lower Grindelwald to 3,400,—being upwards of 5,000 feet below the snow line. On those parts of glaciers that are below the snow line, the winter snows melt as regularly as on the surface of the adjoining land; but on those parts that are above it the French *névé*, and the German *firn*, the snows accumulate, and form the stock from which the waste going on below is made up. In some cases, where the supply exceeds the waste, we have an advancing glacier; and where the waste is in excess, a retreating one.

The waste of glaciers from the action of the sun and rain, and the melting of the ice in contact with the ground from the natural heat of the earth, together with springs under these enormous masses, originate streams which issue forth from their extremities, frequently from caverns which their waters have scooped out, forming the sources of important rivers. The Rhone issues from the glacier of Mont Furca, and the source of the Ganges, first reached by Mr. Elliot, of the Bengal Body-guard, is a rapid stream, forty yards broad, which flows at once from a huge cave in a perpendicular wall of ice, the extremity of a glacier.

V. The size of glaciers sometimes amounts to fifteen and twenty miles in length, and three miles in breadth; the thickness at the lower end varying from eighty to a hundred feet. Their extent obviously depends upon the extent of the snow-fields of which they are offsets, and on the size and slope of the subjacent valleys. The larger masses exhibit a steep ascent at the lower extremity; they then slope gently with a surface more or less broken and undulating; and again become highly inclined towards the *névé*.



Glacier of the Rhone.

The Swiss peasants are accustomed to say that a lean snow mountain cannot produce a fat glacier. Valleys and gorges which descend to a considerable distance from extensive snow-fields, having a slightly inclined plane, enclosed on both sides with secondary ridges, are the sites that favour the formation of large glaciers. The glacier of the Aar, fifteen miles long, exhibits a difference of level amounting to only 3000 feet in that distance. The slope of that of Aletsch is 2° 58′; and that of the Mer-de-Glace of Chamouni, 3° 15′. When the slope along which a glacier descends is very steep, or it is crowded on the edge of a precipice, huge blocks of ice are frequently detached, and form destructive avalanches. The river Drance, in the Val-de-Bagnes, a wild and lonely Alpine valley, has three times been arrested in its course by accumulations of detached ice from the glacier of Getroz, forming a lake, which subsequently broke through the barrier, inundated the plains below, houses, trees, men and cattle, perishing in the resistless deluge. This was the case in the years 1545, 1595, and 1818.

VI. The general contour of glaciers is either canal-shaped, oval-shaped, or basin-shaped, according to the form of the valleys into which they protrude. The ice, when viewed in small pieces, is commonly white, like river ice; but that of the entire mass exhibits every variety of blue tinge, from the slightest cerulean to the deep hue of the *lapis lazuli*. The blue, frequently passing into green, is the deepest in the *crevasses*. No language can describe the beautiful effect of the different blue and green tints, contrasting with the pure white snow at a higher level.

Crevasses, chasms, or clefts, generally vertical in their direction, are very common, varying in width from a few inches to many feet, sometimes extending completely across the glacier, and descending to its very bottom, gradually contracting. They are supposed to be occasioned by changes of temperature in the succession of day and night, summer and winter; but the whole phenomenon is very obscure. Day-chasms and night-chasms are noticed, so called from the times in which they are said to be produced. "When I was once walking," M. Hugi states, "on the glacier of the Lower Aar, at three o'clock in the afternoon, and the weather being very hot, I heard a peculiar noise. Advancing directly towards the spot whence it proceeded, I had hardly walked thirty or forty paces before I felt that the whole icy mass trembled under my feet. The trembling soon ceased, and then began again, continuing by starts. I quickly discovered the cause. The ice was splitting and forming a chasm. Before my eyes it split suddenly over a space of twenty or thirty feet in length, so rapidly that I could not keep up with it. Then it appeared to cease, or, rather, the rent proceeded more slowly, until the trembling returned, and the splitting proceeded at an accelerated rate." While the day chasms have the wider opening at the surface of the glacier, the night chasms are inverse, the wider openings being directed towards the base.

VII. The descending march of glaciers, imperceptible to the eye, is evident from the permanence of the masses, though in the act of constant dissolution; but direct proofs of their progress have been accumulated in abundance, and the rate of motion has been ascertained. The experiments of Professor Forbes and others show decisively, that

"The glacier's cold and restless mass
Moves onward day by day,"

and not by fits and starts, though with variations as to the rate, which depend upon the seasons; thawing weather and a wet state of the ice conducing to its advancement, while cold, whether sudden or prolonged, checks its progress. The movement is the fastest in summer, by day, and during great heats; the slowest in winter, by night, and during severe frosts.

The movement of the ice of the littoral part of the Mer de Glace at Montlavert near Chamouny, attentively observed for nearly a year, was found to be as follows:

From June 29 to Sept. 28 . .	132 feet.
„ Oct. 10 to Dec. 12 . . .	70 „
„ Dec. 12 to Feb. 17	76 „
„ Feb 17 to April 4 . . .	66 „
„ April 4 to June 8	88 „
Added for time during which no observations were taken . . .	51 „
	483 feet.

It is also found that the central parts of glaciers move faster than the sides. M. Agassiz obtained the following results, in 1841 and 1842, upon this point:

		Annual Motion.
Finster Aar.—	Stake nearest the centre of the glacier .	269 feet.
	Stake nearest the side of the glacier .	160 „
	Intermediate stake . .	225 „
Lauter Aar.—	Stake nearest the centre .	245 „
	Stake nearest the side . .	125 „
	Intermediate stake . .	209 „

VIII. The most recent theory to explain glacial motion, that of Professor Forbes, is the best supported. Stiff and altogether rigid as the mass appears, he conceives, from careful observation of the interior structure and other circumstances, a glacier to be an imperfect fluid, or a viscous body, which is urged down slopes of a certain inclination, by the mutual pressure of its parts. He compares it to a thick mortar, or the contents of a tar-barrel poured into a sloping channel, the central parts of which would move faster than the outer edges. Bold and startling as this hypothesis appears, it best answers to observed phenomena, and seems the more probable the more it is examined.

IX. Glaciers, by their motion, break off masses of rock from the sides and bottoms of their valley-courses, and crowd along everything that is moveable, so as to form large accumulations of debris in front, and along their sides. The edges also receive the huge fragments, variously shattered by their fall, that are disintegrated by atmospheric causes; a process going on to a great extent in elevated regions.

These superficial accumulations are called *moraines*. They are of three kinds:— 1. The terminal moraine, or that at the extremity of the glacier. 2. Lateral moraines; or those ridges of rubbish that lie along the sides. 3. The medial moraine, a band of fragments, which sometimes divides a glacier in the direction of its length, into two apparently distinct compartments. Suppose two glacial streams from two valleys to unite, forming a grand ice-flow in a larger valley, there would be a junction between the left hand lateral moraine of the one stream and the right hand lateral moraine of the other, forming the medial or central moraine of the united mass.

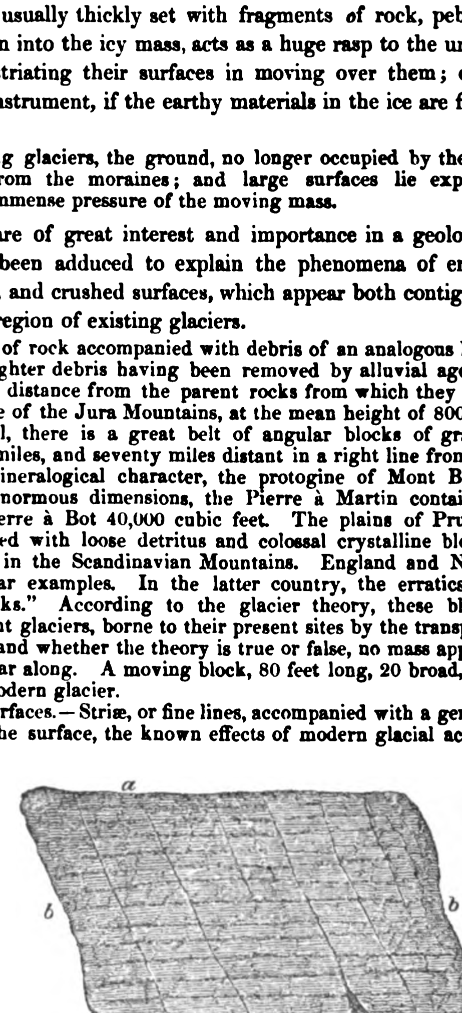
X. The base of glaciers, usually thickly set with fragments of rock, pebbles, and coarse sand, firmly frozen into the icy mass, acts as a huge rasp to the underlying rocks, scratching or striating their surfaces in moving over them; or as a smoothing and polishing instrument, if the earthy materials in the ice are finely comminuted.

In the instance of retreating glaciers, the ground, no longer occupied by the ice, exhibits debris discharged from the moraines; and large surfaces lie exposed, smoothed or striated, by the immense pressure of the moving mass.

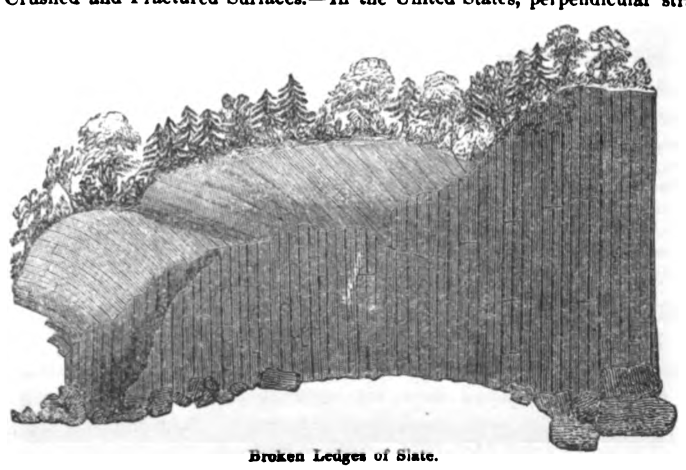
XI. The preceding facts are of great interest and importance in a geological point of view. They have been adduced to explain the phenomena of erratic blocks, of smoothed, striated, and crushed surfaces, which appear both contiguous to, and far remote from the region of existing glaciers.

1. Erratic Blocks.—Masses of rock accompanied with debris of an analogous kind, or completely insulated, the lighter debris having been removed by alluvial agency, are common, at a considerable distance from the parent rocks from which they have been abstracted. On the slope of the Jura Mountains, at the mean height of 800 feet above the Lake of Neufchatel, there is a great belt of angular blocks of granite (protogine) extending many miles, and seventy miles distant in a right line from the nearest mass of the same mineralogical character, the protogine of Mont Blanc. Some of the blocks are of enormous dimensions, the Pierre à Martin containing 10,296 cubic feet, and the Pierre à Bot 40,000 cubic feet. The plains of Prussia, Poland, and Russia, are strewed with loose detritus and colossal crystalline blocks, which have their parent bed in the Scandinavian Mountains. England and North America present many similar examples. In the latter country, the erratics are significantly called "lost rocks." According to the glacier theory, these blocks formed the moraines of ancient glaciers, borne to their present sites by the transporting power of the icy masses; and whether the theory is true or false, no mass appears too weighty for a glacier to bear along. A moving block, 80 feet long, 20 broad, and 40 high, has been seen on a modern glacier.

2. Smoothed and Striated Surfaces.—Striæ, or fine lines, accompanied with a general and often exquisite polish of the surface, the known effects of modern glacial action, are observed on rocks now apart from such agency, as the quartzose granites of the Grimsel, the limestones of Le Chaumont in the Jura, and very frequently in the United States. The cut represents an example in the latter locality, from a rock of gneiss in the neighbourhood of Boston, the lines running in the direction *a a* showing the divisions of the strata, and *b b* the striæ. These striæ, wherever found, have a general tendency to parallelism, as produced by hard fixed particles, which acted as gravers in indenting the surface.



3. Crushed and Fractured Surfaces.—In the United States, perpendicular strata of



Broken Ledges of Slate.

slaty rocks, near the summit of hills, broken and partially knocked over, as if an enormous weight had passed over them, are referred by Professor Hitchcock to glacial agency.

XII. The Glacial theory, proposed to account for these phenomena, first suggested by M. Venetz, a Swiss engineer, then advocated by M. Charpentier, and more recently elaborated by M. Agassiz, supposes an extensive development of glacial formations at a former geological epoch, converting in fact the northern regions of the globe into a vast Mer de Glace. Whatever be its difficulties, those of other theories are perhaps more numerous and formidable.

The entire elephants and rhinoceroses of Siberia, perfectly preserved in frozen mud, show that a change of climate there must have transpired suddenly from great heat to intense cold. The theory may more properly be called Glacio-aqueous, as the melting down of vast icy accumulations, must have occasioned immense currents and deluges, officiating in the transport of materials from one site to another.

XIII. Existing glaciers occur largely in Spitzbergen and in Greenland, where, descending to the sea-level, detached masses constitute the icebergs of the Arctic Ocean, and are drifted into the Atlantic. They are not known in South America within the tropics, though the Andes rise far above the snow line. This is owing to the excessive steepness of the peaks, a feature unfavourable to their formation; but they appear in southern Chili and Patagonia. In Asia, they are found on the northern side of the Himalaya, and in the Kouen-lun, Thian-chan, and Altai. Their existence in the Caucasus and Ural Mountains is uncertain. In Europe, they occur scantily in the Pyrenees, largely in Norway and Iceland, but principally in the Alps; where, independent of the Grisons, the area of the ice is estimated at 1500 square miles, from 80 to 600 feet in thickness.

CHAPTER X.

VOLCANIC PHENOMENA.

I. The term Volcano, derived from the name which the Romans gave to their imaginary god of fire, Vulcanus, denotes a peculiar class of mountains emitting from their summits or sides molten mineral masses, with columns of flame,

Volcano of Orizaba.

smoke, and ashes. They are aptly styled in various languages Burning Mountains. A conical figure, with a cauldron-like hollow at the summit, denominated the crater or cup, is their general physiognomy.

The rocky wall of a crater is sometimes entire as a circus, but often rent. Through the rents, or by descending from the summit of the rampart, the floor may frequently be reached, exhibiting hillocks of ashes, cones of eruption, extensive fissures, and "small rounded fiery throats," through which, in times of repose, vapours of various kinds find vent, but unaccompanied with luminous phenomena. The interior of some craters is however perfectly inaccessible, owing to their vast depth, and the perpendicularity of the internal wall.

II. Most volcanoes, not extinct, emit smoke and jets of aqueous vapour at all times; but the great paroxysmal efforts occur at distant and irregular intervals. Eruptions differ in detail, but have a general resemblance. If the mountain rises above the line of perpetual snow, the approach of a crisis is indicated by its sudden melting, which occasions destructive torrents. Subterraneous sounds are heard, at first like a low prolonged moaning, gradually changed into a succession of loud detonations. Vibrations of the soil are felt, sometimes for several weeks beforehand; and as the interior war of elements is about to manifest its violence, the smoke of the hidden furnace rises in a vast, dense, black column from the crater. Unable because of its weight to ascend beyond a certain height in the atmosphere, the summit of the smoky column falls down upon itself, assuming the appearance of a gigantic pine-tree; as noticed, in the case of Vesuvius, in the younger Pliny's letter to Tacitus. Flashes of red flame, and showers of red-hot stones, like the sparks of fireworks, attended by reports as of a great train of artillery, mark the accumulated intensity of the forces at work, till the climax arrives, when mineral masses, reduced to complete fluidity, escape in fiery, majestic, and slow-winding currents from the interior. A discharge of ashes from the crater, which, borne by the air, fall upon a large area of the surrounding country, commonly terminates a grand eruption.

The products of volcanic action appear in the form of melted rock (lava); ashes, stones, and dust (scoriæ); gases and vapours.

1. Lava is chiefly composed of a very small number of minerals, felspar, augite, or hornblende, and oxide of iron, but other ingredients variously occur to modify the mass. From eighty to a hundred species of minerals have been observed in the products of Vesuvius. Raised by great mechanical pressure from an unknown depth, the melted rock ascends in the funnel of the mountain towards the summit, and sometimes, though but rarely, overflows the top, as Humboldt traced a stream to the very summit of the Peak of Teneriffe. But generally, the lava forces for itself a lateral passage through the flanks of the mountain, or issues through existing fissures, solidifying as it cools, and augmenting the diameter of the volcanic mound. Upon its first emergence, the mass has in general the consistency of honey; and hence it proceeds slowly, but sometimes it is more limpid. The surface soon cools, but the interior retains its heat, and remains semi-fluid long after the portion exposed to the atmosphere has become a hard crust. Some days after emission, lava has raised the thermometer from 59° to 95°, at the distance of 12 feet, while 3 feet off, the heat has exceeded that of boiling water. The temperature at which it remains fluid is sufficient to melt glass and silver; and to render a mass of lead fluid in four minutes, which would have required double that time to enter into fusion, if placed on red-hot iron. Nine months after eruption, in 1819, a lava current from Etna was in motion at the rate of a yard per day; and another is stated not to have been completely solidified and at rest, ten years after its emergence. But a mass of lava at Jorullo, 500 feet thick, erupted in 1759, was found smoking by Humboldt in 1804, forty-five years afterwards, and still in so heated a state that a cigar might be lighted in any of the cracks a few inches below the surface; and smoke was observed to issue from it by Burkart in 1827, though sixty-eight years after its ejection.

2. Ashes, stones, and scoriæ, ejected with considerable violence during an eruption, in clouds which darken the air for hours and even for days, have the same mineral composition as the lava. They are extricated from the liquid mass in the volcano, variously dissipated, and expelled by the explosive energy.

3. Of vapourous and gaseous products the most abundant is steam, often productive of local rains. The gases most commonly evolved are chlorine, sulphuretted hydrogen, sulphurous acid, carbonic acid, and nitrogen.

Boiling water has flowed copiously from Vesuvius during its eruptions. Discharges of water, mud, and small fishes have been observed in the case of the Andean volcanoes, but they are not to be ranked with proper volcanic phenomena. Humboldt relates, that when in 1698 the summit of Carguairazo sunk down, parts of the adjacent country were invaded with argillaceous mud containing dead fishes; and that a putrid fever which prevailed in 1691 at Ibarra, a mountain town north of Quito, was ascribed to the quantity of dead fish erupted from the volcano of Imbaburu. The fish, locally known by the name of "prenadillas," (Pymelodes Cyclopum,) abound in the subterranean reservoirs of the district, and are carried out by internal disturbance through crevices with the water and mud of the pools.

III. The amount of lava ejected in a single case of volcanic excitement is sometimes enormous. The solid contents of a current from Vesuvius in 1737, which destroyed Torre del Greco and ran into the sea, is computed at 33,587,058 feet,—equal to a cone nearly the height of St. Paul's, with a base diameter of 630 feet; but another current in 1794 was supposed to contain 46,098,766 cubic feet. The great stream from Etna in 1669, which destroyed Catania, is estimated at 93,838,590 cubic feet. But the most prodigious fiery flood on record proceeded from Skáptaa Yökul in Iceland, in 1783. The lava flowed in two nearly opposite streams, 50 miles in one direction and 40 in the other, with respective breadths of 15 and 7 miles, and with an average depth of 100 feet, but in narrow defiles amounting to 600 feet. The mass has been calculated at nearly twenty thousand millions of cubic yards, or forty thousand millions of tons, which, accumulated, would cover London with a mountain rivalling the Peak of Teneriffe.

Other volcanic products issue upon a scale of corresponding magnitude. The areas over which the winds have spread the ashes discharged indicate their quantity. Ashes from Vesuvius, A.D. 472, 473, fell in Constantinople, Egypt, and Syria; and ships were covered with them at the distance of 60 miles, in 1631. From the Souffrier Mountain, in St. Vincent's, they extended to Barbadoes in 1812; and while the sun was obscured, the streets and houses in Java were strewed with them, at a distance of 300 miles from Tomboro in Sumbawa, the point of eruption, in 1815. They were found floating in the ocean to the west of Sumatra, a distance of more than 1000 miles, forming a stratum two feet thick, through which vessels with difficulty forced their way. It was not a stream of lava from Vesuvius, but simply its ashes that destroyed the cities of Herculaneum and Pompeii.

IV. The quantity of material ejected is one criterion of the eruptive force; but a further measure of intensity is afforded by the magnitude of projectiles, with the height and distances to which they have been thrown.

A stone, 8lbs. in weight, was thrown from Vesuvius to Pompeii, a distance of 6 miles. A block of 109 cubic yards in volume was projected from Cotopaxi to the distance of 9 miles.

Sir W. Hamilton observed stones thrown out of Vesuvius so high that they occupied 11 seconds in falling; which gives a height of 2000 feet, and an initial velocity of above 350 feet in a second. During an eruption in Teneriffe, in 1798, the mountain Chahorra threw out stones which occupied from 12 to 15 seconds in their descent; which gives a height of from 2500 to 3600 feet, and an initial velocity of from 380 to 480 feet per second.

V. The degree of mechanical pressure competent to sustain a column of lava of the ordinary weight (about 2½ times that of water), so that it would overflow the craters of the respective volcanoes whose heights are given, is stated in the following Table, with the velocity with which such a pressure might eject lava at the base:

	Height in feet.	Force exerted upon the lava.	Initial velocity per second.
Stromboli	2957	179 atmospheres	371 feet.
Vesuvius	3948	314 "	496 "
Hecla	5106	413 "	570 "
Etna	10,874	882 "	832 "
Teneriffe	12,184	1009 "	896 "
Popocatapetl	17,720	1435 "	1062 "
Mount Elias	17,860	1465 "	1072 "
Cotopaxi	18,877	1492 "	1104 "

As far as relates to the eruptive force, steam-power appears to be a perfectly adequate agent, and sudden evolutions of it will explain the fits and starts of volcanic violence.

VI. The energy of volcanic action is most strikingly exhibited in the permanent rise of long lines of coast, (to be referred to hereafter), and the elevation of immense masses forming the new islands already mentioned, and new mountains.

In 1538, the Monte Nuovo was thrown up in the Neapolitan district, in 48 hours, 440 feet in height and 8000 feet in circumference.

In 1669, the Monte Rossi was thrown up on the slope of Etna, 450 feet in height and 2 miles in circumference.

In 1759, the mountain of Jorullo arose out of a plain to the west of the city of Mexico, 1695 feet in height.

Volcano of Jorullo.

VII. Volcanic ejections form an immense volume when viewed in isolation, which goes to augment the mean diameter of the earth; but its effect in this respect is still very feeble. Making a confessedly extravagant estimate of the product of eruptions from active or extinct volcanic mountains, and supposing it spread equally over the globe, the result has been calculated at only 2½ feet for the augmentation of the diameter.

The products ejected create corresponding internal cavities, the roofs of which frequently give way beneath the weight of superficial accumulations, which subside into them. The elevating effect of volcanic action is hence very much counterbalanced by consequent subsidences. The general result is an augmentation of the heights and a deepening of the depths.

VIII. The volcanic mountains are either continuously active, or intermittent, or extinct. The frequency of eruptions, with their character, appears to be related to their height. Stromboli—a comparatively lowly mound, 2175 feet high—has been uninterruptedly active from the dawn of authentic history, a permanent fiery beacon to the sailors of the adjoining seas, but very rarely violent. The lofty cones, Etna, (10,874 feet,) Peak of Teneriffe, (12,182,) Tunguragua, (16,579,) and Cotopaxi, (18,877,) have, on the contrary, varying intervals of rest, in some instances amounting to centuries. Extinct volcanoes are those which have plainly once been the outlets of fire and igneous products, but whose activity has for ages been suspended. Some of these may really belong to the intermittent class, now experiencing a long fit of dormancy. A chart of the isle of Palma, one of the Canaries, showing the extinct crater with a side view, is annexed.

Isle of Palma.

The recorded eruptions of Etna are,— B.C. 480—427, interval 53 years.
" " B.C. 427—396, " 31 "
" " B.C. 396—140, " 256 "
" " between B.C. 140—122, four eruptions.
" " B.C. 122 — 56, interval 66 years.
" " between B.C. 56 & 38, three eruptions.
" " B.C. 38 —A.D. 40, interval 78 years.
" " A.D. 40—251, " 211 "
" " A.D. 251—812, " 561 "
" " A.D. 812—1169, " 357 "

From this period to the present the agitations of Etna have increased in frequency and power:

Twelfth and thirteenth centuries	3 eruptions.
Fourteenth	2 "
Fifteenth	4 "
Sixteenth	3 "
Seventeenth	8 "
Eighteenth	14 "
Nineteenth to 1832	6 "

IX. By far the greater number of volcanic vents are situated in close proximity to the sea, either in islands, in chains more or less on the coast, or at the foot of such chains. This fact, in connection with the occurrence of submarine eruptions, has often been cited in behalf of the chemical theory of volcanoes, or the hypothesis of subterranean oxidation, which refers them to the filtration of the waters of the sea into cavities containing incandescent materials, which form the fuel for eruptions. There are, however, important exceptions to the proximity of volcanoes to the sea, or to any sheet of water: some in the New World, but the most remarkable in Central Asia. Hence the position is untenable, that volcanic action depends upon the access of water to the interior regions. Humboldt conceives that coast lands are simply favourable to eruptions, because they form the sides or edges of the deep sea-basin, which, covered with strata of water, and lying many thousand feet lower than interior sites, offers less resistance to subterranean forces.

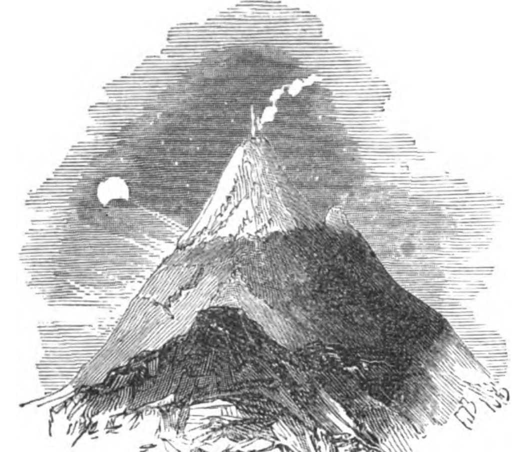
The chief inland volcanoes are at the following distances from the ocean:

Jorullo, in Mexico	81 miles.
Popocatapetl, do.	132 „
Sangai, in South America	93 „
Tolima, do.	105 „
Fragua, do.	156 „

The greatest of these distances is scarcely the tenth part of the distance of the great volcanic mountain chain of Central Asia from the sea, the Thian-chan. Towards the centre of this range, on the northern side, stands the isolated cone of Pechan, (white mountain;) and 670 miles to the east, on the southern side, is Ho-tcheon, (burning mountain,) which are both far apart from any aqueous expanse.

Distance of Pechan from the Arctic Ocean	1530 miles.
„ „ from the Indus, or the Ganges	1512 „
„ „ from the east side of the Caspian	1356 „
„ „ from the Sea of Aral	336 „
„ „ from the Salt Lake of Balkhache	210 „
„ „ from the Salt Lake of Issikoul	174 „

X. Of all the postulates for a general theory of volcanoes, the simplest and best founded, supported by the temperature of the earth increasing with the depth in every parallel of latitude, and by the great extent of rock once fused beneath our feet, is the igneous fluidity of the interior of our planet, a vast sea of melted rock underlying the cooled and solidified crust, which may remain at rest for ages beneath enormous areas, but is liable to be locally excited and uplifted by the force of compressed vapour. Volcanic vents remind us in this view of intermittent springs.



XI. Volcanoes may be characteristically distributed into the two great classes of Central and Linear Systems; an arrangement adopted from Leopold von Buch. A Central System consists of several vents grouped around a principal cone, which serves for a common point of eruption; as those of the isles of Palma, Lancerote, and Gran Canaria in relation to the Peak of Teneriffe; or they are arranged in an expanded area, as in Iceland. A Linear System consists of several vents extending in one direction, at no great distance from each other, apparently the apertures of the same great longitudinal fissure; as the volcanoes of America and the Asiatic isles. The figures in the following Table include active and extinct volcanoes, with some of doubtful existence:

CENTRAL CLASS.

System.	No. of Vol.	System.	No. of Vol.
I. Etna	1	XI. Traverse Is.	1
II. Vesuvius	1	XII. Trinidad I.	1
III. Lipari Is.	2	XIII. Mauritius	3
IV. Jan Mayen	2	XIV. Hawaii Archipelago	4
V. Iceland	8	XV. Galapagos Is.	1
VI. Azores	2	XVI. Marquesas Is.	1
VII. Canary Is.	7	XVII. Society Is.	1
VIII. Cape Verde Is.	1	XVIII. Easter I.	1
IX. Ascension I.	1	XIX. Western Asia	3
X. Tristan da Cunha Is.	1		

LINEAR CLASS.

System.	No. of Vol.	System.	No. of Vol.
I. Greek Is.	1	XII. Bonin Sima Is.	2
II. Thian-chan	2	XIII. Aleutian Is.	35
III. Red Sea	2	XIV. North West America	10
IV. Friendly Is.	2	XV. Mexico	7
V. Australian Is.	13	XVI. Guatemala	38
VI. Sunda Is.	80	XVII. Antilles	10
VII. Molucca and Philippine Is., Formosa	37	XVIII. Quito	17
VIII. Japan Is.	23	XIX. Peru and Bolivia	18
IX. Kurile Is.	18	XX. Chili	22
X. Kamtschatka	21	XXI. Tierra del Fuego and South Shetland Is.	4
XI. Mariana Is.	21	XXII. Antarctic	2

The numbers in both classes amount to 407, of which only about 270 are active volcanoes, and of these 190 belong to the islands and shores of the Pacific Ocean. In no part of the globe of the same extent are there so many volcanoes as in the island of Java. Out of 80 assigned to the linear system of the Sunda Isles, 43 belong to Java.

XII. Among the specialties of volcanic action, may be enumerated, eruptions of mud, the fires of Bakou, the fire-hills and fire-springs of China, and the Geysers of Iceland.

1. Mud Volcanoes (*salsen*).—Near the ancient Girgenti, in Sicily, many conical hillocks occur, from 8 to 30 feet high, but varying at different times both in height and in form, from which there are periodic escapes of gas and of clayey mud, a rushing noise accompanying the discharge.

In Java, mud volcanoes, from 25 to 30 feet high, are described by M. Diard, discharging hot water, mixed with chloride of soda, hydrogen gas, and carbonic acid. The eruptions are attended with a subterranean noise, sometimes like thunder, heard at a considerable distance.

Near the village of Tokmali, in the district of Bakou, west of the Caspian, a remarkable eruption occurred on the 27th November, 1827. A column of fire rose to an extraordinary height, at which it continued for three hours, afterwards sinking to three feet, and burning for twenty-four hours. The fire was accompanied with an outburst of argillaceous mud, which covered a space of from 1500 to 2000 square feet, to the depth of two or three feet. Similar eruptions had before taken place, the soil, to a much greater distance, consisting of mud of a volcanic origin.

Near the village of Baklikhli, in the same district, similar phenomena occurred on the 7th of February, 1839. According to Eichwald, the jets of fire were visible at the distance of forty versts. Large lumps of earth were cast into the air, and a prodigious quantity of small hollow spheres, like small shot, were carried off by the winds, and deposited at the distance of six leagues. The spheres consisted of a black earthy calcined matter. The jets of flame continued twenty hours.

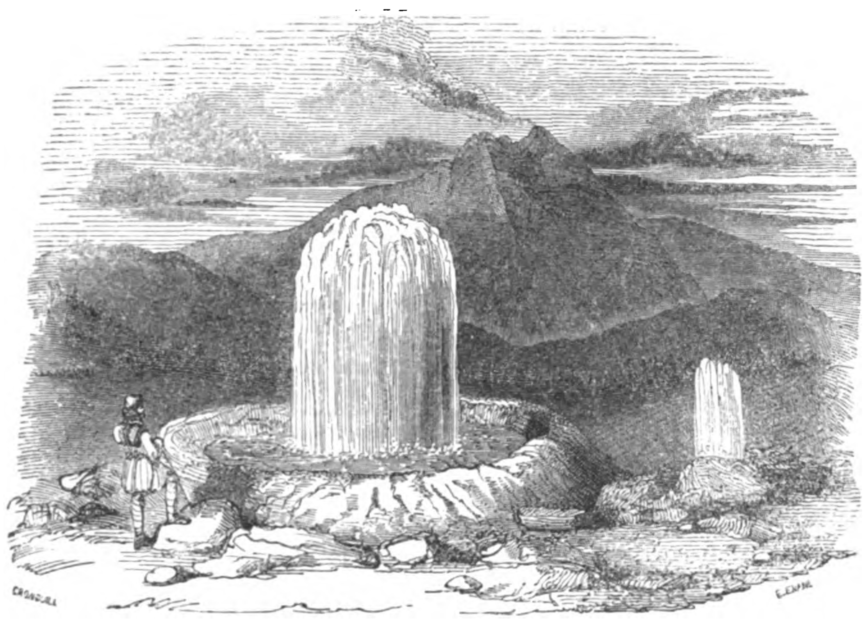
The Volcancitos de Turbaco, in South America, described by Humboldt, consist of several small truncated cones, with small apertures or craters at the top, filled with water and dark-coloured soft clay, through which air-bubbles obtain a passage. About five explosions usually take place in two minutes, a dull but rather loud sound preceding the disengagement of the air. The gas collected from the bubbles was found to be pure nitrogen.

2. Fires of Bakou.—The western peninsula of the Caspian on which Bakou is situated, is remarkable for luminous phenomena apart from its mud volcanoes. The soil is saturated with naphtha, from which inflammable gas is profusely exhaled. The *great fires*, situated about fifteen versts from the town, are not mentioned by either Greek or Roman writers, and are therefore supposed to have burst out in more recent times. The burning field is a hollow expanse, full of clefts, coated with white sand and gray dust, and abounding with particles of sulphur. Some of the clefts are seen burning, some smoking, and others emitting only vapour. The principal fire springs from shell limestone. This spot was formerly one of the most celebrated shrines of grace among the Ghebers or fire-worshippers of Persia, and a few still find their way to it even from India. The *small fires*, as they are called, in another locality, are annually extinguished by the rains.

3. Fire-springs (*Ho-tsing*) and Fire-hills (*Ho-chan*).—While there are no volcanoes in China, fire-springs occur in different parts of its western provinces, and on the borders of Thibet, far from the sea. In the *Annales de l'Association de la Propagation pe la Foi*, 1829, M. Imbert, a missionary, mentions many thousands in a space of about ten leagues long by four or five wide. They are artificial borings for the purpose of raising water, which is strongly impregnated with salt and nitre. They yield inflammable gas which burns with a blue flame, and is collected to be used in evaporating the salt water. When a torch is applied to the opening of these wells, a great stream of fire rises to the height of 20 or 30 feet with great violence and noise. In order to put out the flame, in one instance, four men placed an enormous stone upon the orifice of the well, but it was immediately projected into the air, and three of the men were injured.

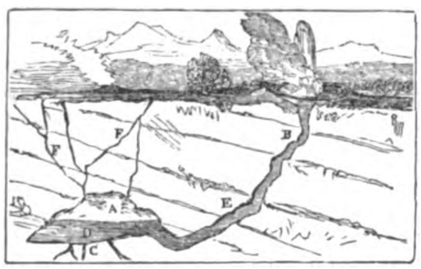
The Fire-hills exhibit during the night a light like that of the aurora. In the province of Chan-si, there is a fire-mountain with a large crevice on the summit, out of which issues a powerful heat accompanied with a continual noise like thunder. In the province of Se-tchouan, the whole eastern flank of Py-kiachan is illuminated at night. The illumination is attended with no noise, but it sheds over the faces of the rocks, the tops of the mountains, the forests, trees and sky, a bright red light equal to that of the day, which disappears in the morning. It is supposed to be a volcanic flame proceeding from a deep ravine which the Chinese have not visited.

4. Geysers.—Hot-springs, common to the neighbourhood of volcanoes, occur in a remarkable group of fifty or more in Iceland, about thirty-six miles from Hecla. Some give vent to warm vapours, accompanied with very little fluid: others are filled with hot water, clear as crystal, constantly ebullient, and occasionally discharging their waters in great jets to a considerable height. Two of the latter class, called the Great Geyser, and Strokr or the New Geyser, are the principal. The Great Geyser is a circular mound of siliceous deposits, with a basin at the summit, 60 feet in diameter,



The Great Geyser.

and six or seven deep. At the bottom of the basin, there is a well or funnel, 10 feet wide at the mouth, but gradually narrowing to seven or eight, with a perpendicular descent of 70 feet. Small jets of water, rising to the height of 20 feet, take place frequently. The grand eruptions are often after intervals of a day or more. Hollow rumbling sounds and thundering explosions in the bowels of the earth announce their approach, and warn the spectator to retire to a safe distance. The water in the basin boils furiously, and is projected into the air in a succession of jets, accompanied with immense volumes of steam. The power of the Geyser varies, and the height of the aqueous columns. Mr. Lyell supposes an interior cavity, as at A, D, receiving water from the surface by the fissures F F, while steam, at an exceedingly high temperature, rises upwards by the fissures at C. The condensed steam raises the temperature of the water in the lower part of the cavity. The upper part becomes filled with steam under high pressure, which forces the water up the funnel E, B, and projects it with more or less violence at the mouth. The term Geyser, from the Icelandic *geysa*, signifies to rage, or burst forth impetuously.



CHAPTER XI.

EARTHQUAKES.

I. Earthquakes and volcanic eruptions are undoubtedly phases of the same phenomenon, now one and then the other, or both together, but at different points. The concussions so named are by far the most abundant and violent in countries which surround or lie between volcanic districts; but the shocks are most severe in places distant from active volcanic sites, the vents of the latter acting as a kind of safety-valve to the elastic force, which, when pent up, agitates the crust of the earth in effecting disengagement.

II. No phenomena are so terrible in their effects, or so fatal to the human species, as earthquakes. The volcano gives timely notice of an approaching explosion; and confines its ravages to a limited area. The lava current is readily avoided, and a safe distance from the burning mountain may speedily be reached. But the earthquake commences without the slightest warning; the shocks follow in quick succession, the first or second being usually the most tremendous; and almost at the same instant, a vast extent of country is involved in disaster from the oscillation.

Earthquake of Lisbon, Nov. 1, 1755.—The line of devastation extended from Lisbon, the central point, north to Oporto and south to the Bay of Cadiz, a distance of 300 miles.

The area of concussion formed an ellipse, the major axis of which extended 2700 miles, from Abo in Finland to the Canary Isles.

The area of vibration, or the space through which the waters were observed to oscillate from the shock, upwards of 4000 miles in length, included a superficial extent more than four times that of Europe, comprising the lakes of Scotland, small lakes in the northern flats of Germany, springs in Hungary, the Atlantic to the West Indies, and a portion of the Canadian lakes.

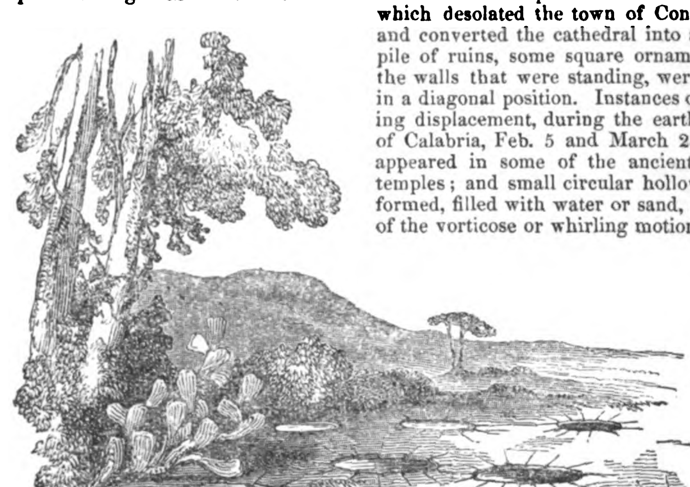
III. The movements of the ground during an earthquake are described as consisting of a series of tremulous, vertical, horizontal, or rotatory vibrations, rapidly following each other, sometimes occurring singly, or taking place together.

1. Tremblores, so called by the Creoles of South America, are tremors of the surface, common in Chili and other adjacent countries, occurring almost every day in certain seasons. Though walls are sometimes split, and objects thrown down, they are not dreaded by the inhabitants, life and property being generally secure.

2. Vertical movements, like those produced by the explosion of a mine, marked the earthquake of Riobamba, Feb. 4, 1797, which destroyed the town, and threw the bodies of many of the inhabitants upon the hill of La Culla, several hundred feet high; one of the most terrible catastrophes of physical history. Shocks acting in a perpendicular direction were experienced during the Lisbon earthquake. In a vessel far west in the Atlantic, a seaman on deck was thrown bodily upwards.

3. Horizontal movements, propagated in undulations, like waves upon water, appear to characterise every great earthquake. The undulations are estimated to travel at the rate of from twenty to thirty geographical miles in a minute.

4. Rotatory movements are rare. They are evidenced by walls being twisted round without being prostrated, and by the deflection of parallel rows of trees, and parallel ridges in the fields. After the Chilian earthquake of Feb. 20, 1835, which desolated the town of Conception, and converted the cathedral into a grand pile of ruins, some square ornaments on the walls that were standing, were found in a diagonal position. Instances of twisting displacement, during the earthquakes of Calabria, Feb. 5 and March 28, 1783, appeared in some of the ancient Greek temples; and small circular hollows were formed, filled with water or sand, a result of the vorticose or whirling motion.



IV. Earthquakes are either linear as to the direction of the concussions, or the shocks are propagated in circles and great ellipses, gradually decreasing in intensity with the distance from the focal points.

The earthquake of Guadaloupe, Feb. 8, 1842, was felt along a right line from 60 to 70 miles in breadth, and 3000 miles in length, extending from the mouth of the Amazon into South Carolina.

The Calabrian earthquake vibrated through a circular, and the Lisbon earthquake through an elliptical area.

V. The sounds which usually form part of the phenomena vary greatly. Dull rumbling noises, and detonations like the discharges of cannon, the clanking of chains, or as if masses of obsidian and vitrified matters were struck in caverns, underground, are noticed.

Sometimes, at stations very remote, where no shock whatever has been perceived, the sounds of explosion have been heard the same instant as at the sites of catastrophe. As sound requires a definite time to be transmitted through the air, it could not, in these cases, have been propagated by that medium. Solid bodies are much better conductors of sound, baked clay transmitting it with ten or twelve times the velocity of the open air; yet the supposition of the sonorous waves being conducted by the surface of the earth, is untenable, because time is still demanded for the transport. It is likely, in such instances, that the sounds originated at such an immense depth below the surface, as to be nearly equi-distant from all the places where they were observed.

The very remarkable fact has been ascertained by Humboldt, that the dreadful earthquake of Riobamba was accompanied by no noise whatever.

The equally singular occurrence took place at Guanaxualo, a town of Mexico, remote from any volcano, of subterraneous bellowings and thunderings, *bramidos y truenos subterraneos*, being heard for more than a month, commencing Jan. 9, 1784, which caused the inhabitants to flee, yet not the slightest movement of the ground could be perceived.

VI. Earthquakes furnish the most striking examples with which we are acquainted, of the production of stupendous effects in very brief intervals. The most severe are generally the shortest in their duration.

The catastrophe which destroyed Lisbon, with sixty thousand persons, shook Europe, and rocked the waters of Lake Ontario, was over in six minutes.

The desolation of Caraccas, March 26, 1812, felt on the banks of the Magdalena, occupied less time. In the space of fifty seconds, three great shocks shattered the city, killed ten thousand of its inhabitants, and covered the province with ruins.

VII. It is popularly supposed that a direct relation exists between earthquakes and certain meteorological conditions of the atmosphere. Though such impressions may be largely fanciful, it is by no means certain that no connection subsists between subterranean and atmospheric phenomena.

Calms, long droughts, oppressive heat, with misty reddish vapours at the horizon, are believed to prognosticate earthquakes by the people of some South American districts. But Humboldt speaks of the dreaded evil arriving in all kinds of weather; of having experienced earthquakes when the air was perfectly clear, and while a fresh east wind was blowing, as well as during rain and thunder-storms.

In Northern Chili, where rain is extremely infrequent, and even weather foreboding rain, the inhabitants are firmly convinced that an earthquake is a certain herald of its fall. Mr. Darwin mentions several instances of rain following earthquakes in that region, at a period of the year when its fall is quite a phenomenon. Mr. P. Scrope remarks, to explain the connection between the two events, that when the barometer is low, and when rain might naturally be expected to fall, the diminished pressure of the atmosphere over a wide extent of country, may well determine the precise day on which the earth, already stretched to the utmost by the subterranean forces, shall yield, crack, and consequently tremble.

From a comparison of dates, earthquakes appear to be most frequent about the epochs of the equinoxes.

VIII. The phenomena of earthquakes comprise the permanent displacement of large areas of land by elevation and subsidence, the opening of extensive fissures, great oceanic waves, and a train of varying incidents dependent upon the sites and strength of the concussions.

1. Elevations.—The Chilian earthquake of 1822, which agitated the coast for 1000 miles, permanently raised it for a distance of 100 miles,—at Valparaiso, 3 feet, at Quintero, 4 feet; the greatest movement being to the north-east of Valparaiso, where beds of oysters and other shells were brought clear to the surface.

By the second great disaster of that coast in 1835, strata of clay slate in the Bay of Conception were elevated 3 or 4 feet; the land rose about a foot and a half at San Viaente, a port south of Talcahuano; and in the small island of Santa Maria the rise was estimated by Captain Fitzroy at 8, 9, and 10 feet. He found beds of putrid mussel-shells still adhering to the rocks, 10 feet above high-water mark. The inhabitants had formerly dived at low water spring tides for these shells.

2. Subsidences.—In the year 541 Pompeiopolis was half swallowed up in an earthquake; in 867, Mount Acraus fell into the sea; in 1596, the ocean covered many towns in Japan; in 1638, St. Euphemia became a lake; in 1692, Port Royal is commonly believed to have sunk; 1755, the new quay at Lisbon subsided, and its place was occupied by water 100 fathoms deep; in 1819, a town and large tracts of country were submerged at the mouth of the Indus, the Ullah Bund rising up as a compensating elevation.

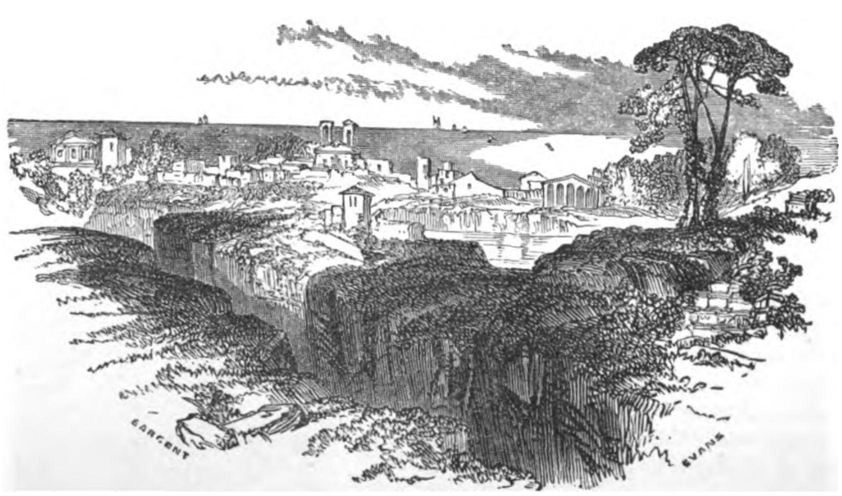
3. Fissures.—Clefts radiating from a central point are frequently formed, or horizontal openings of the ground; as at Polistena in Calabria.

4. Oceanic Movements.—The neighbouring waters of the sea in a severe earthquake exhibit strong agitation: first, as observed on the west coast of America at the instant of the shock,—the waters gently rise high up on the beach, and then as quietly retire; secondly, some time afterwards the whole body of the sea retires from the coast, and then returns in a wave of overwhelming force. The great wave is sometimes half an hour after the proper catastrophe.

5. Other incidents include discharges of hot water, hot steam, irrespirable gases, mud, black smoke, flames, the landward flight of sea birds, and the strongly-marked anxiety of the animal races.

IX. Though unable to trace the intimate connection of earthquakes, volcanoes, thermal and hot waters, the disengagement of mephitic vapours, steam, and inflammable gases, it is impossible to doubt their direct relationship and mutual dependence upon one grand phenomenon—a prevailing high temperature in the interior of the earth at an unknown depth below the surface. Thermometrical experiments made in mines, show that at a certain depth the thermometer rises and goes on rising proportionably as the depth increases.

X. Humboldt finely records the peculiar impression produced by earthquakes, experienced for the first time:—"From early childhood we are habituated to the contrast between the mobile element water, and the immobility of the soil on which we stand. All the evidences of our senses have confirmed this belief. But when suddenly the ground begins to rock beneath us, the feeling of an unknown mysterious power in nature coming into action, and shaking the solid globe, arises in the mind. The illusion of the whole of our earlier life is annihilated in an instant; we are undeceived as to the repose of nature; we feel ourselves transported to the realm and made subject to the empire of destructive, unknown powers."



Fissures at Polistena.

CHAPTER XII.

LANDSLIPS AND GRADUAL DISPLACEMENTS.

I. The dislodgment of mountain masses, which fall a heap of ruins into the subjacent valleys, or simply slide to a lower level without entire derangement, is not uncommon with certain stratified formations of a loose and solvent texture. Though the work of a few moments as to the proper catastrophe, the preparing process for the event extends through a series of ages. It is in general due to the solvent power of water percolating by rents and fissures to a stratum of soft sandstone, limestone, or conglomerate, the base of other strata, and gradually carrying away its material.

No considerable derangement would ensue, but the superior strata would simply exhibit a change of level, and gradually settle upon the new base, if its plane coincided with that of the former. If, however, it should be more highly inclined, the overlying mass either slides down it or is precipitated from it with tremendous violence, according to the amount of the varying inclination.

In 1248, a part of Mont Grenier in Savoy fell, burying five parishes, and covering an extent of nine square leagues with its ruins, now called *les Abymes de Myans.*

In 1618, Mont Corno fell into the Val Bregaglia, in Lombardy.

In 1714, one of the peaks of the Diablerets, or Devil's Horns, which lie on the borders of the cantons of Valais and Pays de Vaud, fell; and again in 1749, completing its destruction.

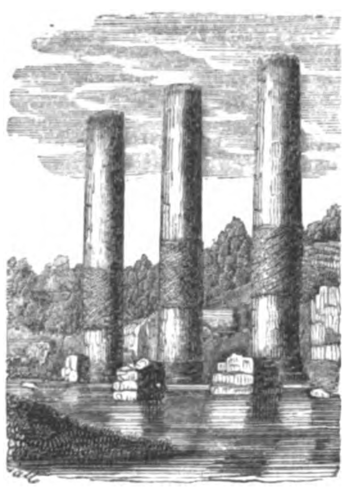
In 1806, the vale of Goldau, in the canton of Zug, with 97 houses and 484 persons, was overwhelmed by the fall of the Rossberg (Mont Ruffi).

In 1826, after violent rains following a dry season, an extensive land-slip occurred in the White Mountains, a part of the Alleghanies.

On the 20th of December, 1846, a hill, called the Bingeler Kopf, on the Rhine, which rises 380 feet above the river, gave way.

II. In addition to examples of permanent displacements of land, arising from convulsive movements, certain districts appear to be subject to slow elevation or subsidence, or to both alternately.

The pillars of the temple of Jupiter Serapis, in the volcanic district of Naples, exhibit a zone in the middle pierced by marine perforating bivalves, evidencing a long immersion in the sea, during which accumulations of rubbish probably protected the lower parts of the columns from the attacks of the shell-fish, the upper parts being above the waves. Of course the building was originally erected at a safe height from the waters. The site subsided into them, was re-elevated, and it now appears to be subsiding again at a slow rate. In March, 1819, the floor was about 6 inches above the level of the sea; in May, 1845, it was 18 inches below it at low water, and 28½ at high water.



III. On the coast of Norway from the Naze to the North Cape, and on that of Sweden along the whole west shore of the Gulf of Bothnia, raised beeches, former sea-margins, 100, 200, and even 600 feet above the present level of the ocean, chronicle a process of elevation which is still going on at the estimated rate of 4 feet in the course of a century, the maximum of the upheaving power lying

Fiord of Norway.

in North Lapland, and gradually falling off towards the south. On the contrary, South Sweden, below Sölvitzborg, is sinking; the village of Stafsten being now 380 feet nearer the Baltic than it was in the time of Linnæus, who carefully measured the distance. West Greenland also exhibits gradual depression. According to Mr. Lyell, experience has taught the aboriginal Greenlander never to build his hut near the water's edge, as ancient buildings have been slowly submerged; while the Moravians have been obliged more than once to move inland the poles upon which their large boats were set, and the old poles still remain beneath the water as silent witnesses of the change.

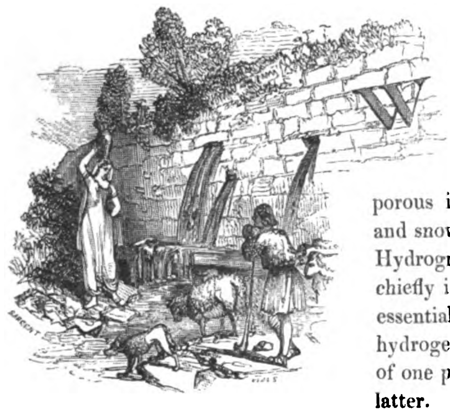
IV. Raised beaches and submarine forests, the monuments of elevation and of subsidence, occur at various points of the coast of Great Britain and other maritime countries, which have never been visited by violent earthquakes in historic times, and are far from the vents of igneous activity. There is reason for the general conclusion that while certain parts of the crust of the globe are subject to paroxysmal disturbances, it undergoes gradual expansion and contraction also, in some cases both alternately; the whole phenomena depending mainly upon different conditions of interior temperature.

Diluvial Formations.—Seen from the Acropolis of Athens.

HYDROGRAPHY.

CHAPTER I.

CHEMICAL CHARACTERS OF WATER.



WATER, one of the most important and abundant substances in nature, very widely diffused, is found in each of the three forms which bodies are capable of assuming, vaporous in the atmosphere, solid in ice and snow, and liquid in rivers and seas. Hydrographical science deals with it chiefly in the last condition. Water is essentially a compound of two gases, hydrogen and oxygen, in the proportion of one part of the former to eight of the latter. It seldom occurs however in a state of perfect purity, but variously impregnated with ingredients derived from the atmosphere, from strata in contact with it, or from decomposed and living animal and vegetable substances. Though tasteless and inodorous when pure, the foreign ingredients impart to it a peculiar taste, frequently an odour also, which the senses of man may fail to detect, but is readily observed by certain animals. At a great distance in the Desert, the scent of water is recognised by the camel.

Rain-water is the purest kind that can be collected without having recourse to distillation. It contains however a portion of carbonic acid and air, absorbed from the atmosphere; and minute quantities of iron, nickel, and manganese have been detected. Spring-water, derived mainly from rain, contains most of its ingredients, with foreign matters dependent upon the nature of the rocks through which it percolates. Large springs are commonly purer than small ones; those which occur in primitive countries, filtering through granite and siliceous rocks, are comparatively pure; but those which pass through limestone or gypsum, take up a considerable portion of these substances. River-water has its general character determined by the soil of its basin. Lake-water corresponds to that of the rivers which form it, except in the case of lakes without an outlet, which are commonly saline. Marsh-water abounds in impregnations from animal and vegetable decomposition, those members of both classes which are of the lowest grade usually flourishing in such sites. Sea-water is fully described below.

II. The water of wells, springs, rivers, marshes, and lakes, is for the most part fresh, containing no amount of saline matter appreciable to the taste, and unfitting it for domestic use. A fluid covering of this description composes a large portion of North America, its lakes comprising more than half the amount of fresh water on the face of the globe.

There must be deep subterranean reservoirs of fresh water, for it rises up in springs along the bed of the ocean. A powerful jet of this kind occurs in the Gulf of Spezzia, a branch of the Gulf of Genoa. In the bay of Xagua, on the south coast of Cuba, similar springs gush up with such force as to be dangerous to small canoes, while vessels sometimes take in supplies from them, and the lamartine, or fresh water cetacea, abounds in the vicinity. There are several other examples.

III. The amount of fresh water compared with the whole aqueous portion of our planet is utterly insignificant. The universal ocean is salt, and by a process of evaporation, a considerable proportion of our common salt is procured from its waters. A few years ago, Dr. Schweitzer, of Brighton, made a very careful analysis of the water of the English Channel, and obtained the following results:

Water	964·74372	grains.
Chloride of sodium (common salt)	27·05948	"
Chloride of potassium	0·76552	"
Chloride of magnesium	3·66658	"
Bromide of magnesium	0·02929	"
Sulphate of magnesia	2·29578	"
Sulphate of lime	0·40662	"
Carbonate of lime	0·03301	"
	1000·00000	"

IV. The oceanic waters vary in their density, or amount of saline impregnation, in different zones. Those of the southern hemisphere exceed those of the northern in saltness, while the Atlantic is in excess of the Pacific. Humboldt has concluded from good experiments, as follows:

Proportion of salt between	0°	and	14° lat.	= 0·0374
" "	15°	"	25° "	= 0·0394
" "	30°	"	44° "	= 0.0386
" "	50°	"	60° "	= 0·0372

It thus appears that the ocean is least dense at the equator and towards the poles, arising from the copious equatorial rains, and the melting of the polar ice.

At the same point of the ocean, the minimum of density is at the surface. This is owing to the rains. The fresh water is the lightest, and slowly commingles with the salt.

The saltness of the ocean diminishes at the mouths of large rivers. The Atlantic is only brackish 300 miles from the mouth of the Amazons. Mr. Darwin, when off the estuary of the Plata, observed how slowly the waters of the sea and the river mingled. The river-water, muddy and discoloured, from its less specific gravity, floated on the surface of the salt. This was curiously exhibited in the wake of the vessel, where a line of blue sea-water was seen mingling in little eddies with the adjoining fluid.

Inland seas are commonly less salt than the main ocean. While three pounds weight of Baltic water yield about 390 grains of salt, the same quantity taken from the German Ocean contains 747 grains. This is due to the large rivers which flow into the Baltic, draining more than a fifth of Europe, while the narrowness of the channel connecting it with the ocean only allows of a scanty influx of sea-water. The Gulf of Bothnia branch of the Baltic has the least saline impregnation, where the inflowing streams are the most numerous, and the ocean is at the greatest distance. In this gulf the water is less salt in summer than in winter, owing to the larger supply of fresh water received at that season from the melting of the winter snows. The direction of the wind has great influence upon the saltness of the Baltic. An easterly wind co-operates with the natural current to keep out the waters of the ocean: a westerly wind promotes the influx.

The case of the Mediterranean is inverse to that of the Baltic. Its water is four times salter than that of the Atlantic. The mineral character of its bed may have some effect, while the supply of water flowing into it from the ocean is larger than that of the return current, but the main cause is the excessive evaporation to which the Mediterranean is subject. Sheltered from the cold of the north by the Alps, and exposed to the heat of the African deserts on the south, its temperature is 10° or 12° higher than that of the Atlantic under the same latitude.

V. The origin of the saline quality of oceanic water is a physical question involved in obscurity. We merely know that various salts, and immense masses of rock salt, are constituent parts of the terraqueous system, a large quantity of which has come in contact with the ocean, and been dissolved by its waters. The saline ingredients render sea-water more buoyant than fresh, and, consequently better adapted for navigation, while a larger area is preserved from being ice-bound. Fresh water freezes at the temperature of 32°: salt water requires a lower temperature to be frozen, or 28½°.

VI. Besides the ocean, salt water has an extensive distribution on land, in lakes and springs, the salts occurring in a far more concentrated state than in the sea. They are common in Europe, Africa, and America, but the table lands of western and central Asia, with the adjoining steppes, constitute the great salt water lake district of the globe.

1. Salt Lakes.—The Caspian Sea, Lakes Aral, Urumiah, Toozla, Elton, and the Dead Sea occur in this region, with innumerable others of small dimensions. Some of these waters are so excessively saline as to irritate the skin. Fish cannot live in them, and if a bird dips on their surface, its wings are incrusted with salt on drying. The Lake of Toozla, in the centre of Asia Minor, nearly 100 miles in circumference, locally bears the name of Agi-gol (bitter lake), Tuz-goli (salt lake), and Tuz-choli (salt desert), the latter because its waters retreat in summer, and leave bare a thick crust of solid salt. The water of the Dead Sea, peculiarly bitter and pungent to the taste, contains a fourth part of its weight of saline matter; but that of Lake Elton, in the steppe east of the Volga, is more strongly impregnated with saline ingredients than any other known example, furnishing two-thirds of the salt consumed in Russia. Very little more than 4 per cent. of solid matter has been obtained from oceanic water; that of the Dead Sea contains 26 per cent.; and that of Lake Elton 29 per cent.

Expanses of salt and fresh water are frequently found in contiguous situations. The Lake of Urumiah, on the confines of Persia and Armenia, 300 miles in circumference, the water of which in still shallows almost forms a paste of salt, is only separated by a range of hills from Lake Van, 240 miles in circumference, renowned for its beauty, the water of which is fresh.

2. Salt Springs.—Saline mineral waters, resorted to for medicinal purposes, occur in the springs of Epsom, Cheltenham, Bath, Barèges, Buxton, Pitcaithly, and Töplitz. They have their character determined by the presence of various saline compounds,

the salts most frequently contained in them being the sulphates and carbonates of lime, magnesia, and soda, and the chlorides of calcium, magnesium, and sodium.

Pure brine springs are rare. Those in Cheshire, and some in the United States, are especially rich, and are extensively evaporated to obtain table-salt.

VII. Water appears in other mineralised forms in many localities, constituting acidulous, chalybeate, sulphureous, and siliceous springs, some of which are known to have preserved their peculiar character from very early historic times.

1. Acidulous waters are commonly associated with much free carbonic acid gas, in consequence of the escape of which they sparkle when poured from one vessel into another. They frequently contain carbonate of lime, magnesia, and protoxide of iron, because of the facility with which these substances are dissolved by water charged with carbonic acid. Examples, at Carlsbad, Seltzer, Spa, and Pyrmont.

2. Chalybeate waters are specially characterised by the presence of iron, most frequently held in solution by free carbonic acid. Examples, at Tunbridge, Cheltenham, and Brighton.

3. Sulphureous waters, readily recognised by their odour, contain sulphuretted hydrogen. Examples, at Aix-la-Chapelle, Harrowgate, and Moffatt.

4. Siliceous waters, charged with silica held in solution by free soda, are very rare, and are only found in the vicinity of volcanic or other igneous rocks. Examples, the boiling springs of the Geyser and Rykum in Iceland, and the hot springs of Pinnarkoon and Loorgootha in India.

CHAPTER II.

PHYSICAL CHARACTERS OF WATER.

I. Water appears at the surface of the globe at every temperature from the freezing to the boiling point. The mean temperature of ordinary springs is lower than that of the atmosphere of the place where they occur, if the water is derived from high-lying levels, as is commonly the case; but if it has penetrated deep into the earth, it acquires a temperature from that circumstance, which increases with the depth.

Thermal and hot waters issue from great depths, to which they have descended from the surface, and from which they are returned by hydrostatic pressure, variously affected by differing contact with the heated rocks of the interior, in some instances bringing back an insupportable temperature.

The north thermal springs of England, at Matlock, Stony Middleton, and Buxton, range from 66° to 82°, while those of the south at Bath have a higher temperature from 109° to 117°.

The thermal springs of the Alps range from 86° at Naters to 126° at Leuk.

The Ursprung at Baden has a temperature of 153½°.

The hottest permanent springs, observed by Humboldt in America, range from 204° to 207°, and flow remote from all volcanoes. Mr. Wilkes, the commander of the recent exploring expedition from the United States, observed the beach of one of the islands of the Fejee group absolutely steaming, the water oozing through the sands and gravel with a temperature of from 200° to 210°.

Thermal waters have been observed to be affected in quantity and temperature by earthquakes. The temperature of the spring of Bagnères de Luchon in the Pyrenees was raised 75°, in the year of the Lisbon earthquake, while in 1660, an earthquake which desolated the country between Bordeaux and Narbonne, caused one of the hottest of the Pyrenean springs to become so cool as to be no longer of any value.

II. The mean temperature of the ocean at the surface diminishes from within the tropics as the latitude increases, more rapidly in the southern than in the northern hemisphere, till towards the poles the sea is ice-bound. A great number of observations justify the following conclusions respecting the superficial temperature of the ocean:—1. It is generally lower at midday than that of the atmosphere, noticed in the shade. 2. It is always higher at midnight. 3. Morning and evening the two temperatures usually correspond. 4. In the usual and mean state of its surface, the ocean, from the equator to 48° of north and south latitude, is somewhat warmer than the stratum of air resting immediately upon it. 5. Banks diminish the temperature of the sea, so that it is always colder over them than where it is deeper; and the difference is the greater, the greater the shallows.

III. The following are well-supported conclusions respecting the temperature below the surface:—1. Water, being a slow conductor of heat, is less liable to sudden changes than the atmosphere, and has only its upper strata affected by seasonal influences. The temperature of the Swiss lakes often fluctuates 20° or 30° at the surface, and at the bottom no more than 3° or 4°. 2. In the ocean, the influence of seasonable vicissitudes is imperceptible at the depth of 300 feet. 3. Throughout the whole of the deep ocean, there is, at a certain depth, varying with the latitude, a stratum which maintains invariably the temperature of about 39° 5′, marking the limit of the influence of the sun's heat. 4. In equatorial seas, the line of unvarying temperature is found at the depth of 7200 feet. 5. From this depth at the equator, the line gradually rises, till it comes to the surface in S. lat. 56° 26′, according to the recent determinations of Sir James Ross. It rises also to the surface at a corresponding latitude in the northern hemisphere; and here the water has the same temperature, 39° 5′, at all depths. 6. From the latitudes named to near the degree of 70, the line descends to the depth of 4200 feet, beneath which, to the greatest depths, the temperature of 39° 5′ obtains, while that of the surface is 30° 7′. Thus the temperature of the ocean decreases with the depth to a certain limit at the equator, and increases with the depth to a certain limit towards the poles.

The stratum of unvarying temperature leads to the conclusion, that the internal heat of the earth exercises no influence upon the temperature of the ocean.

IV. The oceanic warmth equator, or the line of greatest warmth at the surface, does not coincide with the geographical equator, but runs for the most part on the north of it, the ocean in the northern hemisphere being warmer than in the southern. At one point, in the Gulf of Mexico, the greatest heat is situated 28°, or about 1500 miles north of the Line.

POSITION OF THE GREATEST OCEANIC HEAT.

1. Atlantic Ocean.—The line of the greatest heat of the surface water of this ocean is entirely north of the equator, the temperature varying in different places from 77° to 88° 5′.

The minimum of 77° is near the coast of Guinea, lat. ½° N., long. 2° E.

The maximum of 88° 5′ is in the Gulf of Mexico, lat. 28° N., long. 89° W.

2. Indian Ocean.—The line of the greatest heat is here also in the northern hemisphere, except in the Java Sea between Sumatra and New Guinea, where it crosses the terrestrial equator, and extends along the northern shores of Java. Temperature varies from 85° 5′ to 87° 4′.

The minimum of 85° 5′ is found in the Molucca Sea, lat. 4° S., long. 129° E.

The maximum of 87° 4′ is in the Arabian Sea between Africa and India, lat. 11°. N., long. 60° E.

3. Pacific Ocean.—In the eastern portion, the warmth equator lies in the northern hemisphere: in the western portion, in the southern. Temperature varies from 81° 7′ to 88° 5′.

The minimum of 81° 7′ is found between the Galapagos and Sandwich Islands, lat. 3° N., long. 124° W.

The maximum of 88° 5′ is found in the haven of Dorerei, New Guinea, lat. 1° S., long. 134° E.

Thus the absolute greatest heat of the surface water amounts to 88° 5′, and occurs in the Mexican Gulf and Dorerei haven.

The oceanic warmth equator is traced on the Hydrographical Map, showing the currents, temperature, &c., the temperatures being expressed in full without the decimals.

V. The propagation of light through water is not carried far below the surface. Its influence at the depth of 300 feet is scarcely equal to the glimmer of twilight, and below about 700 feet there is perpetual darkness.

It has been calculated that of vertical rays only ½ advance downwards through the first 17 feet, ¼ reach 34 feet, and $\frac{1}{100000}$ penetrate to 282 feet.

VI. The waters of the globe exhibit various hues, which depend upon a variety of circumstances. The ocean absorbs all the prismatic colours except that of ultramarine, which is reflected in every direction. This is its true colour in general, when seen apart from atmospheric influence, modified by depth; but every gleam of sunshine, passing clouds, winds, shoals, and sandbanks affect its tints. Particular parts of the ocean show peculiar colours. The sea is white in the Gulf of Guinea, and black amid the Maldive Islands. Variously purple, red, and rose-coloured waters occur in the higher parts of the Mediterranean, in the Vermilion Sea off California, the Red Sea, and in tracts along the coasts of Chili, Brazil, and Australia. Green water appears in the Persian Gulf, off the Arabian coast, and in connection with the deepest blue in the Arctic Ocean. These appearances are permanent, and so distinct that ships have been seen partly in blue and partly in green water at the same time.

These tints are occasioned by differently coloured animalcules, which swarm in countless myriads in the tracts in question. The same species (*Trichodesmium erythræum*) which colour the Red Sea, have been found in other similarly tinted districts of the ocean. The green of the Arctic Seas is produced also by minute animals, which visit in spring the coast of Holland, and have been encountered in immense shoals migrating in the Atlantic. In the Antarctic regions, Sir James Ross remarked repeatedly the change of colour of the sea from light oceanic blue to a dirty brown, caused by ferruginous animalculæ.

The phosphorescence of the ocean, a magnificent and imposing spectacle, when the waves scintilate with bright green sparks, or exhibit a long line of fire, flashing in a thousand directions, is mainly caused by minute organic beings, which are phosphorescent while alive, a property retained by the gelatinous particles with which certain tracts of the deep are thickly charged,—their dead and dismembered relics. At the same time a disturbed electrical condition of the atmosphere may be most favourable to the phenomenon.

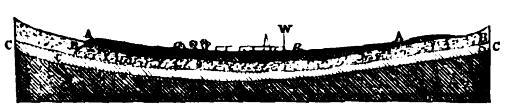
VII. Lake waters in mountain districts are frequently very transparent, and of the purest azure hue, like the lake of Geneva and the Great Bear Lake; others are intensely green, as the Lake of Zug, supposed by some to be the effect of vegetable dyes dissolved in the water; others are brown, of various shades, which may be caused by impregnation from peat mosses, or by iron oxide from the rocks; others are black, which may be the effect simply of the dark ground of their beds. River waters exhibit a similar diversity, even those that are most apart from earthy admixtures. The Ohio, Cassiquaire, and Orinoco are white; the Rio Negro, as the name implies, and the Essequibo, are black. The different hues of clear and comparatively shallow waters are perhaps generally referrable to the characters of their beds. They are observed to be light green over chalk and white sand, dark green over yellow sand, grey over mud, and brown or black over dark ground.

Cader Idris, Wales.

CHAPTER III.

SPRINGS.

I. The rains and melted snows are partly drained from the surface of high grounds into rills and streams, or returned again to the atmosphere by evaporation, or devoted to the purposes of animal and vegetable life. But a large portion is received into the soil by minute absorption, or percolates through cracks and fissures in the rocks, pursuing a downward course till arrested by clays and impermeable strata, where the water accumulates, and is forced by hydrostatic pressure to find its way again to the surface, occasioning the phenomena of natural springs. Artificial springs, called Artesian Wells, from the province of Artois in France, the ancient Artesium, where they have been long in use, are constructed upon the principle of the natural.



Artesian Well.

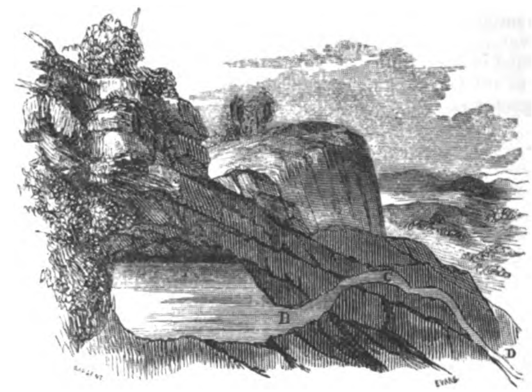
Suppose A A a bed of clay or mass of rock, impervious to water, the site of a town; B B a stratum of sand or sandstone, through which it readily passes, cropping out from beneath A A on each side; C C also an impervious stratum. Rain falling upon B B where it crops out, and absorbed by it, yet prevented from passing downward under the action of gravity by C C, will travel laterally through the pervious stratum and completely saturate it. In this condition, if the superincumbent rock A A is bored at W, the water of B B will rise through the vent to the surface, because the water-bearing stratum at both its prolongations is at a higher level than that of the point where the boring is made. The hydrostatic pressure is sometimes so great as to cause the water to rush up impetuously, forming jets 40 or 50 feet high.

Artesian wells may fail, either because no water-bearing stratum is reached, or because that stratum does not rise high enough above the place to bring the water to the surface.

II. Some springs are perennial or constant, discharging a great volume of water, and a few show no diminution in seasons of the longest drought. These are quite independent of the last showers that fall, though primarily derived from rain and melted snow, which originate bodies of water in subterranean reservoirs, so vast as not to be exhausted before they are replenished.

III. Other springs are intermittent, depending entirely upon the prevailing character of the season. They gush abundantly after heavy rains; flow feebly, and completely fail in continued dry weather. Valleys in the chalk downs of the south of England have numerous and copious springs during one part of the year and are dry in another.

IV. Reciprocating springs, or those which ebb and flow at short intervals, with somewhat of a character of periodicity, are rare; but to this class belong the Ebbing and Flowing Well of the Peak, and the far-famed Pool of Siloam.

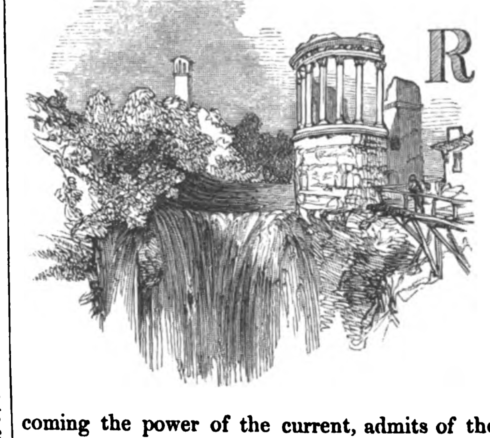


The explanation commonly received, though it does not account for all the phenomena, supposes an interior cavity as A, discharging itself by a syphon-formed channel, B C D. At a particular moment, when the water in the cavity is sufficiently high, it overflows the level of C, and runs out, the current ceasing till the supply has raised the water again to the vertex of the syphon-formed arch.

On some of the low islands in the West Indies, and on Keeling Island in the Indian Ocean, there are wells which regularly ebb and flow with the tide. The compressed sand, or porous coral rock, is permeated like a sponge with the salt water of the ocean. It does not mix with the fresh water in the wells derived from the surface rains, but forms a stratum beneath it,—the whole rising and falling with the tides.

CHAPTER IV.

RIVERS.



RIVERS have their origin in springs, a number of which commonly unite their waters to form a stream, so that it is difficult to single out the head fountain; or they flow from lakes; or have their source in the melting of glacial ice and snow. They are important auxiliaries to civilization, as means of communication between inland nations, and channels of commerce, rendered vastly more efficient in these respects since the discovery of steam navigation, which, overcoming the power of the current, admits of the most rapid floods being readily ascended. Rivers are either oceanic or continental.

Oceanic rivers are those which flow into the sea. 1. The Arctic Ocean receives several grand contributions, the Obi, Yenesei, and Lena from northern Asia, the Mackenzie from North America, rivers of the first class, but impaired in their utility by their lower courses being frozen up for long periods and their mouths being almost constantly encumbered with ice. 2. The Indian Ocean has principal rivers in the Ganges, Bramahpoutra, Irawady, Indus, and Euphrates. 3. The Pacific Ocean, considering the vast extent of its basin, has few river contributions. None of importance enter it on the American side, but the Columbia and Colorado, but eastern Asia discharges into it the great systems of the Amour, Yang-tse-Kiang, Hoang-Ho, Si-Kiang Meinam, and Camboja. 4. The Atlantic Ocean has the mightiest river-floods of the globe in direct or indirect communication with it; all the leading rivers of Europe except the Dwina; the Nile, Senegal, and Niger from Africa; the St. Lawrence, Mississippi, Orinoco, Amazons, and La Plata from America.

Continental rivers are those which never reach the ocean, but disembogue in lakes that are unconnected with it, or are absorbed and lost in sandy deserts. The Volga, Ural, and Kour terminate in the Caspian; the Sir, or Sihoun, the Amu, or Gihon (ancient Oxus), flow into Lake Aral; the Jordan enters the Dead Sea; and a great number of small streams in western and central Asia either end in lakes, or are lost in their own sands. This appears to be the case also in interior Africa, and many similar examples occur in America.

The Rio Grande, which rises on the table land of Mexico, is lost in Lake Parras after a course of 300 miles; and the Rio Desaguadero, which flows from Lake Titicaca on the Bolivian plateau, is lost in lakes and swamps after a course of about the same extent.

II. The hydrographical region of a principal river, or its basin, includes, besides the bed actually occupied by the water, the whole of the declivities from which its tributaries descend, or the entire country drained, which is defined by an imaginary line passing through the sources of its feeders. Each affluent, and each rill flowing into it, has a basin peculiar to itself, defined in the same manner, their united areas constituting the basin of the grand stream.

The greatest river-basins are in America; the least in Europe.

III. The country which divides one basin from another is called the water-parting, the drainage from thence being in different directions, of which the ridge of a house-roof affords a rough illustration. This is sometimes a lofty range of mountains, as the Alps, the water-flow from thence being through the Rhine to the German Ocean, through the Danube to the Black Sea, through the Rhone to the Gulf of Lyons, and through the Po to the Adriatic. But very commonly a water-parting has no great elevation, a slight convexity sufficing to separate one river-basin from another, and produce distinct systems of drainage.

In the east of Europe, the water-parting, commencing at a spur of the Carpathian Mountains and extending to the Waldai heights, a distance of 600 miles, is formed by very slight elevations on the great plain of Russia, separating the systems of the Vistula and Niemen, from those of the Dneister and Dnieper, which respectively flow to the Baltic and Black Seas.

IV. Where the water-partings are low, rivers are largely united in civilised countries by canals promoting navigation; or, as in Canada, barges are carried across the intervening country at points favourable for the transport; but there are examples of river-basins so running into each other as for water communication to subsist naturally between two primary streams. The most remarkable case of this kind, long deemed to be impossible by physical geographers, is the bifurcation of the Orinoco.

In the plain of Esmeralda, the Orinoco, there running west, sends off a branch to the south, the Cassiquiare, which joins the Rio Negro, one of the leading affluents of the Amazons, and thus connects the two primary rivers. The Cassiquiare is 100 yards wide where it leaves the Orinoco, and 550 where it falls into the Rio Negro after a course of 180 miles. Humboldt, in 1800, satisfactorily ascertained this fact, by passing along the natural canal from the one river to the other. There are other instances, but they are very rare. We give a translated copy of Humboldt's map of the Orinoco, exhibiting its bifurcation.

V. The course of rivers is in general very tortuous; an apparent disadvantage, as it increases the time necessary for their navigation, but hereby a larger area of country is furnished with the means of inter-communication, and that velocity of the current prevented which would render navigation altogether impracticable.

The amount of meandering in some principal rivers, including that of their tributaries, or the difference between the direct distance from sources to mouths, and that by the channels, is given approximately in the annexed Table:

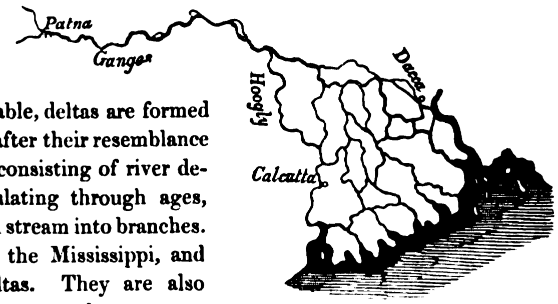
Rivers.	Meandering.
Rhine	240 geog. miles.
Elbe	340 „ „
Rhone	352 „ „
Dnieper	532 „ „
Don	552 „ „
Danube	616 „ „
Ganges	856 „ „
Indus	864 „ „
Euphrates	892 „ „
La Plata	892 „ „
Nile	920 „ „
Orinoco	984 „ „
Lena	1004 „ „
Obi	1044 „ „
Mackenzie	1156 „ „
Hoang-Ho	1160 „ „
Volga	1440 „ „
Amazons	1562 geog. miles.
Yenesei	1572 „ „
Mississippi—Missouri	2148 „ „

VI. The form of the channel, the slope of the bed, and the volume of water, are the elements upon which the velocity of rivers depend. If the banks offered no obstruction, and the molecules of water were not checked by friction with the sides and bottom of the bed, the accelerating force of gravity would convert gently flowing streams into irresistible torrents, perfectly impassable to the inhabitants of the opposite banks.

It has been calculated, in the circumstances supposed, that the Thames would flow at the rate of 50 miles an hour, while the Rhone would rush at the whirlwind speed of 164. The fall of the Thames is only 376 feet: that of the Rhone 900 from the point where the great body of its waters are received, but 4540 feet from its source. The entire fall of the Danube is 2850 feet: the Elbe 4000: the Rhine 7650: the Ganges 13,672 feet. The principal part of the fall of rivers occurs in the upper portions of their course where they are mountain torrents. Of any extensive river, the Volga has the least fall, 633 feet, from its source on a slope of the Waldai heights, at an elevation of 550 feet, to its entrance into the Caspian, which is 83 feet below the level of the ocean,—a direct distance of 900 miles, but 2400 miles including the meanderings.

When water has once received an impulse by following a descent, the simple pressure of the molecules upon each other is sufficient to keep it in motion long after its bed has lost all inclination, the pressure and the rate of motion being proportionate to its volume. The Amazons falls only 4 yards in the last 700 miles of its course, or $\frac{1}{4}$th of an inch in $1\frac{1}{4}$ miles; and for 400 miles from its estuary, the Plata has only a descent of $\frac{1}{33}$rd of an inch a mile.

VII. The alluvial soil transported by great streams is gradually deposited as the current slackens.



Where the coasts are flat, and the quantity of solid matter brought down considerable, deltas are formed at their mouths, called after their resemblance to the Greek letter Δ, consisting of river deposits, silently accumulating through ages, and cutting up the main stream into branches. The Ganges, the Nile, the Mississippi, and others, have large deltas. They are also formed in the same manner, but upon a smaller scale, at the junction of an affluent with its primary, and at the confluence of a river and lake.

The water of the Ganges, according to Rennell, yields about one part in four of sediment. He estimates the mean quantity of water discharged throughout the whole year at 80,000 cubic feet in a second, but when the river is in flood, the quantity is 405,000 cubic feet in a second. These data lead to the conclusion, that there daily passes down in the flood seasons, a mass of matter equal to 74 times the weight of the Great Pyramid of Egypt. The Hoang-Ho, which traverses the great alluvial plain of China, is supposed to bring down in one hour 2,000,000 cubic feet of earth.

Many rivers have no deltoid formations, owing to not traversing alluvial plains, or to lofty coasts lying around their confluence with the ocean, or strong lateral sea-currents bearing off the sediment to distant parts of its own bed. They empty themselves by a single channel, broad, deep, and unobstructed, in which large navies may ride. This circumstance gives importance to many rivers of inferior order, as the Tagus and the Thames.

VIII. Rivers are subject to changes of level, which are either irregular or periodical, according to the nature of the producing cause. The irregular alterations are the effect of casual heavy rains, which temporarily convert insignificant streams into vast floods—of which a remarkable example occurred in Scotland in 1829, in the case of the Nairn, Spey, and Findhorn; or they are occasioned by peculiar winds. A strong easterly wind causes a rise in the St. Lawrence, which is unaffected in its level by either rains or drought, while it causes a rise of 6 feet in the eastern waters of Lake Erie. In a similar manner, a strong westerly wind blowing from the Gulf of Finland acts as a dam to the waters of the Neva. On the 26th of November, 1838, the water failed so completely in the Clyde, Nith, and Teviot, that the mills were stopped eight hours along the lower parts of the streams, owing to the coincidence of a gale of wind and a strong frost, which congealed the water near their sources. A sheet of water ten miles broad, and generally only three feet deep, has, by a strong wind, become six feet deep on one side, while the windward side was laid dry. The periodical changes in the level of rivers are diurnal, semi-annual, and annual.

Rivers which fall into tidal seas have the level of their lower course daily varied by the tidal wave for some distance, depending upon the strength of the tide, the breadth and shape of the river-channels, and the force of their currents. The wider and more direct the bed of a stream the further the tide will penetrate, other circumstances being equal, while a narrow sinuous course offers obstructions to its progress. The tide is perceptible about 70 miles in the Thames, 576 in the Amazons, and 255 in the Orinoco. The upper course of streams which immediately descend from snow mountains exhibits diurnal variation, the heat of the sun producing high water every day by melting the snow, the increase being the greatest in the hottest days.

Semi-annual and annual variations distinguish the rivers of tropical regions, and of countries bordering on the tropics. They are the effect of regular seasonal changes, which occur at exactly opposite periods, north and south of the equator.

The Tigris rises semi-annually, first and most remarkably in April, owing to the melting of the snow on the Armenian Mountains: secondly, in November, from periodic rains. The Mississippi rises twice in the year, first, about January, in the lower part of its course from periodic rains; but the grand flood, which affects the entire stream, commencing in March and continuing till June, is caused by the melting of the snow in the high latitudes in which its sources lie.

The most remarkable river-inundations are annual, and are the effect of seasonal rains. The flood of the Orinoco is at its greatest height in August, extending 600 miles in length, and from 60 to 90 in width, covering the savannahs to the depth of 12 or 14 feet. Those of the Ganges, Niger, and Gambia, attain their full elevation about the same period. On the contrary, the Amazons, south of the equator, begins to rise in December, is at its greatest height in March, and its least in July and August.

IX. A slope of 1 foot in 200 in the bed of a river renders it unnavigable; a greater inclination produces a rapid; and one still greater, approaching the perpendicular, a cataract. Rapids occur in most principal rivers, the navigation being carried on by the transport of barges along the banks, or by artificial canals, but in some instances they are surmounted by the aid of the tide. The rapid of Richelieu, in the St. Lawrence, between Quebec and Montreal, appears and disappears with the ebb and flow of the tide, the water rising fifteen or eighteen feet temporarily removes the obstruction. Cataracts exhibit either the singular perpendicular descent of a mass of water, or a series of descents, according as the change from a higher to a lower level is effected at once, or by several precipices. They depend for their sublimity upon the height of the Falls, but mainly upon the magnitude of the volume of water.

The Falls of Niagara, one of the grandest natural spectacles on the globe, occur in the river Niagara, which connects Lake Erie with Lake Ontario, and divides Upper Canada from the State of New York. The river, about three-quarters of a mile wide, first descends over a rugged limestone bed about 50 feet in less than a mile, forming rapids, and is then thrown down perpendicularly, Goat Island, near the centre of the stream, dividing the Falls. The largest of these, on the Canadian side, called the Horse-shoe Fall, from its shape, is 1800 feet broad, more than the third of a mile, and 153 feet in height. The other, on the American side, is 600 feet in breadth, and 164 feet in height. A cloud of mist points out the locality of the cataract at a distance, and under favourable circumstances its roar may be heard for 40 miles. Below the Falls, the river flows in a deep narrow chasm, between almost perpendicular banks, from 250 to 300 feet high, emerging at Queenstown, at the distance of seven miles, into an open and flat country, nearly on a level with Lake Ontario. It has long been supposed, that the Falls were first situated at the present opening of the gorge, to which the Niagara flowed in a shallow channel from Lake Erie, and that the river has been slowly eating its way backwards through the rocks for a distance of seven miles. It is known that the Falls have retrograded during the period of modern observation, at a slow rate, the consequence of disintegration. Many rivers have higher falls, but the volume of water is far less.

This erosive action of running water is strikingly exhibited by several rivers which penetrate through rocks and beds of compact strata. The formation of the magnificent rock-bridge which overhangs the course of the Cedar Creek, one of the natural

Natural Bridge, Virginia.

wonders of Virginia, is due in part to the solvent and abrading power of the stream. It is 213 feet above the river, 60 feet wide, 90 long, and the thickness of the mass at the summit of the arch is 40 feet.

PRINCIPAL WATERFALLS AND RAPIDS.

EUROPE.

Staubach, near Lauterbrunnen in Switzerland, a perpendicular descent of 800 feet.

Reichenbach, canton of Berne, a series of six falls, one of which is 250 feet, the whole forming a descent of 1000 or 1200 feet.

Rheinfall, canton of Schaffhausen, where, after a succession of rapids, the Rhine bursts in three distinct branches over a precipice upwards of 80 feet high.

Saut de Doubs, canton of Neuchatel, a fall of the Doubs of 80 feet.

Ache, a small river of Bavaria, descends, in five great falls, 2000 feet. The current of air produced by the descent is so violent that it can hardly be withstood.

Terni, Italy, a fall of the Velino of 300 feet, usually regarded as the finest European cataract.

Trollhatten, Sweden, on the river Gotha, which rushes down a deep gorge, a height of 190 feet.

Clyde, near Lanark, in Scotland, a series of falls extending over four miles, amounting to 230 feet.

Grey Mare's Tail, in the county of Dumfries, a discharge of the waters of Loch Skene, which fall 350 feet.

Upper and Lower Falls of Foyers, near Loch Ness, the Upper consisting of three descents, amounting to about 300 feet: the Lower a single leap of 212 feet.

Rapids of the Danube, three between Drencova in Hungary and Scala Kladova in Servia, the principal and last or lowest of which is the celebrated Iron Gate, formed by a ledge of rocks running across the bed of the river, over which it rushes with immense force, producing below dangerous eddies and whirlpools.

Rapids of the Dnieper, extend for 150 miles from Krementchchug to Alexandrofsky, where there is no navigation.

Rapids of the Shannon, above Limerick, obstruct its navigation completely, which is carried on by means of lateral cuts. The river issuing from Lough Allen has a descent of 161 feet; but of this fall 97 feet lie between Killaloe and Limerick, a distance of 19½ miles.

ASIA.

Falls in Bundelcund, a part of Central India:—1. at Bilohi, of 398 feet; 2. at Bouti, of 400 feet; 3. at Keuti, 272 feet; 4. at Chacai, 362 feet; and 5. on the Tonse river, 200 feet.

Falls of Girsupah, near a town of that name in the Western Ghauts, where a considerable stream has a tremendous fall of 872 feet.

Falls of the Cauvery, the principal river of Southern India, two cataracts, not far from Seringapatam, of extraordinary grandeur, 350 and 460 feet high.

Rapids of the Kizilozan, in Persia, formed by the famous pass of Rûdbar, a deep gorge 30 miles long, through which the river rushes with incredible velocity.

AFRICA.

The Tecazze, an affluent of the Nile from the high mountains of Lasta, receives its name, signifying "the terrible," from its numerous cataracts, from 100 to 150 feet high.

The cataracts of the Nile are more properly rapids, nine or ten in number, consisting of successive sloping descents, with perpendicular falls of water, seldom more than a foot high.

King George's Cataract, on the Orange River in South Africa, discovered by Mr. Thomson in 1824, a fall of 400 feet.

AMERICA.

The Falls of Niagara, already described, have been estimated to roll down 18,524,000 cubic feet of water per minute.

Potomac, in Maryland; the Little Falls are rapids; the Great Falls descend 76 feet in about a mile and a half, and have in one place a perpendicular plunge of 15 feet.

Passaic, a river in New Jersey, falls 70 feet into a chasm.

Montmorenci, a river in Lower Canada, near Quebec, descends 240 feet in an unbroken sheet.

Falls of St. Anthony, on the Mississippi proper, 700 miles from its source, a descent of 17 feet.

Falls of the Missouri, 500 miles from its source, a succession of rapids and cataracts, 26, 47, and 87 feet in perpendicular height; the great river descending 360 feet in 17 miles, forming a scene only inferior to Niagara.

Rapids of the St. Lawrence, above Montreal,—the Coteau du Lac, the Cedars, the Split Rock, and the Cascades, extending about 9 miles

Cataract of Tequendama, in the environs of Santa Fe de Bogota, a magnificent fall of the river by which the plateau is drained, of 574 feet.

X. Rivers depend for their magnitude upon various elements, the length of their course, the extent of their basins, the rain-producing character of the climate, and connection with mountains covered with eternal snow. The Mississippi, following the Missouri branch, which ought to be the name of the united streams, has the longest course of any river on the globe; but the Amazons stands at the head of rivers, draining by far the largest area of country, and rolling the greatest volume of water to the ocean. The length of the principal rivers, with the area of their basins, is given on the Hydrographical Map. The following Table exhibits a proportionate view of these elements, to be considered as approximations merely:

	Proportional Length.	Proportional size of Basin.	Proportional quantity of water discharged per annum.
Thames	1	1	1
Rhine	4½	12½	13
Loire	4	2½	10
Po	2¼	5	6
Elbe	4⅓	9	8
Vistula	4¼	13½	12
Danube	9¾	56	65
Dnieper	7¾	36	36
Don	7½	37	38
Volga	14	94	80
Euphrates	9¾	42	60
Indus	11½	72½	133
Ganges	10	76	148
Yang-tse-Kiang	21½	138	258
Amour	16	164	166
Lena	13½	174	125
Obi	15	236	179
Nile	18½	90	250
St. Lawrence	22½	109	112
Mississippi—Missouri	23	249	338
La Plata	13¼	225	490
Amazons	22¾	395	1280

XI. Some peculiarities of rivers remain to be noticed. The effect of the junction of two great streams is not always an expansion of the surface, but sometimes a contraction, the depth of the channel being increased, and the velocity of the current. The Mississippi is upwards of a mile, and the Missouri half-a-mile wide at their confluence, but from thence to the mouth of the Ohio the medium width of the united waters is only three-quarters of a mile. The Nile is remarkable for not receiving a single brook between its junction with the Tecazze and the Mediterranean, a distance of 1500 miles; a fact without parallel anywhere else. Some rivers temporarily disappear in swamps and underground channels, having in the latter case in many instances scooped their way through obstructing rocks. The Rhone, soon after coming within the French frontier, has a subterranean course for about a quarter of a mile; the Guadiana is lost for about 7 leagues in sandy and marshy grounds, emerging at the Ojos (eyes) de Guadiana. Powerful streams meeting with strong oceanic currents and tides frequently occasion a violent disturbance of the waters, as the effect of the collision and strife for the mastery. When the tide ebbs in the Amazons, the river pours forth its liberated flood with increased force and velocity, and meeting nearly at right-angles with the sea-current from Cape St. Roque, an enormous wave is created, the *pororoca* of the Indians, from the agitations of which fishermen and navigators fly in dismay. A similar phenomenon occurs at the embouchere of the Garonne, and forms the terrific *Bore* of the Hooghly, off the mouth of the Ganges.

Valley of Chamouni after a Flood.

CHAPTER V.

LAKES.

THE inland waters which pass under the denomination of lakes are most numerous, as well as upon the largest scale, in the higher latitudes, and have a marked northerly distribution in particular localities, as those of the Alps and Pyrenees are chiefly on the Swiss and French side of the mountains. Some expanses, lifeless and in general small, occupy the highest mountain passes; larger sheets are found on lower table-lands; but the most extensive are on the great lowlands of the globe. The elevation of some principal lakes is shown on the Hydrographical Map. A space of nearly 17,000 feet extends between the highest, the Sir-i-Kol, and the lowest, the Dead Sea. Four great systems are traceable: two in the old world, and two in the new,—the latter the grandest of all.

1. A system of lakes commencing in Great Britain extends through Norway and Sweden, along the south coast of the Baltic, through Finland, North Russia, North Siberia, to Behring's Strait. The areas of the most important are, Saimas, in Finland, 1602 square miles; Wener, in Sweden, 2136; Onega, 3280; and Ladoga, 6330, both in North Russia.

2. A second system extends principally north of the mountain spine of the old world, and includes the lakes of the Pyrenees, Alps, Apennines, Bavaria and Austrian Empire, Western and Central Asia. The Caspian Sea, the largest lake on the globe, belongs to this band, and has an area of 160,000 square miles, nearly equal to the kingdom of Spain; the second in point of extent, Lake Aral, has an area computed at 21,000; the third, the crescent-shaped Lake Baikal, surrounded by lofty granite mountains, is 1793 feet above the sea, about 1200 miles in circumference, with an area estimated at 12,800 square miles.

3. A third system comprises the great Canadian masses of fresh water, with their dependencies, which are continuous, connected by rivers: Lake Superior, area 43,000 square miles, nearly equal to the extent of England; Huron, 25,000; Michigan, 25,000; Erie, 11,000; and Ontario, 10,000. The different level of these lakes marks the descent of the country, and the inclination of the uniting rivers. The surface of Lake Superior is 627 feet above the level of the sea; Lakes Huron and Michigan, 595 feet; Lake Erie, 565 feet; and Lake Ontario, 231 feet.

4. A fourth system, north-west of the former, extends from the Lake of the Woods to the icy shores of the Arctic Ocean, including Lake Winnipeg, area 9000 square miles; Athabasca, 3000; Great Slave Lake, 12,000; and Great Bear Lake, 8000.

Independent of these systems, there are a vast number of lakes in Northern, Central, and Southern America; some of very considerable extent occur in Africa; others in China, as the celebrated *Mer des Etoiles*, (the *Sea of Stars*,)—the mysterious sources of the Hoang-ho.

II. The water of lakes is derived either from rivers or subaqueous springs. They are for the most part affected by seasonal changes, in some instances spreading out in extensive inundations, followed by a corresponding reduction of surface. The lake of Cirknitz, alternates from being full to absolute dryness, from which a connection, through crevices in its bed, may be inferred with a subterranean body of water, whose increase and diminution from rain and drought causes its intermissions. The greatest depths of the following lakes are:

	Feet.
Lough Neagh, Ireland, largest lake in the United Kingdom	102
Killarney, Lower Lake, ditto	252
Lomond, Scotland, average depth 120 feet	720
Ness, ditto	810
Constance, Switzerland, near the south-east extremity	2334
Geneva, ditto, medium depth, 560 feet; greatest depth, at Meillerie	1000
Neuchatel, ditto, level varies greatly	426
Lucerne, ditto	600
Zurich, ditto	600
Maggiore, Italy, 800 metres	2625
Como, ditto, 588 metres	1698
Iseo, ditto, between Bergamo and Brescia	984
Garda, ditto, Lombardy	951
Nemi, ditto, south of Albano	2700
Wener, Sweden, average depth 120 feet	288
Wetter, ditto	440
Hielmar, ditto	66
Caspian Sea contains extensive shallows, but at one place near the middle no bottom has been found at the depth of	2800
Superior, depth varies from 500 to 900 feet, and amounts in some places to	1200
Huron	1800
Michigan	900
Erie, depth seldom exceeds 100 feet, though reaching in a few places to	270
Ontario, general depth varies from 15 to 500 feet, but in the middle it exceeds	1800
Titicaca	720

It affords a striking instance of deep indentation in the solid matter of the globe, that while the surface of the Caspian is 83·4 feet below that of the Black Sea, its bed at one place descends upwards of 2800 feet below that level, or has a total depression of more than 2883 feet below the level of the sea. It appears also that while the surface of Lake Superior is 627 feet above that of the Atlantic, its bed descends 573 feet below it; while Lake Ontario, with a surface elevation of 231 feet above that of the sea, descends in its bed upwards of 1569 feet below its level.

III. A fourfold classification may be made of lakes, founded upon their physical differences. 1. Some have no apparent affluents or outlets. They commonly occupy hollows, extinct volcanic craters, and depend upon subaqueous springs to supply the waste occasioned by evaporation. 2. Others have outlets, but no apparent affluents, deriving their supplies from subterranean sources. 3. A third class have both affluents and outlets, the common arrangement. They are either formed by a number of streams flowing into a central basin, the superabundant waters escaping by a principal outlet, or they occur in the channel of a river, the waters of which enter and escape at opposite extremities. 4. A fourth class receive affluents, but have no outlets. Lakes of this class are rare, but the great inland salt waters of the Caspian, Lake Aral, and the Dead Sea, belong to it, supposed by some; in common with similar saline waters, to be the remains of the universal ocean which once covered the earth.

Though the Caspian has no outlet, while receiving the majestic volume of the Volga through its seventy mouths, the largest river of Europe, with the Ural and other great streams, an immense evaporation not only keeps its level in check, but appears to exceed the supply. Its waters are however thought to be subject to anomalous variations, increasing and decreasing in volume through periods of about thirty years. Lake Aral is diminishing rapidly. The Kirghisians pointed Baron Meyerdoff to inland places in their memory covered with its waters. Most of the lakes of western Asia appear to be decreasing in magnitude, losing more water by evaporation than what is supplied by tributaries, and at the same time becoming more salt.

IV. Some lakes exhibit the phenomena of floating islands, anomalous undulations, and other striking peculiarities.

1. Floating islands have been formed by the gradual accumulation of vegetable matter, of reeds, marsh plants, and trees from the undermined banks, matted together, with accretions of sand and gravel deposited by the water. There are several examples, clothed with living vegetation, even with forest trees, and cattle have been pastured on them. Similar formations are common in the North American rivers from accumulations of drift-wood. The "Great Red River Raft" obstructed completely the navigation of that noble stream for no less a space than 165 miles, till the impediment was removed at a great expense by the United States government in 1838. The dimensions of a raft of the same kind in the Mississippi are given at 10 miles long, 220 yards broad, and 8 feet thick, supposed to have been formed in about 40 years, presenting all the appearances of solid land, having green bushes and beautiful flowers.

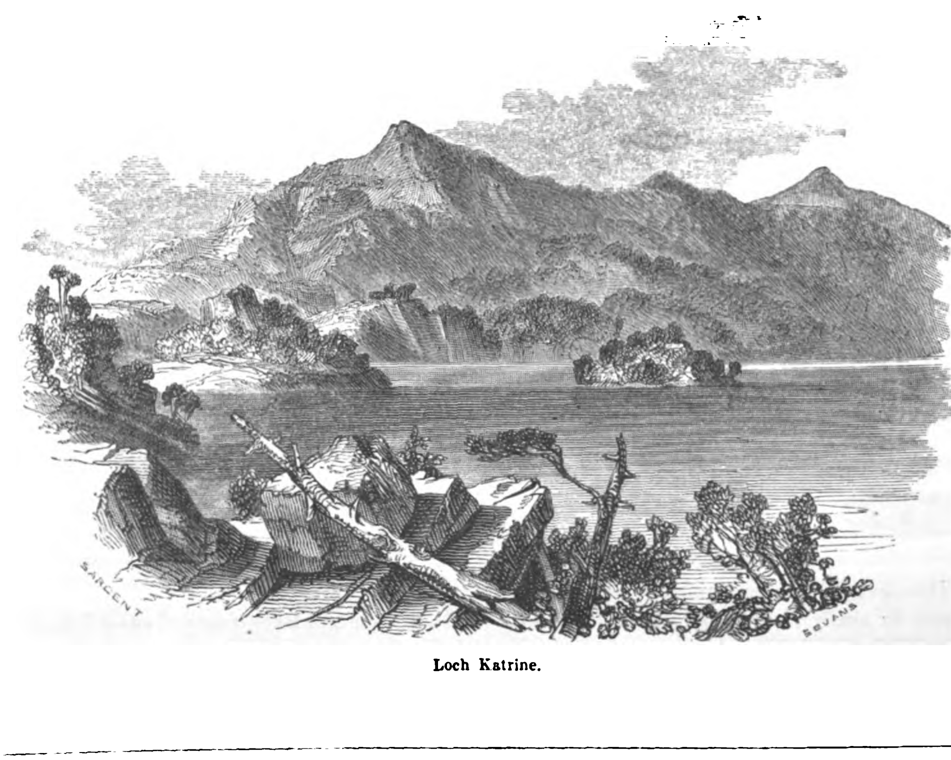
2. The Lake of Zurich is distinguished annually by the appearance of a very minute vegetation upon its surface, exhibiting what is called the flowering of the waters.

3. The *Seiches* of the Lake of Geneva, observed also in other places, consists of a sudden rise in the form of a tidal wave, sometimes amounting to five or six feet in a few hours, apparently due to a local and transient change of atmospheric pressure. The *Vaudaise* of the same lake, an agitation of the water, sometimes violent, appears to be due to the escape of subaqueous currents of air. A lake near Boleslau, in Bohemia, of unknown depth, in winter, is so disturbed by subaqueous winds, that masses of ice are said to be actually thrown up to some height from its surface. The beautifully clear Lake Wetter, in Sweden, is subject to agitation from the same cause.

4. The attractive power of the mud at the bottom of some of the North American lakes has been noticed by Sir Alexander Mackenzie, Captain Back, and others. It is only observed in shallows, and is sometimes so great that boats can scarcely be urged on at all.

5. One of the bays of Lake Huron, seems to be the focus of peculiar electrical phenomena, for whenever traversed, peals of thunder are said to be heard.

6. Lake Baikal—the holy sea of the Tunguses and Yakutes, the largest body of fresh water in the old world, and the largest of all elevated lakes; exhibits the most striking peculiarities. In the most perfect calm, its surface is seldom without an undulation, which increases previous to a wind arising, the undulation proceeding from the quarter of the wind. Frequently shocks from internal commotions are experienced on board of vessels, so violent, as to make it difficult to stand in them. The lake lies in the focus of earthquakes, or near it, which are very common, and to the operation of that force its phenomena are no doubt due.



Loch Katrine.

CHAPTER VI.

THE OCEAN.

THE oceanic waters which continuously environ the continental and island masses are artificially distributed into great sections, forming the Arctic, Atlantic, Indian, Pacific, and Antarctic basins.

1. The Arctic basin, surrounding the North Pole, is bounded by the northern shores of America, Europe, and Asia, and in the spaces between the two continents, the astronomical line of the arctic circle is usually considered as its limits. But satisfactory reasons are assigned on the Hydrographical Map for shifting this limit, in the case both of the Arctic and Antarctic Oceans, from lat. 66½°, that of the polar circles to lat. 60°. The latter parallel, in the northern hemisphere, runs south of Behring's Strait, cuts the Shetland Isles, and the southern extremity of Greenland.

Principal Branches,—Gulf of Boothia, Hudson's Bay, Baffin's Bay, the White Sea, Sea of Kara, Gulf of Obi, Behring's Strait.

2. The Atlantic basin lies between America on the west, Europe and Africa on the east, and the parallels of latitude, 60° north and south. The equator divides it into the North and South Atlantic.

Principal Branches.—The Baltic, the German Ocean, the Mediterranean, Gulf of Mexico, the Caribbean Sea, Gulf of Guinea.

3. The Indian basin has for its boundaries, Africa on the west, Persia and Hindostan on the north, the Sunda Isles and New Holland on the east, and the Antarctic Ocean on the south.

Principal Branches.—The Red Sea, the Persian Gulf, the Bay of Bengal.

4. The Pacific basin is enclosed between America on the east, Asia, the Sunda Isles, and New Holland on the west, and the Antarctic Ocean on the south. The equator divides it into the North and South Pacific.

Principal Branches.—Sea of China, Yellow Sea, Sea of Japan, Sea of Okhotsk, Gulf of California, Gulf of Panama.

5. The Antarctic Ocean is confined between the south pole and the latitude of 60°.

II. The Arctic Ocean is closed to navigation in its higher latitudes by eternal frost. The summer and winter limits of the frozen zone are shown on the map, which of course descend more southerly in the latter than in the former season; but as the Arctic winters vary in severity, like those of temperate climates, though not so extensively, the area of the ice formed varies correspondingly. Hence some navigators have found an open ocean, where to others it has presented an impassable icy barrier at the same period in a different year, and have been unable to penetrate to the high latitudes reached by the former. In summer, when the whalers pursue their perilous occupation at a high latitude in the northern seas, the waters, though open, are by no means clear, but exhibit immense icy masses floating to and fro, fraught with peril to the voyager, which are drifted by the winds and currents far from the sites of their origin, some perishing by collision, and others reaching the heart of the Atlantic, where they are dissolved in its warmer waters.

These floating masses are of two kinds, sheet ice and bergs, which have quite an independent origin.

1. Sheet ice resembles that of lakes and rivers, presenting a generally level surface, but here and there diversified by projections, called *hummocks*, the ice having been thrown up by lateral pressure, upon two masses coming into collision. Sheets of ice, the whole extent of which cannot be seen from the masthead of a vessel, are called *ice-fields*, and have sometimes an area of more than 100 square miles, rising from 2 to 8 feet out of the water. Smaller sheets are called *floes*. Fields and floes when much broken up, the fragments crowding together, form what is termed a *pack*, which when much elongated, is called a *stream*. When the parts of a pack are loose and open, so that a vessel may sail between them, it is called *drift-ice*; and *brash-ice* when the fragments have been much ground down by abrasion. The *ice-blink* is a stratum of lucid whiteness on the verge of the horizon, indicating its presence in the direction of the appearance. These shoals of saline ice are the work of the arctic winter's cold, which freezes the superficial waters of the ocean to an extent and depth proportional to its intensity and continuance. Upon the return of a milder temperature the ice formed is gradually broken up, the ocean is unbound, enormous fields of its solid covering are set afloat, soon to be reduced and dissipated by thawing, by concussion with each other, and by the ordinary swell of the sea, which acts with tremendous power upon a large tract. But in some cold seasons the floating ice is overtaken before dissolution by the frost of an early winter, and preserved to the following summer.

2. Icebergs, altogether different in shape from ice-fields, towering like cliffs to a considerable height, are quite distinct in origin, being fresh-water formations from the arctic lands, identical with the glaciers of the Alps. They have their principal birthplace on the coasts of Spitzbergen and the eastern shores of Greenland. The latter site presents to the play of the waves a breastwork of ice upwards of 600 miles in length, formed by the congelation of the fresh water produced in summer by the melting of the snow. The annually renewed congealed masses, projecting into the sea, yield to its undermining and wrenching power, by which immense blocks are broken off, constituting icebergs. The process has often been witnessed by the Danish residents, by whom it is familiarly termed the *calving* of the glacier. Mr. Darwin observed it likewise along the coast of Terra del Fuego. Icebergs are found of various dimensions, from a few yards to miles in circumference, rising hundreds of feet out of the water, having the appearance of glittering chalk cliffs, their fractures showing an emerald green hue; azure blue pools lying on their surface, or falling in cascades into the sea.

Data are as yet much wanting respecting the extent of the permanent polar ice. Only the general limit of the winter ice is pretty well ascertained in the northern hemisphere. It occupies the northern coasts of America, encloses Hudson's Bay, Baffin's Bay, and part of Davis's Strait, extends along the shores of Labrador, Newfoundland and Greenland, to Spitzbergen, but excludes Iceland and the Small Bear Island, south of Spitzbergen. The latter has been accessible to vessels in the severest winters. It embraces all the northern coasts of Asia, but in the eastern portion it has been observed to terminate north of the islands of Kotelnoi and New Siberia, and from thence at a less distance from the continent further east. This part of the Arctic Ocean has been called in consequence Polynja, or "open water." In summer the compact ice breaks up as far as the northern shores of Nova Zembla, Spitzbergen, and Baffin's Bay.

Icebergs.

III. The Atlantic Ocean rolls in the deep longitudinal valley between the eastern shores of America and the western coasts of Europe and Africa, which exhibit corresponding projecting and retiring angles, a disposition to interlock. The valley, comparatively narrow towards the equator, expands from thence north and south. This portion of the great deep is the best known of any, as the highway of the world's commerce, perpetually traversed by hosts of merchant vessels, in which millions of property and thousands of lives are embarked. Its tropical districts exhibit several remarkable phenomena—the phosphorescence of the sea—the flying-fish chased by the dolphin—successive regions of steady breezes and calms, the latter interrupted by short and sudden squalls, and enormous deluges of rain towards the equator generally descending in a perfectly still state of the atmosphere. The region of steady breezes, where the waves are low and the swell is gentle, the Spaniards called *il golfo de las damas*, from the easy navigation, supposing that even women might venture to conduct the navigation from the Canaries to America. The South Atlantic has no peculiarities which require notice, but several belong to the northern portion.

1. The North Atlantic is remarkable for the number and extent of its indentations of the continents, some of which form mediterranean or close seas, as the sea of that name, which alone affords a navigation of 3000 geographical miles, and the Baltic.

2. A very large portion of the surface of the North Atlantic is occupied by sea-weed, (*fucus natans*,) closely matted together, forming the "Grassy Sea" of the English, the Kroos Zee of the Dutch—"sea of duck-weed," and the Mar de Sargasso of the Portuguese and Spanish—"the sea of lentils." A well-defined region of the weed extends along the meridian of 40° W. and between the latitudes 20° and 45° N., bearing the name of the "Fucus Bank of Corvo and Flores," from the two most western islands of the Azores, which are situated not far from it. It occurs also from thence in varying quantities to the Bahamas, the area occupied amounting to 1,000,000 geographical square miles and upwards, almost six times the extent of Germany. Much of this sea-weed may be brought down by the gulf stream from the Gulf of Mexico; but the quantity is so great that Humboldt reasonably infers the existence of an immense sand-bank in the Atlantic on which it grows.

3. Drift-ice annually makes its appearance in the North Atlantic, much nearer to America than to Europe, borne by a current from the Arctic seas. It descends more southerly before being dissolved, as might be expected, in the spring months, March and April, than in the summer months, May and June. Icebergs travel south in the Atlantic to 40¾° of latitude, but are confined to the space between 42° and 50° of west longitude; ice-fields of any extent seldom pass southward of 45° of latitude. Deviations from these limits occur, but they are very rare. In 1817, when many thousand square miles of ice, which from time immemorial had been permanent on the north of Iceland, suddenly broke up from some unknown cause, drifts occurred in 32° of longitude, but about 800 miles west of Ireland. Again, in 1841 the "*Great Western*" steamer encountered an extensive ice-field between 42° and 43° of latitude, and proceeded along its southern edge from east to west for more than a hundred miles. This was the year in which the ill-fated steamer the "*President*" was lost, most likely by being surrounded and crushed by the floating ice which came out in peculiar force at that period from the northern regions.

IV. The Indian Ocean has no distinct character independent of phenomena which belong to the department of meteorology, its hurricanes and monsoons. The Pacific, properly styled the Great Ocean, is chiefly remarkable for its vastness, and the number of its islands. On the American side, it corresponds to the South Atlantic in rarely running into the land: on the Asiatic side, it corresponds to the North Atlantic, in largely indenting the coasts. The seas of China, Japan, and Okhotsk, enclosed with islands, are the analogues of the Caribbean Sea and Mexican Gulf, shut in by the West Indian groups. The Antarctic Ocean presents similar features to the Arctic, but is more completely an icy sea, and the drift ice appears to travel farther from the south, than from the corresponding pole. Even near the Cape of Good Hope and the mouth of the Plata River, icebergs have been encountered, at about latitude 36°.

Packed ice occurs in immense quantities in the Antarctic Ocean, but great differences subsist respecting its *locale* in different seasons. The discovery ships under Sir James Ross passed through a belt upwards of 800 miles broad, where Cook, under the same meridian and in the same latitude, had no occasion to enter the pack at all. The southern icebergs have not the diversity of form of the northern, being commonly tabular masses. Ross met with the same berg on two succeeding years, 150 feet high and 4 miles in diameter, which appeared from its change of place to have drifted at the average rate of about a mile per day. He reached the latitude of 78° 10′, the highest ever attained in the southern hemisphere; Parry in the northern, by travelling over the ice, penetrated to 82° 40′.

V. Some variations of level are observed between different sections of the universal ocean. This is the effect of local winds and currents, and chiefly occurs in landlocked seas.

The surface of the Red Sea at the Isthmus of Suez is from 24 to 36 feet above that of the Mediterranean. This is caused by the peculiar form of the canal connecting the Red Sea with the Indian Ocean, the Straits of Babelmandel, through which the oceanic waters find readier access than outlet.

The effect of the equatorial current which sweeps across the Atlantic from the Gulf of Guinea to the Gulf of Mexico, where its farther progress westward is arrested, is to pile up the waters in the latter to a height estimated at upwards of 200 feet above the level of the ocean near the Cape de Verde Islands.

There is no considerable difference, as formerly supposed, between the level of the Pacific at the Isthmus of Panama, and that of the Atlantic on the opposite side.

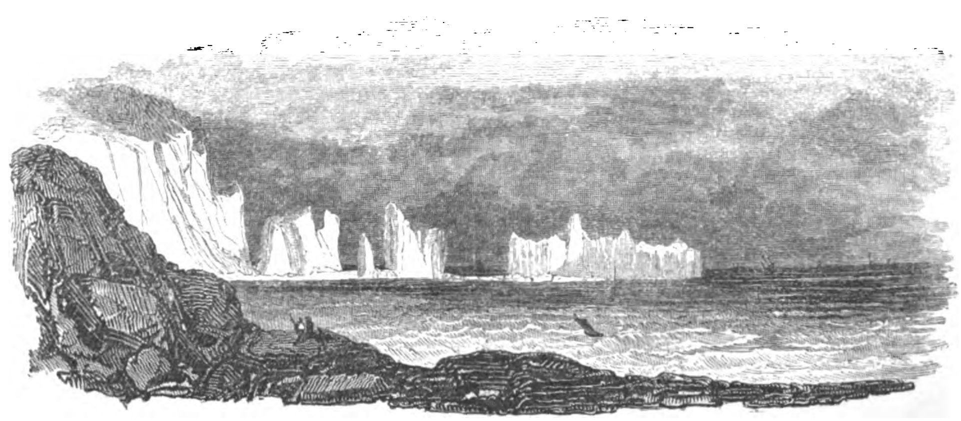
VI. The bed of the oceanic waters exhibits similar inequalities to those which mark the surface of the dry land—abrupt eminences, gentle slopes, and deep depressions; and hence the various depths of the fluid, now beyond the reach of the sounding-line, or a thin stratum scarcely concealing the sand-bank from the eye of the navigator. Off a low, level, and sandy shore, the sea is in general shallow for a considerable distance, and very deep close to a bold towering coast. But near to islands of coralline formation, which are so little elevated as not to be visible at any great distance, the Pacific Ocean frequently shows profound depths. Within a mile and a half of Keeling Island, Captain Fitzroy found no bottom with a line of 7200 feet, plainly proving it to be the crest of a lofty submarine mountain, with sides steeper than those of the most abrupt volcanic cones.

The south part of the German Ocean is very shallow, sandbanks encumbering its bed; but towards the north the depth increases to from 300 to 540 feet between Kinnaird's Head, Scotland, and the Naze of Norway.

The Mediterranean, on the contrary, has generally a great depth, being 1800 feet deep between Italy and Greece, 2700 in the Gulf of Nauplia, 3000 between Sardinia and Sicily, 4800 north-west of Sardinia, and 5880 between Spain and Africa.

The Atlantic shows a depth of 600 feet on the north of Ireland, and 1662 feet on the south-west. It does not perhaps exceed 3000 feet anywhere in the tract between Europe and the United States. In the channel of Yucatan the soundings reach to 6000 feet. The greatest depths are in the South Atlantic. About midway between the Cape of Good Hope and Rio Janeiro, Sir James Ross found the depth 14,550 feet; a depression of the bed of the ocean very little short of the elevation of Mont Blanc above it. About 450 miles west of the Cape of Good Hope he found the depth 16,020 feet; but on June 3, 1843, the water being calm and smooth, a line of 27,600 feet did not reach the bottom. This is the greatest depth of the ocean that has yet been satisfactorily ascertained. The spot was in 15° 3′ S. lat. and 23° 14′ W. lon., about 486 miles from the small island of Trinidad, and 1180 from Cape Frio, the nearest point of South America.

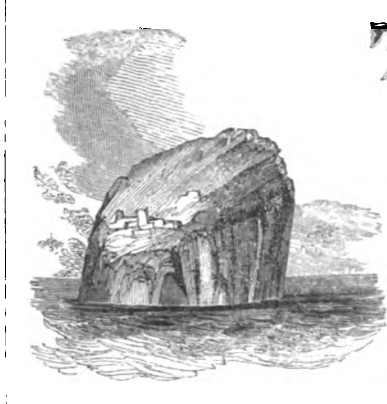
VII. The pressure exerted by the ocean, increasing with the depth, must be enormous in its more profound abysses. Even at the depth of 120 feet, the same amount of sea-water will be reduced in bulk by compression from 20 to 19 solid inches. In the Arctic Seas, where the specific gravity of oceanic water is at its minimum, its pressure on a square inch of surface is estimated to be 2809lbs. at the depth of 7600 feet. A sensible proof of the pressure at a great depth was afforded to Captain Scoresby. A piece of wood that got entangled, and was dragged down by a whale, was found when drawn up so saturated with water forced into its pores, that it sank like a stone for a year afterwards instead of floating.



Alum Bay, Isle of Wight.

CHAPTER VII.

OCEANIC MOVEMENTS.



THE ocean is subject to the three general movements of waves, tides, and currents, the causes of which are independent. The wave movement is of an inconstant and transitory character, occasioned by winds; that of the tides is regular and periodical, the result of the attractive influence of the moon, modified by that of the sun; while the currents are the effect of various circumstances, and permanently flowing, resemble great rivers in the sea.

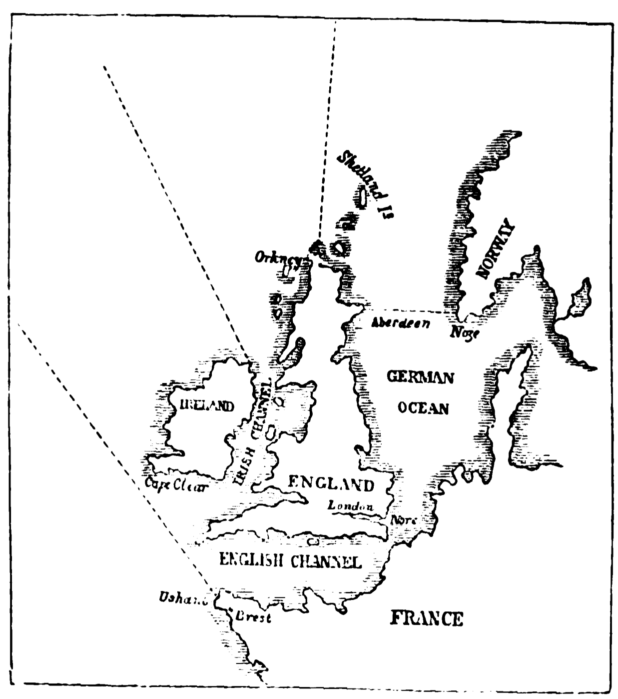
II. Waves arise from the action of the atmosphere, the lower stratum of which is in contact with the surface of the ocean, and when agitated by winds, disturbs the equilibrium of the water, in proportion to the intensity and duration of the force exerted. The progressive motion of the undulations produced appears like an onward flow of the water, but a bird resting on the sea, or a boat adrift upon its surface, is not carried forward by the waves. There is merely a rise and fall with them, except in the case of a strong continuous wind, which occasions a superficial current. At a comparatively small depth, the ocean is tranquil, when furious tempests are agitating its surface.

1. By experiments in 1836, it was found, that in water 12 feet deep, waves 9 inches high and 4 or 5 feet long, did not sensibly affect the water at the bottom. The effect of the strongest gales does not probably extend beyond the depth of 200 feet.
2. The common saying of the waves running mountains high is a popular exaggeration. The highest rise noticed in the Mediterranean is only 16 feet, and 20 feet off Australia. The French ship Venus, in a recent circumnavigation of the globe, met with no wave higher than 23 feet. In the Bay of Biscay, during a strong southwesterly breeze, the highest waves measured by Sir James Ross scarcely exceeded 36 feet from the base to the summit; and in the south Atlantic, the result of several experiments gave only an entire height of 22 feet, and a velocity for the undulations of 89 miles per hour, the interval between each wave amounting to 1910 feet. Off the Cape of Good Hope, notoriously the Cape of Storms, according to its former name, 40 feet is considered the extreme height of waves, or 20 feet above and below the general level of the ocean.
3. Waves formed by a wind blowing from the shore, increase in height with the distance from the land, but preserve the same height while the impulse is the same.
4. A breeze blowing perfectly parallel to the level of the water produces waves, but the surface continues smooth. The slightest inclination in the wind causes ripples. Local and transitory deviations from the parallel direction occasion the streaks of ripples that are often seen running along the smooth general surface, the "catspaws" of mariners.
5. Oceanic waves are long rolling billows; those of close seas are abrupt and short.
6. Long after the storm-winds have subsided, and the surface of the ocean has become smooth, it is observed to heave with mighty undulations, which are propagated far beyond the area visited by the gale, the oscillations becoming more feeble with the distance from the focus of disturbance. This is called the "swell." It is not uncommon for a swell advancing in one direction to meet another coming from an opposite quarter, and even a third from another point; or after a breeze has produced a series of waves, it may chop about, and form an inverse series; or within a limited space, aërial currents may be blowing at the same time from various points of the compass; in either of which cases, the aspect of the surface water becomes complex in the extreme.

III. The theory of the tides has been explained as far as it depends upon astronomical causes, the attraction of the moon being the prime agent, strengthened or weakened by that of the sun, according as the relative position of the two bodies with regard to our planet enable them to act in concert or in opposition, their influence being modified by a varying distance from the earth. (Astronomy, page 24.) The south polar ocean is the only deep, unobstructed, and sufficiently capacious sea-basin extending east and west for the production of a wave of high water. The innumerable islands, coral reefs, and submarine table lands of the Pacific are impediments to tidal phenomena, while the Atlantic is disqualified for originating a great wave or tide owing to its form and direction, that of a narrow meridional canal. Accordingly, it has been ascertained, that the seas to the south of New Holland form the grand centre from which tidal action radiates. A high water ridge being raised, and receiving an impulse in the direction of the acting luminaries,—that is westward, the apparent lunar and solar path, but trending north towards the tropics, the region of the direct line of their attraction,—it expends its force in displacing a contiguous mass of fluid, similarly raising it, and in like manner the undulation is propagated with immense velocity from the scene of its origin. It travels at the rate of nearly 1000 miles an hour in the deep and open southern ocean, but with a much less velocity in shallows and near the land, owing to obstruction from the shores and bed of the sea. The propagation of a tide-wave is not a transference of water, but the motion of an undulation. There is no perceptible advance in the profound open sea, only an alternate rise and fall of the surface; but a flow of water takes place over shoals and near land.

The general history of a tide-wave may be briefly sketched, the reader bearing in mind, that in rather more than 12 hours after it has started on its route, another has set out on the same course.

Suppose that at 11 A.M. a tide-wave has brought high water to the coast of Van Diemen's Land. In thirteen hours, or at 12 midnight, it will strike the south point of Hindostan, the east coast of Madagascar, and be off the Cape of Good Hope, carrying high water to those localities. Arrived at the entrance to the Atlantic, it follows the direction of the ocean, north by west, successively bringing high water to the different ports on its eastern and western shores, but travelling with much greater velocity through its central parts than along the coasts, so that the cotidal line becomes extremely elliptical. Thus, in eleven hours from the Cape, or at 11 A.M. of the following day, the twenty-fourth hour of its life, the central area of the oscillation will have reached Newfoundland, its skirts being at the Bahamas on one side, and Cape Blanco in Africa on the other. Turning north-east, the direction of the ocean, in four hours afterwards, or at 3 P.M., the twenty-eighth hour of its career, the tide-wave



has advanced to the British Isles, the ridge extending from Ushant, across the mouth of the English Channel, by the south promontory of Ireland, Cape Clear; as in the annexed sketch. Here, interrupted in its progress, it divides into three branches. One branch travels up the Channel, carrying high water to the opposite coasts of England and France. A second branch enters the Irish Sea through St. George's Channel. The third and principal branch proceeds along the shores of Ireland and Scotland, rounds the northern extremity of the latter, advances into the German Ocean, reaches Aberdeen at 11 P.M., and finally meets the tide from the English Channel; being in twelve hours more off the mouth of the Thames, at 11 A.M., the forty-eighth hour of its existence.

Thus, in the contracted and shallow German Ocean, the tide-wave occupies as much time in passing from Aberdeen to the mouth of the Thames, as in proceeding through the central part of the Atlantic from the Cape of Good Hope to Newfoundland.

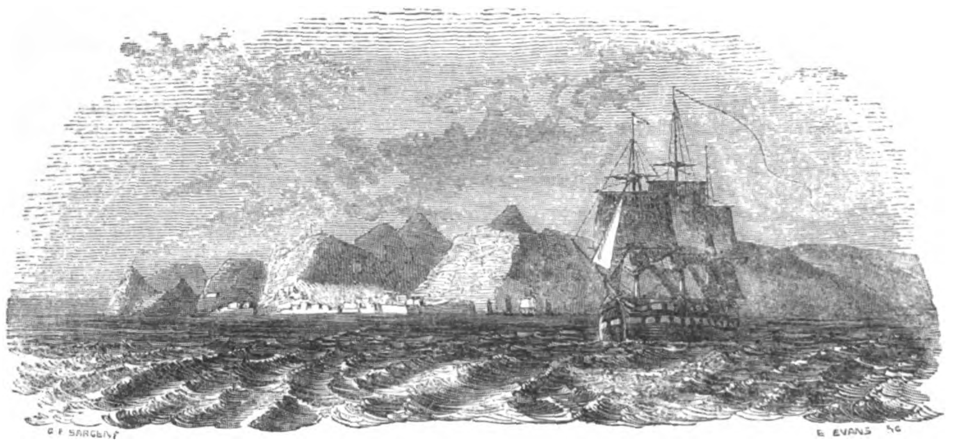
In the open ocean also, as at St. Helena, the rise never exceeds the height of 3 feet, but in narrow seas and confined channels, the elevation is very great, for the same motion is evidently capable of raising the smallest quantity of water the highest. At St. Malo's, on the north coast of France, the spring tides rise 50 feet; at Chepstow in the Bristol Channel 60 feet, and the same in the Bay of Fundy in Nova Scotia.

The shores of the Pacific exhibit tidal action very feebly in comparison with those of the Indian and Atlantic Oceans. Great islands, swarms of islets, and vast submarine constructions, allow only to a limited degree the ingress of the oscillations that are generated in the south polar waters.

Cotidal lines are imaginary lines connecting places to which the same tidal wave brings high water at the same time.

IV. The oceanic currents, permanent but of unequal force, are the effect of winds, of differences of temperature between different parts of the ocean, of the melting of the polar ice, of variations of atmospheric pressure, and other minor circumstances. Drift currents are due to the action of permanent or prevailing winds upon the surface water, by friction impelling it to leeward, until meeting with some obstacle, such as land, or sand-banks, its progress is arrested, and an accumulation of the water produced. In such circumstances a drift current give rise to a stream current, carrying off the collected waters, to restore the equilibrium of the surface of the ocean.

The velocity of a drift current is in general half a mile an hour: that of a stream current is usually greater, often amounting to five miles an hour.



Island of St. Helena.

V. No ocean is so remarkable for the variety of its currents as the Atlantic, which seem chiefly to arise from the variegated outline of its shores. They are also the most accurately known, its waters having been most subject to scientific navigation. The origin of the main series is at the Cape of Good Hope, and from thence almost a complete circuit of the coasts appears to be made.

I.—CURRENTS OF THE ATLANTIC OCEAN.

1. South Atlantic Current.—This is a discharge of water from the Indian Ocean, by a current round the Cape, which flows northerly along the coast of Africa nearly as far as the equator. It is much colder than the superincumbent air, and is overhung with mist, occasioned by the condensation of the vapour of the atmosphere. Average breadth, according to Sir James Ross, 60 miles: depth 1200 feet: velocity 24 miles per day.

2. Equatorial Current.—So called from its course lying under or near the Line. It is a continuation of the former, commences at the coast of Congo, flows north-west to the equator, which it reaches about the meridian of Greenwich. It then proceeds across the whole ocean, increasing in extent and velocity till off Cape St. Augustin, South America, it divides into two branches. This is the most powerful and extensive of all the Atlantic currents, and by its nature and position interferes the most of any with navigation, forming a wide and complete bar across the narrow part of the ocean between the shores of Guinea and Brazil. Velocity—between the coast of Congo and the island of Annabon, from 14 to 30 miles per day: in its progress to Cape Palmas from 52 to 63 miles: between 10° and 16° W. long. from 44 to 80 miles, the strongest part of the stream: from 16° to the coast of South America the mean velocity is 30 miles per day. Temperature—at least 3° colder than the ocean on each side of it, because its waters come from a colder region.

About the middle of the ocean, in W. long. 23°, the equatorial current sends off a large stream, called from its direction the North-west Branch. It may be traced as far north as lat. 28°, sometimes as far as 30°. This branch favours the return of vessels from the southern hemisphere to Europe. Velocity—about 20 to 24 miles per day up to lat. 10°.

Off Cape St. Augustin, where the equatorial current divides, a branch to the south forms the Brazil current, running at the distance of from 200 to 250 miles from the shore, and extending to the outfall of the Plata River, sometimes traceable much farther. Velocity—off Rio Janeiro, 30 miles per day: near the Plata from 15 to 20 miles.

3. Guyana Current.—The main stream of the equatorial continued along the coast of Guyana to the Caribbean Sea, entering it between the Islands of Trinidad and Martinique. Velocity—varies from 10 to 40 miles per day; it has been found about 90 miles in the strongest part; it decreases towards the coasts.

4. Caribbean Current.—The Guyana current continued through the Caribbean Sea, flowing with a very gentle motion through the channel of Yucatan into the Gulf of Mexico.

5. Current of the Gulf of Mexico.—The slight flow received from the Caribbean Sea divides into two branches: one, turning to the right, passes Cuba to the Strait of Florida: the other, turning to the left, makes a complete tour of the Gulf by Vera Cruz and the mouth of the Mississippi. Both branches flow gently. The temperature of the Gulf of Mexico is at least 7° higher than that of the Atlantic in the same parallel. It amounts in general to 89°, but has been observed 90°, being probably the highest temperature of the ocean over the globe.

6. Gulf Stream.—The branch currents of the Gulf of Mexico unite at the Strait of Florida to form the powerful and celebrated stream which carries off the heated water of the Mexican cauldron, and distributes it at great distances. The stream proceeds along the coast of the United States as far as Cape Hatteras. It then gradually turns eastward, maintains that direction as far as the Azores, where it bends south, and loses itself a little to the south of that group of islands. The length of its course from the Strait of Florida to the Azores is about 3000 geographical miles; but part of the warm waters of the Gulf stream find their way to the shores of Europe as far up as the North Cape, and even to Spitzbergen. Velocity—noted as high as 120 miles per day after passing the narrows of the Strait; 48 to 60 at 1100 miles from its egress; and 30 or more after a course of nearly 3000 miles. Temperature—after issuing from the Gulf exceeds 86°: after running 1100 miles 81°: after 3000 miles 76° to 79°: at the Azores 74°.

7. Arctic Current.—Flows from the Arctic Ocean to the Gulf stream which it joins east of the Great Bank of Newfoundland, the polar ice descending by it into the North Atlantic. Velocity—from 36 to 60 miles per day. Temperature—has been observed 43°, which is 17° below that of the adjacent ocean. It bears the name therefore of the Cold Current. Scoresby counted 500 icebergs setting out upon it at once. The Icelanders receive large quantities of drift-wood by the medium of this current; an important benefaction to them, in the absence of natural forests. It is supposed that the great rivers of Northern Asia bring it down from the Siberian woods to the Ocean, from whence it is transferred to the shores of Iceland.

8. North Atlantic Drift Current.—Comprises that part of the Atlantic east of the Arctic current, and north of the Gulf stream. The direction is easterly towards Europe; the flow very weak: but the two following currents originate from it.

9. North African and Guinea Current.—Commences between lat. 45° and 53°, runs southward between the Cape Verde Islands and the coast of Africa, then turns easterly, and flows close to the equatorial current, but in an opposite direction, into the Bay of Benin. The north part of this current between the Bay of Biscay and Madeira trends easterly, and a portion enters into the Mediterranean through the Straits of Gibraltar. Velocity—12 to 20 miles per day. Temperature—at the Cape Verde Islands 8° lower than that of the surrounding ocean.

10. Rennell's Current.—Begins near Cape Finisterre, runs along the coast of the Bay of Biscay, then shoots across the mouths of the English and Irish Channels, bends round to the west, and thence through all the intermediate points till it falls into itself, performing a complete rotation. It bears the name of the late Major James Rennell, who first accurately traced its course, and is the current which so often endangers vessels near the Scilly Islands. Velocity—on the Spanish coast 24 miles per day: greatest velocity 90 miles, observed on the French coast opposite Brest.

11. Southern Connecting Current.—Arises from the drift current of the south-east trade wind, and flows to the Cape of Good Hope where it divides, a branch joining the North Atlantic current, and another passing into the Indian Ocean.

II.—CURRENTS OF THE INDIAN OCEAN.

1. Bengal Current.—Runs principally along the coast of Coromandel, but depends entirely upon the monsoons for its direction and force. It flows in summer, the time of the south-west monsoon, to the north-east: in the opposite direction in winter, when the north-east monsoon prevails. Velocity—the greatest in winter, often 50 miles per day: east of Ceylon from 30 to 70 miles.

2. Malabar Current.—Flows along the coast of Malabar from Bombay to Cape Comorin: depends upon the monsoons: runs northerly in winter and southerly in summer. Velocity—in winter very slight; in summer from 10 to 20 miles per day, increasing towards Cape Comorin to from 20 to 30 miles.

3. United Bengal and Malabar Current.—The Bengal current, flowing through Palk Strait and round Ceylon, joins the Malabar current, the united waters proceeding westerly towards Africa, depending however upon the north-east monsoon. Velocity—between Ceylon and the Maldiva Islands from 30 to 35 miles per day in winter: towards Africa very slight

4. Passage Drift Current.—The equatorial current of the Indian Ocean. It originates south-west from Australia, flows first northerly to the Tropic of Capricorn, where it bends west, and sweeps across the whole ocean. Approaching Madagascar, it becomes narrower, and flows on the north of that island towards the African coast, having previously sent off a small branch to the south-west at the Island of Rodriguez. Velocity—near Australia from 20 to 30 miles per day; in the middle of the ocean

from 10 to 20; but north of Madagascar, where it becomes narrow and more powerful, from 45 to 60 miles.

5. Mozambique Current.—The strongest in the Indian Ocean, a continuation of the Passage Drift, which after having passed Madagascar, and being joined by the weak Bengal and Malabar current, turns south, and flows through the Mozambique Canal to the southern extremity of Africa. Velocity—from 20 to 50 miles per day in general; most rapid near the African coast off Cape Corrientes, where it has been observed to run at the rate of nearly 6 miles an hour, or 139 per day. This is perhaps the greatest velocity ever noted of any current.

6. Lagullas or Cape Current.—On the southern extremity of Africa, at the First point of Natal, the Mozambique current is joined by that branch of the Passage Drift which separates from it at Rodriguez; and thus the chief movements of the Indian Ocean here blend, forming a strong stream, part of which reaches the Atlantic, and is called the Lagullas current from the cape and sand-bank of that name. Velocity—greatest at its commencement, from 60 to 110 miles per day: decreases towards the west: mean velocity at the Cape of Good Hope, 33 miles.

7. Counter Current.—The preceding current meets with resistance from the great Lagullas bank, about half-way between the First point of Natal and the Cape of Good Hope, and unable to pass round or entirely over it into the Atlantic, a great portion of the water is returned by a counter current to the Indian Ocean.

III.—CURRENTS OF THE PACIFIC OCEAN.

1. Antarctic Drift Current.—Flows from the south-polar regions in a north-easterly curve towards the coast of South America, where it divides into two branches, nearly opposite the Island of Chiloe.

2. Peruvian or Humboldt's Current.—One of the branches mentioned, first discovered by Humboldt in 1802. It proceeds northwards along the shores of Chili and Peru, as far as Cape Blanco, where it turns north-west, embraces the Galapagos group, and expanding from thence in breadth, is lost in the great equatorial current of the Pacific. Velocity—from Valparaiso to Lima 12 or 18 miles per day: at the Galapagos Islands it has been noted at from 70 to 120 miles.

3. Cape Horn Current.—The second branch from the Antarctic Drift, running south, passing round Cape Horn to the Falkland Isles, and perhaps finally joining the southern connecting current of the Atlantic. Velocity—from 54 to 100 miles per day, in lat 55° to 58°: near the coast, mean velocity, 24 miles.

4. Equatorial Current.—The principal movement of the waters of the Pacific, from east to west, flowing on both sides of the Line, its limits coinciding with lat. 24° N. and 26° S., making a breadth of 3000 geographical miles. Velocity—the general mean, 30 miles per day.

There are two minor currents within the equatorial, flowing in an opposite direction, from west to east.

Mentor's Counter Drift.—About the Tropic of Capricorn, and the meridian of 80° W., named after the Prussian ship "Mentor," on board of which the first observations were made in 1823.

North Equatorial Counter Current.—Between lat. 5° and 10° N.; long. 115° and 150° W.

5. Mexican Coast Current.—Periodical, dependent on the monsoons, flowing south-east in winter, north-west in summer.

6. Japanese Current.—Formed by the approach of the equatorial current to the coast of Asia. A portion is deflected north by the Island of Formosa, and passes along the east of Niphon, finally losing itself in the ocean. Velocity—off Niphon, from 50 to 120 miles per day.

7. Carolinian Monsoon Current.—Formed by the central portion of the equatorial approaching the Caroline Islands, where it becomes influenced by the monsoons, flowing west in summer, east in winter.

8. Rossel's Drift Current.—Formed by the southern portion of the equatorial, approaching the New Hebrides and New Caledonia, the course changing from west to north-west, towards Torres Strait, named after the discoverer M. Rossel.

9. New South Wales Current.—Runs along the coast from 20° S. to Van Diemen's Land; periodical, depending on the winds; flowing south in summer and north in winter. Velocity—from 20 to 30 miles per day.

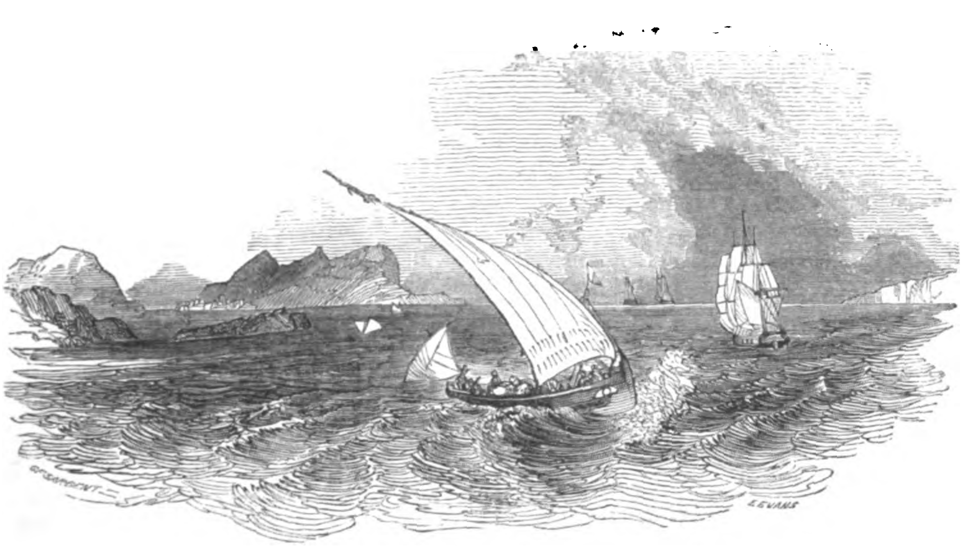
10. Current at Behring's Strait.—Flowing from the Pacific to the Arctic through the narrow channel which separates America and Asia. It follows an easterly direction, having passed the Strait, runs along the northern coasts of America, and may not improbably in that way reach the Atlantic. Velocity—greatest on the side of Asia, varying from 35 to 70 miles per day.

See Hydrographical Map of the World, showing the Currents, &c.

VI. The great sea-streams have offsets, in some instances occasional, due to a transitory cause, or there is a change in the set of a current; circumstances which may endanger the most skilful commander, hurry his vessel ashore, when his reckoning gives him a considerable distance from it,—a misfortune which happened in the night to the fine frigate, the "Challenger," in the year 1835, upon the south coast of Chili.

VII. There are strong local currents produced by tidal action, encumbered by narrow channels and projecting coasts, as the "race" of Portland, along the Dorset coast, which flows with considerable velocity, and the "roost" of Sumburgh, at the south promontory of the Shetlands, which runs at the rate of 15 miles an hour. These local currents sometimes meet from opposite quarters, and cause a whirlpool, like the long-celebrated maelstrom, on the coast of Norway, occasioned by the meeting of tidal currents round the islands of Logodon and Maskoe.

VIII. The Oceanic currents have exerted an important influence in the past history of the globe, and are necessary to its occupation by the human race. The productions of the vegetable kingdom have been widely diffused by the transport of seeds in the waters from one region to another. In like manner, animals have been translated involuntarily to a fresh home on floating ice; and canoes of men and women, driven out to sea by the winds, have got entangled in its powerful streams, and been borne to lands before without a human tenant, but thenceforth to be established in them. Materials drifted across the Atlantic to the Azores strengthened Columbus in his design to navigate it, and led to the gates of a new world being opened. The currents carry the warm water of the tropics to the polar regions to moderate the cold, and bear the cold water of the poles to the tropics to moderate the heat. It is the warmth of the Gulf stream, conveyed to the north-west of Europe, that renders the climate so mild, clothing Britain in "ever-green robes," when, in the same latitude, the shores of Labrador are encased in ice. Without waves, tides, and currents, the ocean, charged with an immense amount of decomposing animal and vegetable matter, would become a stagnant fetid pool, give off noxious exhalations, infect the whole atmosphere, and reduce the habitable parts of the earth to the condition of a desert.



Strait of Gibraltar.

CHAPTER VIII.

ACTION OF THE WATERS UPON THE LAND.

I. Mere rain is a powerful agent of disintegration, and in course of time largely alters the contour of the most solid masses subject to its action. The tremendous showers which fall upon the plateau of Abyssinia, originating the floods of the Nile, have given a peculiar shape to its projections, in process of further change. Some are flat, thin, and square, in form of a hearth-stone or slab, scarcely seem-

Disintegrated Granite.

ing to have base sufficient to resist the winds; others are like pyramids, obelisks, and prisms; and some, the most extraordinary of all, resemble pyramids pitched upon their points, the base being uppermost. The torrents discharged from the clouds have been for ages skeletonising the country, dismantling the harder masses of the softer deposits, wearing away also the granitic rocks, and carrying away the soil of Ethiopia, strewing it along the valley of the Nile, and the shores of the Mediterranean.

The effect of rain is universally similar in proportion to its violence. The Devil's Arrows, near Boroughbridge, Yorkshire, three gigantic obelisks or single stones, supposed to be Druidical, are fluted from this cause from top to bottom. In the same county, the mountain limestone floors supporting the noble masses of Ingleborough, Penyghent, and Wharnside, exhibit rain channels, which have often attracted the attention of artists and tourists.

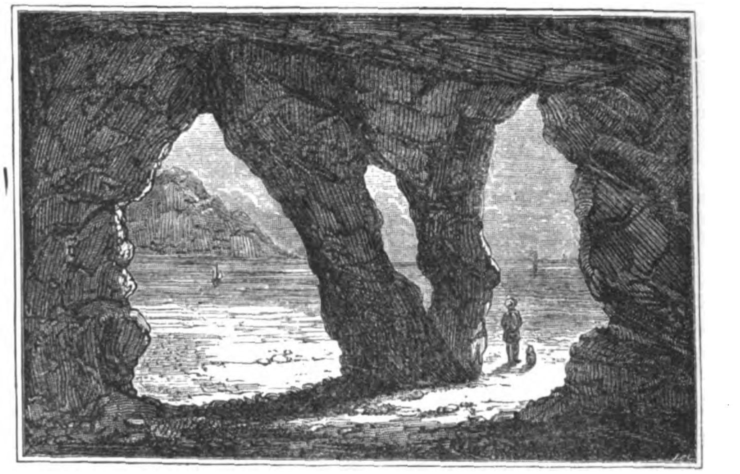
II. Springs and rivers officiate largely in either chemically corroding rocks and soils, or mechanically forcing particles asunder, transporting them to fresh sites by their currents; but river-floods sweep before them immense blocks, and plough their way through obstructions in their course.

It has been stated that a velocity of water, at the bottom of 6 inches per second, will move fine sand on a horizontal surface; 8 inches, sand as coarse as linseed; 12 inches, fine gravel; 24 inches, rounded gravel an inch in diameter; and 36 inches, angular fragments of the size of an egg.

Dr. Dana estimated the quantity of matter chemically and mechanically suspended in the Merimac River, United States, and brought past the town of Lowell during the year 1838, at 1,678,343,810lbs. avoirdupoise, the quantity of water discharged by the river during the same period amounting to 219,598,840,800 cubic feet. The deltas, which owe their origin to deposition from the rivers, are continually increasing by the constant supply of sediment. The delta of the Mississippi has advanced several leagues since New Orleans was built; that of the Nile has grown in some parts upwards of a mile since the 15th century; while the gain of land at the mouth of the Po has been from fifteen to twenty miles since the time of the first Roman emperors.

III. The action of the ocean by its waves and breakers upon abrupt coasts, especially when composed of rather yielding materials, is very powerful in wearing them away, and preparing detritus for the currents to convey to distant parts of its own bed. On the east side of England, there has been an extensive loss of land by this process since the dawn of authentic history; and within the memory of man, acres have been sown and reaped which are now the property of the sea. During storms, masses of rocks many tons in weight are sometimes wrenched from their ledges, and have been driven up a surface sloping with a considerable dip towards the ocean; while mounds protecting low-lying territories have been violently forced, and the areas beyond them permanently submerged.

The Abbey of Whitby, now about 200 yards from the edge of a perpendicular cliff, was a mile from the sea at its foundation in the year 658. In the same locality, the cave called Hob-hole, scooped by the waves, had a few years ago a double pillar at the entrance, now demolished by their play.



Hob hole, Whitby.

Some idea may be formed of the changes wrought by the ocean in its angry moods in the course of a few thousand years, from the following chronicle of selected cases:

Years.

800. The sea carries off a large quantity of the soil of Heligoland, islands in the German Ocean, off the mouth of the Elbe, previously of considerable extent, but subsequently much reduced.

800—900. Tempests change the coasts of Brittany; valleys and villages are swallowed up. The Bretons have a tradition, which has descended from the fabulous ages, of the destruction of the south-western part of Brittany.

800—950. Violent storms agitate the Lagunes of Venice. The Isles of Ammiano and Constanziaco disappear.

1044—1309. Terrible irruptions of the Baltic on the coasts of Pomerania, which commit great ravages, and give rise to the popular rumour of the disappearance of the fabulous city of Vineta.

1106. Old Malamocca, a considerable town near Venice, engulfed by the sea.

1218. A great inundation formed, near the mouth of the Weser, the Gulf of Jadhe, so named from the small river which watered the fertile country destroyed by this catastrophe.

1219, 1220, 1221, 1246, 1251. Terrible storms form the island of Wieringen. This lies to the south of the Texel, and was part of the mainland of North Holland in the year 1205. It was detached from the continent by the high floods which occurred in the annexed years.

1277, 1278, 1280, 1287. Inundations engulf the fertile country of Reiderland, an alluvial plain at the mouth of the Ems in the time of the Romans, stretching between Groningen and East Friesland. Two small streams, the Tiam and the Eche, which watered this district, disappeared. The town of Torum, a considerable place, was destroyed, along with upwards of fifty market-towns, villages, and monasteries. A new gulf, called the Dollart, now occupies their site.

1282. Violent tempests break the isthmus which united Holland with Friesland, and form the Zuider Zee.

1240. An irruption considerably changes the western coast of Schleswig; many fertile territories are swallowed up, and the arm of the sea which separated the island of Nordstrand from the continent is greatly enlarged.

1300, 1500, 1649. Three-fourths of Heligoland are swept away.

1300. Ciparum, in Istria, destroyed.

1303. A great part of Rugen engulfed, and many villages on the coast of Pomerania.

1337. An inundation carries off fourteen villages in the Isle of Cadsand, in Zealand.

1421. An inundation covers a district named Bergseweld, in Holland, destroys twenty-two villages, and forms the Bies-bosch, a large sheet of water extending from Gertruidenberg to the isle of Dordrecht.

1475. Land near the mouth of the Humber swept away, and several villages destroyed.

1500. The parish of Bourgneuf, in Brittany, and several others in that neighbourhood, overflowed.

1510. The Baltic forms the mouth of the Frische Haff.

1530—1532. The sea engulfs the town of Kortgene, in the island of North Beveland. In the latter year the eastern portion of South Beveland is carried away, with several villages, and the towns of Borselen and Remerswalde.

1570. A violent storm destroys half of the village of Scheveningen, north-west of the Hague. The church, once in the middle of the village, now stands on the shore.

1625. The sea detaches part of the peninsula of Dars, in Swedish Pomerania, and forms of it the island of Zingst.

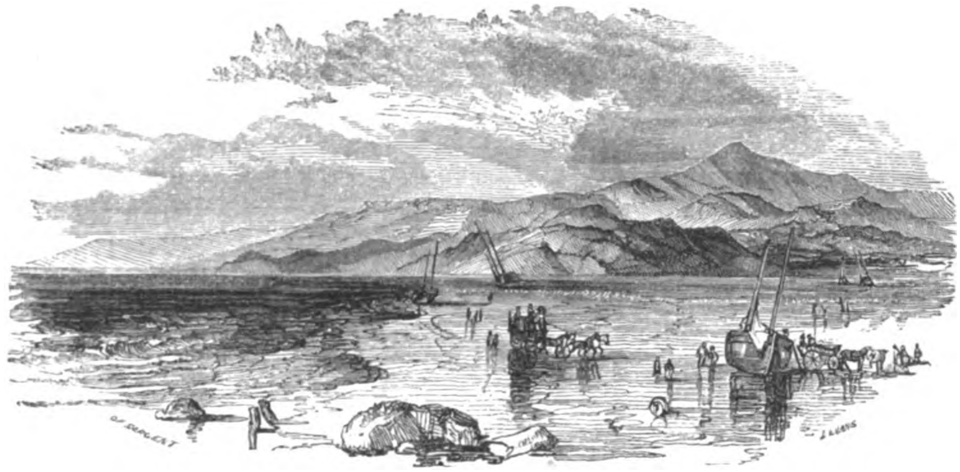
1634. An irruption submerges the whole island of Nordstrand, a large and populous district, which had originally been a part of the continent, and detached by a previous inroad of the waters. On the evening of the 11th of October, 1634, the sea broke over it, destroying 1358

Years.	
	houses, churches, and towns, 50,000 head of cattle, and upwards of 6000 persons. There now remains of this once flourishing and fertile island, the three islets named Pelworm, Nordstrend, and Lütze-moor.
1658.	The island Orisant annihilated.
1719.	Land torn away at Catwyck, which, though once far from the sea, is now upon the shore.
1726.	A violent storm changes the Salt Marsh of Araya, in the province of Cumana, into a gulf several leagues wide.
1770—1785.	Currents and tempests hollow out a channel between the high and the low parts of Heligoland, and transform into two islets this island, so extensive before the eighth century.
1784.	A violent storm, according to M. Hoff, forms the lake of Aboukir, in Lower Egypt.
1791—1793.	New irruptions destroy the dykes, and carry off other parts of the already reduced island of Nordstrand.
1803.	The sea sweeps away the last remains of the priory of Crail, in Fifeshire.

IV. While the ocean thus encroaches upon the land to diminish its quantity, it tends in some instances to increase it. Where the coast is low, and the bottom sandy, the waves carry the sand forward, which becomes dry at every reflux of the tide; and as the habitual direction of the wind is from the sea, the loose particles are further conveyed inland, forming hillocks around stones and bushes, which increase into sand-hills, and are called *dunes* or *downs*.

This is a destructive gift from the ocean, converting fertile districts into sterile wastes. The ancient barony of Coubine, near the mouth of the Findhorn, in Scotland, once remarkable for its fertility, has been rendered unproductive and depopulated by invasions of sand. The old town of Bannow, on the coast of Wexford, Ireland, bears the name of the Irish Herculaneum, from being now buried beneath accumulations of sand, above which a square tube of masonry still peeps, believed to have been the massive chimney of the town-house. The coast of France from Brittany to the Pyrenees, especially below the Garonne, presents vast undulating tracts of sand, the gift of the Atlantic, on the advance inland.

V. The waters tend in general to reduce the high grounds, and raise the low; to equalise the level of the land by the transport of matter torn from the more elevated parts to inferior sites; as well as perhaps to contract the habitable area of the globe by transference of its material to the floor of the ocean; but this tendency of aqueous action, is sufficiently counterbalanced by the upheaving force which operates upon the solid crust of our planet, and keeps up a due proportion between the areas of its dry and fluid portions.

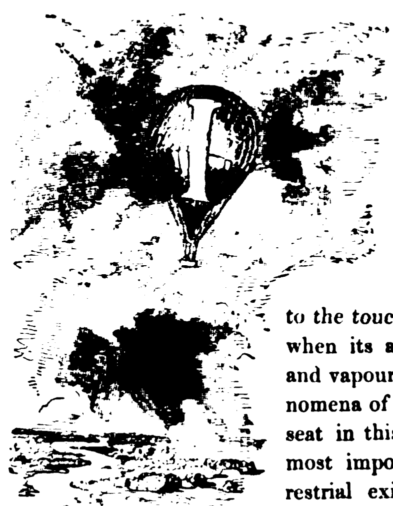


Lancaster Sands.

METEOROLOGY.

CHAPTER I.

THE ATMOSPHERE,



AS that stratum of gaseous matter which everywhere surrounds the earth, and is maintained at its surface by the force of gravity, while sharing in the orbital revolution and diurnal rotation of our globe. In consequence of the latter motion, it forms, when in equilibrio, an ellipsoid flattened at the poles. Unlike the great divisions of land and water, it is imperceptible to the touch, unless in agitation; and only visible when its aqueous particles are collected in clouds and vapours. Some of the most marvellous phenomena of the natural world have their source and seat in this fluid envelope. It performs also the most important functions in the economy of terrestrial existence; for upon its chemical constitution all organic life absolutely depends, while its mechanical agency, as indicated by winds and temperature, is not less essential to the preservation of the animal, vegetable, and human races.

The atmosphere consists of dry air and the vapour of water. The air is essentially composed of oxygen and nitrogen, in definite proportions; gases which are highly injurious when inhaled separately. Repeated analyses show that in 100 measures of pure atmospheric air, there are 20 or 21 volumes of oxygen, and 80 or 79 of nitrogen. But it is never absolutely pure. There is a minute and variable quantity of carbonic acid gas present, with the odoriferous matter of flowers, and other volatile substances. The amount of aqueous vapour fluctuates; but in the dryest weather, it is supposed by Dr. Ure to be at least 1 per cent. Under ordinary circumstances, the composition of 1000 parts of the atmosphere may be stated as follows:

Oxygen	210·0
Nitrogen	775·0
Aqueous Vapour . . .	14·2
Carbonic Acid . . .	0·8
	1000·0

In all regions of the globe, at all altitudes, and at all times, the atmosphere yields the same chemical results. Berthollet found the air of Egypt identical with that of France; and air collected on the summit of the loftiest mountains, Mont Blanc and Chimborazo, or brought down by Gay Lussac from the elevation of 21,735 feet, exhibited the same chemical composition as that analysed from the lowest valleys.

The quantity of carbonic acid gas in the air is, however, greater near the level of the sea in summer than in winter; greater during the night than the day; and rather more abundant on the summit of mountains than on the plains. It appears also, from the analysis of a young Danish chemist, M. Levy, who collected the air as near as possible to the surface of the sea, during a voyage from Havre to Copenhagen, that this air, as compared with that of Copenhagen, presented a somewhat less proportion of oxygen.

It is true that the air of the densely populated city, and of such districts as the Pontine marshes, which brands with pallidness and premature old age the natives constantly exposed to it, cannot be the same as that which gives bloom to the cheek and vigour to the frame; but the difference is only known by these effects, chemical means having hitherto failed to detect it.

II. It was surmised as early as the age of Aristotle, that air had weight; but the verification of the fact did not occur until the former part of the seventeenth century. The atmosphere, it is now known, exerts a pressure or weight of about 15 pounds on every square inch of the earth's surface, which is equal to the weight of a column of mercury 1 inch square and 30 inches high, or a column of water of the same base, and 34 feet high.

The pressure of the atmosphere was noticed by Galileo, but demonstrated by his pupil, Toricelli, who invented the barometer, a simple instrument, consisting of a column of mercury, poised, or pressed upwards into a vacuum by the weight of the atmosphere.

The barometer shows the atmospheric pressure to vary according to the elevation above the level of the sea. The pressure diminishes as we ascend; hence the mercury falls; and making allowance for the increased rarity of the air with the greater altitude, the height of mountains may be estimated by barometric indications.

The pressure varies also in the same place from causes which are not well understood. This is indicated by the barometer. The mercury is commonly high in calm and fair weather; it falls when it is wet and stormy; and hence the use of the instrument as a weather-glass.

When the barometer is at 31 inches, the atmosphere presses on the surface of Great Britain with a weight equal to 291,793,239,406 tons; when it sinks to 27 inches, there is a diminution of weight on the same area equal to 37,648,938,386 tons; being about 427,231 tons on each square mile.

III. The atmosphere is in a high degree elastic, or possesses the property of occupying less space under the influence of certain forces, and returning to its original volume when the influence is withdrawn. Hence its density is not uniform, but diminishes from below upward, because the lower portions are compressed by the superincumbent air. The height of the atmosphere is not known, but it is supposed to extend to about fifty miles; yet by far the greater portion of it is within fifteen or twenty miles of the earth's surface; and at a much less distance it becomes so rarefied as to be incapable of supporting life.

In ascending high mountains, the rarity of the air sensibly diminishes the intensity of sound, renders respiration difficult, produces a loss of physical strength, and travellers have found it impossible to reach their crests. The blood burst from the ears and lips of Humboldt in attempting to reach a high elevation in the Andes. He experienced the same difficulty in kindling and maintaining a fire at great heights, which Marco Polo felt on the mountains of Central Asia. Captain Gerard, who crossed the Mannering Pass in the Himalaya, remarks, "Our elevation was now 16,000 feet, although we had but ascended in company with the river. Here only began our toils; we scaled the slope of the mountain very slowly; respiration was laborious, and we felt exhausted at every step. Our situation was different from anything we had yet experienced; it cannot be described. Long before we got up, our respiration became hurried and oppressive, and compelled us to sit down every few yards; and then only could we inhale a sufficient supply of air. The least motion was accompanied by debility and mental dejection."

The effect of the diminished density of the atmosphere on the heights of the Andes, is supposed to be a malady by the natives, due to exhalations from metals, and is called the *veta*. "The first symptoms of the veta," according to Tschudi, "are usually felt at the elevation of 12,600 feet above the sea. These symptoms are vertigo, dimness of sight and hearing, pains in the head, nausea, and blood flows from the eyes, nose, and lips."

IV. The atmosphere is naturally colourless. Its prevailing blue arises from the rays of the red extremity of the spectrum freely passing through it, while the blue rays undergo the greatest reflection. The hue of the sky, however, presents all imaginable shades, from deep blue in the zenith, to paler tinges and complete whiteness towards the horizon. This is owing to the blue tints in the zenith being darkened by the deep black of inter-planetary space, and lightened towards the horizon by the white vesicles of fog and vapour, which occur in the greatest abundance in that direction. The former cause explains the deeper hue of the sky as seen at great heights; a fact long observed by the shepherds and chamois-hunters of the Alps.

CHAPTER II.

CURRENTS OF THE ATMOSPHERE.

I. The varying attraction of the sun and moon occasions disturbances in the aërial ocean around us,—an alteration in the heights of vertical columns of air,—or atmospheric waves analogous to tidal phenomena; but the agitation with which we are familiar, or the winds, are chiefly owing to changes in the temperature of a portion of the air, and in the quantity of water which it holds in a state of vapour. The equilibrium of the atmosphere being broken, the particles of air are set in motion to restore the balance; and as the deranging causes act with varying intensity, the winds or currents created are diverse in power.

1. The effect of heat upon the air is to expand its volume and diminish its density. When any portion of the earth's surface is more heated than the surrounding districts, the air there ascends and blows over the adjoining cooler and denser strata, causing an upper outward current, while the colder and denser fluid rushes towards the spot where the balance has been lost by expansion, and a lower inward current is produced. If we open a door in winter communicating between a hot room and a cold space, there will be an upper current of air directed from the heated apartment, and a lower current flowing into it. The flame of a taper held near the ceiling will be directed from within outwards; it will be driven from without inwards if held towards the floor; and be upright and still if placed midway between the two positions.

Volcanic eruptions are frequently accompanied with violent storms. The heat of the volcano determines an ascending current, and the cool air rushes from all sides towards the mountain.

2. An addition of vapour to the atmosphere, causing a local increase in its density, produces currents flowing away from the district of evaporation; while an abstraction of it by showers of rain and snow, creates a partial vacuum, towards which the air rushes from all points of the compass.

II. To indicate the direction of the winds, the horizon is divided into various equal parts, and each current receives the name of the point of the horizon from whence it flows.

The horizon is usually divided into eight parts, the points being thus noted in meteorological registers:—N, north; N E, north-east; E, east; S E, south-east; S, south; S W, south-west; W, west; N W, north-west. Most meteorologists add eight intermediate points, making sixteen, thus:—N, north; N N E, north north-east; N E, north-east; E N E, east north-east; E, east; E S E, east south-east; S E, south-east; S S E, south south-east; S, south; S S W, south south-west; S W, south-west; W S W, west south-west; W, west; W N W, west north-west; N W, north-west; N N W, north north-west.

Müller observes, that although the changes in the direction of the wind appear on a superficial view to be utterly devoid of rule in our regions, yet attentive observers have long since made the remark, that winds generally succeed each other in the following order:

S, S W, W, N W, N, N E, E, S E, S.

A complete change of the wind, as from south to east, north, or west, passing over the intermediate points, is very rarely observed in Europe.

Currents of water and air are named inversely. An easterly stream is a flow of water *towards* that point of the horizon; an easterly wind is a flow of air *from* it.

III. There are atmospheric currents, the direction of which no point of the horizon will indicate, for miners have long been familiar with very strong ascending gusts before and during violent tempests.

The explanation is, that storms are almost always preceded or accompanied by a great fall in the barometric column. The atmospheric pressure becoming less, the air in the bowels of the earth expands, and ascends to the surface.—M. Kaemtz.

IV. Currents of air frequently move in contrary directions at different elevations. This is apparent from the course of the clouds being divergent from the one indicated by the weather-vane; and from the higher clouds passing in an opposite direction to those below them.

The occurrence of upper inverse currents is very decisively proved by the following circumstances:

The inhabitants of Barbadoes one day observed, to their astonishment, a shower of ashes fall from the sky. They came from the volcano of St. Vincent, which is situated to the west of their island. The ashes had been launched high in the air, and been transported in the direction from west to east, opposite to the course of the trade wind blowing below.

On the 25th of February, 1835, the ashes emitted from the volcano of Cosiguina, in the state of Guatimala, were precipitated on the island of Jamaica, and fell in the streets of Kingston, which is situated to the N. E. of Guatimala, the trade wind blowing below to the west.

At the summit of the peak of Teneriffe west winds almost always prevail, while the inferior currents are from the N.E.; and the remark has often been made, that in the elevated parts of the Canary Islands a contrary wind has been experienced to that prevailing at the general surface.

Lunardi travelled at the rate of 70 miles an hour in his balloon, while at Edinburgh, where he ascended, the air was quite tranquil, and continued so throughout his expedition. Mr. Green, the aëronaut, in a communication to the Meteorological Society, states: "Several instances have occurred where I left the earth about noon, in a complete calm; and after rising between 3000 and 4000 feet, I entered a current from the N.W. which carried me above a mile per minute. I must here observe, that if I leave the earth with the wind at W. or S.W., I invariably find, at an elevation of from 3000 to 4000 feet, a current either W. by N., or S. by W. This fact the inhabitants of London have had repeated opportunities of witnessing, by the ascent of my two balloons at the same time from Vauxhall Gardens. Whenever there was sufficient difference in the elevations of them, that which attained the greatest altitude frequently descended in Kent, at the same time the under current carried the lower balloon into Essex."

V. The velocity of winds is open to sensible observation, by the force exerted upon our own body, and the impression made upon light pliable objects. But a variety of experiments have been made by the *anemometer*, an instrument constructed for the purpose, though serious difficulties attend this class of researches. The following are some results obtained by Smeaton:

Miles per Hour.	Feet per Second.	Perpendicular force on one Square Foot in Avoirdupois pounds and parts.	Characteristics.
1	1·47	·005	Hardly perceptible.
2	2·93	·020	Just perceptible.
3	4·4	·044	
4	5·87	·079	Gentle, pleasant wind.
5	7·33	·123	
10	14·67	·492	Brisk wind.
15	22	1·107	
20	29·34	1·968	Very brisk wind.
25	36·37	3·075	
30	44·01	4·429	High wind.
35	51·34	6·027	
40	58·68	7·873	Very high wind.
45	66·01	9·963	
50	73·35	12·300	Storm.
60	88·02	17·715	Great storm.
80	117·36	31·490	Hurricane.
100	147·7	49·200	Hurricane, carrying trees and buildings before it.

The great storm from the S.W., on the 29th of November, 1836, passed over London at ten o'clock in the morning; at the Hague at one o'clock; at Amsterdam at half-past one; at Embden at four; at Hamburgh at six; at Lubeck, Bleckede, and Salzwedel at seven; and finally, at Stettin at half-past nine in the evening; thus taking between ten and eleven hours to traverse the space which separates London from Stettin. Its velocity was about 120 feet per second, or upwards of 80 miles an hour. The cross and ball of St. Paul's vibrated fearfully, and were expected to fall. This storm appears to have commenced on the east coast of America. It traversed the Atlantic, reached Europe in the latitude of the English Channel, and was finally lost in Lithuania.

Winds are commonly the strongest in mountainous countries, owing to the obstacles presented by the surface, which determine aërial accumulations escaping in furious local currents through the valleys and gorges. In a similar manner, when the bed of a river becomes narrow, or impeded with rocks, violent currents are produced in all directions, even where the water, a few yards higher up, has but a gentle flow. The winds acquire a fury, of which no idea can be formed, in the valleys of the Swiss Alps, where they are known by the name of *foen*.

VI. Permanent breezes prevail within the tropics, called Trade winds, which maintain nearly the same direction and rate throughout the year. Their limits in the Atlantic ocean have been fixed by navigators with great precision. They are termed from their direction being from N.E, in the northern hemisphere, and from S.E. south of the line, the north and south-east trades; but both blow more decidedly from the east as the equator is approached. Between them is a zone styled the Region of Calms, in which a thick foggy air prevails, with frequent sudden and copious rains attended by thunder and lightning.

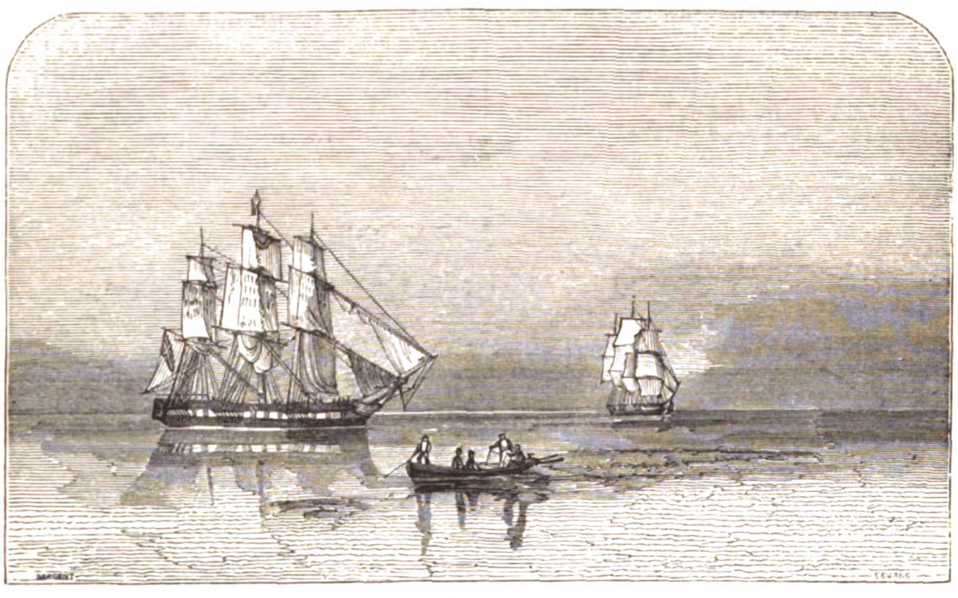
The north-east trade-wind prevails at a mean between 8° and 28° of north latitude. The limits of the south-east trade-wind are at a mean the parallels of 3° N. and 28° S.

The trade-winds may be readily explained. The regions bordering on the equator are the hottest on the earth. In consequence of rarefaction, the air there ascends, and flows over the colder masses on either side towards the poles, from which a colder atmosphere moves to supply its place. Thus two currents are created in each hemisphere, an upper and a lower, but flowing in opposite directions; and if the earth did not rotate upon its axis, the direction of the lower current in the northern hemisphere, or the trade-wind, would be from north to south, and in the southern hemisphere from south to north. The earth, however, rotates from west to east; and the atmosphere surrounding it partakes of this rotatory motion. Yet in proceeding from the poles to the equator, the masses of air flow from regions where the rotatory motion of the surface is less to where it is greater; and unable to acquire the new velocity at once, they are deflected towards the west just in proportion as they do not keep up with the surface towards the east. Hence instead of being north and south winds, which they would be if the earth were at rest, they become north-east and south-east winds.

The trade-winds would blow regularly round the entire globe within 30° of the equator on each side, but the uneven surface and unequal temperature of the land divert and derange them. Thus on the African side of the Atlantic, within a considerable distance of the land, they are not experienced at all, but contrary westerly winds prevail. This is owing to the rarefaction of the air over the hot desert of the Sahara, which creates a current of colder air blowing towards the shore. The Pacific ocean has regular trade-winds with the Atlantic; but in the Indian ocean they are interrupted by the monsoons. They are also experienced on equatorial lands which exhibit extensive levels, as in the basin of the Amazons, where a constant breeze is found, blowing from its estuary to its sources at the foot of the Andes.

While the north-east trade-wind, first discovered by Columbus, facilitated his course across the Atlantic, its constancy filled his companions with dismay, as it seemed to preclude the hope of their return to the shores they had quitted. The phrase *trade-winds* is supposed to have been applied to these breezes on account of their permanence and steadiness, *trade* originally signifying a common *course* or *track*, the *course treaded.* Hakluyt speaks of "the wind blowing trade," or a regular course.

Where the north-east and south-east trade-winds approach each other, they tend to produce a purely eastern breeze; but this is not perceptible, because the horizontal motion of the air is neutralised by the vertical motion consequent upon excessive heat and rarefaction. Here is the Region of Calms, in which there would be an almost perfect calm, but for the great evaporation and violent rains which disturb the equilibrium of the atmosphere, and occasion sudden storms and squalls. This zone, separating the trade-winds of both hemispheres, is entirely north of the equator, extending about 6° in width at a mean.



A Calm at Sea.

VII. Periodical winds, or those which regularly prevail at a certain time of the year or of the day, belong to various districts of the globe. The monsoons of the Indian ocean, the Etesian winds of the Mediterranean, and the land and sea breezes, are of this class.

1. *Monsoons.*—Throughout the year nearly, two winds are sweeping the surface of the Indian ocean and the adjoining land, blowing from different quarters and in different localities. From November to March, a N.E. wind reigns, north of the equator, making its appearance sooner in the Arabian than in the Bengal Sea, while at the same time, a N.W. wind blows south of the equator, between Madagascar, the Sunda isles, and the northern shores of Australia. From the middle of April to the end of September, north of the equator, a S.W. wind blows, and at the same time, a S.E. wind, south of the line. These are the monsoons, a term derived from the Malay *moussin*, signifying "a season." They last respectively about five months, there being two months in the year in which no monsoon is experienced, from the middle of March to the middle of April, and from the middle of September to the middle of October. The changes of the monsoons are effected during these intervals, in which calms and light breezes alternate with gales, hurricanes, and thunder-storms. It is a remarkable fact, that as soon as one monsoon ceases, though a month elapses before the succeeding one appears, the clouds at once take the direction of the approaching monsoon, and herald its coming to the regions below.

The N.E. and S.E. monsoons may be regarded as trade winds, explicable on the same principles, but counteracted for a certain time by causes which produce winds from a different quarter, or the S.W. and N.W. monsoons. The former, from S.W.

prevails coincidently with Bengal, Siam, and the adjacent countries, receiving their maximum of heat, occasioning a flow of cold air towards the region of rarefaction: the latter, from N.W., is coincident with the sun being vertical south of the equator, when the sandy plains of New Holland are powerfully heated, and the colder atmosphere is set in motion in that direction.

The monsoons are much stronger than the trade winds, frequently amounting to gales. They are also more serviceable to navigation, from the change in their direction, for a ship sailing with one monsoon to a distant port, may be aided on the return voyage by its successor.

2. *Etesian winds.*—The ancients gave this designation, signifying "annual" or "seasonal," to periodical winds which blow strongly from the north in the Mediterranean in summer. The immense desert of Sahara, south of the Mediterranean, deprived of water, and composed of sand and flints, becomes very highly heated under the influence of an almost vertical sun, and currents are created from the colder atmosphere of the north. Hence the passage from Europe to Africa in summer is much quicker than the return. Periodical currents, called *nortes*, or north-winds, blow from September to March in the Gulf of Mexico. They occur also on the Brazil coast, from N.E. in spring and S.E. in autumn.

3. *Land and Sea breezes.*—On the sea-shore, especially the coasts of tropical islands, a breeze from the sea is experienced a few hours after sunrise, owing to the land being more strongly heated than the sea by the sun's rays. At first light and scarcely perceptible, it increases till mid-day, is the strongest between two and three, P.M., afterwards dying away to a perfect calm at sunset. Soon after sunset, a breeze from the land commences, and continues till the morning, for at night the land rapidly cools, while the sea retains nearly the same temperature. Around spacious lakes, for the same reasons, there is a breeze from the lake by day, and towards it by night.

VIII. Variable winds prevail in mean and high latitudes, the same wind seldom lasting for several successive days. Designating the total number of winds that blow in a given time by 1000, the following Table shows their relative frequency in the countries named:

Countries.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
England	82	111	99	81	111	225	171	120
France	126	140	84	76	117	192	155	110
Germany	84	98	119	87	97	185	198	131
Denmark	65	98	100	129	92	198	161	156
Sweden	102	104	80	110	128	210	159	106
Prussia	99	191	81	130	98	143	166	192
N. America	96	116	49	108	123	197	101	210

The number of days in each month during which each wind prevailed at London, is indicated in the next Table, as registered at the Royal Society for a period of twenty years, ending 1846:

Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
January	2·8	4 7	3·7	2·4	4·5	5·7	4·0	2·9
February	2 2	3·3	3·2	2·0	4·4	5·8	5·1	2·1
March	2·5	4·8	2·9	1·8	3·2	6·5	6·0	3·0
April	4·0	4·9	3·5	2·1	3·4	5·0	3·5	3·1
May	2 4	6·4	5·2	1·2	5·0	5·1	3·1	1·5
June	1·4	3·4	2·3	1·4	4·7	7·1	6·2	3 0
July	1·2	2·1	2·8	0·9	4·1	9·0	7·1	2·8
August	1·2	3 2	2·8	1·1	5·2	7·4	7·2	2·7
September	1·5	3·1	2·7	1·5	6 4	6·3	6·1	2·1
October	1·6	3·7	2·5	1·5	6·1	6·6	5·4	3·2
November	1·2	3·8	3·2	2·2	5·2	7·1	4·4	2·6
December	1·9	3·4	1·5	2·5	4 5	8·3	6·1	2·5

This register shows that the south-west wind blows more frequently than any other during every month of the year, and that it is most common in July, August, November, and December. The number of days during which westerly and easterly winds blow in a year in different parts of Great Britain,—including under the term westerly the north-west, west, and south-west, and taking the term easterly with the same latitude,—has been thus registered:

Years of Observation.	Places.	Westerly.	Easterly.
10	London	233	132
7	Lancaster	216	149
51	Liverpool	190	175
9	Dumfries	227·5	137·5
10	Branxholm, Northumberland	232	133
7	Cambuslang	214	151
8	Hawkhill, near Edinburgh	229·5	155·5
	Mean	220·3	144·7

Thus, in Great Britain, Europe, and the north temperate zone, not only are the west winds more prevalent than the east, but their mean direction comes from the south-west quarter. Professor Daniel states that in our island, upon an average of ten years, the westerly winds exceed the easterly in the proportion of 225 to 140; and that the northerly exceed the southerly as 192 to 173. In the south temperate zone the mean direction of the prevalent winds is from the north-east. The hot air of the equator, which ascends and flows off towards the north and south poles, descends as it cools, meets the lower currents from the poles, prevails in the struggle,—variable but prevailing S.W. and N.W. winds in the respective hemispheres being the result.

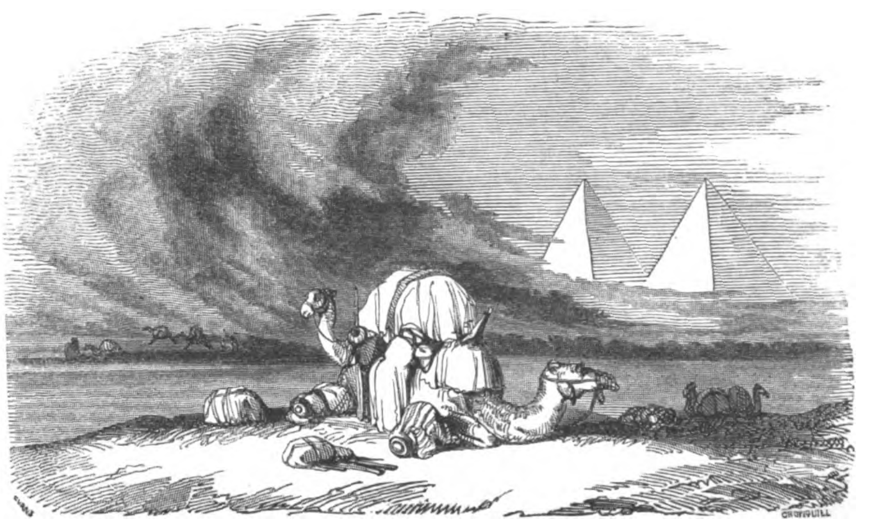
IX. Winds may be further discriminated by certain physical properties, derived from the regions from which they proceed. Thus with us the west winds blow from the sea, and are much more moist than the east, which traverse the continent. In 100 showers observed at Berlin, the different winds blew in the following proportions:

N.	N.E.	E	S.E.	S.	S.W.	W.	N.W.
4·1	4·0	4·9	4·9	10·2	32·8	24·8	14·4

The atmospheric currents are also variously hot or cold, as they come from highly heated deserts and warm climates, or from snow-capt mountains, ice-bound seas, and high latitudes in general.

Cold winds.—The north, north-east, and east winds in our country are almost invariably cold; those between south and west are warm; and those between west and north are of a mixed character. South of the Alps the north winds are very cold, and frequently very violent, owing to the contrast between the snow-covered mountains and the elevated temperature of the Mediterranean. The *bora*, a north-east wind, so called in Istria and Dalmatia, is sometimes so furious as to overturn horses at plough. The same cause, the perpetual Alpine snows, renders the south wind so piercing in the valley of the Rhone, where it is styled the *vent de bise.*

Hot winds.—The burning deserts of Africa and Asia are the countries where hot winds occur in force; but in India, covered with luxuriant vegetation, in Chili, Louisiana, the llanos of the Orinoco, Spain, Sicily, Italy, and New Holland, winds of a very high temperature are frequent. They may be briefly noticed under local denominations.



Sand Storm in the Desert.

The *Samoom*, known in the deserts of Arabia, Nubia, Persia, and Syria, derives its name from its temperature and supposed pestilential character, the Arabic *samma* signifying at once hot and poisonous: the Turks call it *samiel*, which likewise means poison. But though dangerous and sometimes fatal in its effects, the pestilential and deadly attributes assigned to the blast may be deemed an oriental fiction. The dry soil of the desert becoming prodigiously heated, if a wind arises it must be burning. The fine sand and dust, frequently deeply tinged with oxide of iron, raised in the air, obscures the face of the sky, and gives to the whole atmosphere a dull fiery appearance; the sun loses its brilliance, and its light no longer projects a shadow. A rapid evaporation occurring at the surface of the human body dries the skin, accelerates respiration, inflames the throat, and produces intense thirst. The water carried in skins by the caravans evaporates, and thus the simoom has been fatal to many over-taken by it since the expedition of Cambyses. A sufficient reason may be found for the Arabs covering their faces when it blows, and the camels turning their heads in the direction from it; viz., to avoid the flying sand, without imagining poison in the air. "In June, 1813," says Burckhardt, "in going from Siout to Esne, I was surprised by the *samoom* in the plain which separates Farschiout from Berdys. When the wind arose I was alone, mounted on my dromedary, and at a distance from every tree and habitation. I endeavoured to protect my face by wrapping it in a handkerchief. Meanwhile the dromedary, into whose eyes the wind drove the sand, became restless, commenced galloping, and caused me to lose the stirrups. I remained lying on the earth, without moving from the spot, for I could not see to a distance of ten metres, and I wrapped myself up in my clothes until the wind had abated. I then went to search after my dromedary, which I found at a very great distance, lying down near a bush, which protected his head against the sand raised by the wind." The samoom blows only occasionally, during intense heats, and seldom lasts longer than from a quarter of an hour to 20 minutes, though sometimes it continues for days.

The *Khamsin* (fifty) is the name given to a hot south wind, not so oppressive as the samoom, which blows in Egypt, continuing at intervals for a period of somewhat more or less than 50 days, from the end of April until June, at the commencement of the inundation of the Nile.

The *Harmattan*, experienced over Senegambia and Guinea, at intervals in December, January, and February, is an easterly wind, blowing from the Sahara, from which it derives an extraordinary degree of heat and dryness. It continues sometimes only for a day or two, but it has been known to last 15 or 16, and there are commonly three or four returns of it every season. A fog or haze always accompanies it, so dense that the sun is only visible for a few hours at noon. No dew falls while it lasts, nor is there the least appearance of moisture in the atmosphere. Vegetation consequently suffers; tender plants are destroyed, vigorous evergreens are withered, and the grass becomes like hay. To the human species the Harmattan is salubrious, though occasioning disagreeable sensations. It occurs after the rainy season on the African coast, during which diseases are induced by an excess of moisture, which its singular dryness removes from the atmosphere.

The *Sirocco*, the hot wind of Italy and Sicily, from the south, sometimes commences faintly about the time of the summer solstice, and occasionally blows with great force in July. Though usually attributed to the Sahara, it is supposed by Kaemtz to arise on the arid rocks of Sicily; and hence is far more violent on the north than on the south coast of the island, about Palermo, and also in the neighbourhood of Naples. The *Solano*, the hot wind of Spain, he refers likewise to the plains of Andalusia.

X. Storm-winds result from a very considerable disturbance in the equilibrium of the atmosphere, arising principally from a rapid condensation of vapour. When they occur upon a great scale, electricity is very powerfully developed with the precipitation of immense quantities of rain. Barometric oscillations indicate their approach. Scoresby affirms that he predicted tempests seventeen out of eighteen times, by consulting the barometer. They are generally observed at the period of the greatest heat of the day; but in the interior of continents and in mountainous countries nocturnal storms are by no means uncommon. It is stated by Eschwege, that no idea can be formed of the violence of a nocturnal storm in the virgin forests which clothe the mountains of Brazil.

XI. Tropical storms frequently exhibit terrific violence, tearing up forests, levelling solidly-built houses; and human life has been largely sacrificed in the war of elements. They are variously termed hurricanes, tornadoes, and tyfoons; seldom occur nearer the equator than 8° or 10°, or beyond the tropics; and are most tremendous in the vicinity of continents and islands. It appears from recent investigations that hurricanes, tornadoes, and tyfoons are to be regarded as great whirlwinds in motion, the meeting of two opposite winds producing the whirlwind. According to M. Dove, the rotatory motion of the air is from right to left in the northern hemisphere, or in a direction *opposite* to the hands of a watch; from left to right in the southern hemisphere, or *with* the hands of a watch; gusts and lulls occurring in the vortices. It is further ascertained that the northern hurricanes travel in an oblique direction from the equator towards the north pole, while the southern hurricanes move obliquely from the equator towards the south pole.

There are three well-known hurricane regions,—the West Indies, the Indian Ocean, and the Chinese Sea.

The general course of the West Indian hurricanes is from the Leeward Islands W.N.W., passing around the shores of the Gulf of Mexico or across it, then following the Gulf stream and terminating in the Atlantic, or exhausting their fury in the United States. From Oct. 3, 1780, to Aug. 25, 1837 inclusive, 38 hurricanes occurred in this region, in the following months: in June, 1; July, 4; August, 13; September, 10; October, 8; exclusive of 2, the months of which have not been recorded. Thus they are very rare in June; most frequent in August. The only instance in June occurred in 1831, when Trinidad, Tobago, and Grenada were devastated, before supposed to be exempt from hurricanes.

The hurricanes of the Indian Ocean come from the N.E., near Sumatra and Java, and travel to the S.W. towards Rodriguez and the Mauritius. They occur chiefly from December to April, the hot season in that hemisphere; are very rare in November and May; and are quite unknown during the other months of the year.

In the Chinese Sea, hurricanes, there styled tyfoons, range from the shore to about long. 150° E. They occur from June to November, after an interval of three or four years.

The progressive motion of hurricanes is very various in its rate, but very slow as compared with the rotatory velocity of the wind at the circumference. Their diameter has been noted at 1000 miles, and their track at 3000 miles.

XII. In mean and high latitudes storms are commonly far less extensive and violent than in tropical districts. There are, however, local storm regions, where the winds often blow with the fury of the hurricane, as in the Gulf stream, the vicinity of Cape Horn, and the territory of Buenos Ayres.

In the latter locality, the *pamperos*, or south-west winds, which originate among the snow of the Andes, rush with incredible velocity over the level pampas, and so suddenly set in that persons bathing in the Plata have been drowned, finding it impossible to regain the shore.

XIII. We frequently observe in serene hot weather the whirling motion of the air, betrayed by sand and dust ascending in spiral columns. Larger and stronger whirls carry up leaves and straw, and even buildings lying in their course. These whirlwinds are generally caused by the struggle of two winds meeting at an angle, in the same manner that eddies and whirlpools are formed in water, by two currents being obliquely impelled against each other.

Commencement of the Monsoon.

Whirlwinds usually form a double cone. The upper cone has the vertex inclining downwards, while the point of the lower cone is directed upwards. In passing over the sea, lakes, and rivers, the water is raised by the lower cone in a spiral column, often to the height of several hundred feet, while the clouds are brought down by the upper cone, and a *water-spout* is formed. The two cones have frequently been observed to separate and re-unite; and in the Mediterranean as many as sixteen water-spouts have been seen at the same time. In water-spouts on land the upper cone consists of a mass of clouds, and the lower cone of sand, dust, and other bodies found on land. Deluges of rain accompany their disruption.

XIV. The winds perform a grand and important part in the economy of Nature. They moderate the severity of northern climates by bringing to them the heat of the south; promote the fecundation of flowers by agitating the branches of plants, at the same time diffusing the productions of the vegetable kingdom, by the transport of pollen and seeds, to great distances; and but for the aërial currents rain would be confined to maritime countries, the interior of continents becoming arid deserts. They serve also to renew the air of cities, where causes of vitiation largely operate, and prevent that stagnation of the atmosphere which tends physically and mentally to deteriorate the human race.

Goitre, a disease of the thyroid gland, ending in cretinism, a malady of the brain and nerves, attended with malformation of the skull, common in those valleys of the Alps and Pyrenees which are closely confined by rocky heights, is commonly ascribed to the air wanting free circulation, and thereby becoming in summer excessively heated and loaded with moisture. The philosophical traveller Erman found goitre prevalent, and a healthy breed of Russians brought in two centuries to the very brink of cretinism in certain parts of the valley of the Lena, where the strata of air are checked and confined between steep and parallel heights, producing a marked effect upon temperature and humidity in the district. He observes, "The atmospheric phenomena of the valley of the Lena recal to mind in every particular the excellent description of the Cretin valleys in the district of Salzburg, given by Wenzel. The luxuriant growth of trees, which Fodere found to accompany cretinism in the valley of Maurienne, distinguishes also all the hollows in the rocks along the valley of the Lena; for here, between the parallels of 55° and 57° 7′, and close to the coldest meridian on the earth, a variety and beauty in trees of the pine family must be allowed to be as remarkable as the pistacios and laurels at the foot of Mount Cenis. The goitres on the Lena are most conspicuous between 1115 and 645 French feet above the sea, showing another instance of agreement with experience in Europe, where the height of 1170 feet above the sea appears to be the most favourable for cretinism, and that of 795 feet to be the lowest limit of the phenomenon." Cretinism is said to be more recent in the Pyrenees than in the Alps; but it may be traced in them back to the eighth century, when it attacked the Visigoths, who had been driven by Clovis into the valleys of that chain.

Loch Achray.

CHAPTER III.

HYDROMETEORS.

I. Upon exposing a vessel of cold water in the open air on a hot day, the quantity of the fluid soon sensibly diminishes, or it evaporates, being converted by the heat into invisible vapour, and diffused through the air. In like manner evaporation transpires upon a grand scale from the great collections of water on the earth's surface, the oceans, lakes, and rivers, as well as from the moist ground, subject to diurnal and annual variations, because depending mainly upon temperature.

Diurnal variation.—In summer, and throughout the year, the quantity of vapour diffused through the air is at its minimum in the morning before sunrise. Evaporation increases as the temperature rises with the ascent of the sun; but before mid-day, or at nine o'clock according to Müller, ascending currents, occasioned by the strong heating of the ground, carry the vapours towards the upper parts of the atmosphere, so that the quantity of water contained in the lower strata of the air diminishes, without, however, attaining a minimum so low as that of the early morn, though the evaporation keeps pace with the increasing heat of the day. This diminution continues till towards 4 p.m., when the ascending current ceasing, the quantity of water in the lower strata of air again increases, till towards nine o'clock the decreasing temperature puts a stop to the further formation of vapour.

In winter, owing to the diminished power of the sun producing feeble ascending currents, there is but one maximum observed in the quantity of vapour, at about 2 P.M.; and one minimum, just before sunrise.

Annual variation.—In January the quantity of vapour, like the mean temperature of the air, is at its minimum; it increases from that period, and in July attains its maximum; it then decreases to the end of the year. It appears, however, from Professor Daniell's Table, that in the vicinity of London the largest amount of water is elevated into the atmosphere in June:

Month.	Inches.	Month.	Inches.
January	0·413	July	3·293
February	0·733	August	3·327
March	1·488	September	2·620
April	2·290	October	1·488
May	3·286	November	0·770
June	3·760	December	0·516

II. The amount of moisture in the air is an element on which the life of plants and animals as much depends as on temperature; and the character of the landscape, with the development of disease, is greatly influenced by the dryness or humidity of the atmosphere. The amount varies in different regions of the globe. As resulting from the action of heat on water, the quantity of vapour diminishes with the temperature from the equator to the poles. It decreases also as we pass from coasts into the interior of continents, the degrees of temperature being the same, because in the one situation water is abundant, and in the other scarce.

That the air is habitually drier in continental than in maritime countries is confirmed in the interior of the United States, in the middle of the plains of the Orinoco, in the steppes of Siberia, the deserts of Asia and Africa, and the central parts of New Holland. The greater clearness of the sky in continental countries is a proof of the same fact.

In the temperate zone, in general, the annual evaporation is estimated at between 36 and 37 inches of water. In the torrid zone, at Guadaloupe, it has been found to amount to 97 inches, and at Cumana to 100 inches.

III. The air is only capable of receiving a certain quantity of vapour. Its capacity depends upon its temperature, and is invariable in its extent at the same temperature. When as much has been taken up as from its temperature it is capable of receiving, the air is said to be at the point of saturation, and any further supply is resolved into a fluid condition, or floats in a state of cloud and mist. When, too, the atmosphere is saturated, the least decrease of temperature is followed by the precipitation of moisture; hence arise aqueous or hydrometeors, which result from the same causes, but assume different forms,—as mists, clouds, rain, snow, hail, dew, and hoar-frost.

The varying capacity of the atmosphere to receive vapour removes an apparent discrepancy between our impressions and physical facts. Thus, when evaporation proceeds rapidly, and wet objects speedily become dry, as in summer, we say that the "air is dry," although the absolute quantity of water contained in the air is then at its maximum. But in summer, when the temperature is high, the capacity of the atmosphere to receive vapour is the greatest; and on an average it is further removed from the point of saturation at that period.

IV. Mists and fogs are formed when the air is saturated, and generally when the moist soil, or the water of lakes and rivers is warmer than the air, the vapours from which are immediately condensed, like the vapour of expired air in winter, which becomes condensed, and visible on its escape from the mouth. Mists differ in no respect from clouds except in position, being on the surface of the earth, instead of being suspended at a height in the atmosphere. Travellers, on the summit of high mountains, frequently remark upon the fog intercepting their view, while the inhabitants of the valleys below speak of clouds clothing the mountain crests.

The thick mists which prevail in the neighbourhood of Newfoundland arise from the warm waters of the Gulf stream, which flow to that locality, the temperature of which is much higher than that of the saturated air.

Soon after sunset, in calm and clear weather, mists are frequently formed over the beds of lakes and rivers, while the adjacent land is free from them. This arises from the land more rapidly losing its heat by radiation than the lake or river. The air over the land necessarily becomes the coldest; and when the situation of the ground is such as to bring the cold air of the land over the warmer water, a fog confined to its expanse ensues. On descending the Danube in June, Sir H. Davy found mist regularly forming over the river in the evening, when its temperature was from 3° to 6° higher than that of the air on its banks, and none at all when the temperature of the air on the banks surpassed that of the river. His observations below Passau, where the Inn and Ilz join the Danube, show the different state of the rivers as it respects fog, owing to their difference of temperature, that of the air being the same:

Temp. of the air on the banks.	Temp. of the rivers.	State of the rivers.
54	Danube 52°	Thick fog on the whole breadth.
	Inn, 56½°	Slight fog.
	Ilz, 56°	Haziness.

Kaemtz, during the finest weather on the Faulhorn, observed the lakes of Switzerland covered with fogs of various densities. That over the lake of Zug was very thick, while a stratum of light vapour rested only partially upon Lake Brienz. The phenomenon occurred so frequently as not to be referrible to an accidental cause. He remarks, in explanation, that the Lake of Zug is very deep, while its feeding streams do not come directly from the region of eternal snows; that its temperature must therefore be higher than that of the Lake of Brienz, into which the Aar is precipitated immediately after having come from the glaciers of the Grimsel; that thus more vapour is raised from the Lake of Zug than from that of Brienz; and that at equal temperatures of the air the former is more easily covered with fog than the latter.

V. Clouds are masses of visible vapour like mists, occurring at a distance from the surface of the earth, floating under the direction of the winds, exhibiting an endlessly diversified outline, a very varying density, and appearing at different elevations. The denser clouds are usually formed towards noon, when the vapours are raised up by the ascending currents of air, and then condensed by the lower temperature of the upper regions. Notwithstanding the varied dispositions of clouds, they may be classified under a few principal types, first distinguished and named by Mr. Luke Howard.

CLASSIFICATION OF CLOUDS.

The following three primary forms are noticed. Mr. Foster's English names are placed beside the Latin nomenclature of Mr. Howard.—See Plate of Clouds.

Cirrus—Curlcloud. Plate, fig. 1.—The cirrus is composed of white thin filaments, variously disposed, in the form of woolly hair, a crest of feathers, or slender net-work. These clouds are known in Germany under the name of *Windsbaume*, wind-trees. Their appearance often precedes a change of weather,—rain or wind in summer, frost or thaw in winter.

Cumulus—Stackencloud. Fig. 5.—This modification of cloud, usually under the direction of the surface winds, presents itself in the form of a vast hemispherical heap of vapours, resting on an horizontal base; hence its name, *cumulus*, a heap or pile, and *stackencloud*, masses of vapour stacked into one enormous fabric. This may be called the summer-day cloud, from its frequent occurrence at that period, resembling a mountain of snow when lighted up by the beams of the sun. It usually begins to form early in the morning, enlarges as the day advances, attains its greatest magnitude when the temperature of the day is at its maximum, decreases as the sun declines, and breaks up towards sunset.

Stratus—Fallcloud. Fig. 7.—This cloud consists of horizontal bands contiguous to the surface of the earth. It belongs to the night, forming at sunset and disappearing at sunrise.

To the above primary varieties four transition or composite forms are added.

Cirrocumulus—Sondercloud. Fig. 2.—This name designates the feathery accumulated cloud, familiarly known as fleecy, intermediate between cirrus and cumulus. It consists of small orbicular patches, arranged in extensive beds, the component parts being quite distinct or asunder.

Cirrostratus—Wanecloud. Fig. 3.—Bands of filaments more compacted than those of the cirrus compose this cloud, lying inclined, or disposed in horizontal strata. It is sometimes seen cutting the sun on the moon's disc with a dark line.

Cumulostratus—Twaincloud. Fig. 4.—Two or more cumuli united together, and resting on a common stratum form this cloud, the most magnificent variety, which often exhibits a copper tinge, indicating a highly electrical condition of the atmosphere, and precedes the thunder-storm. The cumulo-stratus is often seen cut by the cirro-stratus, as in the Plate.

Nimbus—Raincloud. Fig. 6.—Any of the preceding modifications may pass over into the actual rainy cloud, first exhibiting a great increase of density and a bluish black tone of colour, then putting on a lighter shade, or gray obscurity, and becoming fringed at the edges.

HEIGHT OF CLOUDS.

The clouds are most frequently higher within the tropics than in the temperate zones; and in the temperate zones they are commonly higher in summer than in winter.

During five years, Mr. Crosthwaite examined the height of clouds, at Skiddaw, a mountain in Cumberland 3022 feet above the level of the sea. The number of observations made amounted to 5371. Of these, there were 3273 times in which there were clouds below the summit of Skiddaw; and 2098 times in which the clouds were either above it, or there were no clouds at all.

The *cirri* are the highest clouds. Dalton gives their range as frequently from 3 to 5 miles. Kaemtz's measurements at Halle assign to them also a frequent elevation of nearly 5 miles. He states, that during a stay of eleven weeks within sight of the Finsteraarhorn, upwards of 14,000 feet high, he never observed any *cirri* below the summit of the mountain. Travellers have often remarked, that on the most elevated peaks, these clouds appear the same as from the plains. It is highly probable that they consist of flakes of snow.

SUSPENSION OF CLOUDS.

Composed of vesicular vapours, or minute globules of water filled with air, resembling soap-bubbles, the suspension of the clouds aloft seems extraordinary, since they are specifically heavier than the medium in which they float.

A vesicle of vapour falls *in vacuo* with a great required rapidity. It falls also in a perfectly calm atmosphere, yet very slowly, experiencing resistance from the air. But in descending, the vesicles soon reach warmer strata of air which are not saturated, where they dissolve, and are lost to view; while, at the same time, new vesicles are formed above. Thus the component parts of a cloud are often slowly descending, and yet the cloud appears to be suspended motionless in the air, its lower limits being continually dissolved, and the upper renewed.

The agitations of the air, though moving in a horizontal direction, contribute to the suspension of the clouds, in the same manner that we observe dust and soap-bubbles borne to great heights and distances by the winds.

Ascending currents of heated air exert also a force directly opposed to the fall of clouds. Hence the mighty masses of cloud, *cumuli*, attain their greatest elevation about noon, when the temperature of the day is the highest, and the ascending current is the strongest. Towards evening, as the temperature declines, and the ascending current becomes feeble, these clouds descend, and are dissolved on reaching the lower and warmer regions of the atmosphere.

VI. Rain is produced by the continued condensation of vapour, its vesicles becoming larger and heavier, separate globules merging together, forming actual drops of water, which are precipitated towards the earth. Rain may have begun to fall, and yet not reach the ground, being resolved again into invisible vapour on arriving at strata of air removed from the point of saturation. For the same reason, rain-drops may become smaller in their descent, a portion being evaporated, and less rain arrive at the general surface than at a certain height. Usually the drops increase in their descent, bringing with them the low temperature of the upper regions, and condensing on their surface the vapour in the lower and warmer strata of the atmosphere. Hence a rain-gauge placed on the ground will collect a larger quantity of water in a given time than another placed at some height above it, the drops increasing by the condensed vapour added to them in the space between the two points.

At the Paris Observatory, there is a rain-gauge on the terrace at the roof of the building, and another on the ground in the court. The gauge of the terrace is 27 metres above that in the court, about 34 yards. During ten years, from 1817 to 1827, the mean annual depth of rain as observed in the court was 56·371 centimetres, or 22·21 inches; and as observed on the terrace 50·471 centimetres, or 19·88 inches.

VII. Instances of rain without clouds are by no means rare. They may occur when the equilibrium of the atmosphere in its upper regions is intensely disturbed by very cold and warm currents of air coming into collision, condensing the vapours into water without going through the transition state of vesicular vapour.

M. de Nevew was in a shower at Constantinople for ten minutes when the sky was perfectly serene. M. Babinet observed the same phenomenon at Paris, May 2, 1842. On the following May 11, M. Wartmann, while in the Rue de l'Hôtel de Ville at Geneva, was surprised by an unexpected and abundant shower, so as completely to wet the pavement of the street, while the most beautiful azure prevailed over head. He mentions the singular fact in a letter to M. Arago, that while the rain from a serene sky at Paris on May 2, consisted of very small and very cold drops, the similar rain at Geneva on the 11th, was formed of drops very large and warm.

VIII. The contents of a single shower vary greatly in different localities, and at different periods in the same place. Kaemtz states, that when the quantity of rain that falls per day exceeds three centimetres, less than an inch, the low plains of Europe are soon inundated.

The following are examples of very extraordinary showers:

1822. Oct. 25, at Genoa, 30 inches of rain fell in the 24 hours. The effects of this deluge in the neighbourhood were proportionate to the magnitude of the cause.

1826. Nov. 22, at Naples, in 37 minutes, Professor Fable observed a fall of $\frac{9}{10}$ of an inch.

1827. May 27, at Geneva, there fell 6 inches of rain in 3 hours.

1829. Aug. 3, at Perth, there fell $\frac{4}{5}$ of an inch in half an hour. At Huntly Lodge, $3\frac{3}{4}$ inches fell in 24 hours, or about $\frac{1}{8}$ of what annually falls in the district.

1839. June 4, at Brussels, a rain fell which was only very heavy for three hours, yet 112 millemetres, upwards of 4 inches were collected in the day, while from 1833 to 1838, not half that quantity had been known to fall at Brussels in the same time.

1841. ——, at Cuiseaux, a small town in the valley of the Saone, there fell 270 millimetres, about 11 inches, in 68 hours.

At Cayenne, Admiral Roussin collected 10 inches in 10 hours.

In excessively rainy seasons, especially when harvests are blighted, the ignorant are apt to infer a deterioration of climate. But on comparing different years, the annual amount of rain, like mean temperature, is remarkably stable.

IX. The following are general laws relative to the distribution of rain:—1. It decreases in quantity as we proceed from the equator towards the poles, because heat, the cause of vapour, diminishes. 2. It decreases as we pass from maritime to inland countries, because the land supplies a less quantity of vapour than the sea. 3. It decreases in the temperate zones, on eastern coasts as compared with the western, because the latter are first exposed to the western winds, which blow from the ocean, and discharge their moisture upon them; but within the tropics, it increases on eastern coasts as compared with the western, because of their exposure to the trade-winds. 4. More rain falls in mountainous regions than in level districts, because mountains arrest the course of the clouds, and a condensation of vapour ensues from collision with their cold summits.

1. The diminution of the average annual quantity of rain from the equator to the poles, appears from the Table, which contrasts the amount of places within the tropics and in mean or high latitudes:

Tropical Lat.	Inches.	Mean and High Lat.	Inches.
Mahabaleshwar, Western Ghauts	302·66	South Slope of the Alps	57·57
San Luis de Maranhao, Brazil	276·12	Charlestown, South Carolina	47·60
Parimaribo, Guyana	229·20	Rhone Valley	35·18
Sierre Leone, Guinea	189·69	North France aud Belgium	22·47
Cape Haiti, St. Domingo	127·88	Sicily	23·55
Granada, Little Antilles	103·41	Rome	30·00
Adam's Peak, Ceylon	100·00	Geneva	42·06
Columbo, ditto	99·21	North Germany	20·35
Havannah, Cuba	90·66	England (Dalton's Mean)	31·03
Bombay	80·04	Petersburg	17·05
Macao, China	68·30	Uleaburg, Finland	13·05
Annual quantity of Rain within the Tropics of the New World	115 inches.	Annual quantity of Rain in the Temperate Zones of the New World (United States)	37 inches.
Annual quantity within the Tropics of the Old World	76 „	In the Temperate Zone of the Old World (Europe)	$31\frac{3}{4}$ „
Average for the Tropics generally	$95\frac{1}{2}$ „	Temperate Zone generally	$34\frac{6}{8}$ „

But though the amount of rain is greater within the tropics than in the temperate zone, the number of rainy days is less, because two seasons divide the year—wet and dry; and during the dry season, entire months frequently pass away without a drop falling or a cloud being seen.

In the temperate zone also, in passing from south to north, the number of rainy days increases, although the intensity of rain diminishes;

Annual number of rain days in the	North of Syria	54
„ „	Strait of Gibraltar	68
„ „	Plains of Lombardy	96
„ „	Buda, Hungary	112
„ „	Plains of Germany	141
„ „	England and West France	152
„ „	Poland	158
„ „	Petersburg	169
„ „	Netherlands	170
„ „	East of Ireland	208

Average of rain days throughout the year, according to Müller:

Southern Europe	120
Central „	146
Northern „	180

Though on the east side of Ireland the rainy days amount to 208 in the year, a far less quantity of rain descends than what falls at Gibraltar in 68 days.

2. The decrease of rain as we recede from the seashore, and penetrate into continents, is exemplified in the interior of the United States, of the llanos of the Orinoco, of the Siberian steppes, of Australia, and on comparing the amount of precipitation in inland and maritime countries. It declines from an annual fall of between 30 and 35 inches on the shores of Great Britain and France to from 15 to 13 inches as the borders of Asia are approached. Mountain chains produce several exceptions to this rule.

The annual number of rainy days decreases also with the increased distance from the sea.

West coast of France	152
Interior of France	147
Kasan, Plains of the Volga	90
Interior of Siberia	60

3. The greater moisture on western than eastern coasts in the temperate zone, appears in our part of the globe, on comparing the rain-fall on our western and eastern shores, and on the coast of the Atlantic in general with the interior of Europe.

4. The excess of rain in mountainous districts, as compared with the amount in adjoining low and level countries, is sometimes very striking. Thus the annual average at Coniston and Keswick, among the hills of North Lancashire and Cumberland, is 84 and $67\frac{1}{2}$ inches, while 19 and 17 inches are registered for the flats of Norfolk and of Essex. On the plains of Great Britain the yearly amount of rain is 24·51, and among the mountain ranges 40·59 inches.

Proceeding from Paris to the Alps, the following differences occur in the annual amount of rain:

Paris	500 millimeters = 20 inches.
Valley of the Middle Rhine	21 „
Berne, at the foot of the Alps	43 „
Great St. Bernard, highest meteorological station in Europe	63 „

High mountain ranges sometimes occasion an excess of rain in the country on one side, while a vast reduction occurs on the other. Nowhere is this better exemplified than in Norway and Sweden, divided by the Scandinavian Alps. At Bergen, on the Norwegian coast, there fall annually 82·12 inches, or more than at any other city in Europe, and more than the amount at many places within the tropics. The clouds brought from the Atlantic by the prevailing south-west winds, are arrested by the mountains and confined in the fiords, where they accumulate, and lose their moisture, as it were, by mechanical compression, so that the sea winds discharge nearly all the water held in suspension in passing the mountains. Hence it frequently rains for entire days in Norway, while only a few drops fall in Sweden, on the opposite side of the chain; while the mean annual fall in the latter country is only 20 inches.

X. There are extensive tracts of the globe in which rain is unknown; in some districts it falls periodically; and in others, precipitation may be said to be constant:—1. The Rainless Regions of the New World comprise portions of California and Guatimala, the Mexican table-land, and the coast line of Peru: those of the Old World comprehend an immense territory, stretching from Morocco, through the Sahara, a part of Egypt, Arabia, and Persia, into Beloochistan, with another great zone, commencing north of the Hindoo-Koosh and Himalayas, including the table-land of Thibet, the desert of Gobi, and a portion of Mongolia. In these tracts there is either no rain at all, or only a very small quantity; so seldom occurring as to be quite a phenomenon. 2. The Regions of Periodical rain are within the tropics, and have seasons of extreme humidity alternating with excessive drought. The length of time of the rainy season differs in different districts, but lasts generally from three to five months. North of the equator, the rains fall during the northern declination of the sun, and commence south of the equator with its southern declination; except in India, where the rainy and dry seasons are regulated by the monsoons. 3. The Regions of Constant Precipitation, in which rain falls irrespective of times and seasons, at any hour of the day, or on any day of the year, are extra-tropical; except the Zone of Calms, a narrow belt between the periodic rains of the northern and southern hemispheres, in which heavy showers occur almost daily.

In the rainless regions, consisting for the most part of rocky and sandy deserts, precipitation is unknown, because, as Kaemtz remarks, the highly heated atmosphere does not contain sufficient moisture to admit of it, under any decrease of temperature.

The periodical rains commence at Panama, on the west coast of America, in the early days of March: in Africa, near the equator, and on the banks of the Orinoco, they begin in April: in the countries watered by the Senegal, and at San Blas in California, they begin in June. The violence of these tropical showers may be inferred from the large annual amount of rain, and from its fall being limited to a few months, and to a few hours during the day. The drops are enormous, very close together, and fall with such rapidity as to occasion a sensation of pain if they strike against the skin. Erxleben mentions drops of rain at the equator an inch in diameter. Though the nights are almost always serene, the showers occurring in the day time, yet in some districts it rains also in the night, and even more than during the day.

Beyond the tropics, where the periodicity of rain disappears, its quantity is not uniformly distributed throughout the year; but while some portions fall in each of the four seasons, the larger amount descends in some particular season. Thus, designating the annual quantity by 100, the following is the seasonal proportion at the places mentioned:

	Madeira.	Lisbon.	Mafra.
Winter	50·6	39·9	53·4
Spring	16·3	33·9	27·5
Summer	2·8	3·4	2·7
Autumn	30·8	22·8	16·4

The winter rains are here comparatively abundant, while the summer rains are insignificant. It is the same on the N.W. coast of Africa, and at the Canary Isles; but in Germany, at Petersburg, and in the interior of Siberia, a far larger quantity of rain falls in summer than in winter.

Europe may be divided into three provinces of seasonal predominant rains:

1. Province of the winter rains—comprising those portions of the continent which are nearest to Africa, the south of Portugal, of Spain, of Italy, and of Greece.

2. Province of the autumn rains—including the remainder of southern Europe, with the west and north coast of France, the Netherlands, Great Britain, and Norway.

3. Province of the summer rains—consisting of interior Europe, with Denmark Sweden, and Russia.

The Table shows the monthly amount of rain, in inches, in the year 1846, at the places mentioned.

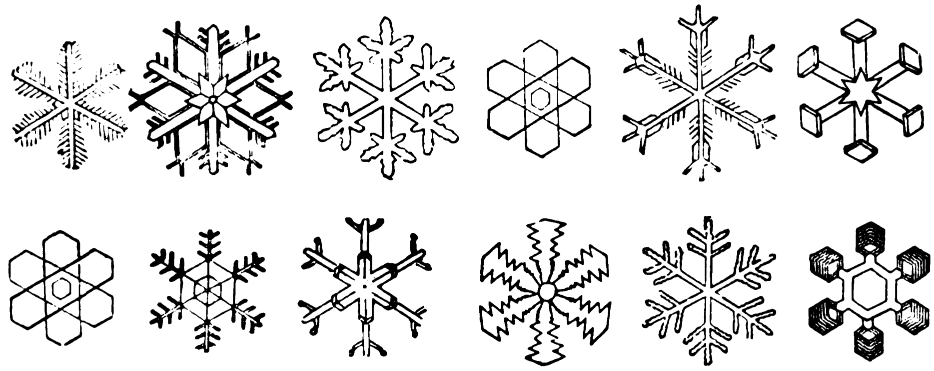
Places.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total for the year.
Ackworth, Yorkshire	2·145	0·510	0·730	5·945	0·840	2·000	2·500	4·070	0·900	3·890	1·575	0·970	26·075
Chiswick, Middlesex	2·850	1·470	1·090	3·930	1·350	0·800	1·780	4·500	1·760	5·540	1·430	1·210	27·710
Empingham, Rutland	2·100	0·520	0·700	3·400	1·250	0·400	1·990	3·650	2·050	4·950	0·800	1·050	22·860
Epping, Essex	3·915	1·173	1·240	2·744	1·135	0·591	1·324	3·667	2·702	5·422	1·305	1·044	26·062
Falmouth, Cornwall	5·923	1·888	4·671	1·572	3·119	1·492	3·875	1·756	1·444	5·473	3·909	3·732	38·854
Greenwich, Kent	3·090	1·305	1·025	2·910	1·610	0·165	1·740	5·210	1·917	5·765	1·330	1·180	27·274
Keswick, Cumberland	5·112	4·840	8·542	4·546	1·724	4·710	9·320	4·676	2·902	12·248	6·472	2·586	67·678
Retford, Notts	2·375	0·280	1·360	5·550	1·145	0·875	3·450	4·175	1·750	3·900	0·785	0·575	26·220
Thwaite, Suffolk	2·620	0·710	0·810	3·150	1·100	0·680	1·790	2·940	1·520	3·200	1·020	0·860	20·470
Whitehaven, Cumberland	4·604	2·007	4·460	2·848	2·317	2·311	9·061	4·066	2·857	7·962	4·671	1·950	49·134

At the Royal Observatory, Greenwich, in 1846, there was collected by the rain-gauges:

177 feet above the level of the sea	22·63 inches.
155 „ „ „	25·29 „
35 „ „ „	24·37 „

XI. Snow is nothing more than the frozen visible vapour of which the clouds are composed. A quantity of very minute crystals of ice having been formed, they are enlarged by the condensation and freezing of vapour, and merging together constitute flakes, which increase in size during the period of their descent. When the quantity of moisture separated from the atmosphere is not great, flakes are not formed, but the crystals remain detached, float in the air, and give rise to what is called the *frost smoke* observed in high latitudes. Snow falls to the ground when the temperature of the atmosphere down to the earth's surface is sufficiently cold; but if the lower strata of air are too warm it melts in traversing them, and then we have rain below while it snows above. Hence snow is never seen at the level of the sea within the torrid zone, and it becones more abundant with the decrease of temperature towards the poles.

Flakes of snow are best observed when placed on objects of a dark colour, cooled below the freezing point, a method first described by Keppler, who expressed the highest admiration of their structure. The minute crystals exhibit an endless diversity of regular and beautiful forms, of which some examples are given, observed by Scoresby, who has described ninety-six varieties. Kaemtz states that he has met with at least twenty forms different from those figured by Scoresby; and they probably amount to several hundreds. It will be seen, however, at a glance, that the annexed forms are all essentially referable to a regular hexagonal star, and consequently snowflakes belong to the hexagonal system of crystals. Kaemtz observes that flakes which fall at the same time have generally the same form; but if there is an interval between two consecutive falls of snow, the forms of the second are observed to differ from those of the first, although always alike among themselves.

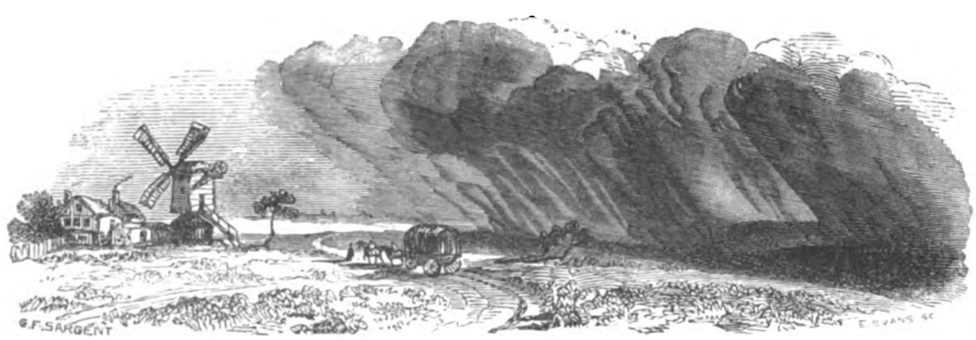


Various forms of Snow Crystals.

The limits of the fall of snow at the level of the sea in the northern hemisphere are generally the parallel of 30° in America, which cuts the southern part of the United States; 43° in the centre of the North Atlantic; and 36° in the Old World, the latitude of Algiers. But for some distance above these limits its appearance is rare and brief. The whole of Europe is included in the snowy region; but it becomes more abundant the further we recede from the Atlantic into the interior of the continent. Snowflakes never fall at Malta, are very infrequent at Gibraltar, and scarcely ever seen at Seville. The increase in the average annual number of days of snow from south to north is as follows:

	Days.		Days.
Rome	1½	Paris	12
Florence	1⅓	Carlsruhe	26
Venice	5½	Copenhagen	30
Milan	10	Petersburg	171

In February, 1836, a fall of snow occurred at Canton, in latitude 23° N, a fact without precedent in the memory of the oldest Chinaman.



Thunder Storm.

XII. Hail is one of the most obscure problems of meteorology. It no doubt often consists simply of raindrops more or less suddenly frozen by exposure to a temperature below the freezing point; yet true hailstones are not transparent ice, but have usually an opaque snowy nucleus, resembling a granule of sleet, sometimes coated with alternating layers of ice and snow. Sleet seems to be the germ of hail, changed in form and increased in size during its descent in the atmosphere. The great difficulty, however, is, that during fine seasons and the hottest days such intense cold should be suddenly produced as the phenomenon of hail indicates; and that certain countries, as some parts of France, should be almost annually ravaged by considerable falls of opaque ice, from which adjacent localities are almost wholly free. These are circumstances which have not been yet satisfactorily explained, though probably dependent upon electricity, which is almost always powerfully developed during hailstorms.

Hailstones are variously pear-shaped, flat, and angular; but most commonly rounded. When of considerable size they fall with great velocity, ploughing up the earth like musket balls, destroying the standing corn, stripping the trees of their foliage, penetrating the roofs of houses, and killing poultry, sheep, and even larger animals. Many instances are well authenticated of their circumference amounting from 6 to 9 inches, their weight from 12 to 14 ounces; but much larger masses are recorded. June 15, 1829, the hail beat in the roofs of the houses at Cazorta, in Spain,—some of the hailstones weighing 2 killogrammes, or upwards of 4lbs. avoirdupois. In Hungary, May 8, 1832, a block of ice fell, about 39 inches in breadth and length, and 27 inches in depth. An equally large block fell near Seringapatam, towards the close of the reign of Tippoo Saib. Mr. Darwin mentions a fall of hail in the state of Buenos Ayres which killed a large number of the wild animals, deer, and ostriches. These enormous masses are either the fragments of a thick sheet of ice suddenly formed, and broken in the atmosphere in falling, or they are due to the agglomeration of a great number of hailstones in their descent.

Hail falls most frequently by day, and soon after noon, at the time of the greatest diurnal heat. Nocturnal hail, especially towards midnight, is rare. Like rain, it is more common in some seasons of the year than in others. Associating hail and sleet, and representing the annual number of showers by 100, Kaemtz finds for the different seasons the following proportionate numbers:

	Winter.	Spring.	Summer.	Autumn.
England	45·5	29·5	3·0	22·0
France	32·8	39·4	7·0	20·7
Germany	10·3	46·7	29·4	13·6
Russia	9 9	35·5	50·6	13·0

Thus in England the relative amount of hail is large in winter and small in summer, while in Russia it is exactly the reverse.

A peculiar noise, distinct from that of thunder, has frequently been noticed a few seconds previous to the descent of hail. It is mentioned by Aristotle and Lucretius, among the ancients. Tessier heard it in France, July 13, 1788, when it was louder than the thunder; and Kalm at Moscow, April 30, 1744; Peltier at Ham, in the department of La Somme, heard a sound as if occasioned by the arrival of a squadron of cavalry at full gallop, immediately before a terrible hailstorm fell on the town. It is supposed to be due either to the conflict of contrary winds, or to the hailstones dashing violently against each other in their descent.

Hail showers are commonly over in a few minutes, very rarely lasting so long as a quarter of an hour, though the quantity of ice precipitated is sometimes enormous, covering the ground to the depth of several inches. The breadth of their course is often very narrow in proportion to its length. The storm of August 13, 1832, which came from Holland, traversed the Meuse, and destroyed all the crops along the Rhine through a space about 70 miles long, but not more than 6 or 7 miles wide. Tessier has minutely described the hailstorm of July 1788, memorable for the havoc it caused in France. It traversed the country from S.W. to N.E., in two parallel belts, extending from 400 to 500 miles in length, by a mean width of only 9 miles. The belts were distant from each other about 15 miles, and in this intermediate space no hail fell, but only heavy rain.

Hail rarely occurs in higher latitudes than 60°. It is seldom seen within the tropics at the sea level. A shower at Martinique, in 1721, excited universal astonishment. But at elevations of above 2000 feet it becomes more common, so that its rarity at a lower level is owing to the hailstones melting into rain as they descend.

In the St. Bernard, and other high regions of the Alps, prodigious falls of snow are the ordinary phenomena of the winter season. They occur in sudden storms, and being drifted on the ground by the winds, the path of the traveller is speedily blocked up by the accumulations. The spaniels of the St. Bernard have become celebrated through the civilized world for the fine intelligence they display in discovering and aiding the perishing traveller, and informing their human allies of his position by their peculiar bark.

XIII. Dew, the moisture precipitated during the night in the form of minute globules on the surface of plants and other bodies, is the effect of these bodies being cooled by nocturnal radiation several degrees below the temperature of the air in contact with them. Chilled by the cold embrace, the aërial particles are no longer able to support the same quantity of humidity in the state of transparent elastic vapour, and a portion is deposited. It is precisely the same phenomenon occurring on a great scale, as the precipitation of vapour on a bottle of wine taken from the cellar, or a decanter of water fresh filled from the well, and brought into a heated room.

The following are the chief circumstances connected with the formation of dew:

1. Dew is produced for the most part on calm and serene nights; an observation first recorded by Aristotle. The reason is, that only in the absence of clouds, is the radiation of the earth's heat towards the sky conducted so powerfully as to cool it sufficiently below the temperature of the contiguous air. When the heavens are overcast, the heat radiated, which would otherwise go off into free space, is returned by the clouds to the earth, and thus the necessary decrement in its temperature is prevented. There is no dew, however, when the sky is cloudless if the wind is brisk, because the air in contact with the soil suffers displacement before it can be cooled to the dew point. But a gentle motion of the air facilitates the disengagement of dew, by bringing fresh portions of the saturated atmosphere into contact with the cold surface of the earth.

2. Dew is formed most abundantly on objects perfectly exposed to the sky, for whatever acts as a shelter impedes radiation. Hence there is less dew in cities, where the houses screen the sky, than in the open country. Plants, also, placed under a tree are much less moistened than the grass in the middle of a field.

3. Dew is deposited much sooner and more abundantly on certain objects than on others, because all bodies have not the same capacity for radiating heat, some parting with it much more rapidly and perfectly than others. Hence some objects will be densely covered with dew, while on others adjoining it will be scarcely perceptible. Plants are sooner bedewed than the earth; sand sooner than hard soil; glass sooner than metals; and chips sooner than wood.

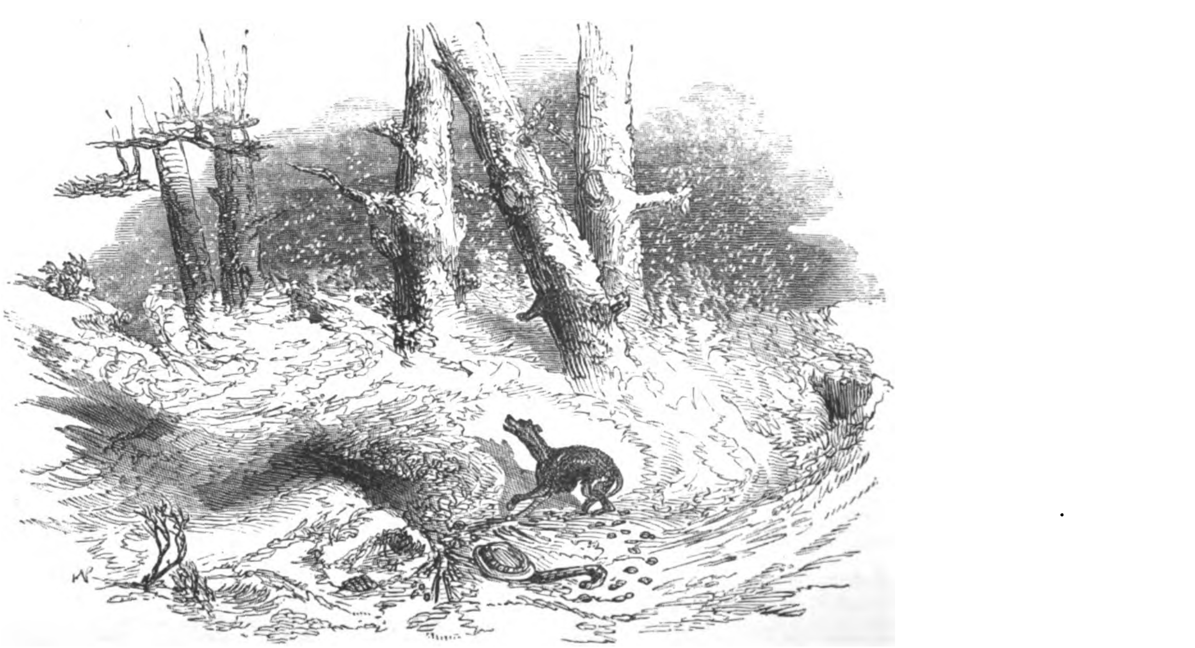
4. Dew is deposited during the whole night, circumstances continuing favourable, and not, as the ancients imagined, in the morning and evening only. When one portion of the air has yielded its moisture, it is removed, in consequence of that agitation which exists in the stillest state of the atmosphere, and succeeded by another having its quantity of water undiminished.

6. Dew is most abundant in maritime countries. The atmosphere, in the interior of large continents, has not the amount of humidity requisite for its production, except near great lakes or rivers. It forms most copiously with us in spring and autumn, because in these seasons there are the greatest differences in the temperatures of day and night. The average annual quantity over all Great Britain, is estimated at a depth of 5 inches, being about $\frac{1}{7}$th of the annual amount of precipitation, or about 22,161,337,355 tons, taking the ton at 252 imperial gallons

The preceding remarks show the inaccuracy of the popular expressions of the dew falling or rising. It is simply deposited, it may be upon an *under* surface which nothing by falling can touch, or upon a *side* surface which nothing by falling or rising can reach.

The dew-point is the degree of the thermometer at which the vapour of water present in the atmosphere, on being exposed to a decrease of temperature, begins to be precipitated. It is the same as the point of saturation. At the Royal Observatory, Greenwich, in 1846, the mean temperature of the dew-point was—in spring, 42·9; summer, 56·7; autumn, 48·4; winter, 36·7; and the year, 46·2.

XIV. Hoar-frost is the ice of dew. When the objects upon which the vapour of water is precipitated are cooled below 32°, the freezing point, the vapour can no longer be deposited in a fluid state, but in the form of icicles.



Snow Storm.

CHAPTER IV.

TEMPERATURE.

I. On observing the temperature of a place, as registered by the thermometer, it is found to be constantly fluctuating through a certain range, above and below a standard mean.

By the temperature of a place, meteorologists always mean, unless it is otherwise expressed, that of the air near the surface of the earth, as indicated by a thermometer efficiently protected from every kind of foreign influence.

Fahrenheit's thermometer is used by English observers; Reaumur's and the Centigrade on the continent; and as in translations of foreign scientific works, the degrees of the scale adopted are rarely converted into those to which the English reader is accustomed, it may be useful to compare their respective values.

Reaumur and the centigrade place the freezing point at 0, or zero; Fahrenheit, at 32. The boiling point on Reaumur's scale is marked 80; on the centigrade, 100; and on Fahrenheit, 212. Subtracting 32 from 212, we have 180° of Fahrenheit, equivalent to 100° centigrade, and 80° Reaumur. Each centigrade degree is therefore equal to $1\frac{4}{5}$°, or 1°·8; and each degree of Reaumur is equal to $2\frac{1}{4}$°, or 2°·25 of Fahrenheit. But after every conversion of the centigrade and Reaumur's degrees into Fahrenheit's, care must be taken to add 32° to that number, the freezing point of Fahrenheit, answering to 0, or zero, the freezing point of the foreign scales.

COMPARISON OF THERMOMETRICAL DEGREES.

Fahrenheit.		Centigrade.	Reaumur.
212°	water boils	100°	80°
200		93·33	74·66
180		82·22	65·77
160		71 11	56·88
140		60	48
120		48·88	39·11
100		37·77	30·22
80		26·66	21·33
60		15·55	12·44
50		10	8
40		4·44	3·55
32	water freezes	0	0
20		− 6·66	− 5·33
10		− 12·22	− 9·77
0		− 17 77	− 14·22

Degrees below the zero of each scale are termed negative, and are always preceded by the sign — *minus*. Those above the zero are termed positive, and are preceded by the sign + *plus*, or have no sign at all.

II. The temperature of the day in our latitudes is at its minimum a short time before sunrise, and attains its maximum about two o'clock in the afternoon, somewhat later in summer, and earlier in winter.

In hot climates, on the sea-coast, the maximum temperature frequently occurs before the culmination of the sun, because, about noon, a fresh breeze sets in from the sea, and lowers it.

III. The mean temperature of the day, is that which is equi-distant from the maximum and minimum. It is obtained by observing the thermometer at short intervals, as every hour, and dividing the sum of the degrees observed by the number of observations.

This is a laborious method, and experience has superseded the necessity for it.

A very correct result will be obtained by taking the mean of four readings of the thermometer, made at equi-distant hours. Thus, the sum of the degrees of temperature observed at 4 o'clock and 10 A.M., and at 4 and 10 P.M., divided by four, will give a value very little differing from the true mean. The result will be correct, according to Sir David Brewster, to $\frac{1}{10}$th of a degree.

M. Schouw recommends readings at 7 A.M., noon, and at 10 P.M., dividing the sum of the degrees by three, as a close approximation.

IV. When the mean temperature of all the days of the month has been found, the sum of the diurnal temperatures divided by the number of days, gives the mean temperature of the month. In like manner, the sum of the mean monthly temperatures in the year, divided by the number of months, gives the mean temperature of the year. The mean temperature of a place may be deduced with tolerable accuracy from a small number of annual means.

A very important result has been obtained from hourly observations at Leith, viz., that the half sum of the mean temperatures of homonymous hours, or hours of the same name. as 5 A.M. and 5 P.M., 6 and 6, &c., differs at an average only a quarter of a degree of Fahrenheit from the mean temperature of the year.

V. Temperature in equatorial regions is distributed tolerably equally over the whole year, owing to the days and nights being equal; but in mean and high latitudes, where the length of the day varies greatly, it takes a wide range above and below the annual mean. But in general, the mean annual temperatures vary very little.

DIFFERENCE BETWEEN SOME MINIMA AND MAXIMA TEMPERATURES.

Places.	Difference.	Authorities.
Rome	73°	Schouw.
Prague	109°	Strnadt.
Paris	108°	Arago.
Stockholm	108°	Nicander, Ronnow.
Copenhagen	90°	Bugge.
Petersburg	117°	Euler.
Moscow	126°	Stritter.

There are greater differences. During the Russian expedition to Khiva, in 1840, the thermometer fell to −43° centigrade, = −45° 4′ Fahrenheit; and for more than three months the mean temperature was between 1° 4′ and −0° 4′ Fahrenheit. In June, the temperature rose to 46° centigrade, = 114° 8′ Fahrenheit. Thus, in the course of a few months, the troops were exposed to a variation of 89° centigrade, or 160° Fahrenheit.

The slight variation in the annual means appears from the following comparison of twenty years at Geneva:

Years.	Mean Temp.	Years.	Mean Temp.	Years.	Mean Temp.	Years.	Mean Temp.
1796	49° 3′	1801	51° 1′	1806	51° 4′	1811	51° 6′
1797	50 5	1802	50 5	1807	49 3	1812	47 8
1798	50 0	1803	50 4	1808	46 9	1813	48 6
1799	48 7	1804	51 1	1809	48 9	1814	48 2
1800	50 5	1805	47 8	1810	51 1	1815	50 0

The highest mean varies only 3° 58′ from the lowest.

At Paris, in the years between 1803 and 1813, the variations from the standard mean, never went beyond it more than 3° 4′, or fell short of it more than 2° 9′. The variable produce of our harvests is owing more to a change in the distribution of heat through the different months, than to any difference in the annual supply.

For the mean temperature of important places in different parts of the globe, see Meteorological Map. At the Royal Observatory, Greenwich, in 1846, the monthly mean was as follows:

January	43° 8′	July	67° 2′
February	44 2	August	65 5
March	44 9	September	61 7
April	49 1	October	51 6
May	57 1	November	45 2
June	67 8	December	32 6

The mean of the year . . . 52° 5′

VI. In our latitudes July is on an average the hottest month, and January the coldest; July the 26th the hottest day, and January the 14th the coldest; and the mean annual temperature generally occurs on the 24th of April, and the 21st of October.

The approximation of the mean temperature of October and April to the annual mean appears from the annexed comparison:

Places.	Mean Temperature. Of the Year.	Of October.	Of April.
Cario	72° 5′	72° 3′	77° 9′
Algiers	69 8	72 1	62 6
Natchez	65 0	68 4	66 4
Rome	60 4	62 1	55 4
Milan	55 8	58 1	55 6
Cincinati	53 6	54 9	56 8
Philadelphia	53 4	54 0	53 6
New York	53 8	54 5	49 1
Pekin	52 8	55 4	57 0
Buda	51 1	52 3	49 1
London	50 7	52 3	49 8
Paris	51 4	51 3	48 2
Geneva	49 3	49 3	45 7
Dublin	48 6	48 7	45 3
Edinburgh	46 6	48 2	46 9
Gottingen	46 9	47 1	44 4
Franeker	52 3	54 9	50 0
Copenhagen	45 7	48 7	41 0
Stockholm	42 1	42 4	38 5
Christiana	41 5	39 2	42 6
Upsal	41 7	43 3	39 7
Quebec	40 0	42 8	39 6
Petersburg	38 2	39 0	37 0
Abo	40 3	41 0	40 8
Drontheim	41 7	39 2	34 3
Uleo	33 1	37 9	34 2
Umeo	35 8	37 8	34 0
North Cape	32 2	32 0	30 2
Enontekies	27 0	27 5	26 6
Nain	25 2	33 1	27 5

Thus, at Nain, on the coast of Labrador, the mean temperatures of October and April differ but little from the standard, 25° 2′, while the mean temperature of the warmest month, August, is 51° 80′, and of the coldest, February, −11° 28′. At Petersburg, in October and April, the divergence is still less from the annual mean, 38° 2′, while the mean of the warmest month, July, is 65° 66′, and of the coldest, January, 8° 60′.

VII. The Warmth Equator, or the line of the highest mean annual temperature, is not coincident with the geographical equator, but lies almost wholly to the north of it; occurring only to the south in the space between 150° W. long. in the Pacific Ocean and the Sunda Isles. It passes along the coasts of New Granada and Venezuela, in South America; intersects Africa from the Gulf of Guinea to the Abyssinian shore of the Red Sea; and cuts the extremities of the Arabian, Indian, and Malayan peninsulas. The minimum mean annual temperature, 81°, occurs in various places. The maximum, 87° 3′, the greatest heat hitherto observed, occurs at Massowah, in Abyssinia, in lat. 15° 36′ N., thus, much nearer to the northern tropic than to the equator.

VIII. Passing from the tropics towards the north pole, the temperature declines gradually, but much more rapidly in the new world than in the old, except under the eastern meridians of Asia, as shown in the following Table:

Latitude.	Temp. of the New World.	Temp. of Western Part of the Old.	Difference.
30°	66° 92	70°·52	3°·60
40°	54 ·50	63 ·14	8 ·64
50°	37 ·94	50 ·90	12 ·96
60°	23 ·72	40 ·64	16 ·92

IX. The lowest mean annual temperature, or greatest cold hitherto noticed, 1° 49′, was observed at Melville Island, lat. 70° 47′ N., during the celebrated northern expedition of Captain Parry, in 1819-20, and is deduced from observations made every two hours on board the Hecla, amounting to 4392. The mean temperature of the warmest month, July, was 42° 41′; of the coldest month, February, −32° 17′. The maximum daily temperature took place at 2 P.M. on July 17th, and was 60°: the minimum was registered at 4 A.M. on February 15th, and was −50°. But on the ice the lowest temperature registered was −55°; and for seventeen hours on February 14th and 15th, the temperature did not rise above −54°.

X. From the rapid decline of temperature in America and eastern Asia, as compared with Europe, it is inferred that the lowest temperature does not coincide with the geographical poles, but that not many degrees distant, and under meridians nearly at right angles with that which passes through the west of Europe, there are two points of greatest cold.

This idea, started by Sir David Brewster, has been adopted by Humboldt, Erman, Dalton, Kupffer, and generally.

The position of these remarkable points, Brewster conceives to be in 80° of north latitude, and in 95° of east, and 100° of west longitude. The mean temperature of the eastern or Siberian pole, is supposed to be 1°, and of the western or Canadian pole, $-3\frac{1}{2}$°. The Canadian pole being thus $4\frac{1}{2}$° colder than the Siberian.

XI. The southern hemisphere is generally considered to be colder than the northern; but this only appears to be true in relation to its higher latitudes. Through the whole torrid zone, and down to about the parallel of 40° S., the temperature of the two hemispheres exhibits little or no discordance, but beyond this limit, towards the south pole, the cold rapidly increases.

Thus, Kerguelen Island, though only in latitude 48°, corresponding to that of central France, was found by Cook covered with snow in the height of summer. Sir James Ross speaks of a narrow belt of green grass running along the quiet shores; of vegetation only existing in scattered tufts higher on the hills, the plants being the same as inhabit a lower level; vegetation almost enitrely ceasing at the elevation of 1000 or 1200 feet. The proportion of the surface covered with plants is about equal to that in Spitzbergen and Melville Island, at a higher latitude by 20° in the northern regions; but the relative number of species to individuals falls strikingly short; for whilst the flora of Melville Island boasts of 67 species of flowering plants, and Spitzbergen of 45, Kerguelen Island contains but 18, and of these only eight cover any considerable amount of the surface.

Along the south coast of South America, in the Gulf of Penas, lat. 46° 50′ S., a glacier descending to the sea-level, was found during the surveying voyage of the "Adventure" and "Beagle;" and according to Von Buch, the most southern European glacier that comes down to the sea, occurs on the coast of Norway, in lat. 67°, being upwards of 20° of latitude nearer to the north pole than the Gulf of Penas to the south.

To explain the lower temperature of the southern hemisphere, the astronomical cause has been assigned of the sun being a shorter time by $7\frac{3}{4}$ days on the south than on the north side of the equator. But this difference can have little effect, and is, moreover compensated by the earth being in perihelion, or nearer the sun during its south declination.

Kaemtz states the probable reason. In the northern hemisphere, the equatorial currents are urged towards the high latitudes by the prevailing S.W. winds: on the contrary, the current of the Indian seas, either returns into itself, or rounds the Cape, traversing the west coast of Africa, and cannot therefore heat the regions around the south pole. Again, the particular configuration of the South American continent. permits the Antarctic Ocean to flow freely towards the equator, carrying the circumpolarice into very low latitudes, and cooling the strata of air in contact with it.

XII. Geology furnishes incontestible evidence of the fact, that the globe has undergone extraordinary thermal changes, having once been a fused mass, its solid crust having arisen from the gradual refrigeration of this mass. We have also ample proof, that races of gigantic plants and animals allied to those of the tropics, altogether dependant upon a certain amount of temperature, once inhabited latitudes where no such productions now exist, or can exist. But whatever may have been the alternations of a long bygone period, it may be stated generally, that the conditions of superficial temperature at present subsisting have experienced no sensible change within the space of time embraced by history. On the one hand, if the earth has not yet reached its limit of cooling, the amount of refrigeration is not perceptible within any given time: on the other hand, the heating influence of the sun has no cumulative effect, but is alternately received and given off to the same amount.

In a paper on the "Thermometric State of the Globe," inserted in the French *Annuaire* for 1834, M. Arago concludes, that the general temperature of the mass of the earth has not varied $\frac{1}{10}$th of a degree for 2000 years; and that the changes we have observed, or think we observe, in certain climates, are not connected with cosmical causes, but with circumstances entirely local.

XIII. While from the phenomena of hot springs and volcanoes, and fro mthe fact of the temperature in all countries increasing with the depth, it is inferred, that the centre of our planet is composed of matter in a state of fusion; it appears from the researches of Fourier and others, that this central focus of heat has no appreciable effect at the surface, and may be altogether neglected in inquiries concerning the temperature of the air. This must be owing to the want of conductibility in the rocks which compose the upper part of the crust of the globe.

XIV. The subject of subterranean temperature, a difficult point of inquiry, has been examined in natural excavations, mines, and Artesian wells, with some general results of interest, upon which dependence may be placed.

1. The effect of solar influence descends to a certain depth below the surface; and within that limit the temperature fluctuates with the periodical superficial fluctuations. The depth varies with the latitude, being least within the tropics, not much exceeding 1 foot, but amounting to 25 feet at Paris, and in several Prussian mining establishments to from 27 to 63 feet; much depending upon the nature of soils and rocks. Thus Professor Forbes states, that in the neighbourhood of Edinburgh, the effects of atmospheric temperature become insensible at the following depths in different substances:

Trap rock	55 5 feet
Sand	65 8 „
Sandstone	96·1 „

2. Throughout the entire globe, at a certain depth, a stratum of invariable temperature is met with, which neither solar influence from above, nor internal heat from below affects; and this temperature is proved to differ very little from the annual mean of the country at the surface. For more than half a century, the oscillations of the thermometer, in the caves of the Observatory at Paris, have not exceeded the $\frac{1}{25}$rd of a centesimal degree.

3. Below the stratum of invariable temperature, the causes of internal heat perceptibly elevate the thermometer, and proportionably as the depth increases. Differences in this respect are observed in different substrata. In Prussia, according to Von Dechen, the increase of temperature is in general much more rapid in coal than in metalliferous mines. Mr. Henwood also states, that at all depths in the mines of Cornwall and Devon, the rocks are warmer than the *lodes*, and the lodes than the *cross-veins*, while the working miners have long noticed, that at equal depths, the lodes containing tin-ores are colder than those in which copper-ores occur. The latter fact is known in Germany among the miners, who hold the prevailing opinion of stanniferous mountains being colder than others.

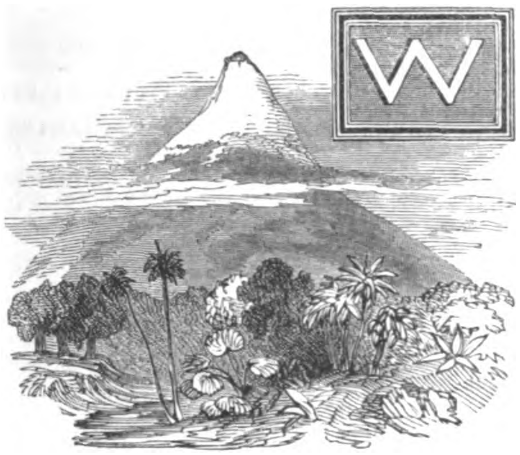
4. The ratio of the increase of temperature with the depth is affected by the nature of soils and rocks, and therefore varies; but in the bore of an Artesian well near Geneva, 727 feet below the surface, M.M. Marcet and De la Rive estimated it at about 1° of Fahrenheit for every 52 feet. Supposing this ratio to be maintained, it is clear that at a very trifling distance below the surface, compared with the earth's semidiameter, the hardest substances must be in a molten state.

XV. The temperature of the medium in which the earth moves, or of interplanetary space, has not escaped the attention of philosophers. It is generally supposed not to differ much from −58°, which is 90° below the freezing point of water; and to have but feeble influence upon the lower strata of the atmosphere.

The temperature of celestial space, as given above, is much inferior to the degree of cold which may be produced artificially, which amounts to −91°, or 123° below the freezing point.

CHAPTER V.

CLIMATOLOGY.



WHEN enumerating the causes of climatic variation, or that diversity of temperature, humidity, and the phenomena of vegetation, which marks the surface of the globe, the *first* determining circumstance to be considered is the position of a country in relation to the sun, or its latitude.

II. The dependence of temperature upon the sun is open to daily observation. In proportion as this body advances above the horizon, the heat increases: it diminishes rapidly with its setting.

III. The calorific action of the sun is the most powerful when in the zenith of the observer. In that position, the solar rays traverse a smaller portion of the atmosphere, and a less quantity are absorbed, than when the position of the luminary is oblique, or at the horizon.

If we collect the solar rays in a burning-glass, in order to inflame tinder, more time will be required to light it as the sun declines in the heavens, and it will be impossible to produce ignition when within a few degrees of the horizon.

Kaemtz states, that when the height of the sun is 40° 30′ only two-thirds of the rays that impinge upon the atmosphere reach the earth: when at 21° 30′ only half; the rest being absorbed or reflected. See Astronomy, page 22, chap. VI., 3.

IV. It follows, that towards the equator, we have the greatest comparative amount of heat and the warmest climates, because at some point or other within the tropics the mid-day sun is always vertically above the heads of the inhabitants, his rays falling at the same time with but little obliquity upon the other points within those limits. It follows also, that heat generally diminishes with the increase of distance from the equator, because as we recede from that line towards the poles, the mid-day height of the sun becomes less and less, till his rays are too oblique to prevent nature from being chained in eternal ice, and render it capable of supporting vegetable life.

The time during which the sun is above and below the horizon, is an important element of climate. When the days are long, the continued solar action causes a powerful accumulation of heat, and the nights being short, but little of this heat is radiated. The effect of course is opposite in inverse circumstances.

LENGTH OF THE LONGEST DAY FOR DIFFERENT GEOGRAPHICAL LATITUDES.

Latitude.	Length of Longest Day.
0°	12 hours.
16 44′	13 „
30 48	14 „
49 22	16 „
63 23	20 „
66 32	24 „
67 23	1 month.
73 39	3 „
90	6 „

Under the equator, the days and nights being of equal length throughout the year, no great differences of temperature, or seasonal contrasts, are experienced.

There is but little variation also in the length of the day under the tropics. But in mean and high latitudes the inequality becomes great; and the long days coinciding with the northern declination of the sun when the solar rays fall less obliquely, and the short days with his southern declination when the opposite takes place, alternations of excessive heat and cold, or great seasonal contrasts, are produced. The further from the equator the more unequally is temperature diffused throughout the year, constituting what Buffon indicated by the name of "excessive" climates, where the winter and summer temperatures are in violent contrast. Grapes sometimes ripen in the open air at Quebec, while the freezing of mercury, which takes place at — 40°, is there no uncommon circumstance.

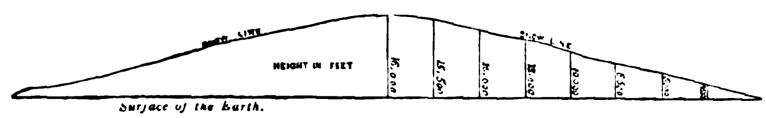
The long period during which the sun remains above the horizon renders the summer temperature sometimes quite oppressive, even within the limits of the arctic circle. In Norway, in lat. 70°, the thermometer has been observed to rise above 80°.

V. Supposing the globe to have a perfectly level surface, either of land or water, possessing the same character, the decrement of heat from the equator to the poles would coincide with the parallels of latitude, so that all places under the same parallel would have the same climate. But actual circumstances are far different from the postulate; and hence a *second* determining cause of climate is the elevation of the surface.

VI. It is well known from the experience of aëronauts, and of travellers who have ascended high summits, as well as from the occurrence of perpetual snow on the tops of mountains while oppressive heat is felt at their base, that the temperature of the air decreases with its height. This arises from the atmosphere not being heated by transmitting the rays of the sun, but receiving its heat solely from the warmed surface of the earth, and chiefly by actual contact. Hence its temperature becomes progressively lower with its distance from the general mass of the globe. Another reason is, its tenuity increasing with its elevation, the temperature of rarefied air being less raised by a given amount of heat, than that of the same portion of air when compressed.

In general, the temperature decreases 1° for about every 352 feet; but the rate varies with the latitude, the season, and even the hour of the day. The decrease is greater in summer than in winter; more sensible in the afternoon than in the morning; and is affected by the presence or absence of hydrometors.

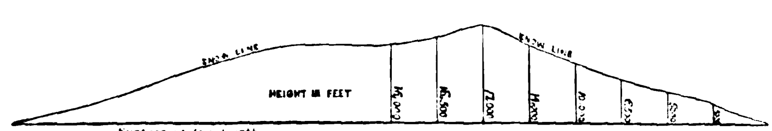
VII. In every latitude, therefore, there is a limit in the atmosphere where the thermometer never rises above 32°, and consequently where ice and snow remain in the solid form. This limit, called the snow-line, or line of perpetual snow, or line of constant congelation, is the highest in the torrid zone, where the heat is the greatest. It rises to about 16,000 feet near the equator, and from thence descends generally in the form of a curve towards the poles, till it reaches the surface of the earth at about N. lat. 80°, but at a lower latitude in the southern hemisphere. The diagram represents the line of perpetual snow, forming the arc of an ellipsoid, passing over the equator from pole to pole.



The diagram but very distantly answers to this important boundary line in the atmosphere. Though osculating with the surface in high latitudes, and occurring at a considerable elevation in the torrid zone, it does not form a regular curve in its descent, but exhibits various inflections, suddenly rising or falling in several districts, owing to their physical peculiarities. Thus, it appears from the observations of Mr. Pentland, on the Bolivian Andes, that between 14° and 20° S. lat. the line of perpetual snow is higher than in the equatorial regions of the chain, and higher than in its Mexican prolongation at the same latitude in the northern hemisphere. The snow-line of the Andes under the equator descends to 15,748 feet, but not a particle of permanent snow was to be seen on the following sites, though in from 15° to 19° of S. latitude:

	Lat.	Elevation.
Cerri di Potosi, the summit of the celebrated metalliferous mountain	19° 36′	16,037 feet.
Mountain of Porco	19 45	15,913 „
Mountain of La Golofa	16 42	16,250 „
Pass of Chullunquani	17 18	15,610 „
„ Las Gualillas	17 50	14,830 „
„ Los Altos di Toledo	16 2	15,528 „
„ Paquani	16 33	15,226 „
„ Leñas	19 16	14,203 „
„ La Compuerta or Lagunillas	15 52	15,613 „

Mr. Pentland found the mean elevation of the inferior limit of perpetual snow to be 17,200 feet on the volcano of Arequipa, in latitude 15° 20′, so that the snow-line of the Andes rises considerably south of the equator, roughly represented as follows:



A remarkable sudden fall of the Andean snow-line occurs farther south, exhibiting a difference of elevation of 9000 feet, within the distance of only 10° of latitude.

Place.	Latitude.	Height of Snow-line.	Authorities.
Cordillera of Central Chili	33° S.	14,500 to 15,000 feet	Gillies and Mr. Darwin.
Cordillera of Chiloe	43° S.	6,000 feet	Officers of the "Beagle" and Mr. Darwin.

This great flexure is attributed to the fact of Chiloe being covered with forest trees dripping with moisture, indicating a clouded sky and little heat in summer, while in Central Chili no rain falls for the seven summer months, the sky is generally clear and the climate hotter.

VIII. The line of perpetual snow sometimes varies in equal latitudes, because the summers are warmer in the interior of continents than on the coasts. Thus, though the Pyrenees and the Caucasus are under the same parallel, the snow-line on Mount Perdu in the Pyrenees was found by Raymond at the elevation of 8700 feet; but on Mount Elbrouz in the Caucasus, it only occurred at the height of 10,880 feet, according to Engelhart and Parrot. The same remark applies to the Scandinavian Alps, the snow-line being higher on the Swedish side of the chain, than on the Norwegian coast. The following Table, taken from the work of Humboldt on Central Asia, with some additions from Mr. Pentland's observations on the Bolivian Andes, gives the heights of the eternal snows at different latitudes:

NORTHERN HEMISPHERE.

Places.	Latitudes.	Lower Limit of Perpetual Snow.
Norwegian Coast, Isle Mageroe	71° 15'N.	2362 feet.
Inner Norway	70°—70 15	3590 „
„	66°—67 30	4154 „
Iceland, Oesterjokul	65	3068 „
Inner Norway	60 62	5118 „
Siberia, Chain of Aldan	60 55	4475 „
North Ural	59 40	4790 „
Kamschatka, Volcano of Chevelutch	56 40	5249 „
Ounalaschka	53 44	3515 „
Altai	49° 15'—51	7034 „
Alps	45° 45'—46	8883 „
Caucasus, Elbrouz	43 21	11,067 „
„ Kasibec	„	10,614 „
Pyrenees	42° 30' — 43	8946 „
Ararat	39 42	14,165 „
Asia Minor, Mount Argæus	38 33	10,702 „
Bolor	37 30	17,011 „
Sicily, Etna	37 30	9529 „
Spain, Sierra-Nevada of Grenada	37 10	11,187 „
Hindoo-Koosh	34 30	12,978 „
Himalaya, North side	30° 15'—31	16,624 „
„ South side	„	12,978 „
Mexico	19°—19 15	14,764 „
Abyssinia	13 10	14,066 „
S. America, Sierra-Nevada de Merida	8 5	14,928 „
„ Volcano of Tolima	4 46	15,321 „
„ Volcano of Purace	2 18	15,380 „

EQUATOR.

Quito . . . 0° 0' lat. . . Height of snow-line, 15,748 feet.

SOUTHERN HEMISPHERE.

Andes of Quito	1°— 1° 30' S.	15,730 „
Bolivian Andes, Nevado of Inkocajo	15 58	16,850 „
„ Volcano of Arequipa	16 20	17,200 „
„ Nevado of Tres Cruces	16 30	17,090 „
„ „ Illimani	16 42	16,865 „
„ „ Chipicani	17 48	16,946 „
Chili, Volcano of Peuquenes	33	14,707 „
„ Andes along the coast	41°—44	6008 „
Straits of Magellan	53°—54	3906 „

It will be seen from the Table that the line of eternal snow falls generally from the equator to the poles. But an important exception occurs on comparing the two sides of the Himalayan Mountains. The line is much higher on the north than on the south side of the chain, a parallel case to that of the Bolivian Andes, in the southern hemisphere, as compared with the chain near the equator. This fact was first ascertained by Humboldt, and though since doubted it has been amply confirmed. The south side of the Himalaya ascends abruptly from the low plains of Bengal, while the north side declines to the immensely elevated table-land of Thibet, and a higher temperature is produced, elevating the snow-line, by the solar action on the contiguous Thibetian plateau.

For the same reason, the cities of Mexico, Quito, Popayan, and Santa Fe de Bogota, seated on elevated plains, have a warmer climate than they would have at the same height if on isolated mountains.

IX. It is obvious therefore that countries which are at different elevations, though in the same latitude, must have different climates; and that in the same country there may be great diversity of climate co-existing, according as the surface is more or less elevated. Hence while the tropical valley or plain is oppressively hot, and loaded with luxuriant vegetation, if moisture is not wanting, the tropical mountain, rising a few thousand feet above it, in its higher regions, is as cold, and as bare of vegetation as any polar island. Successive zones, characterised by a different flora, mark the climatic variations resulting from a change of level.

Thus, in Mexico, where there are low coasts, high table-lands, and mountains covered with eternal snow, there are distinct and well-defined botanical districts:

1. *Tierras calientes*, the hot regions, including the country of the east and west shores below the height of 2000 feet, where bananas, the sugar, indigo, and cotton plants flourish luxuriantly—mean temperature about 77°.

2. *Tierras templadas*, the temperate regions, between the height of 2000 and 5000 feet, where oaks, cypresses, tree-ferns, and the cultivated cereals of Europe are encountered—mean temperature from 68° to 70°.

3. *Tierras frias*, the cold regions, above the height of 5000 feet, where the air is still genial to the elevation of 8000 feet, beyond which limit the climate soon becomes rigorous, fruits are not matured, wheat and oaks disappear, and pines occur.

In Switzerland, the beautiful vegetation in the valleys and on the plains at the foot of the Alps, vineyards, orchards, forest-trees, and cereals, have for the most part disappeared at the height of 6500 feet.

The vine, in the northern districts, does not rise higher than 1800 feet; but on the Italian side, as on the south declivity of St. Bernard, it attains to 3240 feet.

Barley ceases on the north side of Mont Rosa at 4200 feet, but reaches in a few spots on the south side to 6400 feet.

Fruit-trees, in the north, seldom pass above 2800 feet, but a few cherry-trees ascend on the Righi to upwards of 3000 feet.

The chestnut stops at about 2800 feet in the Pennine Alps. Walnut-trees attain about 3300 feet. The birch, larch, cembra, and alder, ascend as high as 7400 feet, on the south side of Mont Rosa.

PERPENDICULAR LIMIT OF TREES ON THE NORTH SIDE OF THE GRIMSEL.

CANTON OF VALAIS.

Hard oak. *Quercus robur*	2650 feet.
Beech. *Fagus silvatica*	3230 „
Cherry. *Cerasus vulgaris* } Hazel. *Corylus avellana* }	3476 „
Norway spruce fir. *Abies excelsa*	5070 „
Service. *Sorbus aucuparia*	5313 „
Scotch fir. *Pinus silvestris V montana*	5936 „
White birch. *Betula alba*	6479 „
Cembra pine. *Pinus cembra*	6889 „

Above the region of forest trees, there is the region of stunted pines, followed by the remarkable zone of rhododendrons covered with beautiful red flowers, beyond which is the region of the Alpine plants, and at a greater height only a few lichens appear. At the summit of the Jungfrau, elevation 12,872 feet, on the surface of the exposed gneiss rock, M. Agassiz, Professor Forbes, and their companions, found five species of lichens: 1. *Lecidea conglomerata*; 2. *Lecidea confluens*; 3. *Parmelia elegans a miniata*; 4. *Umbilicaria atropruinosa γ reticulata*. Saussure found the three last on Mount Blanc and the Col du Géant. 5. *Umbilicaria virginis*, a new species, so named by the lichenologist, M. Schærer, in commemoration of the ascent.

Approximate results of interest are expressed in the Table. The measures given are in fathoms:

	Andes of Quito. Lat. 0°	Mountains of Mexico. Lat. 20°	Caucasus. Lat. 42½.	Pyrenees. Lat. 42⅔°	Alps. Lat. 45½° 46°
Distance between trees and the line of perpetual snow	600	3[illegible]0	650	230	450
Upper limit of trees	1800	2000	1000	1170	920
Last species of trees towards the snow	Esculonia Alstonia.	Pinus occident. The occidental pine covers the Nevado of Tolucca.	Betule alba, common birch.	Pinus rubra. Pinus uncin.	Abies excelsa.
Distance between the snow and corn	800	...	630	...	700

X. The surface of the earth, consisting of land and water, we have a *third* cause of climatic variation in equal latitudes, in the position of countries being marine or continental. The ocean is not so rapidly heated, nor so soon deprived of the heat it has received, as the land. The temperature of its surface does not oscillate between such extreme heat and cold, but is far more uniform, lower in summer and higher in winter, than the temperature experienced in inland districts. The atmospheric currents that sweep over it, transfer the same character, to some extent, to the shores within their range. Hence littoral or maritime climates are more equable than the continental; for though both may have the same mean annual temperature, the range of the thermometer is far less on the coasts than at a distance from the sea. On the sea-side, the winters are mild and the summers cool, as compared with inland places, where the winters are cold and the summers hot.

Another cause contributing to the same effect is the immense evaporation from the sea, producing a frequently overcast sky along its shores. The clouds temper the solar influence in summer, and check radiation in winter.

The contiguous sea renders the summers of London cooler and the winters milder than those of Paris. Hence also the mild winters in the north-east of Ireland, where there is scarcely any ice or frost, in the same latitude as Konigsberg and Moscow. Edinburgh has the same mean annual temperature as Tubingen, or 46° 6'; but at Edinburgh the mean temperature of winter is 38°, and at Tubingen 31°; while that of the summer at Edinburgh is 57°, and of Tubingen 62°. With the same mean annual temperature, therefore, Edinburgh has a milder winter and a cooler summer than Tubingen. Along a line passing from the mouth of the Garonne, on the west coast of France, near Strasburg and Wurzburg, through Bohemia, the Ukraine, the country of the Don Cossacks, and north of the Caspian Sea, there is the same mean annual temperature; but the mean winter temperature differs widely along the line, being 42° at Bordeaux, 32° in Bohemia, 24° in the Ukraine, and 17° north of the Caspian Sea.

The annexed contrast shows the less range of temperature in littoral than in continental climates. The mean temperature of the year is placed first; the mean summer temperature above the horizontal line; and the mean winter temperature below.

Littoral Climate.	Y		Continental Climate.	Y	
North Cape	32° 2′ . . .	$\frac{43^\circ\ 0'\ \text{S.}}{23\ \ 0\ \text{W.}}$	Irkoutsk . . .	32° 0′ . .	$\frac{60^\circ\ 0'\ \text{S.}}{0\ \ 0\ \text{W.}}$
Reikiavig, Iceland,	41 7 . . .	$\frac{53\ \ 6}{30\ \ 0}$	Moscow . . .	38 5 . .	$\frac{67\ \ 0}{10\ \ 0}$

The contrast between places on the coast, and at but a short distance from it, shows the milder winter enjoyed at the former stations, as in France:

Places on the Coast.	Latitude.	Winter.	Summer.	Places on the Coast.	Latitude.	Winter.	Summer.
St. Malo	48°39′	42° 4′	66° 9′	Chalons sur Marne.	48°57′	36° 1′	66° 6′
St. Brieux	48 31	41 7	64 4	Paris	48 50	38 7	65 3
Vannes	47 39	39 7	64 4	Chartres	48 26	37 0	64 6
Nantes	47 13	40 5	68 5	Troyes..................	48 18	38 3	67 3
La Rochelle..........	46 14	40 3	66 6	Chinon..................	47 26	38 7	69 1
Oleron.................	45 56	44 6	68 5	Poitiers	46 39	39 7	67 1
Bordeaux	44 50	42 1	70 9	Vienne	45 31	38 7	71 6
Dax.....................	43 53	44 4	67 3	Montauban	44 01	42 6	69 3

The circumstances stated have a marked effect on vegetation. On the coast of Devonshire, where the winter is not colder than at Florence and Montpelier, the *camellia japonica*, the *fuchsia coccinea*, and the *buddlea globosa*, live through it in the open air; and in the north-east of Ireland, the myrtle thrives as well as in Portugal, 15° further south. On the other hand, at Yakutsk, in Siberia, where the mean annual temperature is only 13° 8′, and the mean winter temperature is considerably under zero, the subsoil remaining constantly frozen at the depth of three feet, wheat and rye are raised, owing to a hot summer, while in Iceland, where the mean temperature of the year is very much higher, none of the cereals are raised, owing to the cool summer not allowing them to ripen.

Lines drawn through places of like summer temperature are termed isotheral, signifying equal summer; and lines connecting places of like winter temperature are called isochimenal, or equal winter.

XI. The prevailing winds to which a country is exposed form a *fourth* determining cause of its climate, because bringing with them a part of the properties of the quarters from whence they come, and the surface over which they have passed. In a calm state of the atmosphere, the effect of one region upon the temperature of another contiguous to it is probably small; but its colder or warmer air is transferred to the adjoining locality with the wind blowing in that direction, and the thermometer falls or rises.

With us, the north winds bring a very low temperature as compared with that which accompanies the south winds; and the thermometer rises or falls very regularly as the wind veers from north to south, or from south to north. In the higher latitudes, the change of temperature incident upon a change of the wind, is very great. Scoresby records an instance, in the neighbourhood of the polar ice, of the wind suddenly veering to the north, and of the thermometer falling in sixteen hours from 32° to −2° =34°.

At Bagdad and at Bushire, under the influence of the south wind heated by the burning sands of Arabia, the thermometer sometimes rises to 125°, and indicates the same degree of heat in Upper Egypt when the wind blows from the Desert.

XII. The soil of a country, and the aspect of a place, are also important constituents of climate. A surface consisting of sand admits of a higher degree of heat than clayey and compact soil, and bare grounds than pasture land. The effect of aspect is most strikingly seen in mountainous districts, where as a general law, vegetation ascends to a higher limit on the southern than on the northern declivities.

The walnut-tree, *Juglans regia*, in the Pennine Alps, rises to near 3500 feet on the south side, and to 3100 on the north. Trees in general ascend to 7400 feet on the south side of Mont Rosa, but do not pass beyond 6550 on the north. The zone of rhododendrons, *R ferrugineum*, and *R hirsutum*, at various points on the declivities of the Alps between Mont Rosa and Mont Blanc, has an altitudinal limit of 7830 feet on the south, and 6500 on the north.

The plants that are useful to man are sometimes carried higher on northern than on southern slopes, owing to differences of industry or skill in the inhabitants of the two sides of a range, or to the different estimation in which the products are held. This appears from the altitudinal limits of cultivated fields in the Pennine Alps.

Passes.	Most Elevated Villages. North Side.		South Side.		End of Cultivated Fields. North Side.	South Side.
		Feet.		Feet.	Feet.	Feet.
Col du Bonhomme .	Nant Bourant .	4670	Chapin . . .	3535	„	„
St. Bernard . . .	St. Pierre . .	5366	St. Remy . .	5309	5530	5315
Col de la Fenétre .	Lourtier . .	3496	Lomond . . .	3442	3756	5495
Mont Cervin . . .	Zermatt . . .	5296	Val Tornanche	5057	6509	5489
Col Macugnaga . .	Saas	5256	Macugnaga .	4264	5740	4264
Simplon	Baerensaal . .	5096	Simplon . . .	4933	3436	3280
Means . . .		4863		4443	4994	4769

XIII. Considerable deviations from the usual climatic state sometimes occur, spreading over wide districts, but it has been remarked, that no instance can be cited of a deviation extending to an entire hemisphere, so that it is highly probable, as before observed, that the same quantity of heat is always distributed over the earth's surface, although unequally. These peculiar atmospheric states are more frequently propagated in a meridional than in a parallel direction, opposite conditions subsisting under opposite meridians. The Danes have observed that unusually moderate winters in Iceland correspond to intense cold at Copenhagen. Generally speaking, the same deviation occurs in Europe and Asia, the opposite in America, or Asia and America are in opposite climatic conditions, while Europe is unaffected by either extreme. The more marked deviations from the usual range of heat occur more frequently in winter than in summer.

The winter of 1790-1 was very mild in Europe, and very cold in America.

The winters of 1794-5, when the Republican armies overran Holland, and of 1809, were very severe in Europe, and very mild in America.

In February, 1828, it was unusually mild in America, and very cold at Kasan and Irkutsk, while Europe was unaffected by the extremes.

In December, 1829, the cold was intense at Paris and Berlin, marked at Kasan, moderate at Irkutsk, while an unusual heat prevailed in North America.

In January, 1837, the temperature was mild in Europe, and very low in America.

XIV. While the general temperature of the globe appears to have suffered no perceptible change during the historic era, there is strong reason to suppose that the climatic condition of particular districts has undergone some gradual alterations. The climate of western Europe seems to have acquired a more genial character, seasons of intense cold occurring at more distant intervals than formerly, which may be due to the careful and vastly more extended cultivation of the soil, the extinction of bogs and morasses by drainage, and the destruction of the vast forests that once overspread the face of Gaul, Germany, and Britain. In the time of Cæsar, the rein-deer, now confined to the colder regions north of the Baltic, was located also on the south, together with the elk and the wild bull. The barbarians usually selected the winter season for their forays into the Roman provinces, when the great rivers were frozen, owing to the facility afforded by the ice for the passage of their armies, horses, and baggage. Marcus Aurelius signally defeated the Marcomanni as they were crossing the Danube, the action being partly fought upon its frozen surface.

CHAPTER VI.

ISOTHERMAL LINES.

I. Humboldt was the first to trace on charts lines connecting all points having the same mean annual temperature, or nearly. These lines are termed Isothermal, signifying equal heat. A distinct view is hereby afforded of the distribution of temperature; and the powerful operation of other causes besides latitude, in determining climate, will at once be seen on examining the curves. (See Map showing the Distribution of the Temperature of the Air).

If we suppose a traveller to journey from London to those places in the northern hemisphere which have the mean annual temperature of London, he would not travel along its parallel of latitude, 51½°, but proceed north-west through Ireland to lat. 55½°, descending south-west towards New York, lat. 40½°; and in the contrary direction, he would travel south-east to Vienna, lat. 48°, and the mouth of the Danube, lat. 44°.

II. Near the equator, the isothermals exhibit no great divergence from the parallels of latitude; but as we go further north, their inflections become remarkable, ranging through 20° and 25° of latitude.

1. The isothermal line indicating 80° of temperature, crosses Central America about the Gulf of Honduras, passes north of Jamaica, through St. Domingo, Porto Rico, descends to the west coast of Africa a little above Sierra Leone, ascends in that continent to the Tropic of Cancer, runs closely parallel to it through Arabia to Hindostan, descends in that peninsula, and cuts descendingly Siam and Cochin China, intersecting the group of the Philippines to the south.

2. The isothermal line of 70° cuts the Californian peninsula on the west coast of America about lat. 25°, falls below the Tropic of Cancer in the interior, rises on the opposite coast, passes by the delta of the Mississippi, through East Florida north of St. Augustine in about lat. 30°, reaches the west coast of Africa above the Canary Islands, ascends towards Tunis about lat. 34°, runs through the Mediterranean south of Candia, enters Syria north of Beirout, traverses Asia south of the Hindoo-Koosh and Himalaya Mountains, descends in China nearly to the tropic, and cuts the east coast of the continent about lat. 25°.

3. The isothermal line of 60° traverses America from the north of New California, near Port San Francisco, in about lat. 39°, to Nashville, lat. 36°, and a little below

Charlestown, falling in the interior. It rises then toward the north, reaches Europe about Cape Finisterre, lat. 46°, descends abruptly in the Spanish peninsula, but rounds the Gulf of Genoa, passes obliquely down Italy, intersects the south of Turkey, Asia Minor, passes by Tiflis, cuts the south of the Caspian, sinks in the interior of Asia, reaches its east coast about the mouth of the Hoang-Ho, and passes through Niphon, the largest of the Japanese group.

4. The isothermal line of 50° passes from Fort George, at the mouth of the Columbia River, lat. 46°, descendingly into the interior of America, rises to the southern extremity of Lake Michigan, and reaches the shores of the Atlantic near New York, lat. 41°. It then rises abruptly towards the north, attains lat. 56°, descends by Dublin, London, through midland Europe, passing near Dresden and Vienna to the mouth of the Danube, cuts the north of the Black and Caspian Seas, runs south of Lake Aral, falls in the interior of Asia, and rises on its east coast to lat 45°.

5. The isothermal line of 40° cuts the west coast of America north of New Archangel in about lat. 59°, descends to lat. 47°, passes Quebec, the south of Newfoundland, rises to lat. 69°, reaches the Norwegian coast about Drontheim, falls in the peninsula, declines to the south of Moscow, and sinks in Asia to lat. 47°, but rises on the east coast of the continent to about lat. 50°.

6. The isothermal line of 30° leaves the west coast of America in lat. 61°, rises to 64°, but soon declines, cuts the south of Hudson's Bay, and falls to lat. 53° on the shores of Labrador to the south of Nain. It then ascends abruptly to lat. 74°, and passing round the North Cape of Europe, as abruptly descends, cuts the White Sea in the latitude of the Arctic Circle, still further declines towards Asia, passes Irkoutsk, and falls to about lat. 50°, rising towards the east coast.

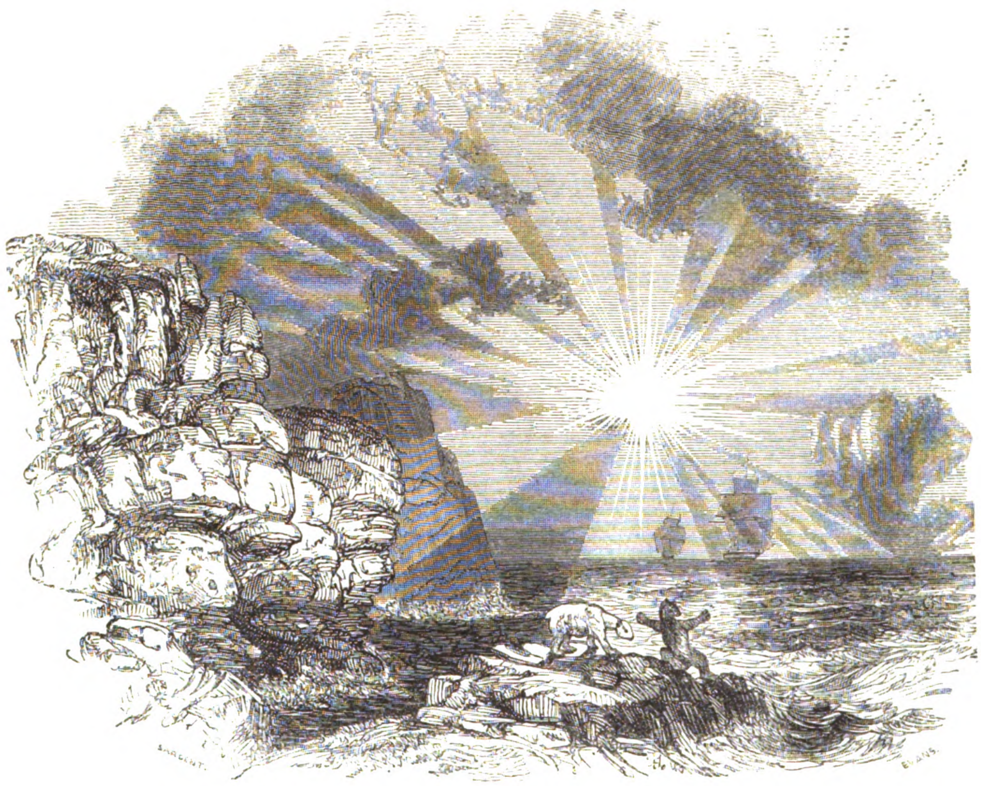
7. The isotherms indicating a lower degree of temperature can only be traced with certainty through portions of their course. That of 20° appears to descend from the mouth of the Mackenzie River, lat. 68°, to lat. 59° on the coast of Labrador. From thence it rises to lat 77°, cutting the south of Spitzbergen, and falls in Asia to lat. 56°. The isothermal line of 10° passes to the north of Hudson's Bay in America, and of Yakutsk in Asia.

III. The remarkable warmth of Western Europe, as compared with Eastern America and Asia, indicated by the great convexity of the isothermal lines about the meridian of Greenwich, has naturally attracted the attention of physical inquirers; and clear views have been obtained respecting the cause of the phenomenon.

1. The prevailing winds being from S.W., come from the equatorial districts, and partially bear the heat of the tropics to the shores of Europe.

2. The vast continent of Africa, bounding Europe on the south, consists to an immense extent of sandy deserts, rendered excessively hot under the vertical solar rays, from which a current of warm air rises continually to descend again in Europe.

3. The warm waters of the Gulf stream, which sweep across the Atlantic to the neighbourhood of Europe, and every year carry fruits and seeds belonging to the hot regions of America to the shores of Norway, notably elevate the temperature of the coasts that are washed by them, not only by the S.W. winds remaining long in contact with a current of heated water, but by the polar ice in its annual descent into the Atlantic being kept apart from the European shores. Shells of the tortoise, and portions of wreck, have often been drifted from the West Indies to the western islands of Scotland, as well as seeds of *Dolichos urens*, *Guilandina bonduc*, *G bonducella*, *Mimosa scandens*, and other plants of Jamaica, Cuba, and America. At Kielvig, near the North Cape, seeds of the *Mimosa scandens* are commonly found in the shingle, and are possessed by nearly all the fishermen.



North Cape.

4. The Gulf stream, it is true, runs along the east coast of America from Florida to Cape Hatteras, but the current is there very narrow, and the prevailing S.W. winds carry the hot circumambient air away from the shore. On the other hand, a sea current comes down from Spitzbergen, running between Iceland and Greenland, to the coasts of Labrador and Newfoundland, which contributes to depress the temperature by its cold waters, but chiefly by the floating icebergs that descend with it.

5. In Asia, there is no extensive tract of land, like Africa, within the tropics, but merely peninsular projections; and the air that is warmed in the basin of the Indian Ocean is prevented from reaching the interior and northern regions of the continent, by the mighty rampart of its central mountains. Asia also has a much greater extent of surface within the Arctic Circle than Europe; and the flatness of its northern districts, which present, however, a general northern declivity, leaves it open to the full operation of the polar cold.

IV. In defining accurately zones of climate, the astronomical lines of the Tropics of Cancer and Capricorn, and the arctic and antarctic circles, are practically useless, because of the divergence of the isothermal lines from the parallels of latitude. Attending only to the isotherms, we may discriminate five climatic zones—the hot, warm, temperate, cold, and frigid, shaded respectively on the map, deep and light carmine, green, light and deep blue.

V. The Hot Zone is bounded on each side of the warmth equator by the isotherm of 80°. It includes the north extremity of New Holland, the islands and peninsulas of Southern Asia, the middle regions of Africa, the north portion of Brazil, Guiana and Columbia in South America, and Guatimala in central America, with Jamaica and a part of the West Indian groups. In this region, at the sea level, frost and snow are unknown. Vegetation is luxuriant and perennial in the well-watered districts, but burning deserts of sand and flint prevail, altogether barren, except in a few cases, where moisture is wanting.

VI. The Warm Zone lies between the isotherms of 80° and 70°, and includes in

Plains of Beloochistan.

the northern hemisphere, Mexico, Cuba, Florida, north-west and northern Africa, excepting a portion of the Barbary States, Northern Arabia, almost the whole of Persia, Afghanistan, Beloochistan, Northern India, the Birman Empire, Siam, Cochin China, south of China Proper, and the greater part of the Philippine Islands. The characteristics of this region are much the same as those of the preceding. It embraces a vast area of bare rock and barren sand, where, as in Beloochistna, the summer heat is overpowering, with districts where the vegetable kingdom is luxuriant, favoured with a sufficient supply of moisture.

VII. The Temperate Zone is bounded by the isotherms of 70° and 30°; and includes a large section of North America and Central Asia, Iceland, almost the whole of Europe, and a small strip of Northern Africa. In its southern portion, we have the northern limit of the region of Palms, and the principal district of the cultivation of the vine. Its northern boundary in Europe nearly corresponds with the most northern limit of the cultivation of barley and rye, and the appearance of trees. In this zone, man has in all ages attained the highest development of his powers, and the most civilized nations have been located in it.

VIII. The Cold Zone is between the isotherms of 30° and 10°; and includes the countries around Hudson's Bay, most of Labrador, Greenland, Spitzbergen, Nova Zembla, part of Lapland, part of North Russia, and the most considerable portion of Siberia. Through great part of this region, the soil at a varying depth remains permanently frozen throughout the year, even in latitudes in Asia as low as that of London; but to a certain varying extent the surface is thawed by the powerful temperature of the brief Siberian summer, so that most of the cereals ripen, and harvests of wheat, barley, and rye, are gathered above subterranean sheets of eternal ice. In Asia also the oak maintains an existence on the southern borders of the zone, and some forest trees pass beyond its northern limit, their roots shooting below the frozen soil; though with reference to the larch and the arve, *Pinus cembra*, this is unnecessary, as recent inquiries have demonstrated that they survive even where the ground is perpetually frozen.

On the southern borders of this zone, at Nijnei Tagilsk, on the Asiatic side of the Urals, about the latitude of the Shetland Isles, the following temperatures, as observed by the thermometer in the year 1844, were submitted by M. Demidoff to the Paris Academy of Sciences:

In January . .	− 35°	In May	+ 14°	In September . .	+ 10°
„ February . .	− 50°	„ June	+ 29°	„ October . . .	+ 4°
„ March . . .	− 20°	„ July	+ 39°	„ November . .	− 31°
„ April . . .	− 10°	„ August . . .	+ 29°	„ December . .	− 37°

Thus there was only one month in the year, July, in which the thermometer did not sink below the freezing point, and no frost occurred.

The elder Gmelin was the first to state, in his travels in Siberia, that at Yakutsk, shortly after the foundation of that town, towards the end of the seventeenth century, the soil was found frozen to a depth of 91 feet, so that the inhabitants were obliged to give up the idea of sinking a well. Many similar statements were subsequently made of other localities; but in 1825, Von Buch, a philosopher of high authority in all physical questions, treated them as erroneous, remarking in a paper published in the Transactions of the Academy of Berlin: "I am fully convinced that the accounts of the soil being frozen in summer to the depth of many feet, in districts capable of maintaining the growth of shrubs and bushes, are not to be relied on." The fact has, however, been placed beyond all doubt by the inquiries of Humboldt, Erman, and others.

It has only recently been ascertained to what depth the stratum of frozen soil extends. For information upon this point we are indebted to M. Schargin, a merchant at Yakutsk. While the other inhabitants contented themselves with the water of the Lena in summer, and that of melted snow in winter, he commenced sinking a well, hoping to succeed in obtaining a supply, if the well could only be sunk deep enough, being quite convinced of the perpetual congelation of the soil immediately below the surface. When this chance failed, Admiral Von Wrangel encouraged him to proceed, in order to determine if possible the depth of the frozen stratum. The bottom of the shaft was 50 feet below the surface when visited by Erman, who buried the bulb of a thermometer at different places in the ground, but never saw the mercury in it rise above − 6° of Reaumur, or 18½° of Fahrenheit; thus showing a very decided winter temperature. The strata of fine sand and clays which formed the sides of the shaft were found uniformly frozen hard, so that instead of digging with the spade, it had been necessary to use the miner's pick-axe. The flakes and frozen pieces of earth in the interior of the well were perfectly dry, and had to be carried up into the warm air and thawed before they gave any signs of moisture.

The operations at Yakutsk have since been conducted to the depth of 382 feet, when the soil became so loose that it was impossible to proceed without timbering, which had not been necessary before, the ground indicating a temperature nearly 32°. The freezing point appears here to have been reached, so that in this part of Siberia, in lat. 62°, about that of Drontheim, in Norway, the layer of frozen soil has the immense thickness of not less than 382 feet. Erman remarks, that "the inhabitants of the Swiss Alps would not unjustly think themselves lost if they were compelled to live at the height of 10,000 feet, or 2300 feet above the Hospice of the Great St. Bernard, and there to support and to clothe themselves by keeping cattle, and with the productions of the surrounding mountains; yet they would then, and not until they arrived at that height, be settled on ground having the same temperature which I found here among the Yakutsks, who are rich in cattle. It would seem, therefore, as if that succeeded in Siberia which is impossible in Europe." At Yakutsk, while the annual mean temperature of the air is nearly 19° below the freezing point, and while in ordinary years a degree of cold is experienced from Dec. 17th to Feb. 18th exceeding 26° below zero, so that mercury is a solid body for two entire months, yet there are noble larch forests east of the town, while useful vegetables are raised in the gardens, and several kinds of grain produce on an average fifteen fold. This is explained by the short warm summer, which thaws the fields resting on perpetually frozen strata to the depth of three feet. There are 128 days in the year without frost; 92 days, those of June, July, and August, the mean warmth of which is 61°; and in the mountainous districts and northern countries of Europe, the cultivation of corn does not cease so long as none of the three summer months has a temperature less than 47°.

IX. The Frigid Zone is bounded by the isotherm of 10°. It includes the countries in America to the north of Hudson's Bay, and a section of Northern Asia, between the Gulf of Obi, in about long. 80° E., and the meridian of 160°, and between the mean latitude of 66° and the Icy Sea or Arctic Ocean. The isothermal lines of America and Asia in these high latitudes are not consecutive, but entirely separate, surrounding the two poles of maximum cold, neither of which coincides with the pole of the earth's diurnal motion. It is supposed that two similar poles exist in the southern hemisphere, but observations are wanting to verify the fact. The effect of cold upon vegetation is most apparent in this zone. The larch and birch pass within its limits, but they are stunted in form, and soon disappear. Hedenström admirably depicts the aspect of the Asiatic frozen regions:

"With painful feelings," he commences, "the traveller observes the trees diminishing in height as he approaches the shores of the Icy Sea. At Werchojantsk, 90 German miles from the sea, (upwards of 300 English) erect and lofty larch-trees afford a veil to expiring nature; but from this place their number decreases, and they become small and crippled. The coating of moss which covers the tree is thicker than the stem itself, but nothing can save it from the destroying breath of the north. Some thin birches endeavour to contend against this fearful foe, but they perish when scarcely sprung from the bosom of mother earth. It is only the moss, the true child of the north, which thrives and blooms even in the midst of winter, and scantily covers a soil which has been barren for thousands of years. From the last tree to the Icy Sea extends an enormous desert covered with lakes and lagunes, their banks consisting of alternating beds of earth and of ice. The beds of ice are generally perfectly level, as are also the beds of earth, which the ice immediately covers. Veins of ice which occasionally descend precipitously downwards, are of more modern formation. They arise from the fracture of the entire mass, and from the snow water which fills up the space thus left void."

CHAPTER VII.

ELECTRICAL PHENOMENA.

I. Of electricity in itself we know nothing more than that it is a mighty imponderable agent, called simply for convenience a fluid, invisible when in a latent state, apparently universally diffused, and capable of penetrating the pores, or even the substance of matter. It may be roused from a neutral condition and made visible, displaying tremendous energies, and producing destructive effects, by a variety of causes, as friction, heat, and chemical action, but we are totally ignorant of the reason why these causes elicit it. Information on the theory and details of electrical science must be sought in treatises specially devoted to the subject. In meteorology, we have merely to deal with it as developed in the atmosphere, its phenomena, effects, and distribution. But the statement of a few general principles may be expedient.

There are two kinds of electricity, each having its peculiar properties, but whether there are really two different electricities, or one electric fluid, which displays peculiar properties according as it is found in superabundance or deficiency, is a point upon which philosophers are not agreed, and either hypothesis will equally explain the facts observed. The discovery of the two kinds was made by Dufay in 1773.

Bodies in one electric state attract, and in another repel each other. The electricity in the former case is called *vitreous* or *positive*: in the latter, *resinous* or *negative*.

Bodies having positive and negative electricity in equal diffusion, or in a state of equilibrium, neither attract nor repel. This is their ordinary and natural condition.

When the equilibrium is destroyed, and the two electricities or electric energies are partially separated, as by friction, heat, and chemical action, their peculiar powers become manifest.

Two bodies charged with the same kind of electricity, brought into the vicinity of each other, mutually repel.

Two bodies charged with different kinds of electricity mutually attract.

In the case of two neighbouring bodies differently yet highly electricised, the one body imparts a portion of its electricity to the other, which returns an equal quantity of its antagonist element, and the derangement is equalised, the natural state restored. The two electricities coalesce with immense rapidity, causing a flash and an explosion, upon which the electric fluid returns to a latent and neutral condition, till a fresh derangement in the distribution is produced.

Though, strictly speaking, there is no known substance perfectly impervious to electricity and which offers no resistance to its passage, there is a certain class of substances through which it passes with greater facility, as metals, water, the human body, &c., than through others, as glass, silk, atmospheric air, &c. The former substances are therefore styled *conductors*: the latter, *non-conductors*.

In conductors, it is impossible for electricity to accumulate unless they are surrounded with non-conductors. They are then said to be insulated.

II. While the earth itself is always charged with negative electricity, the atmosphere, in a cloudless and clear state of the sky, is almost invariably found to be positively electric. But its electricity varies in intensity, being greater in winter than in summer, during the day than by night, and subject also to a kind of diurnal flux and reflux. From sunrise, when the atmospheric electricity is feeble, it increases for two or three hours, and attains its maximum. It declines towards the middle of the day, and attains its minimum in the afternoon. It then advances sensibly till about sunset, and attains a second maximum usually equalling that of the morning, but lasting a shorter time; after which it decreases slowly through the night.

These regular oscillations can only be traced in calm and serene weather, for the electrical state of the atmosphere is very uncertain with an unsettled sky, and changing temperature, being modified in a brief interval by whatever affects its thermometric and vaporous condition.

According to a careful observer, Mr. Crosse of Bloomfield, the comparative intensity of the electricity of the atmosphere in different states of the weather, follows the order of the arrangement in the annexed Table:

1. Regular thunder clouds.
2. Driving fog, with small rain.
3. Fall of snow, or brisk hailstorm.
4. A smart shower, in a hot day.
5. A smart shower, in a cold day.
6. Hot weather, after some wet days.
7. Wet weather, after some dry days.
8. Clear frosty weather.
9. Clear warm weather.
10. Sky obscured by clouds.
11. Mackerel, or mottled sky.
12. Sultry weather, with light hazy clouds.
13. Cold damp night.
14. Cold dry N.E. winds, affecting the feeling to a degree not corresponding with the thermometer.

III. The electricity of the atmosphere is supposed to be principally due to combustion, vegetation, and chemical action.

1. In the combustion of coal, wood, and other substances, the current of carbonic acid formed escapes in a state of positive electricity, the unconsumed portions remaining in the negative state.

2. Growing plants are affirmed by M. Pouillet to pour a great proportion of positive electricity into the atmosphere, which is carried off by the carbonic acid they exhale, while the vessels through which the gas escapes remain in the negative state. So considerable is this cause, that according to the same authority, the positive electricity evolved in a single day from an area of vegetation consisting of 600 square yards, would be sufficient to charge a powerful battery.

3. Among chemical actions, as the source of atmospheric electricity, the first place is due to evaporation in the circumstances in which it generally takes place. Pouillet has shown, that the conversion of pure water into vapour does not produce electricity, but that vapour rising from solutions of salts and acids, however weak, gives evident signs of it, varying in kind, with the nature of the substance dissolved. Thus, from alkaline solutions, the vapour rises with signs of negative electricity; from saline or acid solutions, the vapour carries up a charge of positive electricity. As evaporation therefore is so abundant and constant at the surface of the earth, and as all natural collections of water, the ocean, lakes, rivers, and the humid soil, contain foreign ingredients, it may be supposed that evaporation, especially from the surface of the sea, is the most influential source of atmospheric electricity.

IV. While masses of visible vapour, or clouds, are good conductors of electricity, they are yet capable of electrical accumulation, because capable of being insulated, the air in proportion to its dryness being one of the most complete non-conductors known. M. Peltier, from observations and experiments made at Paris, has drawn the conclusion, that all gray and slate-coloured clouds are charged with negative, and that all the white, rose, or orange-coloured clouds are charged with positive electricity. If two clouds in this state approach within a certain distance, the effect is an accumulation of their respective electricities on the sides that are nearest to each other. When the accumulation becomes intense, the resistance of the intervening and insulating atmosphere is overcome, and an interchange takes place. There is a flash and detonation caused by the union of the two electric forces, or thunder and lightning. The same interchange frequently takes place between a cloud and the earth, with the same phenomena.

When the interchange is between two clouds, the electric spark goes from one to the other, probably leaving both bodies at once. Kaemtz speaks of having several times remarked, in two clouds of the same height, that two flashes of lightning have left each of them, and united in the middle of the interval that separated them.

When the interchange is between a cloud and the earth, the lightning shoots upwards and downwards, though this may not be perceptible owing to its extreme velocity. The ancient inhabitants of Etruria are said to have made the distinction of ascending and descending thunder.

V. Discharges of lightning of three kinds are discriminated by Arago, zigzag, sheet, and globular.

1. Zigzag lightnings, usually called forked, sharply defined on their edges, describe zigzags in space, and frequently bifurcate or trifurcate at their extremity, even ramifying into several divisions, though always proceeding from a single point. Thus on the 3rd of June, 1765, the lightning penetrated at the same instant, by four distant points, Pembroke College, Oxford; and in April, 1718, twenty-four churches were struck in the neighbourhood of St. Pol de Léon, while only three claps of thunder were heard. The zigzag course of the lightning, and its bifurcations, are probably caused by the unequal conductibility of the air.

2. Sheet lightnings, the most common form, are expanded flashes opening up at once, and illuminating whole clouds, so as distinctly to show their entire outline.

3. Globular lightnings, or balls of fire, have a slower motion, and are visible a few seconds. Many examples are on record. Mr. Chalmers states, that on November 4th, 1749, while on board the ship *Montague*, he observed a large ball of blue fire rolling along on the surface of the water, as large as a mill-stone, at about three miles distance; and before they could raise the main tack, the ball had reached within forty yards of the main chains, when it rose perpendicularly with a fearful explosion, and shattered the main-topmast to pieces. Ball lightnings, a subject of difficulty, are considered by Sir W. Snow Harris, as a constant renewal of discharges, instead of an intermittent action, moving onward with the cloud which carries the discharge.

VI. The lightning of the first two classes does not last for more than $\frac{1}{1000}$th of a second; but a less duration in passing than the one millionth part of a second is atrributed to the light of electricity of high tension. In comparison with this velocity, the most rapid artificial motion that can be produced, appears repose. This has been exemplified by Professor Wheatstone in a very beautiful experiment.

A wheel made to revolve with such celerity as to render its spokes invisible, is seen for an instant with all its spokes distinct, as if at rest, when illuminated by a flash of lightning, because the flash has come and gone before the wheel has had time to make a perceptible advance.

VII. The colour of lightning is variously orange, white, and blue, verging to violet. Its hue appears to depend on the intensity of electricity, and height in the atmosphere.

The more electricity there is passing through the air in a given time, the whiter and more dazzling is the light.

Violet and blue-coloured lightnings are observed to be discharged from storm-clouds high in the atmosphere, where the air is rarefied; and analogously, the electric spark made to pass through the receiver of an air-pump, exhibits a blue or violet light in proportion as the vacuum is complete.

VIII. Lightning in its course follows the best conductors, attaching itself principally to metals, and after metals to damp substances; but inferior conductors may be chosen which present to the fluid the most direct route to the earth. Hence objects raised above the surface, whether good or bad conductors, are peculiarly exposed to the stroke of lightning, as church-steeples, houses, trees, especially solitary ones, the masts of ships, animals in the midst of a plain, and men on high points. Other circumstances being equal, there is of course greater safety on a non-conducting than on a good conducting surface.

The loss of life through lightning, which seems to be occasioned by the shock given to the nervous system, may be locally small, but the aggregate of victims in many countries in a few years is great. Volney states, that in 1797, in little more than two months, twenty persons were struck, and seventeen fatally, in the United States. In 1819, twenty persons were killed in France.

On the night of July 4, 1832, M. Buchwalder, engaged in making geodesical experiments on the top of the Sentis, in the canton of Appenzell, at the height of 8200 feet, was in the very centre of a tremendous storm. He was struck, but not mortally, while his sole companion perished by his side.

IX. Lightning falling on combustible substances often produces ignition; and displays its irresistible force when encountering objects on its passage that are bad conductors, displacing walls, and removing large masses of stone to a distance. Vitreous globules found on the surface of rocks, and *fulgurites*, or fulminary tubes, occurring in beds of sand, mark its intense action.

Saussure, in ascending Mont Blanc, observed the vitrifying effect of lightning on the schistose rocks; and Humboldt on the trachytic porphyry of the Nevado de Toluca, in Mexico, at the height of 14,000 feet.

Fulgurites have been observed by Henzen in the sandy hillocks of Holstein; by Dr. Buckland and Mr. Greenough near Drigg, in Cumberland; by Mr. Darwin in sand-hills on the banks of the Plata river; and many other examples are given. They are tubes formed by the lightning striking into the loose sand, composed of its agglutinated particles, varying in length and diameter according to the energy of the electric fluid, contracted towards their lower extremity, and terminating in a point. That they are the effect of lightning has been ascertained by direct observation; and they may be artificially imitated by electrical experiments.

X. The position of the fulminary tubes in all instances hitherto examined deserves notice. They have been found to terminate in springs of water below the sand, or to be directed towards bodies which are good conductors of electricity. Hence it is not unlikely that repeated visits of the electric fluid to the same spot may be determined by the circumstances of the substrata.

A school-house in East Lothian has been struck three times by lightning, and similar repetitions have often been observed. St. Mark's tower at Venice is an example. It was injured in 1388, set on fire in 1417, and entirely consumed, being of wood, in 1489. Being rebuilt of stone, the lightning renewed its stroke in 1548, 1565, 1653, and 1745. Again it was damaged in 1761 and 1762; but in 1766 a lightning-conductor was put up, which has since protected it.

XI. Coincidently with Franklin's celebrated discovery of the electric nature of lightning, the means were suggested by him of protecting edifices from its ravages, by conductors in direct communication with the ground, presenting to the fluid an easier passage than that offered by the materials of a building.

For this purpose metallic rods are used, slightly projecting above an edifice, the object being not to invite the electricity, but to carry it off innocuously in case of an attack. The rod must be finely pointed, in perfect connection with the ground, free from interruption through its entire length, and of the same dimensions. Experience has shown that a proper lightning-conductor applied with the necessary precaution, is able to protect a circle having a diameter of about 20 yards.

The same means are employed with success to protect ships. Sir W. Snow Harris says, that out of 100 cases of ships belonging to the navy being struck, one half of them were struck on the mainmast, one quarter on the foremast, one-twentieth on the mizenmast, and one-hundredth on the bowsprit. One in six were set on fire in some part of the masts, sails, or rigging. In about one-half, some of the men were either killed or injured, to the number of 62 killed, and 114 wounded, exclusive of those instances in which all the crew perished through the vessels taking fire. But since lightning-conductors have been introduced into the navy, very few ships have been damaged, and none destroyed.

It has been conceived, that if a sufficient number of conductors were raised, the electricity of the atmosphere might be so far carried away as either to prevent thunder-storms altogether, or speedily dissipate them. Hence entire towns on the continent have been literally studded with *paratonneres*, thunder-rods. Upon the assumption also that electricity promoted congelation, and therefore caused hail, the foe of the agriculturist, whole fields and vineyards have been planted with *paragrêles*, tall wooden poles with straw ropes hanging loosely from the top to the ground. The inutility of such schemes for the purpose is apparent, when we consider that forest trees, blades of grass, spines of thorns, and all vegetable points, possess extraordinary powers of conduction, yet thunder-storms are just as common in the midst of luxuriant vegetation as in other districts.

XII. Thunder, the report of the electric discharge, heard at varying intervals after it, arises from the violent displacement of the air by the fluid in its passage, and its rush back into the partial vacuum created. The rolling of the sound is due partly to reverberation, and in part to the report from different points in the track of the lightning reaching the ear in succession.

The thunder follows the lightning because sound travels slower than the luminous sensation. The noise of thunder makes its deep impression rather by its volume than by its intensity. The loudest thunder can scarcely be heard at the distance of ten miles, and is less intense therefore than a piece of heavy artillery. The longest peals, as observed by De L'Isle, at Paris, lasted from thirty-five to forty-five seconds.

XIII. Lightning without thunder, usually termed heat-lightning, perfectly harmless, is often observed after sunset in summer, and during the night. By some it is attributed to the air being humid, and therefore favourably disposed for the conduction of the electricity, occasioning very frequent but weak discharges, so that no report is heard, and the flash is invisible by day because of its feebleness. Others regard these lights as reflections of the lightnings of storms situated below the horizon, no thunder being heard because of the distance.

At Demerara, heat-lightnings occur at the commencement of the rainy season, when storms are very common among the mountains in the interior.

Kaemtz relates, that in August, 1832, heat-lightning was very frequent at Geneva. On the 16th the subject was actively discussed in the *Société de Physique et d'Histoire Naturelle*. After the sitting, as though to test the opinions that had been advanced, heat-lightning illuminated the whole of the north horizon; and some days after, the newspapers were filled with accounts of the ravages of storms in Baden, Wurtemberg and Bavaria.

XIV. There is a class of interesting and quite harmless meteorological phenomena, due to the simple communication of electricity in a strong degree. It becomes visible in the form of pale-coloured flames, quivering on the extremities of bodies which are non-conductors, or insulated conductors, as the points of spears and other military weapons, the manes and tails of horses, the top-masts and yard-arms of ships. In showers of rain and snow, the drops have been observed to be luminous, owing to a strong charge of electricity in the air.

Mariner's Lights, or St. Elmo's Fire, often remarked by the ancients, is a phenomenon of this description, usually reckoned by sailors a fortunate omen. It was noticed during the voyages of Columbus and Magellan. M. Forbin thus describes its appearance, as observed by him in 1696:—"The sky was suddenly covered with thick clouds. Fearing a gale, I had all the sails reefed. There were more than thirty of St. Elmo's Fires on the ship: one of them occupied the vane of the mainmast, and was about five decimetres long (rather more than 19 inches). I sent a sailor to fetch it. When he was aloft, he heard a noise like that which is made when moist gunpowder is burned. I ordered him to take off the vane; he had scarcely executed this order when the fire quitted it, and placed itself at the apex of the mainmast, whence it could not possibly be removed."

On the east coast of the United States, in January, 1817, luminous appearances were seen by those who were out of doors. Their hats, gloves, and ears, the manes and tails of their horses, the bushes along the road side, and the trunks of trees, were all surrounded by a lively vacillating flame in different shapes, which emitted a slight noise like the simmering of water over a fire. At Freyburg, Professor Lampadius observed an intense development of electricity during a change of weather, snow and sleet falling. In the neighbourhood there was a strong phosphorescence at the extremities of the branches of the trees, which ceased when the branches were made to touch the ground by bending them down. The light was very distinct, of a bluish white colour, and the snow appeared luminous as it fell. In Iceland, the phenomenon, there called the Laptelltur, occurs in winter, during a strong wind and drifting snow, the whole sky appearing at night as if on fire.

The following is a recent instance of the same kind. On Sept. 25, 1840, an officer of the French army in Algeria observed that the arms of the men, when piled on the ground, exhibited nothing unusual; but when the men carried them, the points of the bayonets were strongly luminous. The drops of rain also that fell on their beards and mustachios, remained hanging from them in a state of phosphorescence. When the hair was wiped, the phenomenon ceased; but was renewed the moment any fresh drops fell on it.

XV. Electricity sympathises generally with light and heat in its geographical distribution, diminishing from the equator to the poles. Hence, it is within the tropics that thunder-storms are the most frequent, and at the same time the most violent, the lightning flashing with a breadth and intensity, and the thunder pealing with an awfulness of which no conception can be formed by the inhabitant of other regions. The coast-line of Peru, however, where it never thunders or lightens, is a remarkable exception. The comparative number of storms becomes less, and their tone more subdued, as we recede from the tropics, so that in Europe, while there are about forty storms in the year in North Italy and Greece, Germany has only about twenty in the same interval, and Scandinavia not more than ten. In polar latitudes electrical explosions are still less frequent, and in some places entirely unknown. At the Faroe Islands thunder is seldom heard, and lightning is never known to do any injury. In Iceland, while lightning is not uncommon, especially in the neighbourhood of the volcanoes, thunder is rare, and was only heard once at Reikiavik in the interval between Sept. 21, 1833, and the end of August, 1835. It is stated by Gisecke, that during a residence for six years in Greenland, in lat. 70°, he only heard it thunder once.

In Europe, north of the Alps, the distribution of electrical explosions is analogous to that of rain. They occur principally in summer, except along the coast of Norway, where the greatest number falls in winter. Let 100 represent the total number of thunder-storms in a year, and the relative seasonal proportion will stand as follows:

	Winter.	Spring.	Summer.	Autumn.
West coast of Europe	8·9	17·7	52·5	20·9
Switzerland	0·4	20·6	69·0	10·0
Germany	1·4	24·4	66 0	8·2
Interior of Europe	0·0	15·7	79·3	5·0

Like the amount of rain, also, the number of storms decreases on passing into the interior of the continent:

	Annual Number of Storms.
West coast of Europe and Germany	about 20
Petersburg and Moscow	„ 17
Kasan	„ 9
Nertschinsk	„ 2
Irkutsk	„ 8

XVI. Magnetism, which extends its influence over every part of the earth's surface, was long supposed to be related to electricity, from the fact of lightning often rendering steel magnetic, and disturbing the magnetic needle, so that in thunder-storms a ship's compass has frequently been seriously injured. The two forces are now known to be identical, or rather but different forms under which the same power manifests itself; for according to Oersted's important discovery, electricity induces magnetism in the vicinity of the body which is conducting it, while Faraday's experiments have shown that free magnetism gives rise to electricity. The experiments of the latter go farther; for having succeeded in magnetising and electrifying a ray of light, and illuminating a magnetic line of force, there is reason to infer the elementary unity of these mightier agencies of nature, light and the magnetic and electric forces, as divergent energies having a common origin, functions of one and the same power.

The general phenomena of terrestrial magnetism are as follows:

1. A magnetic needle, freely suspended, as in the mariner's compass, everywhere on the surface of the earth and in the interior, takes a certain determinate position, more or less coinciding with the north and south polar points, but varying in different regions of the globe. The line of its direction is called the *magnetic meridian*; the divergence of the magnetic from the terrestrial meridian is called its *declination*, or *variation*; and knowing the variation, mariners are as well able to sail by the compass, as though the needle was in exact parallelism with the earth's axis, or pointed due north and south.

At present the variation of the magnetic needle at Greenwich from the meridian of Greenwich is 24° W. On travelling towards the west, the variation increases westerly, attains a maximum in the Atlantic Ocean, then decreases, till in North America there is no variation at all, the needle pointing exactly to the North Pole. Proceeding in the same direction, the variation becomes east, attains a maximum, diminishes, and becomes nothing in the east of Russia, the needle coinciding with the earth's axis. From thence to Greenwich the variation becomes westerly. Lines drawn through places where the needle points due north and south are termed *lines of no variation*.

The variation, however, in general, oscillates at the same place to a certain extent in a cycle of years. Thus at London in 1580, it was 11° 11′ E.; but in 1657, London was on the line of no variation, since which time it has been gradually increasing westerly. But there are places, as Spitzbergen, Jamaica, and the neighbouring islands, where no change in the variation has been perceptible. "The whole mass of West India property," says Sir John Herschel, "has been saved from the bottomless pit of endless litigation by the invariability of the magnetic declination in Jamaica and the surrounding archipelago during the whole of the last century; all surveys of property there having been conducted solely by the compass."

The variation also oscillates daily, probably under the influence of the course of the sun. The needle is in its mean position with us at about 10 A.M.; then it moves slowly westward and returns to its mean position by 10 P.M., moving slowly eastward, and returning during the next twelve hours.

The variation was first observed by Columbus, Sept. 13, 1493.

2. The magnetic needle, exactly poised and freely suspended, will not assume with us a position parallel to the horizon, but the extremity directed towards the north will incline downwards. This is called the *inclination* or *dip*. Exactly the opposite occurs in the southern hemisphere, where the extremity directed towards the south inclines or dips. But in equatorial regions there is no dip whatever, the needle assuming a perfectly horizontal position. A line connecting points where this is the case forms the *magnetic equator*. It does not coincide with the terrestrial equator, but deviates from it in some places as much as 15°, crossing it, however, at two opposite points, near the island of St. Thomas, on the west coast of Africa, and near little Gilbert's island, east of the Carolinas in the South Pacific. Receding from the magnetic equator, southwards and northwards, the dip of the needle increases. It makes an angle of 70° with the horizon in our latitude, the tendency to become vertical becoming stronger in higher latitudes. The dip of the needle was first observed by Robert Norman in 1576.

3. From the preceding facts, it is evident, that the earth acts as a great magnet, the poles of which determine the direction of the needle. Not being coincident with the geographical poles, and situated beneath the surface, we have hence the phenomena of the variation and the dip. In the northern hemisphere, where the north magnetic pole has the greatest effect, the corresponding extremity of the needle is attracted downwards to it, becoming vertical at the polar station. The effect of the south magnetic pole is similar in the southern hemisphere, while at the magnetic equator, where the influence of the two poles is equal, the dip is *nil*.

4. Commander, now Sir James Ross, attained to the north magnetic pole at 8 A.M. June 1, 1831, in lat 70° 5′ 17″, and long. 96° 46′ 45″ W., a spot on the west coast of Boothia, where the dip was 89° 59′ only one minute less than 90°, the vertical position, which would have precisely indicated the polar station. The same enterprising officer, Feb. 17, 1841, attained a point in the Antarctic Ocean where the dip was 88° 40′, making the nearest approach of any navigator to the south magnetic pole, being only 160 miles from it.

5. The intensity of the magnetic force varies in different parts of the earth, increasing generally from the equator to the poles. It is estimated in a similar manner to the force of gravity, by deviating the needle from its position in the magnetic meridian, and then allowing a free return to it, observing the oscillations made, and the interval that elapses before the position of rest is resumed. The oscillations will be more rapid, and the time less, in proportion to the intensity of the magnetic force. From experiments of this kind it is inferred, that there are two foci of greatest intensity in the northern hemisphere, the one in North America, and the other in Siberia, perhaps coinciding with the two points of greatest cold.

6. Lines of equal variation are called isogonial; lines of equal dip, isoclinial; and lines of equal intensity, isodynamical.

XVII. That meteoric display, occasionally seen in our heavens, the Aurora Borealis, or northern-light—the Aurora Australis, or southern-light, of the opposite hemisphere—is unquestionably of electro-magnetic origin, for it may be artificially imitated by passing a current of electricity through an exhausted receiver; violent disturbances of the magnetic needle precede and accompany its appearance; and light has been evolved by Faraday through magnetic power. In the course of the day, says Humboldt, "on which the lights are to appear, irregular horary movements of the magnetic needle usually indicate an interruption of equilibrium in the distribution of the terrestrial magnetism. When this disturbance has attained a great intensity, the equilibrium of the distribution is restored by a discharge, accompanied with an evolution of light. The splendid phenomenon of coloured northern-lights is the act of discharge, the conclusion of a magnetic storm; in the same way as in the electrical storm, lightning indicates the restoration of the disturbed equilibrium in the distribution of electricity."

XVIII. Auroral displays are very diversified, not only at different periods, but the same exhibition usually shifts through a succession of phases. Sometimes only flickering lights are seen streaming up from beneath the horizon towards the zenith; but in the more perfect and gorgeous appearances of high latitudes, there is generally a dark segment, sometimes black, or of a deep gray passing to violet, surmounted by a luminous arc of a brilliant white colour passing slightly to blue, and occasionally a second arc concentric with the first, their culminating points being in the magnetic meridian. The arc seldom remains stationary for more than a few minutes, but extends itself laterally, or rises and falls, or breaks in various places, or bends in convolutions like a ribbon exposed to the wind, while rays of almost every hue are incessantly darting from it towards the zenith, the "merry dancers" of the northern sky.

The northern lights have been seen by day, and in bright sunshine, owing to their intensity.

If the greater number of appearances fall in the winter half-year, one reason is, that the long nights favour the observation of them. In M. Mairan's list of recorded *auroræ boreales* down to the year 1754, the number given is 1441, of which 972 fall in the winter, and 469 in the summer months. They are thus distributed:

January	113	April	124	July	22	October	212
February	141	May	45	August	84	November	153
March	202	June	22	September	172	December	151

Other Tables support the inference to be deduced from this, that the number is very considerable in March, September, and October, or about the period of the equinoxes.

XIX. Auroral appearances, at least in certain districts, seem to observe a secular period, of the cause of which we know nothing, being frequent through a certain cycle, and becoming as rare through another.

XX. While the magnetic and electrical storms have one phenomenon in common—the evolution of light—the sphere of the latter is comparatively contracted, while that of the former embraces vast areas, extending sometimes to entire continents. This is indicated by the magnetic needle showing disturbance at the same time at widely remote points, and by isolated aurora being observed simultaneously at far distant stations.

The aurora borealis has been seen through a wide range of latitude, as far south as 45° in the southern hemisphere, while the aurora australis has been seen in England.

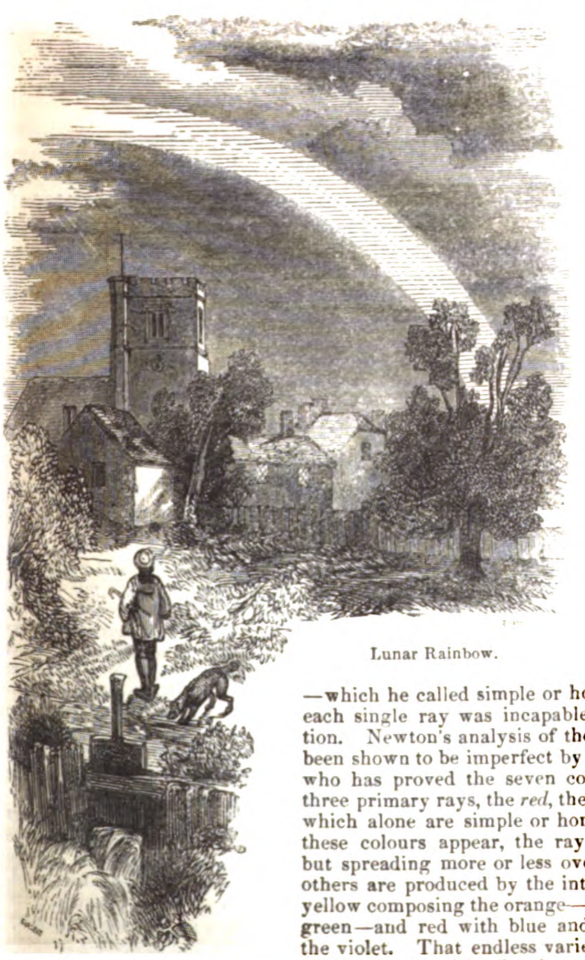
XXI. There is another respect in which the magnetic appears to differ from the electrical storm, in its discharges being conducted silently. It is true, that the Crees, Copper Indians, Esquimaux, and fur-traders of North America, and the inhabitants of the Shetlands, the Orkneys, and the Hebrides, maintain that when the aurora is intense, it is accompanied by a noise, variously compared to that of a fire agitated by the wind, and the crack of the electric spark. But with one or two exceptions, all scientific voyagers and travellers are unanimous in affirming, that when the aurora was most extensive and vivid, and when the most perfect calm and profound silence prevailed, they have failed to catch the faintest noise.

XXII. The northern lights, to us merely an object of curiosity and fascination, are of great practical utility to the natives of high latitudes, relieving their dreary winter night, and compensating for the long absence of solar illumination.

Aurora at Breuillepont, in Normandy, Oct. 19, 1726.

CHAPTER VIII.

OPTICAL PHENOMENA.



Lunar Rainbow.

I. Various and highly interesting effects result from the decomposition, refraction, and reflection of light in its passage through the atmosphere, in different conditions of the medium.

From Newton's analysis of the sunbeam admitted into a dark chamber through a hole in the window-shutter, and subjected to a prism, he inferred white light to be a compound of seven differently coloured rays—red, orange, yellow, green, blue, indigo, and violet—which he called simple or homogeneous, because each single ray was incapable of further separation. Newton's analysis of the solar spectrum has been shown to be imperfect by Sir David Brewster, who has proved the seven colours to result from three primary rays, the *red*, the *yellow*, and the *blue*, which alone are simple or homogeneous. Where these colours appear, the rays are concentrated; but spreading more or less over the spectrum, the others are produced by the intermixture—red and yellow composing the orange—blue and yellow, the green—and red with blue and a tinge of yellow, the violet. That endless variety and combination of tints displayed by the sky and the flowers of the fields, the rich hues of the autumnal woods, and the gorgeous plumage of tropical birds—in short, the colours of all objects, whether opaque bodies or transparent media arise from their varying capacity of absorbing or reflecting certain rays. The reflection of all the rays causes white, and the absorption of all black.

For the general phenomena of Refraction and Reflection, see Astronomy, chap. iii. p. 21—vii. 23.

II. The cerulean tint of the clear sky, as previously explained, is the result of the blue rays being most abundantly reflected or scattered by the aërial particles, the greater paleness of the blue in passing from the zenith towards the horizon arising from the vesicular vapours in the lower strata of the atmosphere. The latter cause occasions the difference in tinge between the clear sky of ocean and of land. At sea the blue is paler than in the interior of continents, for there is a larger quantity of vesicular vapour in the atmosphere in the one place than the other. The Pacific, as seen from the summit of the Andes, exhibits a haziness, extending to the height of about 10,000 feet, covering as with a thin veil the surface of the ocean.

Sometimes, in fine weather, the zenithal sky appears of a paler blue than usual, and the sun is less brilliant. This arises from the vesicular vapours being very abundant, ascending to a great height in the atmosphere, without being sufficiently dense to appear as mists. But brilliant and prolonged twilights ensue, from the reflection of the solar rays, when the vapours are very elevated, while the lower regions of the air are transparent. In the months of August and September, 1831, the twilights were quite remarkable for duration and brightness at Madrid, Genoa, Rome, Odessa, and many parts of Germany.

III. For some time about sunrise and sunset, on serene days, the predominant colour of the sky in the neighbourhood of the ascending and descending orb is very commonly yellow or red, though all intermediate tints between the lightest orange and the deepest purple are often exhibited. The solar beams having then the most considerable portion of the atmosphere to traverse in order to reach us, most of the blue rays are lost by absorption and reflection on their passage, while the red and yellow, which have the greatest momentum, variously modified by reflected light and by peculiar atmospheric conditions, are transmitted. Hence the sun, as seen from a diving-bell at some depth under water, appears a fiery globe, the one class of rays piercing the superincumbent fluid, the others being absorbed by it, or reflected from its surface. The fiery hue of the sky opposite to the setting sun, is caused by the red rays reaching that region being sent back by reflection to the eye of the observer. The rose-tint which frequently appears on the snowy summits of the Alps, a short time after sunset, is occasioned in a similar manner.

It is after all difficult to account for the variegated hues of morn and eve. To the preceding explanation, we may add, the influence of the vapour of water in the air, changeable in its amount and condition. Müller remarks, that when a column of steam rises from the safety-valve of a steam-engine, as, for instance, of a locomotive, the sun seen through the steam appears of a deep red; some feet above the safety-valve, at which the steam is escaping, its colour, by transmitted light, has a deep orange tint; at a greater distance, where the vapour is more perfectly condensed, the phenomenon entirely disappears. Thus, while aqueous vapour in a perfectly gaseous state is quite transparent and colourless, in the process of change to vesicular vapour, it is variously coloured red and orange, by freely admitting the passage of the red and yellow rays. Hence golden, rosy, purple, and fiery hues, may be determined by the presence of vapour in differing stages of condensation, and also in differing quantities, as we know that colour transmitted by a coloured glass often changes with the increase of its thickness.

Aqueous vapour perfectly condensed into vesicles, is transparent and colourless in thin layers; and hence the white fleecy appearance of thin clouds. But a moderately thick volume is impenetrable to the sun's rays, and casts a shadow like a solid body.

IV. As a certain portion of light is lost by absorption, and in other ways, in traversing even the most transparent media, the stars shine with greater lustre as seen from the summits of high mountains, than when beheld from a lower level, through an increased volume of the atmosphere. A number also come into view at great heights, which are not visible from the plains. They likewise scintillate less, as the cause of the phenomenon, the mixture of strata of air unequally heated producing unequal refraction, has less scope in proportion to the thinness of the atmospheric stratum.

The scintillation of the stars is the greatest towards the horizon: the least towards the zenith. It has been observed to occur with marked intensity on clear and very cold nights; also with a sky alternately cloudless and overcast; and during violent winds.

A communication from Professor Necker in the *Comptes Rendus*, 1841, states, that in the lower and eastern parts of Scotland, the fixed stars, even of the first magnitude, never twinkle, or only in a very slight degree. It is also remarked, upon the authority of Professor Forbes, that near Edinburgh, no scintillation is observed, unless when an aurora borealis prevails. "At Skye, on the contrary," he says, "all the fixed stars sparkle and scintillate as brightly as during the beautiful evenings of France and Switzerland. It is the same in the other Hebrides, in the Orkneys, Shetland, the whole of the northern coast of Scotland, and in the high regions of the Highlands. Now, it is to be remarked, that in none of these places are there any large towns, scarcely even burghs or large villages, and no manufactories of large extent which burn coal; the thinly-scattered population of these solitary regions use no other fuel but turf or wood, the very light smoke of which is soon dissipated without obscuring the atmosphere. Therefore the sky is as pure as in any part of continental Europe." The Professor attributes the non-appearance of scintillation in the other districts to the want of clearness in the air, owing to the dense coal-smoke of the large towns, villages, and manufactories, dispersed by the winds. But what influence the aurora borealis can have in re-establishing the scintillation does not appear.

V. When vapour has been condensed into fluid drops of water, and the spectator has his face to the showery cloud, with the sun shining at his back, he sees the glorious vision of the rainbow, a phenomenon due to the action of the rain-drops upon light. A pencil of light, on entering a rain-drop, undergoes refraction; and consisting of differently coloured rays possessed of different degrees of refrangibility, it emerges, after being reflected at the posterior wall of the drop, dissected into its primitive colours. Thus, from the action of the aqueous globule upon the luminous pencil, arises the coloured bow projected on the cloud, displaying the tints of the prismatic spectrum, the image being preserved constant and entire while its conditions co-exist, the continuance of the rain and the incident sunbeams.

Rainbow.

Lunar rainbows appear under the same circumstances as the solar, but are of rarer occurrence, because of the comparative feebleness of the lunar light. The more intense the light, the more vivid and distinct the colours of the bow, and *vicé versâ*. Hence lunar rainbows, while sometimes faintly showing the prismatic tints, are more generally only white or yellowish arcs.

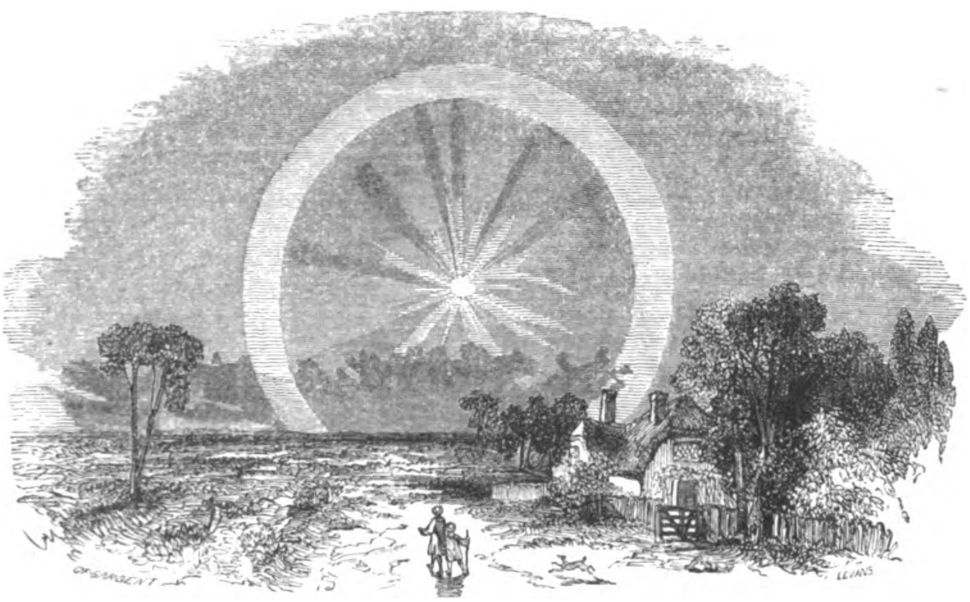
In a letter dated Collingwood, November 13, 1848, addressed to the *Athenæum*, Sir John Herschel describes a very perfect lunar rainbow, witnessed for the first time, as follows: "The moon was near the eastern horizon, shining brilliantly through a considerable clear opening in the otherwise generally and densely clouded sky. A light, drizzling, and very uniform rain was falling, with a gentle wind from the NE. The arch, very nearly a semicircle, was perfect in every part—apparently much better defined and somewhat narrower than the solar rainbow, (circumstances easily accounted for.) Its span also appeared somewhat less, which of course was only an illusion. Though much brighter than I could have expected a lunar rainbow to appear, (the effect no doubt of the very dark background of cloud against which it was projected,) it exhibited scarcely any colour: barely enough to assure the spectators that the order of colour was as in the solar bow—a faint ruddy tinge being sensible on the outer, and a still fainter bluish hue on the inner side. When first seen it was perfect, and continued so for six or eight minutes, when clouds obscuring the moon put an end to it. I will only add, that the impression produced by the spectacle was of that peculiar, solemn, and unearthly kind, which, once experienced, remains ever after ineffaceable."

The rainbow forms the base of a cone, whose vertex is the eye, and whose axis coincides with a straight line passing through the eye and the sun. On a rain-cloud of small extent, only a portion of the bow can be projected, but it is sometimes seen continued along the blue sky, when the air contains a considerable amount of unaggregated vesicular vapour. When the sun is at the horizon, the bow forms a perfect semicircle to an observer on a plain; and more than a semicircle may be seen from an isolated elevation. The greater the altitude of the sun, the lower below the horizon is the centre of the bow, and consequently the smaller is the portion of the arc that is visible. When the sun's height is above 45°, no rainbow can be seen from a site at the sea level, because then its summit coincides with the horizon, and the entire arc falls below it. Hence, in our latitude, there is no rainbow visible towards the middle of the day in summer.

When the rain is copious, and the sun is brightly shining, a second bow appears exterior to the first, and concentric with it, but fainter, and with the order of the colours inverted. The lower edge of the primary or interior bow is violet, and the upper red; on the contrary, the lower edge of the secondary or exterior bow is red, and the upper violet. The secondary bow is produced by rays which have undergone a second interior reflection in the rain-drops, and is therefore fainter than the primary arch, because light is enfeebled by every reflection. Ternary and quaternary rainbows are spoken of, produced by a triple and quadruple reflection, but they are so exceedingly faint as not to be discernible.

A coloured bow, similar to that which is produced by rain, may be observed under similar circumstances in the spray of a cataract, the shower of an artificial fountain, the dew upon the grass, and the mists that lie upon low grounds.

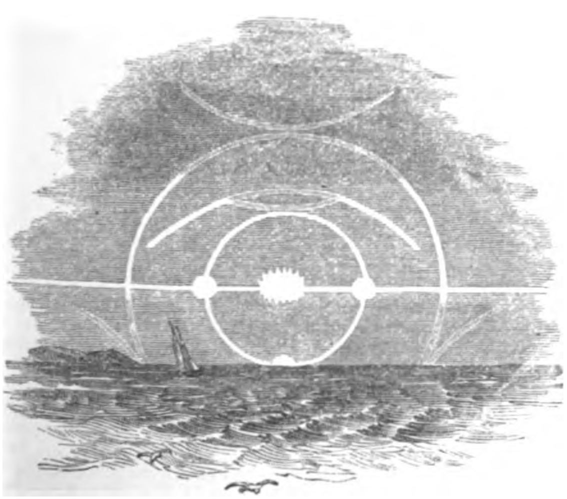
VI. Coloured circles of varying diameter are occasionally seen surrounding the sun and moon when the sky is invested with light clouds. These rings are designated by some *halos;* by others, *coronæ*. They are far more frequently observed around the moon, but this is simply owing to the sun's light being generally too dazzling to admit us to distinguish colours near his disc. If we study the solar image reflected in still water, or use a blackened mirror, and thus reduce the brilliancy of the sun's rays, then solar halos are observed, in that condition of the sky above described. They are occasioned by the inflection of light by the globules of visible vapour, or that property of the rays to bend and divide as they pass near the borders, ridges, and angles of surfaces. When halos are seen closely encircling the luminous body, and well defined, it is because the atmosphere is surcharged with humidity, large globules having been formed; and hence there is truth in the popular remark, that a dense halo portends rain. Frequently, with us, and always in high latitudes, icy particles take the place of vesicular vapours, in the production of halos.



Parhelia.

If we take a glass-plate upon which lycopodium seed has been strewed, and look at the flame of a taper through it, we perceive a glory or coloured circle surrounding the flame. The phenomenon answers to the halo, the minute particles of seed taking the place of the vesicular vapours in its production.

VII. Luminous circles, arcs, and horizontal bands of light, with mock-suns, *parhelia*, and mock-moons, *paraselenæ*, in the neighbourhood of the true orbs, are rare meteorological spectacles in our climate, but very common in the arctic regions, where snowy spiculæ, or minute crystals of ice float abundantly in the air, the angular forms of the crystals determining the rays of light in different regular directions, and originating the visual variety.



Parhelia.

Our old chronicles speak of these appearances. Whiston witnessed an example of parhelia in Rutlandshire, Oct. 22, 1721; and Dr. Trail, of paraselenæ, at Liverpool, on the evening of March 30, 1830. But they peculiarly belong to higher latitudes, and form there very gorgeous spectacles. The Icelandic annalists state, that in the severe winter of 1615, the sun, when seen, was always accompanied by two, four, five, and even nine of these illusions. Captain Parry describes and gives a drawing of a remarkable example, represented in the cut, which continued from noon until six o'clock in the evening, during his winter sojourn at Melville Island.

VIII. Illusions with reference to terrestrial objects are due to extraordinary reflection and refraction, caused by peculiar conditions of the air as to density. The *mirage*, the delusive appearance of water, common in the plains of Asia and Africa, on the verge of the horizon, is a well-known instance. In Egypt, the general aspect of the country is that of a plain, with gentle eminences on which the villages are seated. When the weather is calm, and the ground is highly heated, the landscape at a distance assumes the appearance of a pure transparent lake. The villages seem built on islands, their respective objects, houses and trees, are vividly reflected as if in water, and multiplied enlarged images of them are produced. So perfect is the representation, that experienced travellers, oppressed with heat and thirst, have accepted it as a reality, to find their hopes of speedy refreshment disappointed. This was the case with the French army during the celebrated campaign in Egypt.

"Still the same burning sun! no cloud in heaven!
The hot air quivers, and the sultry mist
Floats o'er the desert, with a show
Of distant waters mocking their distress."

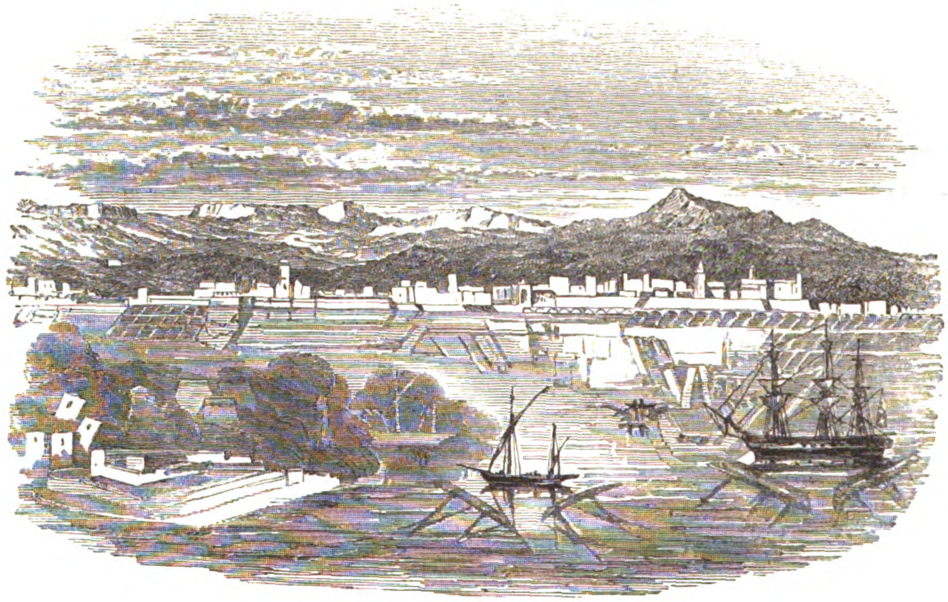
The phenomena of the mirage, as above described, depend upon the earth being highly heated and the resulting evaporation. But the temperature of the air rapidly diminishes from the surface of the ground. Hence there are striking diversities in the density of the lower strata, and the rays of light are unequally refracted and reflected at the surfaces of strata of different densities.

Serab is the Arabic term for what we after the French call mirage. It occurs as a common emblem of deceit in oriental writings. The Koran says: "The actions of the unbelievers are like the *serab* of the plain: he who is thirsty takes it for water, and finds it to be nothing."

Mirage of the Desert.

IX. A singular spectacle is occasionally though but rarely exhibited in the narrow strait between Messina and Reggio. A variety of images, men, houses, cattle, rocks, and trees, are seen pictured on the surface of the water, and in the air immediately over it. Multiplied images of the same object sometimes occur, or two images, one in a natural, and the other in an inverted position; and they have been observed to be fringed with red, green, blue, and other prismatic colours. The scenery in this novel panorama is known by accurate observation to be derived from objects on the shore of Reggio. This exhibition is called by the Sicilians *fata morgana,* a title of uncertain derivation, but supposed to refer to a vulgar presumption of the spectacle being called into existence by fairy art or an enchanter's wand.

The *fata morgana* is a rarity, and appears to vary in its details. The physical circumstances under which it occurs, as to the temperature and humidity of the atmosphere, have not been carefully noted. It has been remarked, that the mountains on both sides of the strait nearly inclose a portion of quiescent or stagnant air, the temperature of which near the surface of the water is therefore easily raised above that of the surrounding objects. The differential refraction and reflection of the rays of light through media of different densities, is quite equal to explain the whole appearance, according to the laws of optics. Dr. Wollaston has shown, by the very simple experiment of looking at a distant object along a red-hot poker, that two images are seen, one direct and another inverted, owing to the change induced by the heat in the density of the adjacent air. If the atmosphere is in that condition adapted to form the iris, or hazy, the colours with which the images are said to be fringed are explained by the refraction of light through the small globules of vapour; and the same tints would equally accompany any real object, as a ship, under the same circumstances.



Fata Morgana at Reggio.

X. The apparitions in the air, which were once regarded as real supernatural appearances, take their rise from terrestrial objects, natural, or more frequently enlarged and distorted images of them being formed by peculiar reflection. The vision of troops of horses and armies marching and counter-marching in cloud-land, has sprung from some animals pasturing on an opposite height, or travellers quietly pursuing their journey.

Dr. Buchan relates, that while on the cliff near Brighton, with a companion, watching the sun rise, Nov. 18, 1804, he saw, just as the solar disc emerged above the surface of the water, the face of the cliff represented precisely opposite to him, with a neighbouring windmill, his own figure and that of his friend, all faithfully depicted at some height above the sea. The appearance lasted about ten minutes, till the sun had risen nearly his own diameter above the waves. The whole seemed then to be elevated into the air, and successively vanished. There was a dense fog upon the water at the time. The rays of the sun fell upon the cliff at an incidence of 73° from the vertical.

As two travellers were standing on the summit of Ben Lomond, Aug. 19, 1820, watching the sun set in the west, the attention of one of the party was arrested by the appearance of two gigantic figures pictured on a cloud in the east, apparently standing on an enormous pedestal. He pointed out the phenomenon to his companion, and immediately one of the figures was observed to strike the other on the shoulder, and point towards them. They waved their hats and umbrellas, and the shadowy figures made a similar movement, faithfully imitating every gesticulation. The spectacle continued about a quarter of an hour.

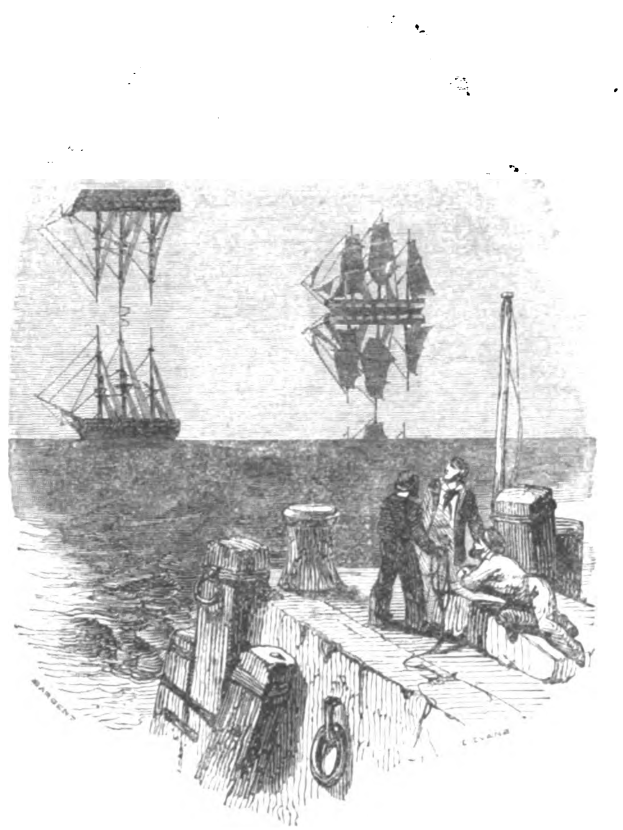
The spectre of the Brocken, one of the Harz Mountains—the colossal figure of a man observed to walk the ridge at sunrise—is an analogous example.

XI. As owing to the refraction of light in the ordinary state of the atmosphere, the sun and moon appear above the horizon when actually below it, and the stars shine out from a greater elevation than what belongs to them, so terrestrial objects undergo an analogous deviation from the same cause, a fact of importance to be attended to in the measurement of mountains. But in atmospheric conditions favourable to extraordinary refraction, and when it takes place laterally and vertically, the visual circle of the spectator is singularly enlarged, and objects are magnified as if seen through a telescope. Mountains unseen before are brought within the range of visibility, and low coasts assume a bold and precipitous outline. Owing to a sudden change in the density of the air, the chain of the Himalaya has been transiently beheld from a point in the plains of Bengal, from which it had never been seen before. On July 26, 1798, the coast of France from Calais to near Dieppe was distinctly visible from the beach at Hastings, and appeared to be only a few miles off, though the nearest points are from forty to fifty, and are not discernible ordinarily from the low situation even with the aid of the best glasses.

In high latitudes, it is very common for extraordinary and unequal refraction to play "high fantastic tricks" with terrestrial objects. They generally occur on the evenings of clear days, and are most frequent on the approach or commencement of easterly winds. The most usual effect is an increase in the vertical dimensions of the objects affected, so that low coasts appear elevated, what seamen call *looming*, and sites below the horizon are brought into view. The Icelanders, who are familiar with this effect of atmospherical refraction, call it *upphillingar*, and regard it as a presage of good weather.

It is an old tradition, that Hvidsærk, a mountain in Greenland, and Sneefields, in Iceland, have both been visible at the same time from the middle of the intervening strait, which at the nearest point is about 300 miles wide. Though treated as a fable, it may be strictly true, owing to the effects of refraction. The last named mountain, Sneefields, though it is not seen under ordinary circumstances for more than 80 miles, has yet been often visible from the sea beyond the Westmanna Isles, a distance of more than 140 miles; and Scoresby relates having seen a part of the Greenland coast of inferior height, Home's Foreland 3500 feet high, when 160 miles distant.

The following details respecting unequal refraction in northern regions, produced by the varying temperature and density of adjacent strata of air, are from Scoresby.



Refraction in the Polar Sea.

June 19, 1822, the sun was very hot, and the coast suddenly appeared to come fourteen or eighteen miles nearer: the different eminences were so raised that they were seen as easily from the deck of the ship as they were before from the foretop. The ice in the horizon assumed singular forms; the larger blocks seemed columns; icebergs and fields of ice, a chain of prismatic rocks; and in many places, the ice appeared to be in the air at some minutes above the horizon. Ships, that were in the neighbourhood assumed the most whimsical forms; in some, the mainsail seemed reduced to nothing, while the foresail appeared four times larger than it really is; the topsail appeared shortened. There were also other whimsical appearances. Above the topsails was seen a sail resembling top-gallant-sails loose from the bolt-rope; in others, the topsail seemed divided into two, inasmuch as the true sail was separated from its image by an interval. Above distant ships their own image was seen inverted and magnified; in some cases, it was very high above the ship, and then it was always smaller than the original. The image of a ship, that was itself below the horizon, was seen for several minutes; a ship was even surmounted by two ships, one in the right position, the other inverted. Some days later, "the most curious phenomenon," says Scoresby, "was to see the inverted and perfectly distinct image of a ship, that was below our horizon. We had observed similar appearances; but the peculiarity of this was the distinctness of the image, and the great distance of the ship it represented. Its outline was so well marked, that on looking at this image through one of Dollond's telescopes, I distinguished the details of the rigging, and of the hull of the vessel, I recognised it as being my father's ship; and when we compared our log-books, we saw that we were then thirty miles apart, namely, seventeen below the real horizon, and many beyond the limit of distinct vision."

XII. The fall of minute particles of earthy matters from the atmosphere, frequently observed where no simultaneous projection of volcanic ashes in any adjoining region has been known to occur, is readily explained. The materials have been swept from the land by the winds, or borne up by ascending currents determined by the heating of the earth's surface, and are returned again in showers after undergoing transport in various directions and to various distances. Where no occurrence of the kind has been noticed before, it excites astonishment, but in certain districts of the globe the phenomenon is annual. Thus, along the west coast of Africa, between Cape Badajor and Cape Verde, and thence to a considerable distance into the Atlantic, the air, from November to May, is literally loaded with fine sand-dust derived from the African deserts, giving it quite a misty appearance. Ships traversing this region have often had their sails, rigging, and decks covered with the finely pulverised substances. At Bombay also a shower of dust on one occasion fell on the decks of the vessels to the depth of an inch, supposed to have been blown from the deserts of Arabia.

The dust has often fallen on ships when several hundred, and even more than a thousand miles from the coast of Africa, and at points sixteen hundred miles distant in a north and south-west direction. It falls in such quantities as to dirty everything on board, injure astronomical instruments, affect the eyes, and vessels have run on shore owing to the obscurity of the atmosphere. From the direction of the wind whenever it has fallen, and from the season coinciding with the months during which the harmattan blows in Senegambia, it is certain that the sand-dust all comes from Africa. The following particulars have been given from the journal of the Prussian ship, *Princess Louisa:*

1839.	Lat.	Long.	Outward Voyage.	Distance from Land.
Jan. 14.	24° 20′ N.	26° 42′ W.	Sails rendered quite yellow by sand, which had probably been brought from the coast of Africa.	12°
— 15.	23° 05′	28° 18′	Sails still yellow: when we struck the sails we found the colour was produced by fine sand, which was thus loosened.	12°
1840.			Homeward Voyage.	
May 6.	10° 29′	32° 19′	We remarked a yellow appearance on the sails like that seen during our outward voyage.	17°
— 7.	12° 20′	34° 0′	The sails more yellow than they were yesterday.	18°
— 8.	14° 21′	35° 24′	Sails and ropes covered with yellow dust.	19°
— 9.	16° 44′	36° 37′	No increasing dust visible on the sails.	20°

The distances from land mentioned are analogous to that of the plains of North Germany from the African Sahara.

Mr. Darwin, when at the Cape de Verde islands, collected a little packet of this brown-coloured fine dust, which appeared to have been filtered from the wind by the gauze of the vane at the mast-head. It was forwarded to Professor Ehrenberg along with four other small samples obtained from a different quarter. He found the dust to consist in great part of infusoria with siliceous shields, and of the siliceous tissue of plants, ascertaining in the five packets no less than fifty-seven different organic forms!

XIII. Though not belonging strictly to the domains of meteorology, yet some notice may be taken of events once supposed to originate in the atmosphere. The relations current in the middle ages, and extant in the Chronicles of those times, respecting showers of sulphur and of blood having fallen in various parts of Europe, have no doubt sprung from the descent of volcanic ashes transported to a distance, or of vegetable pollen, as well as from a development of the microscopic fauna and flora which form the colouring matter of red snow. A yellowish dust, easily inflammable, occasionally observed on ponds in certain districts, supposed to be sulphur, has been referred to the pollen of vegetable productions predominant in the neighbourhood, pines, elders, birch, alders, lycopodium and several species of equisetum, swept off by the breeze, and precipitated with the rain.

1. Red snow.—In all the alpine districts of Europe, crimson and rose-coloured snow is common. Saussure observed it in abundance on Mount Brevern, in Switzerland; Ramond, on the Pyrenees; and Sommerfeldt, in Norway. In 1808 it was seen on the whole country about Cadone, Belluna, and Feltri, in Italy, and at the same time on the mountains of Brescio, Carinthia, and the Tyrol. In 1823, it occurred at various points along the whole chain of the Apennines. Mr. Darwin noticed it on crossing the Chilian Andes in 1835; and it has been repeatedly met with by northern adventurers, as Ross and Parry. In 1840, it was found in great abundance in the neighbourhood of the hotel of Neuchatelois, near the crystal grottoes, on the lower glacier of Grindelwald, Switzerland; at the extremity of the glacier of Oberaar; on the glacier of Finsteraar; on the plains of snow which border the west flank of Siedelhorn; and in numerous points of the lower glacier of the Aar. No one pretends to have ever witnessed the coloured snow fall. Its descent in the night has been the vulgar presumption. Examined by the microscope, the colouring substance is found to be partly vegetable and partly animal. Red granules are observed, which, according to M. Ch. Martins, are vegetables reduced to their simplest expression, namely, to a cell filled with liquid, in which a great number of infusoria circulate.

Showers of blood have been supposed to have fallen at places apart from snow. This was the popular opinion at Aix, in June 1608, when various points in the suburbs, and especially a churchyard, were observed to be covered with crimson-spots. But M. Peiresc gave at the time no doubt the true explanation of the circumstance, referring it to the coincident appearance of prodigious swarms of insects, which always discharge a substance in evolving from the pupa state, of a red colour in the case of butterflies, that of several kinds of moths being orange or whitish.

2. Green snow.—M. Ch. Martins, who twice accompanied the French expedition to Spitzbergen, observed at his landing, July 25, 1838, on traversing a field of snow, that while at the surface it was white, at an inch or so beneath it was green, as if it had been watered with a decoction of spinach. On another excursion, he observed the green snow at the surface. The Parisian Professor and his companions concluded generally, that the red and green granules of coloured snow are one and the same microscopic plant in different stages of development; that red is the colour of the primitive state, which afterwards becomes green under the influence of light and air; but these views require to be substantiated.

3. Black snow.—So the inhabitants of the Orkneys denominated a dark powder resembling lamp black, which fell in those islands, and the Shetlands, Oct. 20, 1755. There is little doubt of this being a volcanic product, transported by the winds, as a violent eruption of Kötlaegia, a mountain in the south of Iceland, commenced in that year, Oct. 17, and continued to Nov. 7. A similar fact has not received any explanation. On February 7, 1837, the remarkably pure Lock Erne, in Perthshire, was observed to be covered with a black scum, which lay in a thin stratum upon its surface. The black powder was not confined to the waters of the loch, but was found on the land, at the farm of Miggar, several miles from it. Professor Connel, upon analysing a portion of the water of Loch Erne, found the powder to be essentially carbonaceous with some siliceous admixtures; but was quite unable to offer an opinion respecting its origin in such a situation. It had evidently fallen in the atmosphere, been transported by it, and the query may be started, whether it may be linked with the earthquake shock which convulsed Palestine early in the preceding month, (January) destroyed Safet, rent the ground into fearful chasms around the lake of Tiberias, threw down the minarets of Damascus, and part of the walls of Acre, and was sensibly felt at Constantinople?

XIV. Fogs, remarkable for their drying properties, hence called Dry Fogs, as distinguished from ordinary damp mists, are at times observed, and have occasioned controversy respecting their cause. They spread as a haze over large districts, giving to nature "a dim and sickly eye," diffuse a peculiar odour, and exhibit a pale blue colour. Local dry fogs may be due to the combustion of peat, as suggested by Kaemtz. This transpires upon an extensive scale in midland Europe, where the peat-bogs are set fire to in very dry seasons in order to form cultivable land, and forests are accidentally ignited, occasioning terrible conflagrations. But it is impossible to account in this way for the fog of 1783, which extended over a large section of the northern hemisphere. It was first seen at Copenhagen, May 29th, and about the same time in England. The sun rose and set without his rays, even in a cloudless sky, and the moon high in heaven had the colour of heated brick. It appeared at Rochelle, on June 6th; at Dijon, on the 14th; everywhere in France, Germany, and Italy, between the 16th and 18th; at the St. Gothard, and at Buda, on the 23rd; at Moscow, on the 25th; in Syria towards the end of the month; and at the Altai mountains, on July the 1st. It reached also the north coast of Africa, and was noticed over a great part of North America. Very probably its production was connected, though in a way we cannot point out, with the natural convulsions of that remarkable year, when the greatest mass of volcanic matter, hitherto ascertained to be the product of an eruption, was ejected in Iceland, and the earthquakes occurred by which Calabria and Sicily were desolated.

The best account of the fog of 1783 is given by M. Arago in his "Scientific Notices of Comets," inserted in the French *Annuaire* for 1832, replying in the negative to the question, "Whether the Dry Fogs of 1783 and 1831, were occasioned by the tail of a Comet?"

XV. The wandering meteor called *Ignis fatuus*, and popularly, *Will-o'-the-wisp*, is peculiar to sites where processes of decomposition and putrefaction are going on. Though now somewhat rare with us, it is not so in various continental districts, appearing in battle-fields and marsh lands, with a flickering unsteady motion, a few feet above the ground, and speedily vanishing. It has been referred to the phosphuretted hydrogen emitted by putrefying animal remains, which inflames as soon as it is in contact with atmospheric air; and to the light carburetted hydrogen obtained from decomposing vegetable substances ignited by an electric spark; but though inflammable action has in some cases been evidenced, the meteor is perhaps more generally only a faint phosphorescence, not burning as a flame, arising from hydrogen gas containing phosphorus.

Ignis Fatuus.

ORGANIC LIFE.

CHAPTER I.

BOTANICAL GEOGRAPHY.

WHEN treating of the geographical distribution of vegetables, we have to mark the general arrangements indicated, and the agencies that have evidently operated in promoting the diffusion of floral tribes. Vegetation occurs over the whole globe, therefore, under the most opposite conditions. Plants flourish in the bosom of the ocean as well as on land, under the extremes of cold and heat in polar and equatorial regions, on the hardest rocks and the soft alluvium of the plains, amidst the perpetual snow of lofty mountains, and in springs at the temperature of boiling water, in situations never penetrated by the solar rays, as the dark vaults of caverns, and the walls of mines, as well as freely exposed to the influences of light and air. But these diverse circumstances have different species and genera. There is only one state which seems fatal to the existence of vegetable life—the entire absence of humidity.

By species we understand so many individuals as intimately resemble each other in appearance and properties, and agree in all their permanent characters, which are founded in the immutable laws of creation. An established species may frequently exhibit new varieties, depending upon local and accidental causes, but these are imperfectly, or for a limited time, if at all, perpetuated.

A genus comprises one or more species similar to each other, but essentially differing in formation, nature, and in many adventitious qualities from other plants. A tribe, family, group, or order, comprises several genera.

II. The known number of species in the vegetable kingdom has been gradually enlarged by the progress of maritime and inland discovery; but owing to great districts of the globe not having yet been explored by the botanist, the interior of Africa and Australia, with sections of America, Asia, and Oceanica, it is impossible to state the exact amount. The successive augmentation of the catalogue appears from the numbers below:

	Species.		Species.
Theophrastus	500	Persoon	27,000
Pliny	1000	Humboldt and Brown	38,000
Greek, Roman, and Arabian botanists	1400	De Candolle	56,000
Bauhin	6000	Lindley	86,000
Linnæus	8800	Hinds	89,000

III. Vegetable forms are divided into three great classes which differ materially in their structure:—1. Cryptogamous plants—those which have no flowers properly so called, mosses, lichens, fungi, and ferns; as distinguished from those which are phænogamous, or flower-bearing, to which the two following classes belong. 2. Endogenous plants, which have stems increasing from within, also called Monocotyledons, from having only one seed-lobe, as the numerous grasses, lilies, and the palm family. 3. Exogenous plants, which have stems growing by additions from without, also called Dicotyledons, from the seed consisting of two lobes, the most perfect, beautiful, and numerous class, embracing the forest trees, most flowering shrubs and herbs.

The exogens furnish examples of gigantic size, and great longevity. In South America, on the banks of the Atabapo, Humboldt measured a *bombax caiba* more than 120 feet high, and 15 in diameter; and near Cumana, he found the *Zamang del Guayra*, a species of mimosa, the pendant branches of the hemispherical head having a circumference of upwards of 600 feet. The *Adamsonia*, or boabad of Senegal, though attaining no great height, rarely more than 50 feet, has a trunk with a diameter sometimes amounting to 34 feet; while the *Pinus Lambertiana*, growing singly on the plains west of the Rocky Mountains, has been found 250 feet high, 60 feet in circumference at the base, 4½ feet in girth at the height of 190 feet, yielding cones 11 inches round and 16 long. The *Ficus Indicus*, or banian tree, sending out shoots from its horizontal branches, which reaching the ground take root, and form new stems, till a single tree multiplies almost to a forest, has been observed covering an area of 1700 square yards.

The Banian Tree.

From the number of concentric zones observed in a transverse section of the stems, De Candolle advances proof of the following ages:

Elm	335 years	Oriental Plane	720 years and upwards
Cypress	about 350 „	Cedar of Lebanon	about 800
Cheirostemon	„ 400 „	Oak	810; 1080; 1500
Ivy	450 „	Lime	1076; 1147
Larch	576 „	Yew	1214; 1458; 2588; 2880
Orange	630 „	Taxodium	4000 to 6000
Olive	700 „	Boabab	5150.

Admitting, with Professor Henslow, that De Candolle overrated the ages of these trees one-third, they are examples of extraordinary longevity. Yew trees upwards of 700 years old remain at Fountains Abbey, Yorkshire, as there is historic evidence of their existence in the year 1133. But a yew in the churchyard of Darley-in-the-Dale, Derbyshire, is considered by Mr. Bowman as 2006 years old.

IV. The cryptogamous plants afford the most numerous examples of wide diffusion. A lichen indigenous in Cornwall, *sticta aurata*, is also a native of the West India islands, Brazil, St. Helena, and the Cape of Good Hope; while

38 lichens and 28 mosses are common to Great Britain and Australia, though the general vegetation of the two districts is remarkably discordant. Some species of endogenous plants are also widely distributed, the *phleum alpinum* of Switzerland occurring without the slightest difference at the Strait of Magellan, and the quaking grasses of Europe in the interior of Southern Africa. But only in very few instances are the same species of exogenous plants met with in regions far apart from each other; and generally speaking, in passing from one country to another, we encounter a new flora; for if the same genera occur, the species are not identical, while in districts widely separated the genera are different.

The cryptogamic plants, mosses, lichens, ferns, and fungi, are to the whole mass of phænogamic vegetation, in the following proportions in different districts: Equatorial latitudes, 0° to 10°, on the plains, $\frac{1}{25}$, on the mountains, $\frac{1}{5}$; mean latitudes, 45° to 52°, $\frac{1}{2}$; high latitudes, 67° to 70°, proportion about equal. Thus the proportion of flowerless vegetation to the flowering increases from the equator to the poles. But the family of ferns, *filices*, viewed singly, forms an exception to this law, decreasing as we depart from equinoctial countries, being $\frac{1}{20}$ in equatorial and $\frac{1}{70}$ in mean latitudes, and not found at all in the high latitudes of the new world.

Proportion which several families of plants bear in different latitudes to the entire mass of vegetation, excluding the cryptogamia, derived from Humboldt. The latitudinal zones, as above defined, are denoted by E equatorial, M mean, H high.

I. ENDOGENOUS.

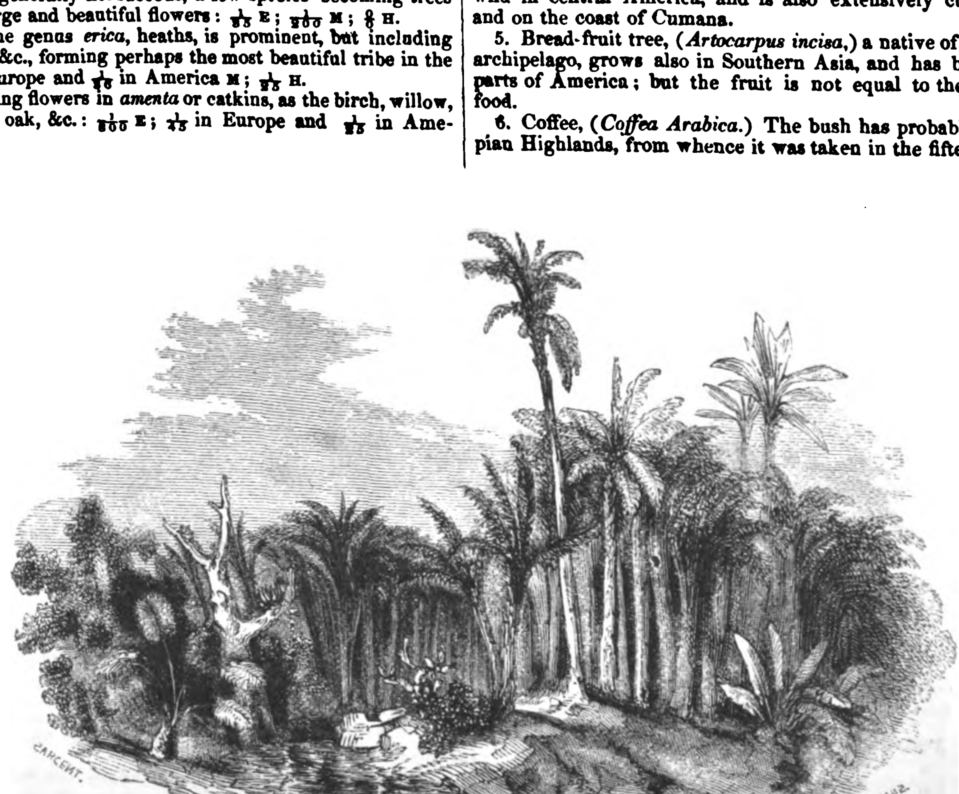
1. *Junceæ*, a small tribe named from its type, the rush: $\frac{1}{400}$ E; $\frac{1}{90}$ M; $\frac{1}{25}$ H.
2. *Cyperaceæ*, an extensive order to which the sedges belong: $\frac{1}{22}$ in the old and $\frac{1}{50}$ in the new world E; $\frac{1}{20}$ M; $\frac{1}{9}$ H.
3. *Gramineæ*, the most important of all vegetable tribes, comprehending the most valuable pasture and all the corn yielding plants, wheat, barley, oats, maize, rice, with the sugar-cane, &c.: $\frac{1}{14}$ E; $\frac{1}{12}$ M; $\frac{1}{10}$ H.

II. EXOGENOUS.

4. *Compositæ*, the largest known natural order of plants, named after their compound flowers, estimated at $\frac{1}{10}$th of the whole vegetable kingdom. The daisy, thistle, dandelion, lettuce, tansy, aster, artichoke, marigold, and dahlia, some of which assume quite an arborescent character in warm climates, are familiar examples: $\frac{1}{15}$ in the old and $\frac{1}{12}$ in the new world E; $\frac{1}{8}$ in the old and $\frac{1}{6}$ in the new world M; $\frac{1}{13}$ H.
5. *Leguminosæ*, plants the fruit of which is generally a legume, varying vastly in form and size, including the common bean and pea, the laburnum, and some of the stateliest members of the tropical forest, the mimosa, tamarind, and the trees yielding logwood, Brazil-wood, &c.: $\frac{1}{10}$ E; $\frac{1}{18}$ M; $\frac{1}{35}$ H.
6. *Euphorbiaceæ*, comprising the plants from which the resin called euphorbium, castor, croton, and other oils are derived, varying from minute herbs to trees of the largest size: $\frac{1}{32}$ E; $\frac{1}{80}$ M; $\frac{1}{500}$ H.
7. *Labiatæ*, an extensive family of plants, generally herbaceous and never exceeding the size of small bushes, usually containing an aromatic or tonic volatile oil, as mint, thyme, sage, lavender, rosemary, horehound, &c.: $\frac{1}{40}$ E; $\frac{1}{40}$ in America and $\frac{1}{25}$ in Europe M; $\frac{1}{70}$ H.
8. *Malvaceæ*, the mallow tribe, generally herbaceous, a few species becoming trees in hot countries, remarkable for large and beautiful flowers: $\frac{1}{35}$ E; $\frac{1}{200}$ M; $\frac{0}{0}$ H.
9. *Ericeæ*, an order in which the genus *erica*, heaths, is prominent, but including the rhododendron, azalea, arbutus, &c., forming perhaps the most beautiful tribe in the vegetable world: $\frac{1}{130}$ E; $\frac{1}{100}$ in Europe and $\frac{1}{80}$ in America M; $\frac{1}{25}$ H.
10. *Amentaceæ*, forest trees bearing flowers in *amenta* or catkins, as the birch, willow, hazel, poplar, chestnut, pine, elm, oak, &c.: $\frac{1}{800}$ E; $\frac{1}{45}$ in Europe and $\frac{1}{35}$ in America M; $\frac{1}{20}$ H.
11. *Umbelliferæ*, herbaceous plants the flowers of which are disposed in umbels, as the hemlock, carrot, caraway, coriander, &c.: $\frac{1}{500}$ E; $\frac{1}{40}$ M; $\frac{1}{60}$ H.
12. *Cruciferæ*, an extensive order, comprehending the mustard, cress, turnip, cabbage, scurvy-grass, radish, and similar plants, which have a part of their inflorescence placed something like the arms of a Maltese Cross: $\frac{1}{800}$ E; $\frac{1}{18}$ in Europe and $\frac{1}{60}$ in America M; $\frac{1}{24}$ H.

V. In equinoctial and tropical countries, where a sufficient supply of moisture combines with the influence of light and heat, vegetation appears in all its magnitude and glory. Its lower orders, mosses, fungi, and confervæ, are very rare. The ferns are arborescent. Reeds ascend to the height of a hundred feet, and rigid grasses rise to forty. The forests are composed of majestic leafy evergreen trees bearing brilliant blossoms, their colours finely contrasting, scarcely any two standing together being of the same species. Enormous creepers climb their trunks; parasitical orchidæ hang in festoons from branch to branch, and augment the floral decoration with scarlet, purple, blue, rose, and golden dyes. Of plants used by man for food, or as luxuries, or for medicinal purposes, occurring in this region, rice, bananas, dates, cocoa, cacao, bread-fruit, coffee, tea, sugar, vanilla, Peruvian bark, pepper, cinnamon, cloves, and nutmegs, are either characteristic of it as principally cultivated within its limits, or entirely confined to them.

1. Rice, (*Oryza-sativa*,) the chief food of perhaps a third of the human race, is cultivated beyond the tropics, but principally within them, only where there is a plentiful supply of water. It has never been found wild; its native country is unknown; but probably southern Asia.
2. Bananas, or plantains, (*Musa sapientum et paradisiaca*,) are cultivated in intertropical Asia, Africa, and America. The latter species occurs in Syria. The banana is not known in an uncultivated state. Its produce is enormous, estimated to be on the same space of ground to that of wheat, as 133 to 1, and to that of potatoes as 44 to 1.
3. Dates, (*Phœnix dactylifera*,) and cocoa, (*Cocos nucifera*,) belong to the family *Palmæ*. The palms, remarkable for their elegant forms and importance to man, contribute more than any other trees to impress upon the vegetation of tropical and equinoctial countries its peculiar physiognomy. The date palm is a native of northern Africa, and is so abundant between the Barbary states and the Sahara, that the district has been named Biledulgerid, the land of dates. As the desert is approached, the only objects that break the monotony of the landscape are the date palm, and the tent of the Arab. It accompanies the margin of the mighty desert in all its sinuosities from the shores of the Atlantic to the confines of Persia, and is the only vegetable affording subsistence to man that can grow in such an arid situation. The annual produce of an individual is from 150 to 260 lbs. weight of fruit. The cocoa palm furnishes annually about a hundred cocoa-nuts. It is spread throughout the torrid zone; but occurs most abundantly in the islands of the Indian archipelago. The family of palms is supposed to contain a thousand species, some of large size, forming extensive forests.
4. Cacao, (*Theobrama cacao*,) from the seeds of which chocolate is prepared, grows wild in central America, and is also extensively cultivated in Mexico, Guatimala, and on the coast of Cumana.
5. Bread-fruit tree, (*Artocarpus incisa*,) a native of the South Sea Islands and Indian archipelago, grows also in Southern Asia, and has been introduced into the tropical parts of America; but the fruit is not equal to the banana as an article of human food.
6. Coffee, (*Coffea Arabica*.) The bush has probably for its native region the Ethiopian Highlands, from whence it was taken in the fifteenth century to the Highlands of



A Palm Forest.

Yemen, the southern part of the Arabian peninsula. It has been introduced, and is now extensively cultivated in British India, Ceylon, Java, the Mauritius, Brazil, and the West Indies, but the quality is inferior, which makes the climate of the Mocha coffee district of importance, as peculiarly favourable to the plant. It grows there on hills described by Niebuhr as being soaked with rain every day from the beginning of June to the end of September, which is carefully collected for the purpose of irrigation during the dry season. Forskhäl gives the following temperatures in the district:

Beit el Fakih	March 16,	7 A.M., 76°	1 P.M., 95°	10 P.M., 81°
„	„ 18,	„ 77	„ 95	„ 81
Hodeida	„ 18,	„ 72	„ 92¾	„ 78
Bulgosa, a village in the hills	„ 20,	„ 69½	„ 85½	„ 73

Coffee was first introduced into Venice in 1615; into England in 1652; and into France in 1658.

7. Tea, (*Thea Chinensis.*) The plant is indigenous in China, Japan, and Upper Assam. In the latter country, it has recently been found in a wild state, and is in process there of extensive cultivation. As the plant is hardy, its culture has very lately been attempted in the south of France, and apparently with complete success. A similar experiment on the burning plains of Algeria completely failed, all the plants being killed by the heat, notwithstanding every precaution. Tea was first introduced into Europe by the Dutch in 1666. The leaves of the coffee-plant have long been used as a substitute for tea by the lower-classes in Java and Sumatra; and recently, Professor Blume, of Leyden, exhibited samples of tea prepared from coffee-leaves, agreeing entirely in appearance, odour, and taste, with the genuine Chinese production.

8. Sugar-cane, (*Saccharum officinarum,*) a species of *Gramineæ*, occurs to some extent without the tropics, having been cultivated centuries ago in Europe, as at present scantily in the south of Spain. But it properly belongs to the torrid zone, and has for its principal districts, the southern United States, the West Indies, Venezuela, Brazil, the Mauritius, British India, China, the Sunda and Philippine Islands. The plant was found wild in several parts of America on the discovery of that continent, and occurs in a wild state on many of the islands of the Pacific.

9. Vanilla, (*Vanilla aromatica,*) the fruit of which forms the well-known aromatic, grows wild principally in Mexico.

10. Peruvian bark, (*Cinchona officinalis,*) a forest tree, of which there are several species, furnishing the valuable medicine so called. It is exclusively confined to South America, and grows chiefly on the Andes of Loxa and Venezuela.

11. Pepper, (*Piper nigrum,*) belongs exclusively to the Malabar coast, where it has been found wild. Sumatra, which produces the greatest quantity, Borneo, the Malay peninsula, and Siam. Other species of *Piperaceæ* occur in tropical America.

12. Cinnamon, (*Laurus Cinnamomum,*) a small tree yielding the aromatic bark, is found native only in the Island of Ceylon; but another species occurs in Cochin China.

13. Clove, (*Myrthus caryophyllus,*) an evergreen small tree, the dried flower-buds of which form the celebrated aromatic, grows naturally in the Moluccas, whence it has been conveyed to other tropical districts. The island of Amboyna, one of that group, is the principal seat of its cultivation. The lowest temperature there is 72°; the mean temperature of the year 82°.

14. Nutmeg (*Myristica moschata,*) grows naturally in several islands of the eastern archipelago, but is principally cultivated in the Banda Isles.—See Botanical Map.

VI. Tropical families and forms successively vanish with an increase of distance from the equator, and new phases of vegetation mark the transition from hot to temperate climates. Vividly green meadows, abounding with tender herbs, replace the tall rigid grasses which form the impenetrable jungle; and instead of forests composed of towering evergreen trees, woods of the deciduous class appear, which cast their leaves in winter, and hybernate in the colder season, the oak, ash, elm, maple, beech, lime, alder, birch, and sycamore. The cultivation of the vine becomes characteristic, with the perfection of the cereal grasses, and a larger proportion of herbaceous annuals and cryptogamic plants.

The vine (*Vitis vinifera*) is less impatient of a cold winter than a cool summer. Hence its northern limit, which coincides with lat. 47° 30′ on the west coast of France, rises in the interior, where, though the winters are colder, the summers are warmer, to lat. 49°, cuts the Rhine at Coblentz in lat. 50° 20′, and ascends to 52° 31′ in Germany.

VII. Receding further from the equator, magnificent forests of the fir and pine tribe prevail, as in the central parts of Russia, on the southern shores of the Baltic, in Scandinavia, and North America. But some of the cereals are no longer cultivatable, and several timber-trees common to the temperate zone do not reach its northern limits. Gradually all ligneous vegetation disappears entirely as higher latitudes are approached, the woods having first dwindled to mere dwarfs in struggling with the elements, hostile to that state which nature destined them to assume. The limit of the forests is a sinuous line running along the extreme north of the old world; and extending from Hudson's Bay, lat. 60°, to the Mackenzie River, lat. 68°, and thence to Behring's Strait. The dwarf birch (*Betula nana*), a mere bush, is the last tree found on drawing near the eternal snow of the pole. At the island of Hammerfest, lat. 70° 40′, near the North Cape, it rises to about the height of a man, in sheltered hollows between the mountains, its lower branches trailing on the ground, affording a shelter to the ptarmigan. In the polar zone, some low flowering annuals, saxifrages, ranunculi, gentians, chickweeds, and others, flourish during the brief ardent summer; a few perennials also accommodate themselves to the rigorous climate by spreading laterally, never rising higher than four or five inches from the ground; till finally no development of vegetable life is met with, but lichens, and the microscopic forms that colour the snow.

In Europe, wheat ceases with a line connecting Inverness in Scotland, lat. 58°, Drontheim in Norway, lat. 64°, and Petersburgh in Russia, lat. 60° 15′. Oats reach a somewhat higher latitude. Barley and rye ascend to lat. 70°, but require a favourable aspect and season to produce a crop.

The northern limit of the growth of oak, lat. 61°, falls short of that of wheat. The oak makes a singular leap at the confines of Europe and Asia, (see Botanical Map,) disappearing towards the Ural Mountains. This is the case also with the wild-nut and apple. The oak and the wild-nut, however, reappear suddenly in Eastern Asia, on the banks of the Argoun and the Amour; and the apple occurs anew in the Aleutian Isles.

The following are the northern limits of several trees in Scandinavia:

Beech, *Fagus silvatica*	60°	0′ lat.
Hard Oak, *Quercus robur*	61	0 „
Common Elm, *Ulmus campestris*	61	0 „
Common Lime, *Tilia communis*	61	0 „
Common Ash, *Fraxinus excelsior*	62	0 „
Fruit trees	63	0 „
Hazel, *Corylus arellana*	64	0 „
Spruce Fir, *Abies excelsa*	67	40 „
Service Tree, *Sorbus aucuparia*	70	0 „
Scotch Fir, *Pinus silvestris*	70	0 „
White Birch, *Betula alba*	70	40 „
Dwarf Birch, *Betula nana*	71	0 „

VIII. Thus distinct vegetable regions are observed on passing from south to north through different climatic zones, defined as to their limits by the isothermal curves, and not by the parallels of latitude. Similar changes of vegetation mark a perpendicular transit through varying climates. A succession of plants appear on the tropical mountains which rise above the snow line, corresponding to those which are encountered in mean and high latitudes. The higher we ascend, the more does the number of the phænogamic class diminish in proportion to the cryptogamic, till only members of the latter family are found, whose further progress upward is arrested by the everlasting snow. The last lichen met with by Saussure on Mont Blanc, *silene acaulis*, was also observed by M. Brevais in the neighbourhood of Bosekop, lat. 69° 58′, where it was vegetating on the sea-shore shaded by the last pines of Europe.

Isolated mountains display to the best advantage the effect of climatic change on vegetation.

I. Etna is divided into three great regions: *La Regione Culta*, or fertile region; *La Regione Sylvosa*, or woody region; *La Regione Deserta*, the bare or desert region. But each of these is susceptible of subdivisions, defined by the presence of certain families of plants, forming seven botanical zones.

1. The sub-tropical zone, which does not rise more than 100 feet above the level of the sea, is characterised by the palm, banana, Indian fig, sugar-cane, varieties of mimosa and acacia, which with us are only found in conservatories.
2. The hilly zone rises about 2000 feet, characterised by the orange, lemon, shaddock, maize, cotton, and grape plants.
3. The woody zone lies between the height of 2000 and 4000 feet, where the cork-tree flourishes, several kinds of oak, the maple, and enormous chestnuts.
4. The zone between the height of 4000 and 6000 feet is distinguished by the beech, Scotch fir, birch, and, among small plants, by clover, sandwort, chickweed, dock, and plantain.
5. The sub-alpine zone, between the elevation of 6000 and 7500 feet, produces the barberry, soap-wort, toad-flax, and juniper.
6. The zone between 7500 and 9000 feet, has almost all the plants of the preceding, with the fleshy and jagged groundsel.
7. The narrow zone between 9000 and 9200 feet, only produces a few lichens, beyond which there is complete sterility.

II. The Peak of Teneriffe exhibits five botanical districts, thus distinguished by Von Buch:

1. The Region of African forms, 0—1248 feet, comprising palms, bananas, the sugar-cane, various species of arborescent *Euphorbiæ*, *Mesembryanthema*, the *Dracæna*, and other plants, whose naked and tortuous trunks, succulent leaves, and bluish-green tints, are distinctive of the vegetation of Africa.
2. Region of Vines and Cereals, 1248—2748 feet, comprising also the olive, and the fruit-trees of Europe.
3. Region of Laurels, 2748—4350 feet, including lauri of four species, the wild olive, an oak, the iron-tree, the arbutus, and other evergreens. The ivy of the Canaries and various twining shrubs cover the trunks of the trees, and numerous species of fern occur, with beautiful flowering plants.
4. Region of the Pines, 2748—6270, characterised by a vast forest of trees resembling the Scotch fir, intermixed with juniper.
5. Region of the Retama, 6270—11061 feet, a species of broom, which forms oases in the midst of a desert of ashes, ornamented with fragrant flowers, and furnishing food to the goats which run wild on the Peak. A few gramineous and cryptogamic plants are observed higher, but the summit is entirely destitute of vegetation.

A Pine Forest.

IX. There are many plants which can accommodate themselves to the most diverse climates and localities; and therefore ascend from the plains close to the boundary of vegetable life on the highest mountains. But it is the general law in these cases for such plants to be singularly modified in appearance and anatomical structure as they ascend. The spring gentian, *gentiana verna*, is one of the exceptions, which Raymond found unaltered at all heights in the Pyrenees.

Trees, plants, and bushes, of humbler growth, which occur on the plains and at great heights, are usually much smaller in the latter situation. The leaves, and everything green about them, dwindle with the increased elevation; and the pure, well-defined green is exchanged for an ill-defined light yellow. Singular enough, those parts which seem most capable of resisting cold as the leaves and stalks, are uniformly subjected to a diminution of their vital functions; while the flowers remain of the same size, are never deformed, and become more dense and richer in their colours. While the *myosotis silvestris* becomes stunted, its flowers assume an intense blue, the admiration of the traveller. The flowers of the pale primrose have a much deeper colour on the top of the Faulhorn, while the plant itself is much smaller than its congener on the Swiss plains. The observations of M. Parrot, among others, are to this effect on the flora of the Caucasus, of Ararat, the Swiss and Italian Alps, and the Pyrenees. The arctic flora is similarly distinguished.

X. The preceding references to different climatic states are, however, perfectly inadequate to explain the phenomena of vegetable distribution. While an analogy is often observable between the plants of different regions under corresponding circumstances of latitude, elevation, and soil, the species are generally found to be different; and usually the botanical character of countries not widely apart from each other, is totally different, though under the same parallels.

Some plants are entirely confined to one side of our planet. The beautiful genus *erica*, or heath, of which there are upwards of 300 species, occurs with breaks over a narrow surface, extending from a high northern latitude to the Cape of Good Hope. But the whole continent of America does not contain a single native specimen; nor has a *pæonia* been found in it, except a solitary one to the west of the Rocky Mountains. On the other hand, the new world contains many families, as the *cacti*, which are not found naturally in the old.

Some plants occur in a single specific locality, frequently a contracted area, and nowhere else. The beautiful *disa grandiflora* is limited to a spot on the top of the Table Mountain at the Cape; and the celebrated cedar of Lebanon appears to be restricted in its spontaneous growth to the Syrian mountains. The small island of St. Helena has an indigenous flora, with a few exceptions different from that of the rest of the globe.

Mountain chains of no great breadth very commonly divide a totally distinct botany. There is a marked difference in the vegetation on the Chilian and opposite side of the Andes, though the climate as well as the soil is nearly the same, and the difference of longitude very trifling. In North America, two completely different classes of vegetation appear on the two sides of the Rocky Mountains. A variety of oaks, palms, magnolias, azaleas, and magnificent rhododendrons occur on the eastern side, all of which are unknown on the western, the region of the giant pine.

XI. The distinct vegetation possessed by various parts of the globe has led to its division into botanical kingdoms, or phyto-geographical regions, named in general after the genera that are either peculiar to them, or predominant in them. The arrangement of M. Schouw, which is usually adopted, discriminates twenty-five great provinces of characteristic vegetation upon the surface of the earth.

In constituting any portion of the globe into a phyto-geographical region, M. Schouw has proceeded upon the following principles:—1. That at least one half of the species should be indigenous in it. 2. That a quarter of the genera should also be peculiar to it, or at least should have a decided maximum. 3. That individual families of plants should either be exclusively confined to the region, or have their maxima there.

XII. The phenomena of botanical geography and the facts of geology are mutually illustrative. The existing dry land having been upheaved above the waters at different epochs, it may be reasonably inferred that each portion on its emergence received a vegetable creation in harmony with its position. The ultimate constitution of the general surface into different botanical kingdoms would hence follow, each of which has preserved its primitive features, while adjoining, and even far distant foci, have to some extent intermingled their respective products, under control of the natural agencies of diffusion.

The agents that involuntarily officiate in the diffusion of vegetable products are the atmosphere, the waters, and many animals.

1. The impulsion of the atmosphere in its calmest state is quite sufficient to transport to considerable distances seeds furnished with downy appendages or winglets, as is the case with many plants, with the minute sporules of cryptogamia, which are light as the finest powder. When ordinary breezes convey the sand-dust of the Sahara a thousand miles or more from the desert, it may be conceived that seeds, which are comparatively heavy, are borne far from home by the hurricane. Two Jamaica lichens, which had never been seen in France before, were found by De Candolle growing on the coast of Brittany, the offspring of sporules which had been swept over the Atlantic.

2. The mountain torrent washes down into the valley the seeds that have accidentally fallen into it, or have been swept away by its overflows; and hence the plants of the High Alps occur on the plains of Switzerland, which are entirely wanting in France and Germany. Rivers answer the same purpose more extensively, and also the oceanic currents. The nicker-tree, one of the leguminous tribe, has been raised from seed borne across the Atlantic by the Gulf stream.

3. Animals of the sheep and goat kinds, with the horse, deer, buffalo, and others, widely disperse several species of plants, the seeds of which, furnished with an apparatus of barbs and hooks, adhere to their coating. Seeds also of various kinds pass through the digestive organs of birds uninjured as to their vitality. The little squirrel buries the acorn in the ground for winter provender, and sows an oak, if prevented from returning to the spot.

XIII. Plants capable of extended naturalization, and serviceable as articles of food or luxury, have been widely disseminated by the human race in their migrations. The cerealia afford a striking example. These important grasses known to the ancients, wheat, barley, oats, and rye, were the gifts of the old world to the new. They are also importations into Europe; but the loose reports of the ancients and the diligent researches of the moderns alike leave us in ignorance of their native seat. Probability points to the conclusion that they have spread from the neighbourhood of the great rivers of Western Asia, the primitive location of the human family; and it is not impossible that in that imperfectly explored district, or further east on the Tartarian table-land, some of the cereals may yet be found growing spontaneously. The first wheat sown in North America consisted of a few grains accidentally found by a negro slave of Cortes, among the rice taken for the support of his army. In South America the first wheat was brought to Lima by one of the early colonists, a Spanish lady, Maria d'Escobar. An ecclesiastic, Jose Rixi, was the first to sow it in the neighbourhood of Quito.

Maize, or Indian corn, (*Zea mays*,) has been dispersed in the Old World from the New; and also a more important product, the potatoe, (*Solanum tuberosum*,) the use of which now extends from the extremity of Africa to Lapland. In Chili, the native country of the plant, it occurs at present in a wild state. The Spaniards imported it into Spain, and from thence it was communicated to Italy. It was first made known in England at a subsequent period from Virginia, having been received there from the Spanish colonists in South America, as it is not a native of intervening Mexico.

The Grape-vine, so extensively spread over Europe, is probably not indigenous in any part of it. It chiefly owes its diffusion there to the Romans, who received it from the Greeks, to whom it most likely immediately came from the country between the Black and Caspian Seas. The Romans introduced most of the finer European fruit-trees, some from Africa, as the pomegranate, but the great majority from Western Asia, as the orange, fig, cherry, peach, apricot, apple, and pear. A variety of the plum, the damson, or damascene, came from the neighbourhood of Damascus during the Crusades. The name of the damask-rose points to the importation of the plant from the same quarter into Europe.

XIV. The ocean as well as the land has different botanical regions; and changes of the vegetation are observed with the depth analogous to the variation of terrestrial plants with the height. Marine vegetation seems to have its vertical extent determined by the subaqueous range of light, which varies with the power of the sun and the transparency of the water.

CHAPTER II.

ZOOLOGICAL GEOGRAPHY.

THE arrangement of the animal kingdom proposed by the illustrious Cuvier, notwithstanding the great modifications it has undergone, is still the basis of zoological classification. It distributes the forms of animal life into four grand divisions, which are subdivided into nineteen orders:

I. Vertebrated Animals. — (*Animalia Vertebrata.*)

Animals having a vertebral column, which, with its termination, the skull, encloses and protects the brain and spinal marrow, the central organs of the nervous system.

1. Mammalia; animals which produce their young alive, and for a time suckle them.
2. Aves—Birds.
3. Reptilia – Reptiles with cold blood.
4. Pisces— Fishes with cold blood.

II. Molluscous Animals.—(*A. Mollusca.*)

Animals of a soft texture, and no skeleton, having the muscles attached to the skin, which produces in many species stony coverings or shells.

5. Cephalopoda, (heads furnished with feet.)—Cuttle-fish, Nautilus, &c.
6. Pteropoda, (wing-like feet.)—Clio, the chief food of the whale, Thyalæ.
7. Gasteropoda, (creeping on the stomach.)—Slug, Snail, Limpet, Whelk.
8. Acephala, (headless.)– Oyster, Muscle.
9. Brachiopoda, (arm-like feet.)—Bivalve Shells.
10. Cirrhopoda, (thread-like feet.)—Barnacle.

III. Articulated Animals.—(*A. Articulata.*)

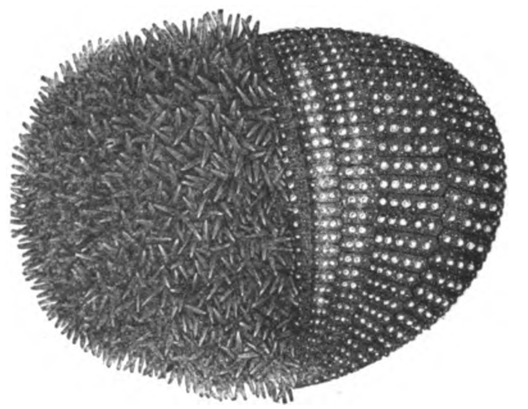
Animals consisting of a number of articulated joints or rings, soft or hard, supplying the place of a skeleton.

11. Annelida.—Worm, Leech, &c.
12. Crustacea.—Crab, Lobster, Shrimp.
13. Arachnida.—Spider, Scorpion.
14. Insecta.—Insects of various families.

IV. Radiated Animals.—(*A. Radiata.*)

Animals which in many instances have their organs arranged like rays proceeding from a centre; also called Zoophytes, or plant animals, from the resemblance of some families to vegetable forms.

15. Echinodermata, (εχινος, a hedge-hog; δερμα, the skin.)—Star-fish, Sea-urchin, &c.



Shell of Echinus, or Sea-urchin.

16. Entozoa (εντος, within; ζωον, an animal.)—Intestinal animals, as the Tape-worm.
17. Acalephæ, (ακαληφη, a nettle.)—Medusa or Sea-nettle.
18. Polypi, (πολυς, many; πους, a foot.)—Sea-Anemone, Coral, Madrepore.
19. Infusoria, microscopic animals.

II. The animal kingdom corresponds with the vegetable in the exuberance and wide diffusion of its inferior organisms. Infusoria occur in numbers which baffle the power of arithmetic to express, or the mind to conceive, living in every variety of situation, in the bed and waters of the ocean, in stagnant pools, the mud of rivers and deltas, in marsh grounds, animal and vegetable juices, in rain, snow, ice, boiling springs, and in peat earth twenty feet below the surface soil. Zoophytes occupy the oceanic waters in vast profusion from the equator to the highest latitudes; the polypi of various families, whose aggregated skeletons compose the coral formations, so beautifully varied, labyrinthine, branching, and arborescent, having their special habitation in the equatorial seas. Molluscous animals also evidence the prodigality of animal life, and its wide-scattering under the control of law, different species of marine testacea, or shell-fish, occurring in different parts of the ocean, and at varying depths. The insect class, embracing a vast number of species, is likewise distributed through all latitudes; but many tribes and species are limited to particular spheres, while from the poles to the equator the development of insect life increases generally, and attains its maximum in the equinoctial regions of the western world.

Caryophyllia fastigiata.

Madrepora muricata.

Mandrina labyrinthica.

1. Such is the remarkable tenacity of life in the infusoria, that some have been observed to recover after drying in vacuo, along with chloride of calcium and sulphuric acid, for 28 days, after exposures to a heat of 248°.

In the Antarctic regions, towards the close of the year 1840, Sir James Ross picked up some brash ice of a brown-yellow colour, not far from Mount Erebus, which was supposed to be due to aluminous matter ejected in fine ashes from the volcano. But upon specimens brought home in sealed glass vessels, being forwarded to M. Ehrenberg, he found the colouring matter to consist of myriads of infusoria, almost the whole of which reached Berlin in 1844, in a living state.

In 1839, Ehrenberg examined the mud-banks in the harbour of Wismar in the Baltic, and found that in proportions varying from $\frac{1}{20}$ to $\frac{1}{4}$, the mass of deposited mud consisted partly of living infusoria, and partly of the siliceous shells of dead specimens. Similar results have been obtained from the deposits in the harbour of Pillau, of the Elbe at Cuxhaven, and of the Nile, from which it appears, that the bars and deltas formed by river deposits, are not due solely to the mechanical transport of soil, but, at least in some cases, are also caused by the agency of animal organisms undiscernible to the naked eye.

2. Among molluscous animals, the marine testacea are widely different in the tropical, polar, and intervening seas. They vary also with the longitude. The shores of America and New Holland have distinct species of shell-fish; and the east and west coasts of tropical America have only one species in common. The pearl oyster only comes to perfection in the equatorial ocean; and the *pinna marina* thrives only in the Mediterranean and Indian Seas. Some species have a much wider range than others, identical examples occurring at the Gallipagos and Philippine Islands, on opposite sides of the Pacific and in the Arctic and Antarctic waters. The east coast of America and the opposite coast of Europe have also several kinds in common. In many cases, by adhering to ships, marine testacea have been disseminated in the ocean far from their natural sphere, to be permanent in a foreign locality.

Maia, or Sea Spider.

In the eastern parts of the Mediterranean, according to the recent researches of Professor Forbes, shell-fish attain their maxima, as to the number of individuals and of species, between the surface and the depth of 12 feet. At the depth of 210 feet, with a greatly diminished temperature, nearly 50 per cent. of species were identical with northern forms, marine depths thus corresponding to terrestrial elevation with reference to organic life. The general limit of organic life in that part of the Mediterranean is at the depth of 1800 feet. But its existence in the profound depths of the ocean, contrary to the general opinion of naturalists, was ascertained by the recent Antarctic expedition. On several occasions the dredge brought up from the depth of 6000 feet, sand, mud, and stones, with living molluscs, which were recognised by Sir James Ross as identical with species common to the Arctic waters. "The only way," he remarks, "they could have got from the one pole to the other must have been through the tropics; but the temperature of the sea in those regions is such that they could not exist in it, unless at a depth of 12,000 feet. At that depth, they might pass from the Arctic to the Antarctic Ocean without a variation of 5° of temperature; whilst any land animal, at the most favourable season, must experience a difference of 50°, and if in the winter, no less than 150° of Fahrenheit's thermometer—a sufficient reason why there are neither quadrupeds, nor birds, nor land-insects, common to both regions."

3. The highest latitude at which insect life has been observed is 82° 26′ 44″, where, on the last day of Captain Parry's attempt to reach the North Pole over the ice, a species of *aphis* was found, about 100 miles from the nearest known land.

III. The more important division of the animal kingdom, which includes the vertebrated forms, followed ascendingly, commences with the ordinary inhabitants of the waters—bony or cartilaginous Fishes with cold blood. While peculiar tribes are confined to the freshwaters of particular districts, each large basin of the ocean appears to have its distinct genera and species. The *habitat* of various families is well known.

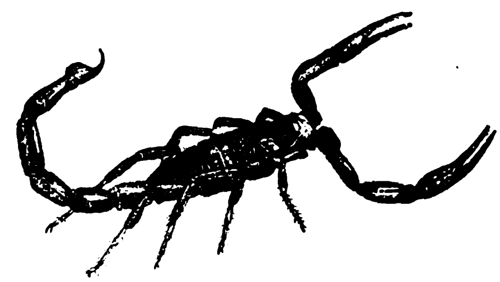
The genera of which carp and perch are the types, *cyprinus* and *perca*, appear in almost all the rivers of the temperate zone.

The *gymnotus electricus*, or electrical eel, which can destroy powerful quadrupeds by the discharge of its galvanic battery, inhabits the rivers and pools of equinoctial America, while fishes similarly endowed, but to a less degree, occur in other spheres, as the *silurus electricus* in the rivers of Africa, and the *torpedo* in the Mediterranean.

Sharks roam in the deep open oceans of tropical and warm climates. Sturgeons occupy land-locked waters, as the Baltic, the Caspian, and the Black Seas, with large rivers, the Volga and the Danube. The cod dispersed through the North Atlantic, congregate chiefly upon the great sand-banks to the south-east of Newfoundland. Flying-fish are principally intertropical, or, at farthest, never go beyond the parallel of 40°, their most active enemies, the *coryphanæ*, named giltheads from their brilliant colours, observing the same limits.

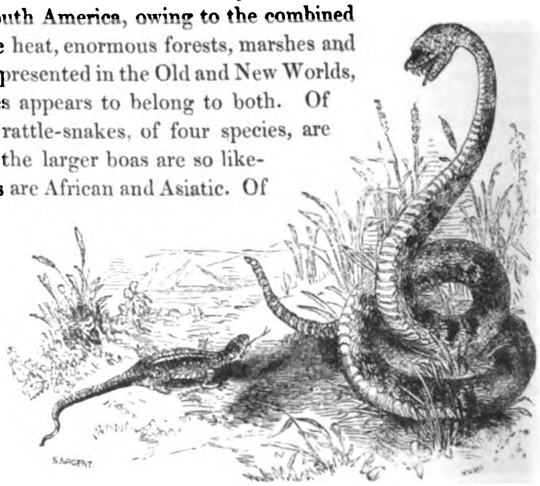
The European salt and fresh waters contain 853 species of fish, of which the waters of Britain and Italy have only 100 in common. The species identical in the Mediterranean and Black Seas amount to no more than 27, notwithstanding the contiguity of the two basins and direct intercommunication. Almost all the fish of the Caspian are specifically distinct from those in other parts of the globe.

Several kinds of fish are eminently social and migratory. The herrings issue every year from the depths of the Arctic Ocean, and repair in vast shoals to the coasts of Western Europe, the United States, Kamschatka, and the Aleutian Isles. The tunnies annually visit the Mediterranean from the Atlantic. The object of the migration has not been satisfactorily ascertained, but both of the commonly assigned causes may operate, the deposition of the spawn in shallow water, and the search for food.



Scorpion.

IV. Reptiles, the next order, occupy the lowest rank among terrestrial vertebrata. They diminish in number, magnitude, and noxiousness, from the equator to the poles; and have their maximum development in the equatorial regions of South America, owing to the combined circumstances of intense heat, enormous forests, marshes and rivers. Each family is represented in the Old and New Worlds, but not a single species appears to belong to both. Of the serpent tribe, the rattle-snakes, of four species, are exclusively American: the larger boas are so likewise, whilst the pythons are African and Asiatic. Of crocodilians, consisting of three genera, the crocodile proper is distributed in the Old and New Worlds, but the species differ; the alligator or cayman, is confined to America; and the gavial is limited to the Ganges and the other large rivers of India. No living crocodilian has ever been known in Europe; and excepting the Marianne Isles, all the reptile tribes are entirely wanting in the islet groups of Oceanica.



The ascertained number of species belonging to the four divisions of reptiles is as follows:

Chelonia (Tortoises)	69
Sauria (Lizards)	203
Ophidia (Serpents)	265
Batrachia (Frogs)	120
Total of species	657

Very few reptiles reach the north boundary of the temperate zone, taking the isotherm of 30° for its limit. Frogs and salamanders go the farthest north.

V. Birds, the members of the succeeding order, have a more perfect organisation; and being endowed with the power of rapid locomotion, several species are wide geographic rangers. This is the case with the house-sparrow, common crow, gosshawk, jay, raven, osprey, or fishing eagle, cliff-swallow, and others. But the majority of species are restricted by geographical laws to particular districts, and have in many instances a very local existence. The far-famed birds of Paradise are confined to New Guinea and the neighbouring islands; the condor never leaves the Andes of South America; the great eagle remains among the ridges of the Alps; parroquets are chiefly intertropical; the albatross is seen skimming the surface of the ocean on approaching the parallel of 40°; the common grouse, the yellow and pied wagtails, and the English starling, are alone known in Great Britain. These are only a few examples of limited distribution. The most beautiful varieties of birds are found within the tropics; where also the number of species and individuals is the greatest, except in the instance of two families, the swimmers and waders, which in both respects are the most numerous in higher latitudes.

The Bustard.

Birds are distributed into the following six divisions: 1. Rapaces—Birds of prey; 2. Scansores—Climbers; 3. Oscines—Songsters; 4. Gallinaceæ—Gallinaceous birds, *gallina*, a hen; 5. Grallatores—Waders; 6. Natatores—Swimmers. The known number of species is upwards of 6000.

Several families have extraordinary powers of locomotion. The hawk and swift can traverse 100 miles in an hour: the eider-duck 90: the common crow 25.

Some birds are solitary, but most families are eminently gregarious, and associate frequently in countless numbers. Immense flocks of sea-fowl of different kinds occupy the vogelbergs, Bird-rocks, of the Faroe Islands. One of the most remarkable, in the harbour of Westmannsharn, on the west of the island of Stromoe, lies in a frightful chasm, entered by a narrow passage, encompassed by high precipitous cliffs. Here thousands of birds occupy a particular rock, each kind having its respective domicile. The glossy cormorants are on the lowest shelves; the voracious skua gulls are above; next come the kittiwakes in crowded rows; higher up is a closely packed colony of auks and guillemots; puffins, scarcely visible, occupying the loftiest station. It is singular, that of twenty-five vogelbergs in Faroe, all open westward, and none eastward, though apparently the situations in that direction are equally advantageous. The preference is due to the greater prevalence of westerly winds, birds in general flying against the wind when departing on a cruise, in order to have its assistance when returning weary.

Many birds alternate regularly between two distant countries as food becomes scarce or abundant by the change of seasons. Swallows, storks, cranes, kingfishers, nightingales, abandon the northern parts of Europe for the southern, even passing over into Africa, on the approach of winter. Vast quantities of aquatics feeding on fish interchange the basins of the Orinoco and Amazon, as the annual inundations of those rivers, which are six months apart, afford a more plentiful supply. Humming-birds advance from the south into the northern parts of the United States, and into Canada, as the return of spring causes millions of plants to expand their blossoms. Some birds migrate singly, others in flocks, and others in vast armies. Alexander Wilson, in North America, estimated a flock of passenger pigeons which continued to pass above him for the greater part of a day to have been a mile in breadth by 240 in length, and to have contained (three birds being assigned to the square yard,) at least 2,230,272,000 individuals.

Birds occupy the whole globe. Voyagers in high latitudes have never gone beyond their horizontal range, while the habitat of the condor extends perpendicularly from the plains to the level of the loftiest crests of the Andes.

The Stork.

VI. Quadrupeds or mammalia, stand at the head of the animal creation, distributed into eight great groups. They differ vastly in appearance and habits, but correspond in the one particular of suckling their young. The groups with some of their types are as follows:

1. *Quadrumana*, (four-handed.)—Monkey, Apes (*Simiæ*.)
2. *Carnivora*, or *Carnassiers*, (flesh-eaters.)—Mole, Glutton, Civet, Bear, Hyæna, Cat, in which last tribe the sanguinary development is at his height in the lion and tiger, sea-otter.
3. *Marsupialia*, (pouched.)—Opossum, Kangaroo, Wombat.
4. *Rodentia*, (gnawers.)—Beaver, Porcupine, Squirrel, Jerboa.
5. *Edentata*, (toothless.)—Sloth, Armadillo, Ornithorynchus.
6. *Pachydermata*, (thick-skinned.)—Elephant, Rhinoceros, Hippopotamus, Zebra, Tapir.
7. *Ruminantia*, (chewing the cud.)—Camel, Ox, Goat, Sheep, Deer, Antelope, Giraffe.
8. *Cetacea*, (belonging to whales.)—Whale, Dolphin, Narwhal, Seal, Porpoise.

VII. The first group has no representatives in a wild state in Europe, except on the rock of Gibralter, whose inaccessible heights have long been occupied by a race of monkeys identical with the Barbary ape. It is not represented either in North America, Australia, or Oceanica. The region of four-handed quadrupeds extends in the New World from central America through the intervening districts to the pampas of Buenos Ayres; and in the Old World, it includes the whole of Africa exclusive of Egypt, the South of Asia, and the Indian Archipelago.

Chimpanzee.

The monkey tribe contains 170 species exhibiting wide differences in form, size, colour, and habits. There is no species common to the two continents; but very few are common to Africa and Asia; peculiar genera having for the most part contracted geographical limits.

In the Old World there are 72 species tailed, and 7 tailless. The baboons, the most numerous of the tailed families, are principally located in Africa; the gibbons, or long-armed apes, a tailless genus, are exclusively Asiatic. The station of the interesting tailless family of orang-outang, "the man of the woods," is both African and Asiatic, but entirely local, and the individuals are rare. The red species appears in Borneo, Sumatra, and Malacca: the black species occurs on the coasts of the Gulf of Guinea.

In America there are 91 species, none tailless, and all more gentle, but having a more decided animal appearance, than their congeners on the eastern continent. They are divided into two classes, the sapajous and sagouins, according as they have or have not propensile tails, by which they suspend themselves, and swing from bough to bough. Of the sapajous, the "weepers," so called from their plaintive cry, are the most local; and the "howlers," whose howling may be heard at the distance of a mile, the most widely distributed.

Distinct from the Simiæ, but belonging to the group of quadrumana, is the Makis tribe. It occurs in Asia, but the type, the genus Lemur is entirely confined to Madagascar, the adjacent islands, and Mosambique. The Lemurs, remarkable for bounding elasticity, boa-like tails, and inoffensiveness, live in troops upon the trees, and apparently supply the place of the monkeys, none of which have yet been observed in Madagascar.

VIII. Carnivorous animals of some kind or other are spread over the entire globe, as their natural food exists in every accessible region; but there are certain limits to which whole races are confined, while the different genera and species are restricted to narrower bounds. Two tribes of the family *Digitigrada*, may be noticed. 1. *Canis*, (dogs.) The dog, properly so called, domesticated by man, has attended him everywhere, his faithful companion and friend; but there are two remarkable instances of the existence of dogs in a wild state, the dhole of India, and the dingo of Australia, besides a half-reclaimed race among the Indians of North America, and another partially tamed in South America. The jackal, the

Australian Dingo.

characteristic dog of Africa, ranges through its entire north to India, and from Abyssinia to the Caspian Sea. The wolf is more widely distributed; in America, from beyond the Arctic circle to near the isthmus of Panama; in the Old World, from the same northern limit to Egypt, Arabia, and India, and from Spain on the west to the eastern shores of the continent; not however occurring in India beyond the Ganges. But of all the members of the dog tribe, omitting the domesticated, the fox is the most extensively diffused, from the highest northern latitudes through great part of Europe, Asia, Africa, and America. The various species are provincial. The red fox, distinct from the European, inhabits the forest district of North America; the black fox, the Siberian woodlands; and the white fox, the polar regions, coming down in midwinter for food to near the parallel of 50° in the western world. 2. *Felis*, (cats.) Europe has no representative of the feline tribe in a state of wildness but the cat and lynx. The wild cat occurs in most of its woody countries, and is found also in Northern Asia, India, and Southern Africa. The feline tribe appears to have no representative whatever in Australia and Oceanica. But the tropical regions of both continents are occupied by powerful animals of the class, lions, tigers, leopards, and lynxes, some of which extend far into mean latitudes. The African lion is found through the whole of that vast peninsula, excluding the Lybian Desert, the Nile countries, and some adjacent districts; the Asiatic lion, specifically distinct, has much smaller domain, stretching from Persia into India; the American lion, the puma, a widely different animal, ranges from Patagonia to the Canadian lakes. The tiger is exclusively Asiatic, occupying the south-eastern countries, with the islands of Sumatra and Java, appearing westward in Persia, and northward in the vicinity of lake Baikal. The leopard and panther, two closely related animals, if not specifically the same, chiefly inhabit Senegambia, the oases of the Great Desert, India and its islands. The jaguar, sometimes called the American

The Jaguar.

panther, a distinct animal, is peculiar to the south part of the continent, and is principally found in Brazil and Paraguay. Lynxes are common to Europe, Asia, Africa, and America, but the species are different.

Hyænas, martens, skunks, otters, civets, represent other tribes of the family of Digitigrades (animals walking on the toes only). The striped hyæna is found in nearly the whole of Africa, and in the southern countries of Asia, extending to the chains of the Caucasus and Altai: the spotted hyæna is entirely African, inhabiting the south, especially the neighbourhood of the Cape colony. The marten tribe is represented in each grand division of the globe; but the more important species, on account of their furs, the ermine and sable, *Mustela erminia* and *M. Zibellina*, have their province in the northern parts of the two continents. Otters haunt most of the rivers, lakes, and coasts of Europe and America; but two species of the sea-otter, the most valuable of the fur-bearing animals, *Lutra marina* and *L. phocula*, are peculiar to the extreme north-eastern shores of Asia and the north-western shores of America, the Aleutian, and other intervening islands.

Of carnivora, belonging to the family of Plantigrades (animals supported in walking on the entire sole of the foot), the most important is the bear tribe (*Ursis*). The European brown bear, which still haunts the recesses of the Alps and Pyrenees, is distributed through the entire north from Norway to Kamschatka, and appears in Japan. The American black bear inhabits all its densely wooded districts from Carolina to the Arctic Sea, and from the Atlantic to the Pacific. The grissly bear, the most formidable species, has a much smaller province, consisting of the Rocky Mountains, and a portion of the eastward territory. The polar bear occupies the icy zone, sometimes extending his excursions southward on the shores of Hudson's Bay and Labrador to the parallel of 55°, appearing also on the northern coasts of Europe and Asia. Abyssinia, Syria, Thibet, and Sumatra, have each different species.

IX. None of the marsupials, quadrupeds furnished with a pouch in which the females carry their young while very small and imperfectly formed, appear on the eastern continent: America has one family, the opossums, spread from the northern United States to the south of the Plata; but the group specially characterises the fauna of Australia, the Moluccas, and New Guinea, constituting in that region one of the best defined zoological kingdoms on the surface of the globe. The Rodents, or gnawers, named from the manner in which they file or gnaw their food with their front teeth, are very extensively diffused, the *muridæ*, or rat tribe, which comprises more than half the species in the group, having the greatest geographical range. The Edentata, or toothless animals, characterised by the absence of front teeth, peculiarly belong to Central and South America, and only occasionally occur in the southern regions of the Old World.

1. Of marsupials, the typical animal, the kangaroos, first discovered by Captain Cook, are found in all the explored parts of Australia, in Van Diemen's Land, New Guinea, and in one instance in Java. The species, about 40, vary greatly in size, from that of a rabbit to the height of a man.

2. Among rodents, the interesting beaver genus ranges in the northern and temperate regions of America, Europe, and Asia. The North American beaver has its furthest northern limit on the banks of the Mackenzie River in lat. 67½° or 68°; its southern boundary is about the confluence of the Ohio and Mississippi, lat. 37°; east and west it extends from the Atlantic to the Pacific, excepting the barren districts. The beaver of the Old World inhabits the rivers between the parallels of 36° and 67°.

The Beaver.

In Asia, it is found on the Obi and its tributaries, but is rare east of the Yenesei. In Europe it occurs, living in burrows along the banks of the Danube, the Rhone, and the Weser. In the Transactions of the Berlin Natural History Society for the year 1829, an interesting account is given of a colony of from fifteen to twenty individuals, settled for more than a century and a half on the small river Nuthe, a short distance above its confluence with the Elbe, in a lonely canton of the Magdeburg district. The little beaver, or the musk-rat of Canada, is a generically distinct animal, but along with the true beaver is incessantly pursued by man for its fur.

The common porcupine, another peculiar rodent, extends from Spain through Southern Europe into Affghanistan and India.

3. Of edentata, the sloths and armadillos are exclusively American: the former extend from the south of Mexico to Rio Janeiro, inhabiting the dense forest districts; the latter occur from the banks of the Orinoco to the most southern parts of the continent, in the open plains and pampas. The great ant-eater, the largest of all the toothless animals, is distributed from the pampas of Buenos Ayres to the north of the Orinoco. Among the edentata of the Old World, the pangolins, or scaly ant-eaters, are common to Africa and Asia: the long-tailed pangolins inhabiting Senegal and Guinea, and the short-tailed pangolins Bengal and Southern China. Australia has the porcupine ant-eater, so named from its covering of spines, as well as its food, chiefly found in New South Wales and Van Diemen's Land; and the ornithorynchus, apparently restricted to the south-east, the most singularly-formed of all mammalia, having a compressed muzzle resembling the bill of a duck, and webbed feet.

X. The Pachydermatous, or thick-skinned group, comprises the largest and most powerful of all the land animals, with some of the most useful as domesticated by man. 1. *Elephas* (Elephants). There are two species of the elephant inhabiting two distinct regions. The Asiatic species ranges from the lower slopes of the Himalaya Mountains through all India on both sides of the Ganges, through the peninsula of Malacca, the south of China, the islands of Sumatra and Ceylon. The white elephants, so highly prized by the potentates of the east, are merely varieties. The African species, of smaller size, and supposed to be more ferocious and less sagacious, extends from the northern borders of the Cape colony to Senegal on the western side and Abyssinia on the eastern. 2. *Rhinoceros*. There are seven species of these huge quadrupeds, none of which are possessed in common by Africa and Asia. Four species belong to Africa, and three to Asia. In both regions, the range of the rhinoceros is nearly the same as that of the elephant, the chief exceptive case being that of the island of Java, where the elephant is wanting, and the rhinoceros occurs. 3. *Hippopotamus*. Some naturalists have discriminated three species of the river-horse, but there appears to be only one, entirely confined to the rivers and lakes of Africa, extending from the Upper Nile in Dongola on the north-east, the streams of

Senegambia on the north-west, and the central lake Tchad, to the Gariep, or Orange River, and its affluents on the south.

The New World has no animal of any kind comparable to the huge Pachyderms of the Old. The tribe of tapirs is common to both, two species of which are located in South America, and one in Sumatra, Borneo, and Malacca. The remaining important tribes of the pachydermatous form are those of the horse and hog.

1. *Equus* (Horses). The Horse, properly so called, now diffused in a domesticated state over the whole civilised world, cannot be traced to his native country. The period when the animal alone existed in a state of nature, or was first reduced by man to obedience and servitude, is equally lost, though it certainly goes back to the most ancient times. At present, the horse runs wild on the table-lands of Central Asia, supposed by some to be the primeval home of the tribe; but more probably this is simply an instance in which the descendants of a domesticated race have returned to a state of wildness. In the same way the animal introduced into South America from Europe by the Spaniards, in their early visits to that continent, now roves wild in immense herds over the vast llanos and pampas.

The Ass, a member of the same tribe, was perhaps domesticated at an earlier period than the horse. There are several species wild, occurring in the countries between north-eastern and south-western Asia. The wild ass of the Tartars (Koulan) inhabits central Asia from about north latitude 48°, to the basin of the Indus. In summer, the animals are common about Lake Aral, but in autumn they migrate in great droves under the conduct of a leader, proceeding to the southern districts of Cutch and Guzerat to pass the winter, returning northwards in the ensuing spring. The wild ass of the Moguls (Djiggetai) roams in troops the sandy deserts of Mongolia, on the borders of Thibet and China. Though hardy in many of his habits, the ass does not support cold so well as the horse, and is hence a far inferior animal at the parallel of 52° in Europe, than his Asiatic brethren between the parallels of 20° and 40°.

The Quagga, belonging to the equine family, and also the zebra, are peculiar to Africa. The beautiful, gaily-striped, but vicious zebras, extend from Abyssinia to the borders of the Cape colony, and appear in Congo and Guinea. The quaggas, of smaller stature, and marked with fewer stripes, occur farther south, below the Orange River. The individuals of each associate in troops, but the two do not herd together. The strange grouping has been sometimes witnessed of ostriches with zebras or with quaggas wandering in company over the plains.

2. *Sus* (Swine).—There are no members of the swine tribe indigenous in America; but a cognate genus, the peccary, of two species, occurs in South America; and since the introduction of the domestic hog, it has run wild, and forms large herds in the western world. Another cognate genus, the wart hogs, is peculiar to Africa. Of true swine, there are several species distributed over the islands contiguous to Southern Asia, and also found in the adjacent continental parts; but the best known species, the European wild boar, has the most extensive range. It occurs generally through the Old World from France eastward to the Asian shores of the Pacific, but is not found in Spain, Italy, and Persia. Its farthest northern limit is in Asia, at about the parallel of 60°.

XI. The group of Ruminants, characterised in their internal economy by four stomachs for the purpose of chewing the cud, comprehends various tribes remarkable for elegance of form, and utility to man, as articles of food and beasts of burden, in climates of the most extreme heat and cold. 1. *Camelus* (Camels). The region of the camel extends from the Canary Isles, through Northern Africa, Arabia, Syria, Asia Minor, Persia, north-western India, the southern districts of Tartary, to the frontiers of China. There are two species, the Bactrian camel distinguished by two hunches on the back, and the Arabian camel with only one, of which the dromedary is a fleet variety. The camel is alone found in a domesticated state. The Bactrian species has been said to run wild in the great Desert of Gobi; but Cuvier remarks, in explanation, that the Calmucks liberate all animals, upon a principle of religion, when their tasks are over. 2. *Auchenia* (Llamas). The camels of the East are represented in the western hemisphere by three species of llamas, remarkably resembling them, but smaller, and without hunches. They are entirely South American, and principally found on the west side of the Andes, from New Granada to the Straits of Magellan, being most common in Patagonia, where the disturbing intrusion of man has been least experienced. Mr. Darwin noticed a habit of this tribe, that of having favourite spots in which to lie down and die, generally in bushy places near the rivers, where at several points the ground was white with their bones—a fact of importance, as illustrative of the frequent occurrence of uninjured bones in caves, or buried beneath alluvial accumulations, and also of certain animals being more commonly embedded than others in sedimentary deposits. 3. *Camelopardalis* (Giraffes). The ruminants of this tribe, so remarkable for their height, peculiar form, swan-like necks, timidity and gentle manners, are exclusively African. There are at least two species, the North African giraffe, inhabiting Nubia, Abyssinia, and the countries around Lake Tcard, and the South African giraffe, which extends from the borders of the Orange River probably into the central regions.

The remaining ruminantia are comprehended in the deer, musk-deer, antelope, goat, sheep, and ox tribes.

1. *Cervus* (Deers).—This genus includes all those ruminating animals which are furnished with solid horns or antlers. The families and species are numerous, and of great importance in the economy of nature.

The Elk or Moose-deer, a gigantic animal, with broad, solid, and very heavy antlers, belongs to the northern regions of both continents. The American elks were formerly found as far south as the Ohio, but at present they only occur further north, in the Bay of Fundy and beyond the Great Lakes, extending from the latter to the mouth of the Mackenzie River on the shores of the Arctic Sea, in lat. 69°. The growth of the willow, upon the tender twigs and leaves of which the elks feed, being promoted by the rich alluvial deposits of the river, is the cause of this high northern distribution, for east and west they are not found beyond lat. 65°. The European elk, a distinct species, very rarely passes north of the parallel of 64° in Scandinavia, and ranges from thence into the interior of Asia, descending more to the south.

The Stag.

The Rein-deer is more capable of enduring cold than the elk, and hence occupies the highest latitudes. Its southern limit is the parallel of 60° in Scandinavia, but that of 50° is gradually approached in the severer climate of northern Asia. Though indigenous in Spitzbergen and Greenland, it did not occur in Iceland before the middle of the last century, when three individuals from Norway were turned loose, whose descendants roam in herds in the mountainous regions. No animal renders more important services to the human population of its district. Hence the few wild herds that remain in the Old World are constantly diminishing, every art being employed to reclaim and domesticate the individuals. The American rein-deer, the caribou, occupies the entire continent north of a line passing across it in about the latitude of Quebec. It was found in Melville Island by Captain Parry's expedition, and was seen in great numbers on the Isthmus of Boothia during Ross's last voyage.

The Fallow-deer, the well-known ornament of our parks, is common also in confinement in various parts of Europe, but is said to run wild in Lithuania and Moldavia. It occurs in Greece, Palestine, Persia, China, and Northern Africa, and is referred by Cuvier to Barbary as its native home. The fallows of the Old World are represented in the New by the Virginian deer, common in that State, but distributed from Canada to the northern parts of South America.

The common Stag or Red-deer, ranges from Great Britain, through western and midland Europe, excluding the greater part of Russia, to the north shores of the Caspian Sea, and from thence through the interior of Asia to Lake Baikal. It seems to be represented in North America by the wapiti.

The Roebuck, peculiar to the Old World, inhabits the midland provinces of Europe and Asia. Though plentiful in the Highlands of Scotland, it has disappeared from England and Wales, and appears not to have been known in Ireland.

2. *Moschus* (Musk-deers).—This tribe, characterised by the absence of true antlers or horns, and a secretion of musk, comprises seven species, two belonging to Western Africa, four to India and the Archipelago, and one, the genuine musk-deer, to central and south-eastern Asia.

3. *Antelope* (Antelopes).—Africa, deficient as to the deer tribe, is peculiarly the land of the antelope, the most numerous in species of any race of ruminants, differing widely in size, colour, habits and station. A few court the shade of the forests; some inhabit the lofty table-lands; but the greater number roam in the plains in troops. The gazelle, long celebrated for its large, mild, and black eyes, is found in Egypt, Barbary, and through all the country bordering on the Great Desert. Of two European antelopes, one is the chamois, so remarkable for its agility, dwelling on the highest ridges of the Pyrenees, and Alps, the Carpathian and Greek mountains, Caucasus and Taurus.

4. *Capra* (Goats).—The several species are mountain dwellers, as the ibex, which inhabits the highest ranges of Europe; the penang, found on the rudest points of the Caucasus and the inhospitable hills of Persia; the goat of Cashmere, occupying the declivities of the Himalaya and the upland plains; the jaal goat, belonging to the Sinaitic Mountains, those of Upper Egypt, and Abyssinia; and the Rocky Mountain goat of North America, attached to its loftiest and least accessible summits. The parent stock of the common domesticated goat is unknown. There are still a few running wild in Wales.

5. *Ovis* (Sheep). The wild races like the preceding are chiefly denizens of mountainous districts. The greatest number of species occurs in Asia. The Asiatic argali, with enormous horns, extends from Kamschatka on the north-east, through the Mongolian deserts, and central mountains, to the steeps of Caucasus on the south-west. The North American argali, or Rocky Mountain sheep, inhabits the range from which it derives its name, and the ridges which intersect the country from thence to the Pacific, between the parallels of 40° and 68°. The mouflon occupies the heights of Corsica, Sardinia, Crete, Cyprus, and other islands of the Greek Archipelago. It is quite uncertain from what race the domestic breeds are descended.

6. *Bos* (Oxen). The largest and most powerful of all ruminant animals belong to this tribe. It comprises several species.

The common Ox, a native of the Old World, now living as far as the parallel of 64°, and in Lapland even under that of 70°, appears to have sprung from the warmer parts of the temperate zone; and probably descends from the *Urus* of the ancients, an extinct race, but described by Cæsar as inhabiting the great Hercynian Forest. The white wild cattle of a few English parks are usually supposed to be the original stock, but it is far more likely that they represent a race which has been allowed to return from domestication to wildness. The Brahminy bull, a sacred animal in most parts of India, is distinguished by a hunch on the back, and the skin of the neck being furrowed with transverse wrinkles.

The Gayal, an Asiatic species, differing from the ox, which has thirteen pairs of ribs, by having fourteen, inhabits the southern and south-western slopes of the hills secondary to the Himalaya, and occurs both wild and domesticated.

The Yak, the mountaineer of Central Asia, is the highest ranger of the bovine tribe. Where the mean annual temperature is below the freezing point, is its appropriate climate. Hence it lives amid eternal snow on the table-land of Pamir, the "Roof of the World," at the height of 15,000 feet. The fine-haired bushy tail of the animal furnishes the well-known *chowry* of Hindostan, used as a fan, and an oriental insignia of rank. When a pacha of so many tails is mentioned, it means the number of tails of the yak which according to his dignity he is allowed to have carried on state occasions.

The Buffalo, confined to the eastern continent, is native to India and Southern Africa. The Indian species, almost universally domesticated in its original country, has been widely extended in that state; eastward to China and the Philippines; westward to Europe below the Alps, and Africa north of the desert. The buffalo of Southern Africa, a much more formidable animal, has never been tamed.

The Bison is common to the eastern and western world, but the species differ. While the ox has thirteen pairs of ribs, the European bison has fourteen, and the

The Bison.

North American fifteen. Both species are remarkable for their daring energy, but the former is nearly extinct, and the latter, though still numerous, is rapidly diminishing. The European bison, or auroch, a forest animal, which was abundant in Germany in the time of Charlemagne, occurs in the countries around the Black and Caspian Seas: the American bison, popularly but erroneously called buffalo, an animal of the open savannahs, roams westward of the Mississippi, and on both sides of the Rocky Mountains, having for its extreme southern and northetn limits probably the parallels of 35° and 64°.

The Musk-ox, peculiar to North America, named from the odour of its flesh, has a confined range extending from the parallel of 60° to that of 74° in Melville Island.

XII. The Cetacea, animals of the whale kind, form the last group of mammalia. Popularly considered as fishes, and resembling them in external appearance and habitat, they have the internal structure, vital functions, and mode of production of land quadrupeds. There are several families, chiefly occupying the seas of high latitudes, comprehending the whales properly so called, with narwhals (sea-unicorn), porpoises, and grampuses.

In former ages whales were frequent in the Mediterranean, along the British shores, and in the Bay of Biscay. In the latter locality the modern whale-fishery commenced, conducted by the inhabitants of the shores, the Basques on the Spanish side, the Bearnese and Gascons on the French. It is only at present very rarely, and as an animal astray, that one of the huge cetacea appears in such a low latitude. In February, 1848, an individual was captured in the Channel between Hythe and Folkstone. The common black or Greenland whale, the chief object of the pursuit of man, has largely left those seas during the present century, and gone farther north. A return of the whale-fishery conducted in the northern seas by British ships from the year 1815 to 1834, shows the smallest number captured to be 161 in the year 1830, the greatest number to be 2,018 in the year 1823, and the average annual number during the period stated, to be 1,024¼. The spermaceti whale, or cachelot, is a much more ranging animal than its congener, descending in the North Atlantic to Newfoundland, and even to the Azores, and abounding in the Southern Ocean. The white whale occurs in all the Polar Seas, but is especially abundant in the North Pacific towards Behring's Strait. In the Antarctic Ocean, into which man has seldom intruded, whales of various kinds occur in great numbers, and to that quarter of the globe the attention of whaling adventurers is now strongly directed.

The Narwhal is located near the polar ice, but individual instances of wandering from it to some distance are not uncommon.

The common Porpoise is plentiful in all the European seas, especially along the coast of North America and the west coast of Ireland.

The common Grampus ranges through the Northern Ocean, and occasionally appears off the coast of Great Britain.

All the preceding cetacea are carnivorous; but there are three genera which are exclusively herbiverous:

1. *Manatus*, locally known as the sea-cow. 2. *Halicore*, daughter of the sea, or sea-lass. 3. *Stellerus*, a name derived from Steller, the first person who observed and described the animal. The manatees occur in some of the tropical rivers of Western Africa; but ascend in far greater numbers those of South America, the Orinoco, and the Amazon, occurring also in shallow bays among the West India Islands. The halicore, or dugong, a more marine animal, remarkable for the devoted attachment subsisting between the mother and the young, has its head-quarters in the Asiatic Archipelago. The steller, which is said to average when full grown a length of 25 feet by 18 at the greatest circumference, inhabits the North Pacific, where it occurs on the coasts of America and Asia.

Seals and Walruses form a distinct family in Cuvier's group of carnivora, but are frequently classed with cetaceous animals. The number of the seal species is very considerable. They inhabit the frozen and higher parts of the temperate zone in both hemispheres. The common seal is extensively diffused in these regions; other species are very local. The ursine seal, or sea-bear, is found exclusively in the North Pacific, towards Behring's Strait: the lion seal, or sea-lion, occurs on the north-eastern shores of Asia, chiefly between the parallels of 40° and 60°. The walrus, or morse, of which but one species is known, is more decidedly confined to the high latitudes.

See Zoological Map showing the Distribution of principal Mammalia.

XIII. It appears from the phenomena of animal distribution, that the globe may be divided into the following great zoological kingdoms, each of which is characterised by a fauna peculiar to itself, and may generally be further subdivided into provinces distinguished by the exclusive possession of certain forms: 1. The Arctic Region, comprehending the northern parts of Europe, Asia, and America, and the district from thence to the pole, to which the same animals are common, but strikingly different from those of other latitudes. 2. The North Temperate Region, in which the species are often identical in Europe and Asia, though more frequently differing, while they are all peculiar in America, which possesses also some distinct genera. 3. Region of Intertropical Asia with the Archipelago, characterised by huge pachyderms, and an intense development of the feline tribe. 4. Region of Intertropical and Southern Africa, to which entire genera of pachyderms and ruminants are confined, with a vast variety of species of the latter race. 5. Region of Intertropical and South America, distinguished by the prevalence of edentata, the occurrence of various genera of other tribes which are peculiar to it, and the absence of every species common to the eastern world. 6. Region of Australia, remarkable for the feeble development of mammalia, with one exception, that of the marsupials, to which almost all the land quadrupeds belong.

XIV. The Antarctic regions, as far as they have yet been explored, appear to have no land animals, contrary to what is the case in the opposite dark and outer boundary of the earth. The Arctic Zone is tenanted by white bears, rein-deer, wolves, the polar hare, and arctic fox, some of which seek no southerly migration to avoid the long rigorous winter. While Parry wintered at Melville Island, a pack of wolves nightly serenaded the crew; and a beautiful white fox was taken and domesticated. But no terrestrial quadrupeds have hitherto been observed on the south polar shores. The oceanic birds, albatrosses, penguins, and petrels, occur in great numbers, with seals reposing on the ice, and whales spouting in all directions in the open water.

XV. Intertropical and the adjoining countries strikingly contrast with other latitudes in being peculiarly the home of carnivora of the feline tribe, lions, tigers, leopards, panthers, lynxes, and jaguars, of which the comparatively small and feeble wild cat is the only representative in northern regions. The same remark applies to the viverrine, or civet tribe, of which the genet is the only European example; and also to the hyænas, with their allied races. On the contrary, the canine tribe, wolves and foxes, excepting the jackal; and the marten tribe, weasels, stoats, ferrets, pole-cats, and others, are most abundant in mean and high latitudes. But of all the land carnivorous tribes, comprising upwards of 500 species, the proportion of species in tropical and temperate regions, is nearly as 3 to 1.

XVI. Contrasting the quadrupeds of the western and eastern hemispheres, we find a much smaller proportion of those that are useful to man in the former than in the latter. The llama, vicugna, turkey, some sheep and dogs, comprise all the important contributions made by America to the domestic stock of animals, which are vastly inferior to the domesticated races it has received from the Old World. In point also of size, courage, and power, the land animals in the New World are inferior to those of the Old. Especially is this the case, limiting the comparison to the southern parts of the two continents, South America and Africa.

From the splendour of the vegetation in South America, it might be inferred that the largest herbiverous quadrupeds would be found there; and only examples on a smaller scale occur in Africa, consisting of such an immense extent of naked desert, and tracts scantily clothed with low bushes and patches of grass. But the reverse of this is the case. Mr. Darwin has remarked, that taking on the African side ten of its largest animals, the elephant, hippopotamus, giraffe, bos caffer, elan. and probably five species of rhinoceros; also the same number on the American side, comprising two tapirs, three deer, the llama, vicugna, peccary, capybara, and a monkey; and it is not easy to conceive ranks more disproportionate in size, placing the two groups alongside each other. The estimated ratio as to weight of the African to the American group will be about as 6048 to 250, or as 24 to 1.

XVII. The conclusion deducible from the facts of zoological geography is parallel to that drawn from the circumstances of vegetable distribution, viz., that certain tribes of the animal creation were originally placed in particular regions, and have since remained attached to them, or to some extent been dispersed, according as their powers of locomotion, their capacity to endure change of climate, and the absence of physical obstacles to migration, have enabled them to wander.

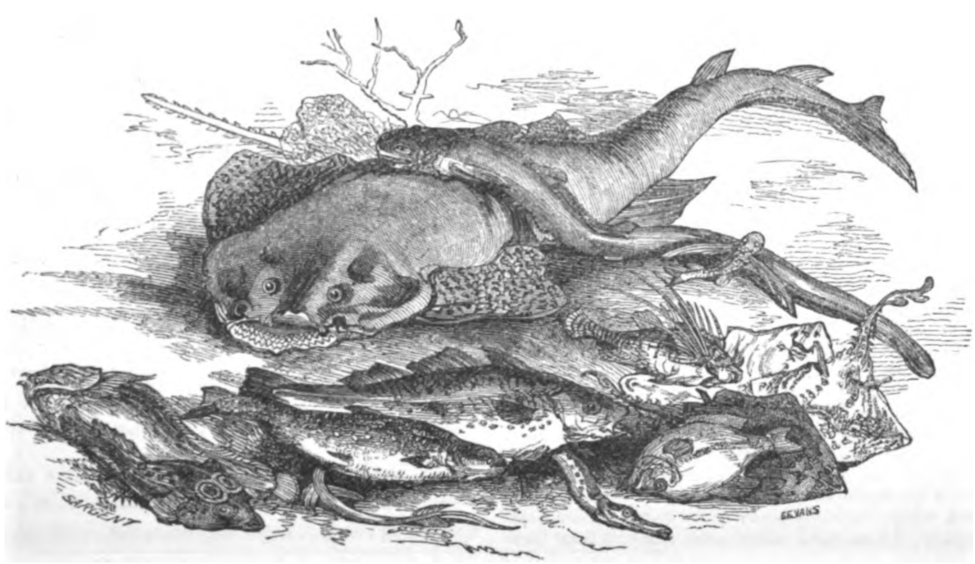
Insects of various kinds, butterflies, moths, beetles, and grasshoppers, some in vast numbers, are often encountered far out at sea, on a voluntary cruise, or blown off from the shore; and have no doubt frequently been compelled by the winds to establish themselves in new countries. The same agency has operated in the dispersion of birds. Captain Smyth, while engaged in a survey of the Mediterranean, experienced a violent gale in the Gulf of Lyons, at a distance of from twenty to thirty leagues from the French coast, bearing along with it many land-birds of various species, which alighted on the ship, or were dashed against the sails. The oceanic currents minister to the same end, as appears from the remarkable instance of a live boa constrictor, which was quickly dispatched, reaching the island of St. Vincent, coiled round the trunk of a cedar tree, probably washed out of the bank by the floods of some South American river, while the folds of the monster encircled its branches. The white polar bear has repeatedly made the passage from Greenland to Iceland on the drifting ice; and wolves and foxes have often been met with far away from the shore on great floating ice-fields. A deficiency of food in one district, and its abundance in another, has not been without its influence in altering the station of some animal tribes.

XVIII. Man has largely contributed, voluntarily and involuntarily, to extend the sphere of various races, diffusing the domestic tribes through the civilised world, and planting them on lonely islands as a source of supply to future visitors, while some diminutive and troublesome parasites, as rats and mice, common in merchant ships, have been transferred from Europe to the remote islands of Oceanica.

Some of the Keeling islets, a group in the Indian Ocean, about six hundred miles from the coast of Sumatra, have been colonised with rats identical with the English kind, which escaped from a vessel wrecked upon the shore. At Kerguelan Island no land animal was seen by the Antarctic expedition under Sir James Ross, but the singular footsteps of a pony or ass were traced for some distance in the recently-fallen snow, supposed to have been cast on shore from some wrecked vessel.

The practice cannot be too highly commended, of introducing the plants and animals that are serviceable to man on shores that are destitute of them, but capable of sustaining them. It is an easy method of conferring a benefit of unknown importance to some unfortunate shipwrecked crew, besides providing a stock from which in ordinary circumstances ships may be provisioned. In the Auckland Isles, to the south of New Zealand, discovered by Captain Bristow in 1806, then without an animal inhabitant, he introduced some pigs, which now occur in great numbers; Sir James Ross added, at his visit in 1840, sheep, rabbits, and poultry, besides sowing and planting various kinds of edible vegetables; and recently the group, thus newly endowed with useful animal and vegetable life, has been granted by the Crown to a Company in order to become the head-quarters of the southern whale-fishery.

XIX. But man, on the other hand, has immensely restricted or modified the natural sphere of many animals, both of the useful and dangerous class. The Asiatic lion, now confined to the country beyond the Euphrates, once occupied Palestine, Syria, Asia Minor, Macedonia, and Thrace. The aurochs, of which only a remnant lingers in the Lithuanian forests, formerly roamed in numbers through the woods of Gaul and Germany. The bear, the beaver, and the wolf have had their habitat in Britain. In the time of the Romans, bears were exported from our island for the purposes of the amphitheatre; and so late as the year 1057, one of the Gordon family became celebrated for slaying a fierce individual in Scotland. The existence of the beaver in Wales comes down to the year 1158; and its presence in that principality is memorialised by the name of "Beaver Lake," given to two or three of its waters. The wolf occurred in formidable numbers in England to the year 1281; in Scotland to 1577; the last of the race being slaughtered towards the close of the seventeenth century. In the Anglo-Saxon age, the whale was characteristic of the British seas; and the number of seals on the coast of Sussex, is commemorated in the name of one of its peninsular projections, Selsey, the Isle of Seals. The presence of civilised man in North America has had a similar marked influence upon the natural boundaries of the brute creation. The bison once inhabited the Carolinas, and indeed existed through nearly the whole extent of the United States. But as the settler has pushed westward, the animal has lost part of his old domain, and chiefly occurs in force on the plains of the Missouri, or on the Pacific side of the Rocky Mountains, having only found a passage through them in recent times, along the sources of the Saskatchawan. The limits of the fur-bearing animals have undergone a similar alteration; and when from eighty to ninety thousand beaver skins, and upwards of half a million skins of the musk-rat, are annually imported into Europe, it is obvious that these races must ultimately disappear before the persevering pursuit of the hunter.



CHAPTER III.

ETHNOGRAPHY.

I. MAN is properly separated from all other members of the animal kingdom, and regarded as forming an order by himself, comprising a single species, exhibiting many varieties. The most inferior specimen of the human race is to be discriminated from any mere animal by a difference immensely greater than the change which species can be supposed to have undergone in the longest periods of time, and under the influence of the most varied circumstances. The diversities of mankind are quite compatible with the idea of their descent from a single stock, for they are precisely diversities of the same nature with those which we know arise in species, under control of external causes.

Linnæus placed man in the order of *quadrumana*, four-handed; but the human hands and feet are totally different in structure, and fitted for different uses. The hand of man is also so far superior to that of the quadrumanous tribes, in its mechanism and adaptations, as to render their classification together inappropriate. Accordingly, Cuvier constitutes of man the single order of *bimana*, for he alone is two-handed. The characteristics of the species, as given by Blumenbach, are:—"Erect, two-handed, unarmed, rational, endowed with speech; a prominent chin; four incisor teeth above and below; all the teeth equally approximated; the canine teeth of the same length as the others; the lower incisors erect."

II. Owing mainly to the flexibility of his constitution, although obtaining much artificial aid, man can subsist under the greatest climatic extremes. The Esquimaux endure the cold between the parallels of 70° and 80°; the African negroes subsist under the burning sun of the Equator; while Europeans, accustomed to an intermediate temperature, have borne the rigour of the highest accessible latitude, and the fiercest heat of the Torrid Zone.

The power of the human frame to resist cold, according to Sir John Ross, who experienced four successive Arctic winters, appears to vary remarkably in different constitutions. His general conclusion is, that the ruddy, elastic, florid, or clear-complexioned man, endowed with what physicians call the sanguine temperament, has a peculiar power of retaining heat; while those having pale, flabby, and sallow countenances, whose temperament is said to be phlegmatic or melancholic, are proportionably deficient. The most ample clothing will not compensate for the deficiency, since it can only retain the internal heat; and if this be wanting, one might as well attempt to "warm a piece of ice by means of a blanket." He places his chief reliance on abundance of food; and it is well known that the Esquimaux take as much as ten and twelve pounds weight of animal food in twenty-four hours, its effect being heightened by the fat and oleaginous quality of their diet. The oxygen which is inhaled with atmospheric air, combines chemically with the carbon of the food, and that chemical action is the cause of heat and vital force. Therefore, a much larger supply of animal food, which contains many times more carbon than vegetables, is necessary in a cold climate; while, amid torrid heat, rice and fruit form an appropriate diet.

III. The human frame can also adapt itself to very different states of the atmosphere as to density, though with a varying capacity in different individuals. The Andean valleys and table-lands, varying 10,000 feet in elevation, where the barometric column stands at 30 inches in the one, and at only 20 on the other, have their respective inhabitants. The French geometers, Bougier and Condamine, while measuring in that region an arc of the meridian, occupied for three weeks a station at the height of 14,000 French feet above the level of the sea. The barometer stood at 15¾ inches, the atmospheric pressure being therefore very little more than half that to which they had been accustomed.

The experience of travellers, from the rarity of the air at great heights, is very various. Some have suffered no inconvenience, while others have been painfully affected; this has no doubt arisen from constitutional differences; but "the difficult air of the iced mountain's top" appears to lose all difficulty to those who have had some acquaintance with it. Professor Forbes felt nothing peculiar on the Jungfrau, at 12,870 feet; but he had been living for weeks at the height of 8000 feet. Mr. Darwin, who experienced painful respiration on crossing the Portillo pass of the Chilian Andes, intimates that, at Potosi, about 13,000 feet above the sea, though strangers suffer at first from the atmosphere, no inconvenience is felt after a short stay. Dr. Le Pileur, with MM. Brevais and Martius, ascended Mont Blanc in August, 1844. They suffered most during the first hour after their arrival at the summit of the mountain; in the second hour, they felt better, and after that suffered very little; but they had no appetite during the whole of the time that they were at a height above 4000 yards.

IV. The human race are not confined to any particular kind of food, but subsist in different situations with equal facility on very varied diet. Vegetables are the chief aliment of the nations within the tropics; animals, of the polar tribes; both sources, with no great disproportion, contributing to support the inhabitants of temperate climates. Man is thus adapted for a very wide geographical range, and fitted to occupy physically discordant regions. In high latitudes, where a mantle of snow covers the ground through the greater portion of the year, and vegetation is very scanty, entire hordes live on fish and seals; towards the equator, where vegetation flourishes most, vast numbers thrive with no other articles of support than cocoa-nuts, bananas, yams, and rice; in the intermediate districts, the special region of the cerealia, and where animal food can as readily be procured, a mixed diet obtains.

An attempt has been made to classify mankind according to particular kinds of food, as follows:—1. *Carnivorous*, flesh-eaters; 2. *Ichthyophagists*, fish-eaters; 3. *Frugivorous*, fruit and corn-eaters; 4. *Acridophagists*, locust-eaters—some wandering Arabs; 5. *Geophagists*, earth-eaters—the Otomacs on the banks of the Orinoco; 6. *Anthropophagists*, man-eaters; 7. *Omnivorous*, devourers of everything. But the only classification that can be made with respect to food, is the very general one already noticed, referring to the inhabitants of polar, temperate, and equatorial regions.

V. Few countries of the globe have been discovered without an indigenous human population. Among the principal are Spitzbergen, Nova Zembla, Iceland, Madeira, St. Helena, the Falkland Isles, Kerguelen's Land, the Antarctic Lands, and the African Sahara, excepting its oases. Respecting the aggregate number of individuals, the estimates made are approximations merely, and are very discordant.

The following are the Estimates of Malte Brun and Balbi:

		Malte Brun.	Balbi.
Population of	Europe	170,000,000	227,700,000
"	Asia	320,000,000	390,000,000
"	Africa	70,000,000	60,000,000
"	America	45,000,000	39,000 000
"	Oceanica	20,000,000	20,300,000
	Total	625,000,000	737,000,000

The total is raised much higher by other authorities:

Europe	250,000,000
Asia, with Oceanica	550,000,000
Africa	150,000,000
America	48,000,000
Australia	2,000,000
	1,000,000,000

Probably 800,000,000 is the closest approximation.

VI. The leading physical differences observable among mankind refer to varieties of strength, stature, proportion of the limbs, texture of the skin, character of the hair, colour, and the form of the skull.

VII. Both barbarous and civilised races exhibit the diversities of physical power which are found in individual families; but, contrary to popular opinion, upon comparing the two together, the result of experiment shows

"The stoic of the woods, the man without a tear," to be inferior to the civilised man in muscular energy and capacity of endurance, though some of his bodily powers and senses, the eye and ear, are remarkably vigorous.

During a voyage to Australia, M. Peron obtained with the dynamometer, an instrument contrived to exhibit the measure of strength in the arms and loins of the parties subjected to trial, results as follows:

	Manual strength. Kilogrammes.	Lumbar strength. Kilogrammes.
17 Natives of Australia	50·8	10·2
12 Natives of Van Diemen's Land	50·6	
56 Natives of the island of Timor	58·7	11·6
17 Frenchmen, attached to the Expedition	69·2	15·2
14 Englishmen of New South Wales	71·4	16·3

The first transportation of the negroes to the New World arose from the Spaniards finding the Aborigines so much weaker than themselves, as to be quite unable to endure the labour of the mines.

VIII. While members of the same nation and family exhibit considerable divergencies from the average height, there are examples of tribes departing generally from the ordinary standard as to stature. Among the natives of the New World, the Esquimaux, Nootka Sound-dwellers, Fuegians, and Peruvians, are diminutive: the Cherokees, Caribs, and Patagonians are tall. In the Old World, the Lapps and Samoides are below the standard height of Europeans; the Hottentots and Bosjesmen are far inferior to the stature of the Caffres.

M. Quetelet finds for the French the following heights:

	feet.	inches.	
Men of the greatest stature	6	8	attained by 1 in 10,000,000
Limit of the ordinary size	5	5	
Medium size	5	3	(for the English 5 feet 7½ inches)
Lowest limit of the ordinary size	5	1	
The smallest men	3	11	exhibited by 1 in 10,000,000

Among the Bosjesmen, 4½ feet is given as the average height of the men, and 4 feet of the women. The Patagonians average 6 feet, and very frequently exceed it.

Different breeds of the same animal species present a precisely similar variety. Compare the small Welsh cattle with the large-sized herds of the south of England: the Shetland ponies, with the tall-backed mares of Flanders: the bantam breed, and the large English fowls.

IX. Diversities occur with reference to the proportional size of parts of the bony skeleton, the texture of the skin and hair. Thus, examples are common in the negro tribes, of the broad, flat foot, projecting heel, "cucumber shin," and of the greater length of the fore arm, measured in proportion to the upper arm, and the height of the body. The skin is also softer and more velvety, a characteristic of some of the South Sea Islanders. The hair has, likewise, that peculiar character which has led to the African nations being styled in general "woolly-haired," fine, wiry, and crisp, while that of the Mongolian tribes is strong, straight, and scanty, and that of Europeans, soft, long, and flowing. But these characters are only variations which may be observed within the limits of any single race.

The disproportionate size of the limbs referred to, is not a constant distinctive feature, but disappears frequently from the negroes, and is found, though not so commonly, in Europeans. Some Aborigines of the Guinea coast have exhibited the utmost symmetry of form, and as such, have served the sculptor for a model.

The woolly hair, common to the negro, does not belong to several African tribes, in all other respects conformable to his type, who have the long flowing hair of Europeans; while, on the other hand, there are many Europeans, free from all negro blood, who have the crisp wiry hair denominated woolly. Scantiness of hair, usual among the Mongolian nations, is not invariable, for there are tribes, undoubtedly Mongolian, as evidenced by their physiognomy and language, with the appendage copious and bushy. Analogous variations mark the same animal species, under change of circumstances. Thus, the fine wool of the domesticated sheep is reproduced if regularly shorn; but, if the flock is suffered to run wild, as was the case with the sheep introduced into the Andean valleys, by the early Spanish settlers, the wool speedily degenerates, is succeeded by a coarser kind, finally falls off, and never reappears, the animal approximating to the Asiatic argali, covered with short fine hair.

X. Complexional differences form the most obvious of those distinctions which subsist among mankind, and have been most relied on as evidencing a descent from different original stocks. Omitting exceptional cases, there is a correspondence maintained between the colouring of the skin, eyes, and hair, which renders their mutual dependence upon the same pigmentary matter highly probable. Light hair is very generally in alliance with light blue or grey eyes; but the hue of the hair and of the skin have an analogy which is almost invariable, the fair and transparent skin, which frequently assumes a ruddy tint, being connected with light hair, and the dark-complexioned skin with black hair.

Dr. Prichard discriminates three principal varieties of the human species, according to the colour of the hair.

1. The Melanic, or black-haired variety. The corresponding hue of the skin varies from the jet black of the Senegal negroes to the very dilute shade apparent in the dark-complexioned races of Europe. The black combines with red in the copper-coloured nations of America and Africa, and with yellow in the olive-coloured tribes of Asia. The swarthy Spaniards, the southern Europeans in general, and, indeed, the great majority of mankind belong to the Melanic class, exhibiting the characteristic hue of the skin under very varying shades.

2. The Xanthous, or yellow-haired variety. The colour of the hair is light brown, auburn, yellow, or red; eyes blue or grey; complexion fair, acquiring a ruddy instead of a bronze tinge on exposure to the light and heat of the sun. The inhabitants of the temperately cold regions of Europe and Asia chiefly belong to this class.

3. The Leucous, or white variety. The colour of the hair is of a milky white, or cream tinge; that of the skin is the same, with occasionally a pinkish hue; the iris is rosy, and the pupil intensely red. The examples are not nations, but individuals, called Albinos. The instances occur in all countries, but are, perhaps, most common in hot climates.

XI. Various considerations decisively show that the distinctions of colour exhibited by the human race are perfectly independent of diversity of origin as the cause, and have sprung up in the species under the influence of purely local circumstances. The colour is not a permanent character. Thus we find the Xanthous variety making its appearance in Melanic tribes, of which a number of examples might be cited. This occurs even among the most swarthy, as the negroes of Senegal. The Jews furnish a remarkable instance: while the Jews long settled in Malabar and Cochin-China are so black as not to be distinguishable by complexion from the native inhabitants; more recent settlers, not yet darkened by the climate, are styled White Jews, and the ordinary Jewish complexion, in Poland and Germany, is florid, with blue eyes and red hair.

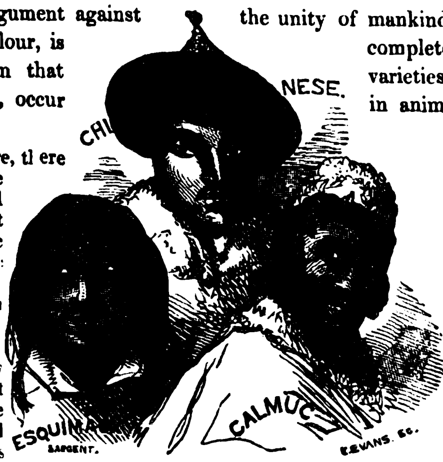
1. Nations whose common origin is evidenced by the fundamental conformity of their language, and who, though now far apart, are led back by history and tradition to the same site, display every variety of shade exhibited by the human race in general. The Japetic, or Indo-European group of nations, extending from the Ganges to our own shores, and the Semitic, or Syro-Arabian tribes, stretching from Western Asia along the Mediterranean coast of Africa, are variously deep black, swarthy, and fair.

2. Various tribes, bound together by the closest affinities of language, and general bodily configuration, occupying a very limited area of country, present very diverse shades. Thus, in Northern Africa, between its Atlantic and Mediterranean shores on the one hand, and the Sahara on the other, is a country varying in physical character, level and mountainous, the native inhabitants of which speak dialects of the ancient Berber language, and are very differently complexioned. The Tuarick tribes, bordering on the Desert, are nearly as black as the darkest negroes; the Kabyles of Algiers and Tunis occupying the hills which form the lesser Atlas, are swarthy; while the lofty table-land of the Aurès (Mons Aurasius,) is inhabited by a tribe so fair and ruddy, and with hair of so deep a yellow, that they have been supposed, though without adequate foundation, to be a colony of Teutonic origin. Among the Hindoos, also, whose territory greatly differs, from the secondary ranges of the Himalaya to the low, level plains of Bengal, the discrepancies of colour are very great,—some being actually fair, others little darker than the south Europeans, and others intensely sable. "The great difference of colour," says Bishop Heber, "between different nations struck me much; of the crowd by whom we were surrounded, some were black as negroes, others merely copper-coloured, and others little darker than the Tunisines, whom I have seen at Liverpool."

XII. Anatomical investigation proves the true skin to be similar in all nations. The pigmentary substance, upon which varieties of colour depend, is apart from it, seated in the cells of the epidermis, or scarf-skin; and our own experience shows that this colouring matter may be temporarily generated, so as to tinge in a marked manner the fairest complexion, under temporary exposure to the more direct and heating rays of the sun. Hence the "freckle" which appears in summer, and the change which we describe as becoming "tanned," or "sunburnt," manifest on those parts of the body exposed to more intense solar influence, as the face and hands; while the general frame, being covered, retains its fairness.

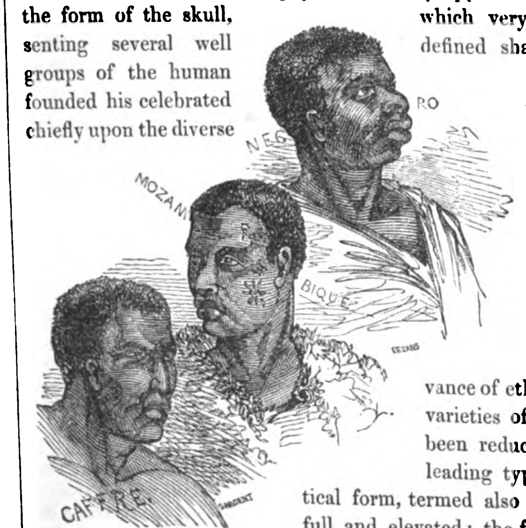
This is a significant intimation that variations of colour are materially influenced by different climatic states. Exposure to a burning sun has been truly recognized in the poetry of the Hebrews as one potent cause of the dark complexion: "Look not upon me, because I am black, because the sun hath looked upon me; my mother's children were angry with me; they made me the keeper of the vineyards." Shut up within the walls of seraglios, and avoiding exposure to the effect of climate, the women of many tropical countries are frequently very fair, being "bleached by artificial protection from light, or at least from the solar rays." A similar bleaching is observed to be coincident with elevation in torrid districts, where a different climatic condition subsists to that experienced in the lowlands. On the lofty table-land of Abyssinia, the inhabitants are characterised by light complexions, though in the same geographical latitude as the negro races. The same remark applies to the Arabs on the highlands of Yemen, who have often blue eyes, red hair, and light complexions; while those of the low countries about the Nile are almost jet black. In the valley of the Jordan, where intense heat is almost invariable, Mr. Buckingham noticed that the Arabs had darker skins than he had seen elsewhere. In fact, the black, dark brown, and copper colours, prevail in equatorial districts; the lighter olive is distinctive generally of the nations immediately without the tropics; and still lighter shades become more universal in the higher latitudes; showing the intimate connection of colour with climate.

XIII. The argument against the unity of mankind, founded upon differences of colour, is completely exploded by the consideration that varieties of hue, quite as strongly marked, occur in animals of the same species.



"In the Mysore, there are three varieties of colour in the sheep; they are red, black, and white; and these are not distinct breeds. The ass of the Carnatic presents singular varieties of colour: some are of the usual ash-colour while others are almost black, in which case the cross on the shoulders disappears: milk-white asses are also to be found, but they are rare. These are not distinct species, for black individuals have sometimes ash-coloured colts and *vice versâ*. Some remarkable facts are mentioned by Azara, with reference to the colour of horses and oxen in Paraguay. It is well known that both of these races have run wild in South America, and the climate being congenial to them, have multiplied prodigiously in the fertile plains in the neighbourhood of the River de la Plata. Azara says that all the wild horses are of a chesnut, or bay-brown colour, while the tame horses are of all colours, as in other countries; hence he conjectures this to be the original colour of the race. He makes a parallel observation respecting the ox." Varieties in the colours of animals sometimes spring up casually and sporadically; in other instances, they are generally prevalent in particular breeds. In the different parts of England, Wales, and Scotland, there are different breeds of cattle and of horses. In some districts the oxen are always black; in others, brown or spotted. The cattle of particular countries are immediately recognized by their colour. Blumenbach has noticed many examples of the same kind. He remarks that all the swine of Piedmont are black; those of Normandy, white; and those of Bavaria, of a reddish brown colour. The same author observes that the oxen of Hungary are of a greyish white; in Franconia, they are red. Horses and dogs are spotted in Corsica: the turkeys of Normandy are black; those of Hanover almost all white. In Guinea, the dogs and the gallinaceous fowls are as black as the human inhabitants of the same country."

XIV. The last important physical diversity apparent among mankind refers to the form of the skull, which very remarkably varies, presenting several well defined shapes, distinctive of great groups of the human population. Blumenbach founded his celebrated classification of mankind chiefly upon the diverse conformation of the cranium. The division is into five varieties:—the Caucasian, Mongolian, Malay, Ethiopian, and American. But this classification, though still often retained, has been rendered largely inapplicable by the advance of ethnographic knowledge. The varieties of cranial conformation have been reduced by Dr. Prichard to three leading types. 1. The oval or elliptical form, termed also symmetrical: the forehead full and elevated: the face small, and distinguished by the regularity and evenness of the features.



2. The narrow and elongated form, suggesting the idea of compression at the two sides, called prognathous, because of its distinctive character being acquired by the forward prominence of the jaws, which gives a peculiarly ferocious and animal character to the countenance. 3. The broad or pyramidal form, which

derives its peculiar character from the great lateral prominence of the cheek bones, and the rapid narrowing of the forehead at its highest part.

The oval form corresponds to the Caucasian of Blumenbach; but, together with the features which belong to it, is probably displayed in its greatest perfection by the Greeks. It characterises all the Indo-Atlantic nations, spread over the countries between the Excalaya mountains and the Indian Ocean, and extending from thence, with a few exceptions, to the Atlantic shores of North-western Africa and Western Europe.

The prognathous form corresponds to the Ethiopian of Blumenbach, but is most distinctive of the Guinea-coast negroes. It is, however, scarcely discernible in many African nations to whom it has been assigned as a type.

The pyramidal form corresponds to the Mongolian of Blumenbach, but peculiarly distinguishes the Esquimaux.

XV. But while there are certain great groups of nations exhibiting differences of cranial conformation, each variety appears with widely different degrees of development in its respective group, and entire tribes, or families, supply evidence of craniological change, which harmonises the unity of the species with the fact of its diversity. It is probable that the numerous distinctions between civilization and barbarism, with great climatic contrasts, originate mainly the structural differences observable in the human race. Near a thousand years ago, the Magyars, a race of northern Asiatics, were expelled from their native region, and exchanged a rigorous for a more genial climate, by planting themselves in Hungary, abandoning at the same time their nomadic habits for a settled mode of life; and in the interval of ten centuries, their cranial configuration has undergone a change from the pyramidal to the elliptical, and they are not now recognisable from regular Europeans. A similar alteration has been observed in the case of many negroes associated with the whites in the West Indies and America, without there having been any intermixture of race.

The lower animals descended from a common stock, present analogous structural differences, which especially distinguish the domesticated breeds from their congeners running wild. Thus, in the most highly disciplined variety of canines, the spaniel, the skull departs more widely from the form distinctive of the wolf, than that of the mastiff, a less cultivated animal. Blumenbach asserts, that there is less difference in the form of the skull in the most dissimilar of mankind, than between the elongated head of the Neapolitan horse and the cranium of the Hungarian breed. That physiologist was the first particularly to describe the remarkable variations of structure presented by breeds of swine. It is certain that they all descend from the wild boar; and equally certain, that they were unknown in America till conveyed there by Europeans; but in the short interval that has elapsed since their introduction, they have degenerated into races very different from each other, and from their original. The domestic swine in general, vary from the wild boar, as to the form of the skull, quite as much as the whole difference between a negro and an European.

XVI. While the physical differences of mankind are not only consistent with the anatomical phenomena exhibited by known species, their unity is strongly confirmed by a common conformity to the same physiological laws. There is a wide distinction between man and the animals that make the nearest approach to him, in point of longevity, the extreme term of the orang-outangs being estimated at not more than thirty years; but the capacity for long life is not greater in one tribe of the human race than in another, nor is there any difference as to its average duration under equal circumstances as to climate, food, clothing, habitation, and the sanitary aids which civilisation furnishes.

The limit of the civilised man's existence in the most favourable circumstances very rarely extends to one century, though most European nations supply a few instances of that boundary being exceeded. In Belgium, on January 1, 1831, there were sixteen centenarians, the three oldest individuals being 104, 110, and 111 years. Occasional examples of greater longevity also occur; but they are not confined to Europeans, or to whites, for negroes have been known to attain an age equal to it. Of the native Americans, Humboldt states, that it is by no means uncommon to see at Mexico, in the temperate zone, which is half-way up the Cordillera, natives, and especially women, reach a hundred years of age: this old age is generally comfortable, for the Mexican and Peruvian Indians preserve their strength to the last. He mentions the case of an Indian woman near Lima, who at the age of 143, went a distance of from three to four leagues daily on foot. Of the Australian aborigines, Captain Grey remarks, that with regard to the age occasionally attained by them, very erroneous ideas have been prevalent, for so far from being short-lived, they frequently attain the age of seventy and upwards. Mr. Eyre speaks of having met with many venerable white-headed men among them, who could not have been less than eighty, retaining the full vigour of mind, and the bold, upright, though wasted form, that had characterised them in the pride of manhood. That the average duration of life should be much inferior among the barbarous races, as compared with the civilised, is adequately explained by a precarious mode of life, physical hardships, ignorance of remedies in sickness, and of the habits favourable or adverse to vitality.

XVII. The same general coincidence prevails with reference to other physiological characters, as the age of puberty, the period of gestation, the signs of advancing life, and the diseases to which the human frame is subject, the greater part of which are common to all communities, modified by differing climates and local position.

XVIII. As far as the Psychical properties of the different nations of mankind have been examined, or those intellectual and moral capabilities in which humanity properly consists, the differences are not greater between the races of men than those which appear within the limits of the same race. Examples are not wanting within our own shores, of individuals apparently shorn of the high prerogatives of their kind, sunk in stolid ignorance, and abandoned to brutal habits, having grown up apart from the means of cultivation; and the case of entire tribes, as the Bushmen of South Africa, and the Fuegians of South America is but a parallel one, deriving its more melancholy features simply from a more complete destitution of improving influences. This may be inferred from the recovery from extreme barbarism exemplified by tribes whose nature has been fairly tested by intellectual, moral, and religious education.

XIX. The result of modern philological inquiry has been to reduce the languages of the great bulk of mankind, the inhabitants of the old continent, to a few great groups, and traces of community are observed in these groups, which indicate a derivation from a common stock.

In referring different languages to a common family their grammatical affinity is the criterion, not their lexicographical agreement. The languages of the Old World are classed by Chevalier Bunsen into the following families:

1. The Indo-European, called also the Japetic, likewise the Iranian, comprising the Sanscrit, Medo-Persic, Teutonic, Græco-Latin, Sclavonic and Celtic branches, with their derivative dialects.
2. The Syro-Arabian, styled also the Semitic, comprising the Aramæan or Syriac, Hebrew, Arabic, and Ethiopic, with their derivative dialects.
3. The Turanian, called also Ugro-Tartarian, including the languages of High Asia, of some inhabitants of Northern Europe, the Lapps and Finns, and probably of the Basques in Spain.
4. The Chinese and Indo-Chinese, or the monosyllabic and uninflected languages.
5. The African languages spoken by the woolly-haired nations within a few degrees north of the equator, and all south of that line.

The Japetic and Semitic groups are considered as one in essential character. The Semitic tongues, which belong to nations who have remained stationary in semi-civilisation, stop short with a tendency towards that system of inflections, characteristic of a progressive people, which the Japetic generally develops, and most highly in its Hellenic branch. The Turanian family of languages, spoken by most of the nations of Asia, exhibits vestiges of original connection with the Japetic; the Malayo-Polynesian languages are through the Malayan connected with the Turanian group; and the further prosecution of Chinese philology will probably bring to light indications of relationship to the same stock. It is, however, a striking fact, that where the philological discordance among nations is at its maximum, the anatomical difference is at its minimum, and *vice versâ*. Thus, while the distinction between the Chinese and the other languages of Central and Northern Asia is very marked, their physical conformity to those nations is just as decided. All information, at present scanty, respecting the languages of Central and Southern Africa, tends to prove, that they have sprung from a single stem referable to the common stock of the preceding branches.

The languages of the aborigines of the New World are very numerous, and exhibit the very singular phenomenon of great lexicographical discordance, amounting in some instances to having not so much as a single word in common; yet from Cape Horn to the Artic Ocean, they are all connected by the same principle of formation and grammatical structure, analogous to that of the Turanian tongues of Asia.

According to Adelung there are 3664 known languages and dialects in the world, distributed as follows:

European	587	American	1624
Asiatic	937	Oceanic	240
African	276		

Modern experience teaches us, that the speech of a nation, maintaining its geographical site and political status, changes remarkably in a short space of time from purely domestic causes. New words are required in the progress of society, and old ones become obsolete. The English of Chaucer and Wickliffe is unintelligible to the general reader; that of Spenser is scarcely less obscure; and a glossary is a common appendage to Shakespeare.

But this modification of the vocabulary forms no case parallel to the phenomenon presented by different languages. Yet as, notwithstanding their variations, the English, German, Dutch, Danish, and Icelandic, are branches from the Teutonic stem; as we certainly know, with greater divergences, that the Teutonic, Celtic, Sclavonic, Græco-Latin, Zend, and Sanscrit, constitute a single family, the Indo-European, having been developed from a common original at a remote era; there is no difficulty in conceiving of the great linguistic families, with still wider divergences, the Indo-European, Semitic, Turanian, &c., having originated from a common source, at a still remoter period; and in the more primitive ages of the world, when mankind, few in numbers, dispersed themselves in detached bodies, losing all traces of each other, making varied progress, and encountering different experiences, it is easy to understand, that the diversifying process with reference to language would be proportionably active.

XX. It may be concluded, therefore, with rigorous certainty that no specific difference exists among mankind, but an immense number of varieties. It is impossible to account for their occurrence otherwise than in a very superficial manner. The causes will probably ever remain enveloped in mystery, along with those of similar variations in single families, and analogous phenomena in the animal kingdom. Owing to varieties existing with very unequal degrees of development, one passing gradually into another, no accurate classification of the species can be made according to characteristic differences. An approximation to such an arrangement is all that can be done, and is given in the Ethnographic map.

1. The Iranian nations. 2. The Turanian nations. 3. Negroes. 4. Hottentots and Bushmen. 5. Oceanic Negroes and Alfourous. 6. Native Americans.

XXI. The Iranian nations correspond to the Caucasian of Blumenbach, and the West Asiatic of other writers. The name is derived from Iran, the ancient and proper appellation of the great plateau of modern Persia, included between the rivers Tigris and Oxus. The class comprises nearly all the Asiatics within a line extending generally from the mouth of the Ganges, along the Himalaya mountains, the course of the Oxus, intersecting the Caspian Sea, and following the chain of the Caucasus to the Euxine; also all the North Africans above latitude 20°; almost all the inhabitants of Europe; and, of course, the European colonists settled in various parts of the globe. This vast section of the human family comprehends at present, and has ever done, since the date of authentic history, the most perfectly formed, vigorous, and intellectual of mankind. The Egyptians, Hindoos, Assyrians, Babylonians, Medo-Persians, Greeks, Romans, and Arabs, successively represented the civilisation of by-gone times, founded mighty monarchies, and obtained paramount influence in the world, a heritage which has descended to the western Europeans, and the offshoot from them in the United States.

Owing to India and the Atlantic Ocean being geographical boundaries of the Iranic nations, they are frequently styled Indo-Atlantic. Their bond of union is a common physical conformation, which may be generally stated as follows: Large cranium, beautifully shaped small head, oval face, expanded forehead, small mouth, regular features, and symmetrical shape: hair, fine and copious; colour not a characteristic, since the complexion is of all shades, fair and florid, olive, swarthy, and jet black. The configuration appears most perfectly developed in the Greeks, ancient Persians, and some others: least so in the ancient Celts.

In Europe, the non-Iranic races are the Tschudic tribes of the north, Finns and Lapps; the Magyars; the Turks; and, perhaps, the Basques.

Complete obscurity rests upon the early peopling of Europe, but as far as history throws light upon the remote past, it seems to have received great waves of Iranian races in the following order of historical succession: 1. The Celtic race, occupying the western and south-western parts of Europe, while the Tschuds possessed the northern and north-eastern, and various tribes of unknown origin were scattered over the south-eastern. The latter, crossed by the Celts, and fresh Asiatic immigrants, originated the Greeks, a mixed race; and the fusion of the native tribes of Italy, with Celts and Grecian immigrants, originated the Latins, a race still more mixed. The Greeks, Italians, French, Spanish, Portuguese, Irish, Gaelish, Welsh, Manx, and Cornish, belong to this branch. 2. The Teutonic race entered Europe at a later period, driving the Tschuds farther north, and the Celts farther west. The Scandinavian branch of this family settled in Norway, Sweden, and Denmark, occupied the adjacent islands, extended themselves to Britain, and finally spread to Iceland. The Germanic branch took possession of Germany, Holland, parts of Switzerland, Schleswick, and contributed a leading element to the population of Britain. 3. The Sclavonic race came into Europe at a date still later, occupying the principal part of Russia, Lithuania, Poland, Bohemia, Moravia, and the provinces on the Danube. The Celtic, Teutonic, and Sclavonic races have been variously mixed, but have remained also to a considerable extent comparatively pure.

XXII. The Turanian nations correspond to the Mongolian and Malayan of Blumenbach. The denomination is derived from Turan, the Persian name applied to the wild and extensive plains of Tartary, and all the countries of Asia beyond the Oxus, as distinguished from the table-land of Iran. But nations apart from these geographical limits are included in this division. The principal are as follows: 1. In Asia, the Tungusian, Mongolian, Turkish, Thibetian, Chinese, and Indo-Chinese races, with the Hyperborean tribes spread along the inclement shores of the Arctic Ocean, as the Samoiedes, Tschuktschi, Kamschatkans, and Aleutian islanders, chiefly ichthyophagi, or fish-eaters. 2. In Oceanica, the Malayo-Polynesians, scattered through various groups of the Pacific, exhibiting wide diversities, but supposed to have sprung from an Indo-Chinese germ. 3. In Europe, the Turks, Magyars, and Tschudic races; the latter extending from Lapland and the White Sea, along the Ural Mountains to the borders of the Caspian. 4. In America, the Esquimaux, and other related tribes, closely resembling the Hyperboreans of the Old World.

These nations are characterised generally by the pyramidal form of the skull; a peculiarity derived from the great lateral prominence of the cheek-bones, and the rapid narrowing of the forehead at its highest part. The face is larger in proportion to the size of the skull than in Europeans, and round instead of oval. The eyes are small, deep, and obliquely set; hair scanty; complexion, a sallow or yellow olive; stature, commonly below the European standard. But many tribes depart widely from one or more of these characters, while conformable to the rest. The Samoiedes, Tungusians, and other northern Asiatics have a dirty brown or swarthy colour; the Mantchoo-Tartars in China, and some of the Chinese themselves, approximate to a fair and even florid complexion; and various tribes have the hair and beard long and bushy.

In Europe, the Turks, a settled race, have become widely different from the nomadic Turkish clans of central Asia, corresponding to the physical character of the great bulk of the Europeans. The same correspondence is also observable among the Magyars of the higher class, while the mass of the people retain the conformation of their ancestors, with some modification. The Lapps, Finns, and other Tschudic races of north-eastern Europe, exhibit very decidedly the characters of the Turanian division of mankind.

Dr. Kombst gives the following summary of the population of Europe:

Total of Teutonic blood, pure and mixed	82,000,000
„ Celtic blood	68,700,000
„ Sclavonian blood	58,000,000
„ Finnian and Samoiedian tribes	3,000,000
„ Lettons, Lithuanians, and Kures, mixed Finnian and Sclavonian	2,000,000
„ Turks	4,000,000
„ Magyars	9,000,000
„ Tartars, in the south and south-eastern provinces of Russia	4,600,000
„ Kalmyks, betweeen the Volga and Ural	300,000
„ Jews, spread over Europe generally	2,000,000
„ Gypsies, ditto	600,000
	234,200,000

XXIII. The Negro nations occupy Africa from the parallel of 20° north latitude to the borders of the Cape Colony; and have been largely planted in the West Indies and United States by forcible transportation.

The peculiar physiognomy of the Negro—skull compressed laterally, and forward prominence of the jaws; low, narrow, and slanting forehead; large eyes, thick lips, and prominent cheek-bones; woolly or crisp hair; black complexion—is most apparent in the natives of the Guinea Coast. Many tribes diverge remarkably in conformation and colour. High foreheads, light brown complexion, and reddish hair, are frequently met with among the Kafirs, though there is no reason to doubt their connection with the proper Negro races.

XXIV. The Hottentots and Bushmen, the latter a degraded caste of the former, inhabit the high table-land of Southern Africa, and the basin of the Orange River. Though usually classed with the Negroes, they are very discordant from their type, having the skull decidedly pyramidal, with obliquely set eyes, yellowish complexion, spare hair, and other characters strikingly according with those of the Central and Northern Asiatics.

XXV. The Oceanic Negroes, resembling the African in various features, and the Alfourous, are islanders of the Indian and Pacific Oceans, forming tribes either associated with the Malayo-Polynesians, or entirely separate.

They comprise, 1. The Negroes of the Indian Seas,—races of puny stature, woolly hair, black or nearly so, with features strongly akin to those of the Guinea Coast natives; found in the Andaman Isles, Bay of Bengal; in Lasso, Luzon, and others of the Philippines. 2. The Papuas, inhabiting New Guinea, the islands and archipelagoes around Australia, of puny stature and sooty hue, distinguished by their bushy frizzled hair growing on the head in separate tufts, described on that account by Dampier, as the "mop-headed Papuas." 3. The Alfourous or Araforas, found in New Guinea, with whom are classed all the natives of Australia, very darkly tinged like the Oceanic Negroes, constitute a variety distinct from them and the Malayo-Polynesians, by decided physical differences.

XXVI. The American nations, excluding the Esquimaux, and the descendants of European and African colonists, are intimately related to each other, so as to form a single family; the last of the great divisions of mankind, divergent in various respects from the groups of the Old World. Though commonly styled the red or copper-coloured race, the cinnamon hue is not universal, some tribes being nearly black, others brown or yellow, and others comparatively fair.

XXVII. The specific identity of mankind by no means solves the problem of their origin—whether they have all sprung from a single pair, or whether duplicates, triplicates, or other multiples of pairs were brought into being in different regions, formed so much alike that there should be no specific difference between them. Some eminent writers conceive that the latter alternative may be held, the two first inhabitants of Eden being regarded as the progenitors only of the race from whence sprung the Hebrew family, in harmony with the announcements of the Scriptures. But the theory appears to be antecedently improbable, and it is quite unnecessary to explain the phenomena of the dispersion of the species. Mankind have not, like plants and animals, a constitution adapted simply to particular geographical localities; and there is no great difficulty connected with the idea of their diffusion from the location of a single pair. The New World might readily receive inhabitants from the Old, across the narrow strait which separates them; and likewise by the chain of the Japan, Kurile, and Aleutian archipelagoes, a series of stepping-stones extending from China to the north-west coast. Canoes, diverted by winds and currents from their course, have borne their occupants into perpetual exile, and contributed to stock remote islets of the ocean with a human population.


OROGRAPHICAL
OF THE
GLOBE
Showing the
CONFIGURATION & PHY
OF ITS SURFAC
Augustus Petermann F.R.
John Dower
WESTERN HEMISPHERE
NORTH AMERICA
SOUTH AMERICA
ZONE OF CORAL REEFS
(Principally confined within the Isothermal Lines of 70° Fahr.)
EQUATOR
Tropic of Cancer
Isotherme of 70°
Warmth Equator
Greenland
Iceland
Labrador
New Foundland
Azores
Bahamas
West Indian
Cape de Verde Is.
Tableland of Guiana
Tableland
Brazil
Galapagos Is.
Sandwich Is.
Hawaiian
Marshall
Ralick Is.
Gilbert Is.
Ellice Is.
Navigators or Samoa Is.
Fidji Is.
Tonga or Friendly Is.
New Hebrides
New Caledonia
Kermadec Is.
NEW ZEALAND
Low Archipelago
Society Is.
Austral Islands
Marquesas or Mendaña Is.
North Pole
South Pole
UNEQUAL DISTRIBUTION OF LAND AND
Equator
Elevation of
Explanation
This Map is intended to represent the leading Features of the surface of the Globe, its Mountains Tablelands and Plains, their character whether Woodland, Prairies, Pampas, Llanos, Steppes, Deserts, Swamps, Lagoons &c.
The Mountains are carefully shaded to scale, the figures annexed to their names express the Height above the Level of the Sea in English feet.
As Temperature prominently operates on the Physiognomy of the Earth's surface, some Isothermal lines have been introduced, which form the boundaries of two characteristic Zones:
1. The Zone of Coral Reefs, limited by the Isothermal lines of 70° F.
2. The Zone of permanently frozen subsoil, limited by the Isothermal lines of 30° Fahr.
Colours: Europe, Asia, Africa, Australia & Polynesia, America
English Feet
Diagram showing the
HEIGHT OF THE PRINCIPAL CULMINATING POINTS OF THE GLOBE.
London Published by

…ICAL MAP
…THE
…OBE,
…ing the
…& PHYSIOGNOMY
…URFACE
…rmann F.R.G.S.
EASTERN HEMISPHERE
ARCTIC OCEAN
North Pole
EUROPE
ASIA
AFRICA
SAHARA
AUSTRALIA
EQUATOR
Tropic of Cancer
Tropic of Capricorn
Borneo
New Guinea
Ceylon
Nipon
Mariana
Guam I.
Celebrated Passes
showing the
WATER ON THE SURFACE OF THE GLOBE
Explanation
Principal Abbreviations
Diagram showing the
HEIGHT OF THE SNOW LINE IN DIFFERENT LATITUDES OF THE GLOBE
Equator
English feet

HYDROGRAPHICAL
OF THE
WORLD
Chiefly with regard
to the
DIVISION OF THE OC
AND THE BOUNDARI
OF THE
RIVER SYSTEMS
Constructed by
Augustus Petermann
Engraved by
I. Dower
London

Elevation of some of ...
Above Level of the Sea

SKETCH showing the COMPARAT

OLD WORLD contin.d	Engl. Miles
Gariep	1000
Murray	1000
Dvina	1000
Indigirka	1030
Meinam	1080
Si Kiang	1110
Don	1110
NEW WORLD	
Magdalena	1050
Orinoco	1560
Columbia	1570
S. Francisco	1610
Saskatchawan	1920
St. Lawrence	2070
R. del Norte	2130
La Plata	2210
Mackenzie	2440
Amazons	3550
Mississippi	4000

DIAGRAM showing the COMPARATIVE LENGTH _
on Scale of Map

Explanation.

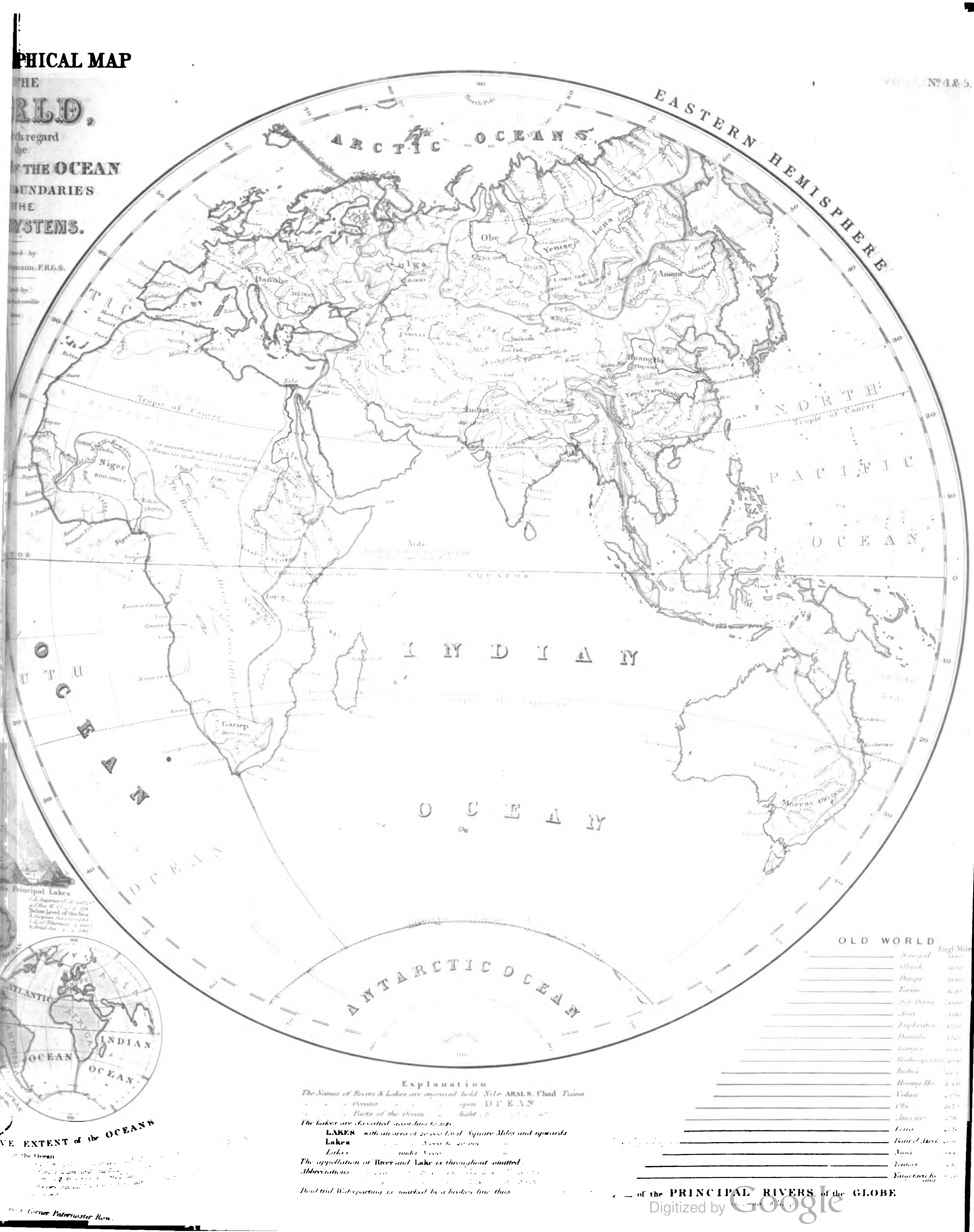
The Colours indicate the extent of the different Oceans and the Waterparting or natural Boundaries of the River Systems, belonging to each.

The shaded Districts, comprise the Regions drained off by Rivers, which do not immediately reach the Sea, but discharge themselves into Lakes or are lost in the Sands, etc.

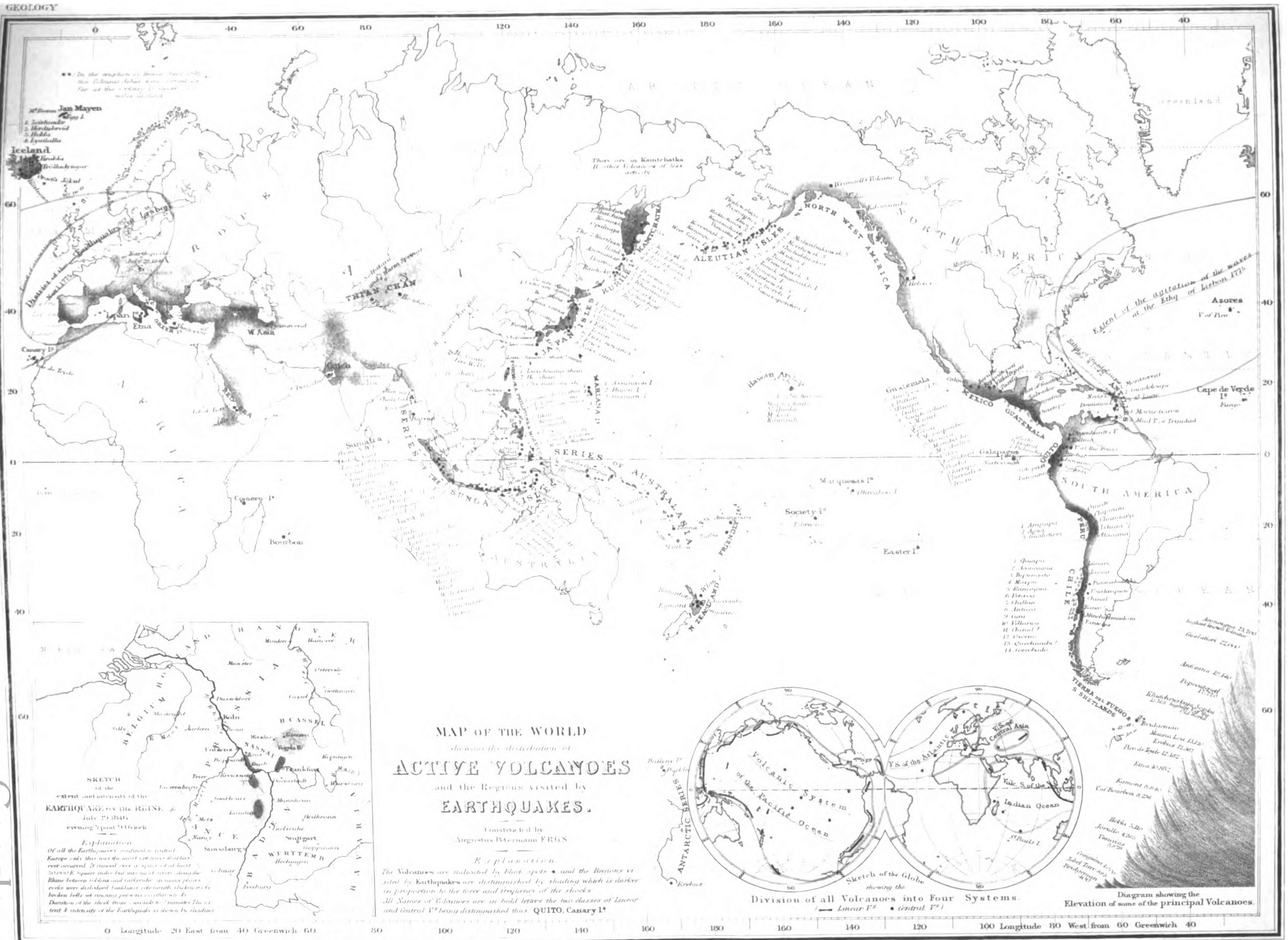
All River Basins, comprising an area of 300,000 Engl. Square Miles *and upwards, are defined by coloured Lines, and inscribed with the name of the River* Danube *and its area in E. Sq. Ms.* (311,000) *— (The area of the following Rivers Amazons, La Plata, Nile, Niger, St. Lawrence, Ganges, Tocantins, Orinoco, Gariep, Murray, — is carefully calculated from the most recent Maps, that of the rest is based on the authority of Berghaus and the Encyclop. Britannica.)*

Remark on the ...
The Polar Circles have hitherto been assumed as Boundaries of the Arctic and Antarctic ... But there are two reasons ... which ... may be ... in a Physical point of view ... of Lat. ... of the Polar Circles the Regions of ...

London, Published by ...



PHICAL MAP
THE
RLD,
th regard
the
F THE OCEAN
UNDARIES
THE
YSTEMS.
No. 4 & 5.
EASTERN HEMISPHERE
ARCTIC OCEAN
NORTH
PACIFIC
OCEAN
INDIAN
OCEAN
ANTARCTIC OCEAN
Tropic of Cancer
EQUATOR
Obe
Yenisei
Lena
Amour
Volga
Danube
Nile
Niger
Chad
Indus
Ganges
Hoang Ho
Yang tse Kiang
Gariep
Murray
the Principal Lakes
ATLANTIC
INDIAN
OCEAN
OLD WORLD
Explanation
The Names of Rivers & Lakes are engraved bold
LAKES
Lakes
VE EXTENT of the OCEANS
of the PRINCIPAL RIVERS of the GLOBE
Corner Paternoster Row.



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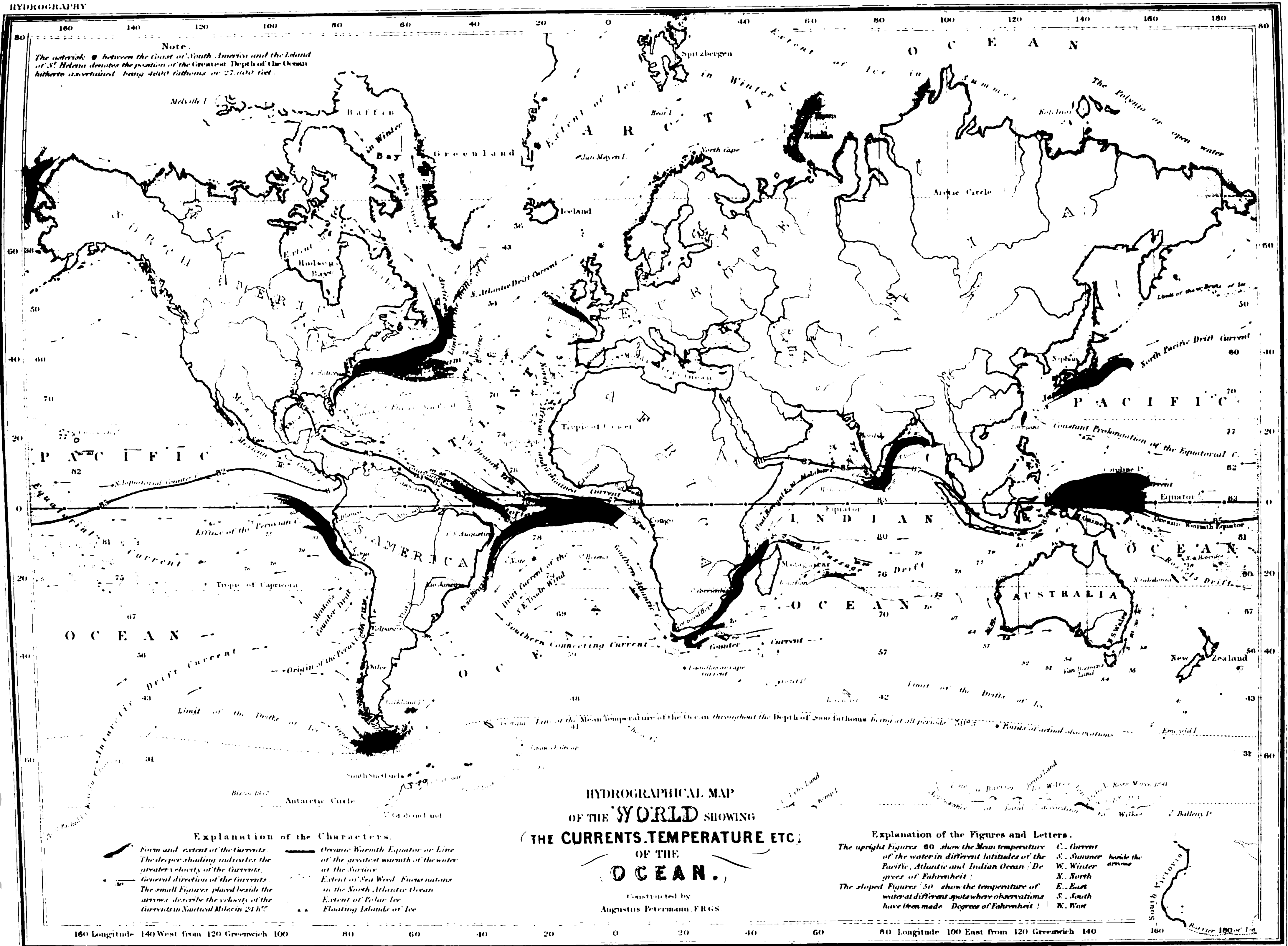

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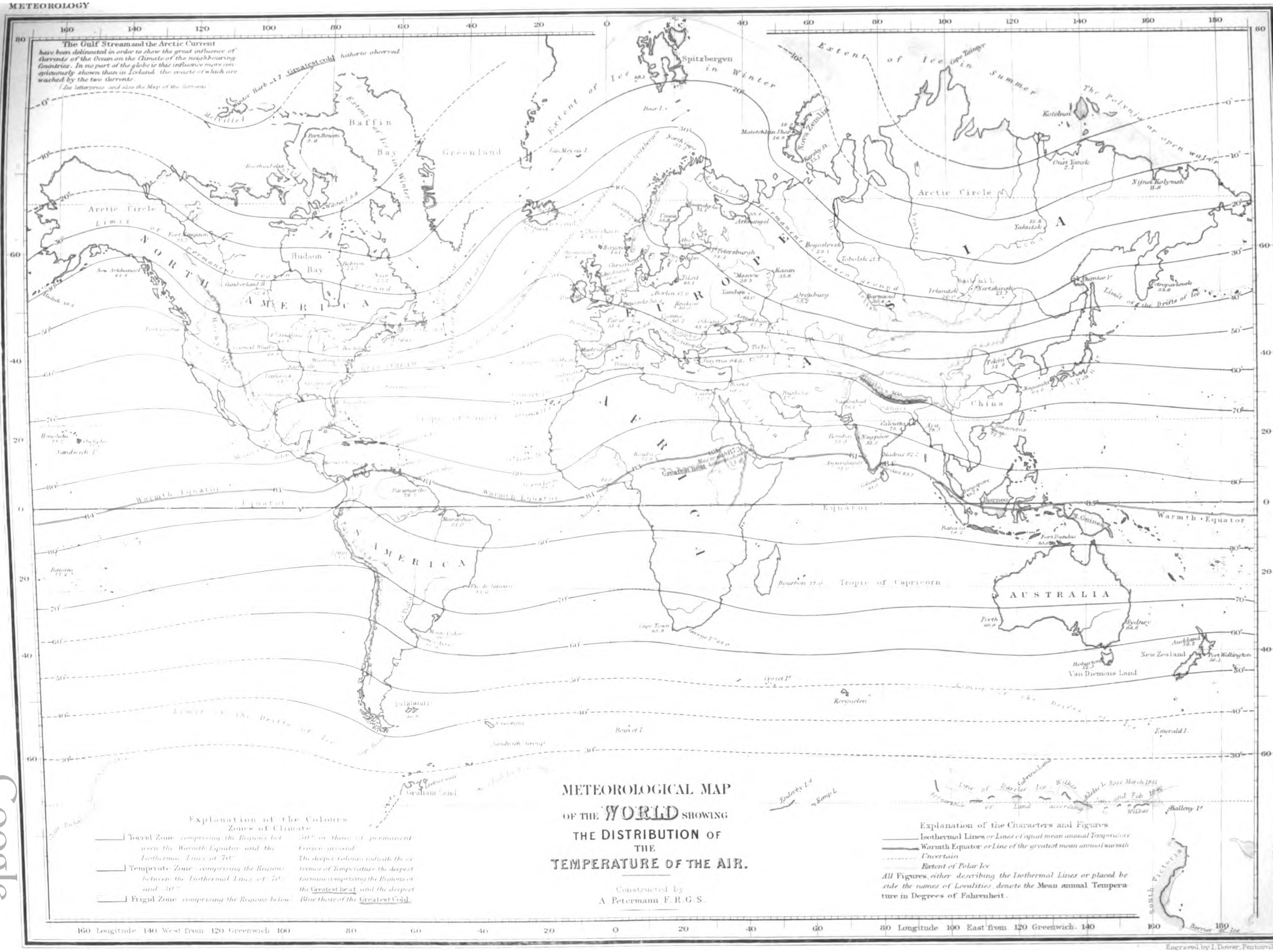
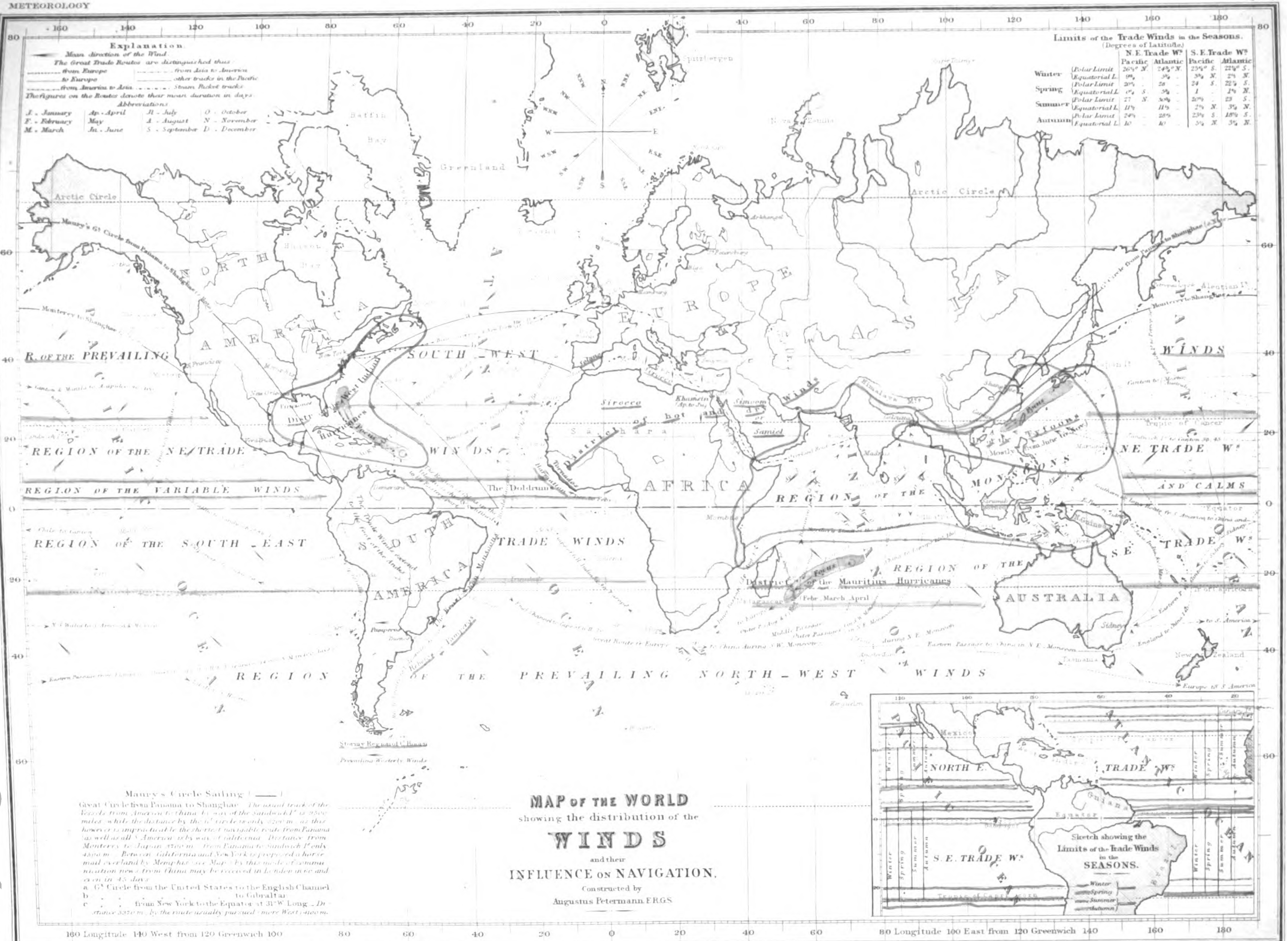

METEOROLOGICAL MAP
OF THE WORLD SHOWING
THE DISTRIBUTION OF
THE
TEMPERATURE OF THE AIR.
Constructed by
A. Petermann F.R.G.S.
The Gulf Stream and the Arctic Current
have been delineated in order to shew the great influence of Currents of the Ocean on the Climate of the neighbouring Countries. In no part of the globe is this influence more conspicuously shown than in Iceland, the coasts of which are washed by the two Currents.
(See letterpress and also the Map of the Currents.
Explanation of the Colours
Zones of Climate
Torrid Zone comprising the Regions between the Warmth Equator and the Isothermal Lines of 70°
Temperate Zone comprising the Regions between the Isothermal Lines of 70° and 30°
Frigid Zone comprising the Regions below 30° or those of permanent Frozen ground
The deeper colours indicate the extremes of Temperature the deepest carmine comprising the Regions of the Greatest heat and the deepest Blue those of the Greatest Cold.
Explanation of the Characters and Figures
Isothermal Lines or Lines of equal mean annual Temperature
Warmth Equator or Line of the greatest mean annual warmth
Uncertain
Extent of Polar Ice
All Figures, either describing the Isothermal Lines or placed beside the names of Localities, denote the Mean annual Temperature in Degrees of Fahrenheit.
160 Longitude 140 West from 120 Greenwich 100
80 Longitude 100 East from 120 Greenwich 140
Greatest cold hitherto observed
Extent of Ice in Winter
Extent of Ice in Summer
The Polynia or open water
Spitzbergen
Arctic Circle
Limit of Permanent Frozen Ground
Limit of the Drifts of Ice
NORTH AMERICA
S. AMERICA
EUROPE
ASIA
AFRICA
AUSTRALIA
Baffin Bay
Greenland
Hudson Bay
China
New Zealand
Van Diemens Land
Tropic of Cancer
Tropic of Capricorn
Equator
Warmth Equator
Greatest heat
Line of Barrier Ice
Graham Land
Kerguelen
Sandwich I.
South Victoria
Engraved by J. Dower, Pentonville.



Maury's Circle Sailing

Great Circle from Panama to Shanghae. The usual track of the Vessels from America to China by way of the Sandwich I.s is 9500 miles, while the distance by the G.t circle is only 8200 m. as this however is impracticable the shortest navigable route from Panama as well as all S. America is by way of California. Distance from Monterey to Japan 4700 m. from Panama to Sandwich I.s only 4300 m. Between California and New York to proposed a horse mail overland by Memphis etc. Maury, by this mode of communication news from China may be received in London in 40 and even in 45 days.

a. G.t Circle from the United States to the English Channel

b. to Gibraltar

c. from New York to the Equator at 31°W Long. Distance 3370 m. by the route usually pursued more West 4000 m.

MAP OF THE WORLD

showing the distribution of the

WINDS

and their

INFLUENCE ON NAVIGATION.

Constructed by

Augustus Petermann. F.R.G.S.

Engraved by I. Dower, Pentonville, London.

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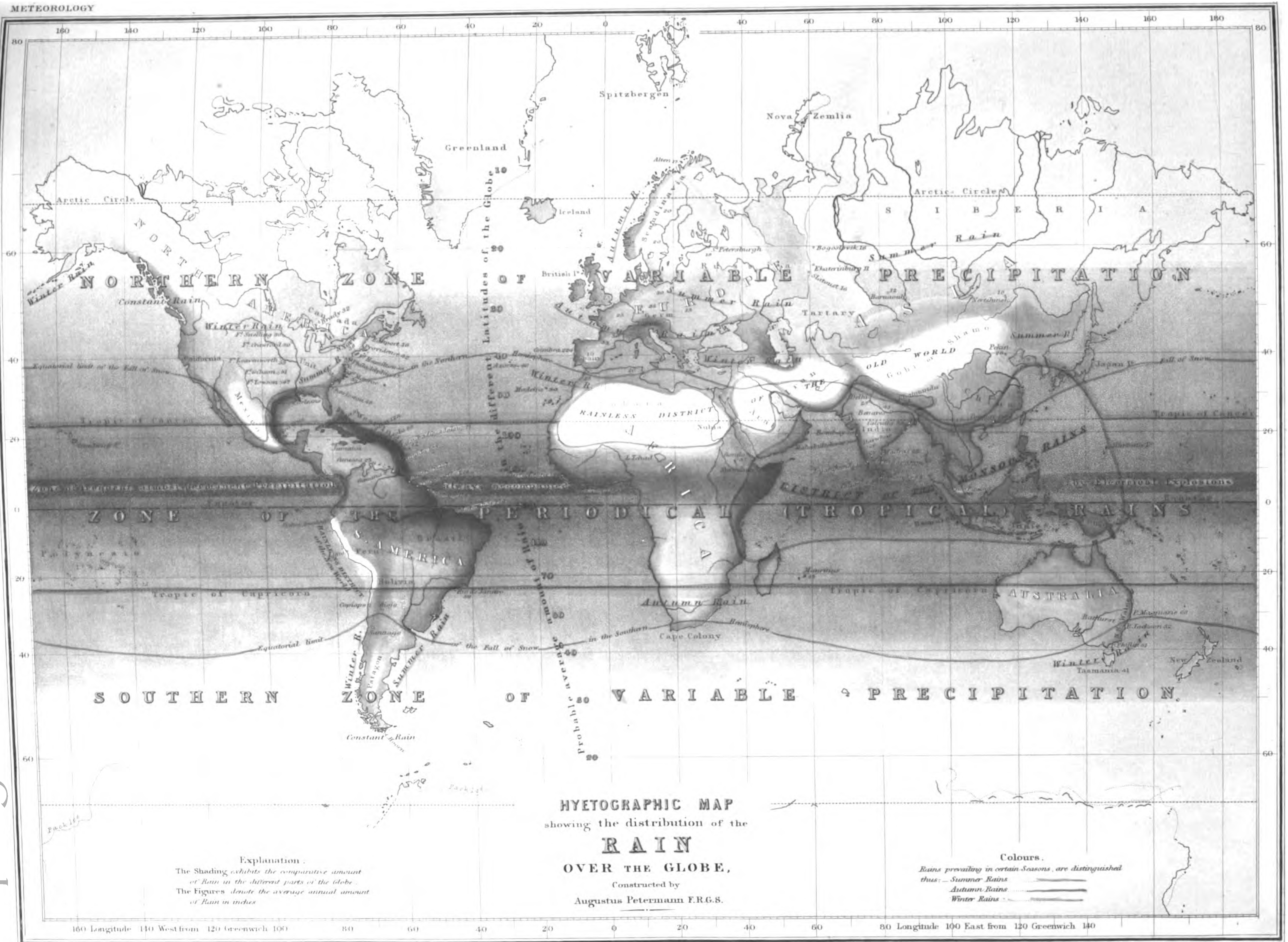

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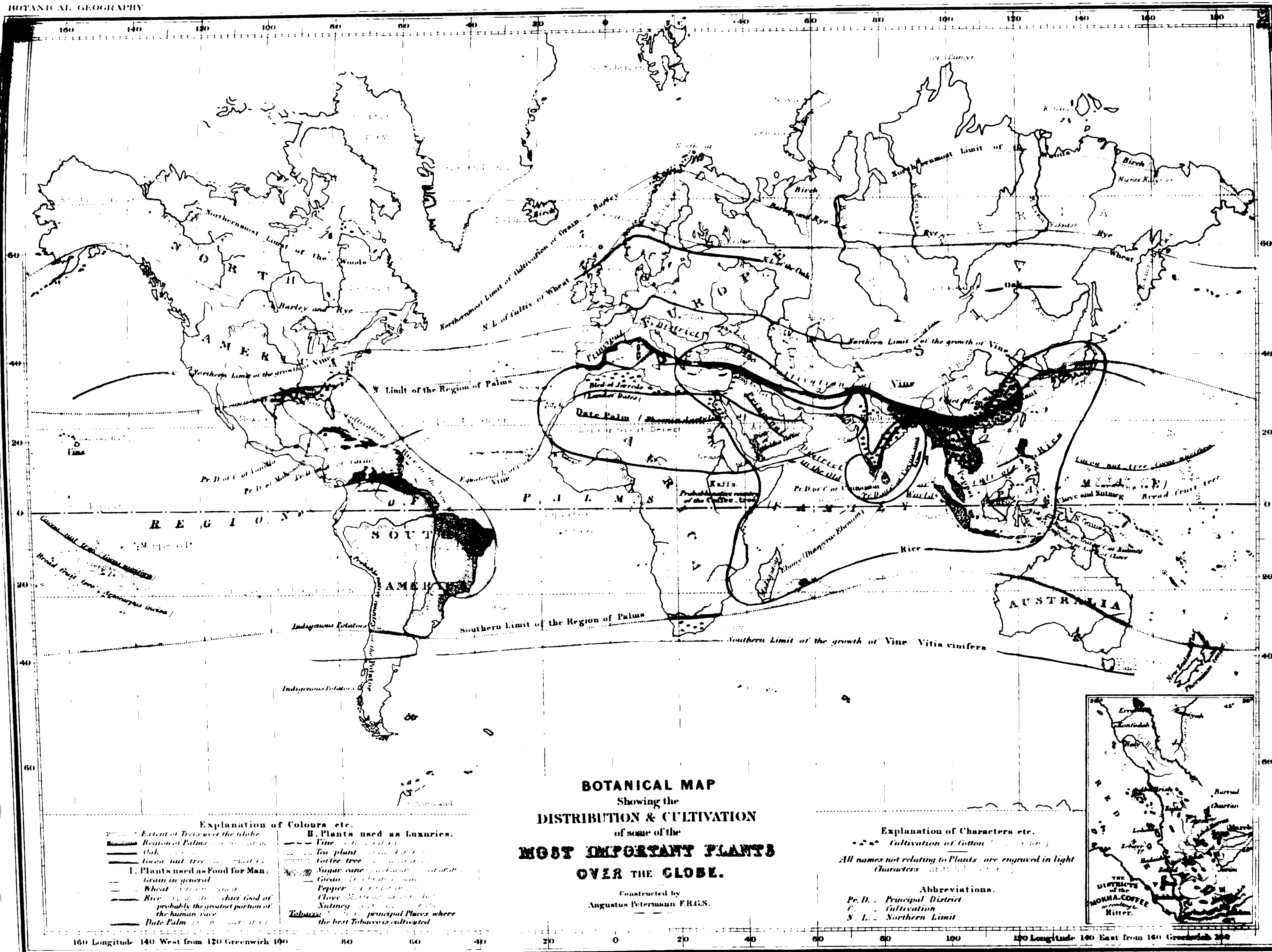

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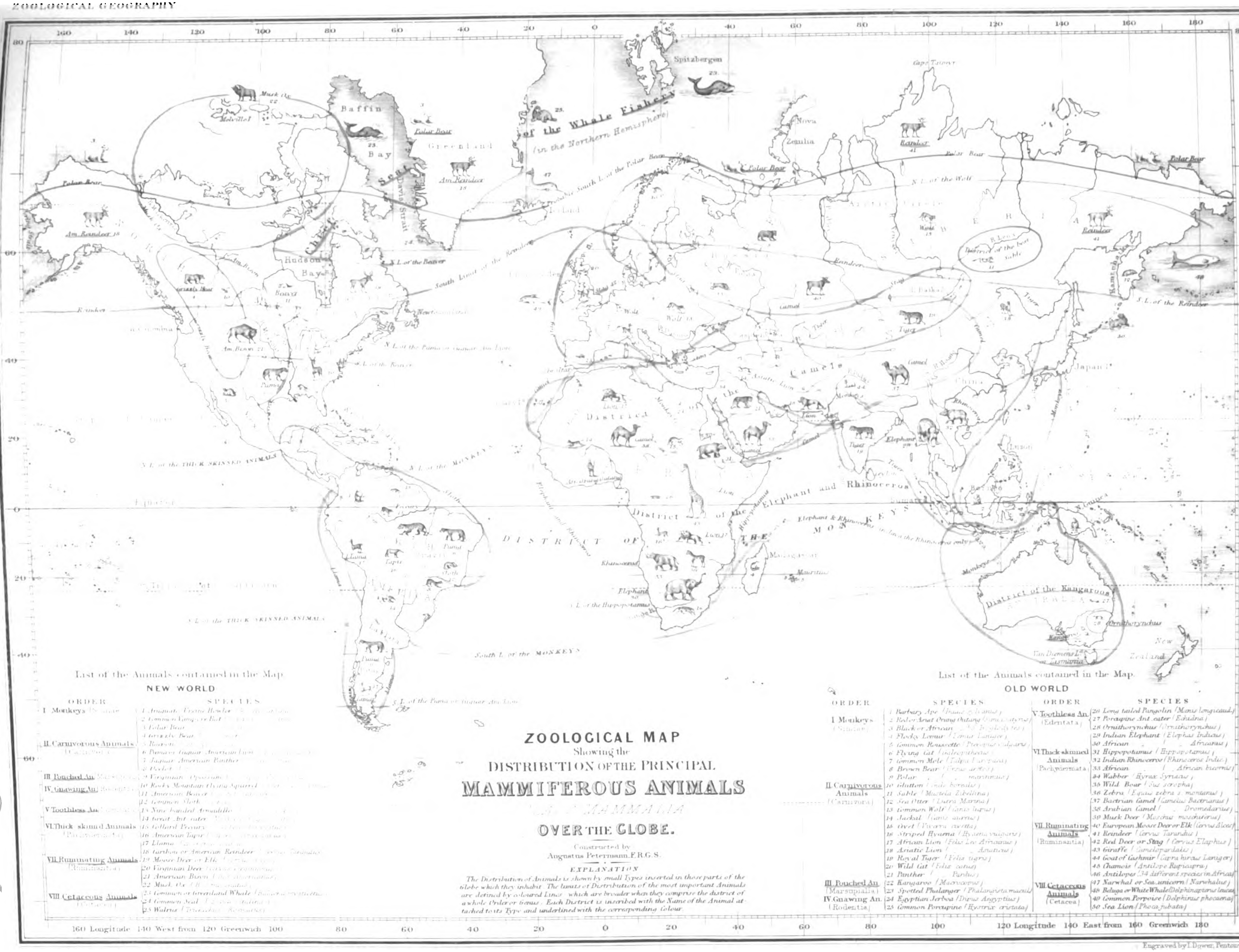

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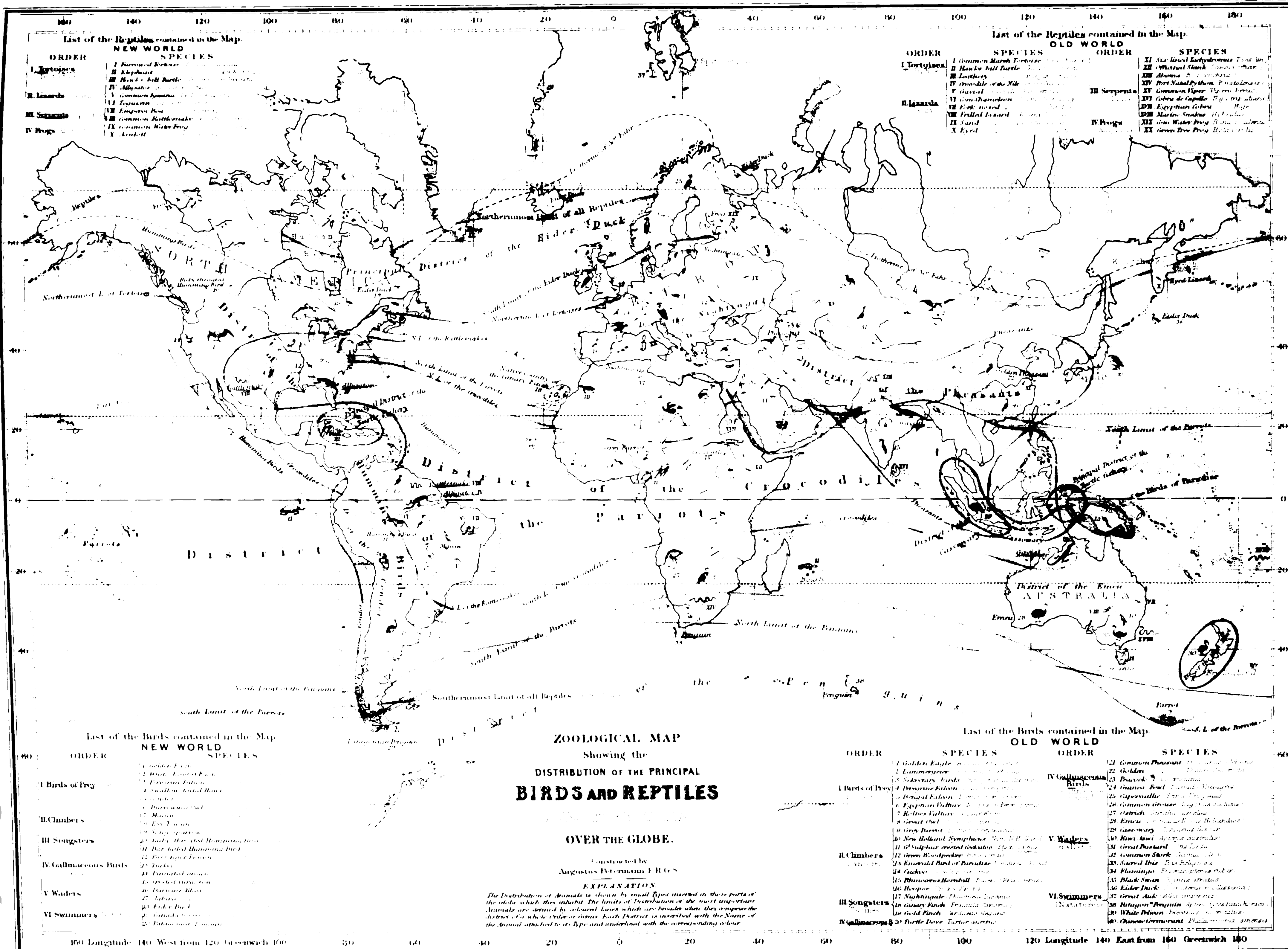

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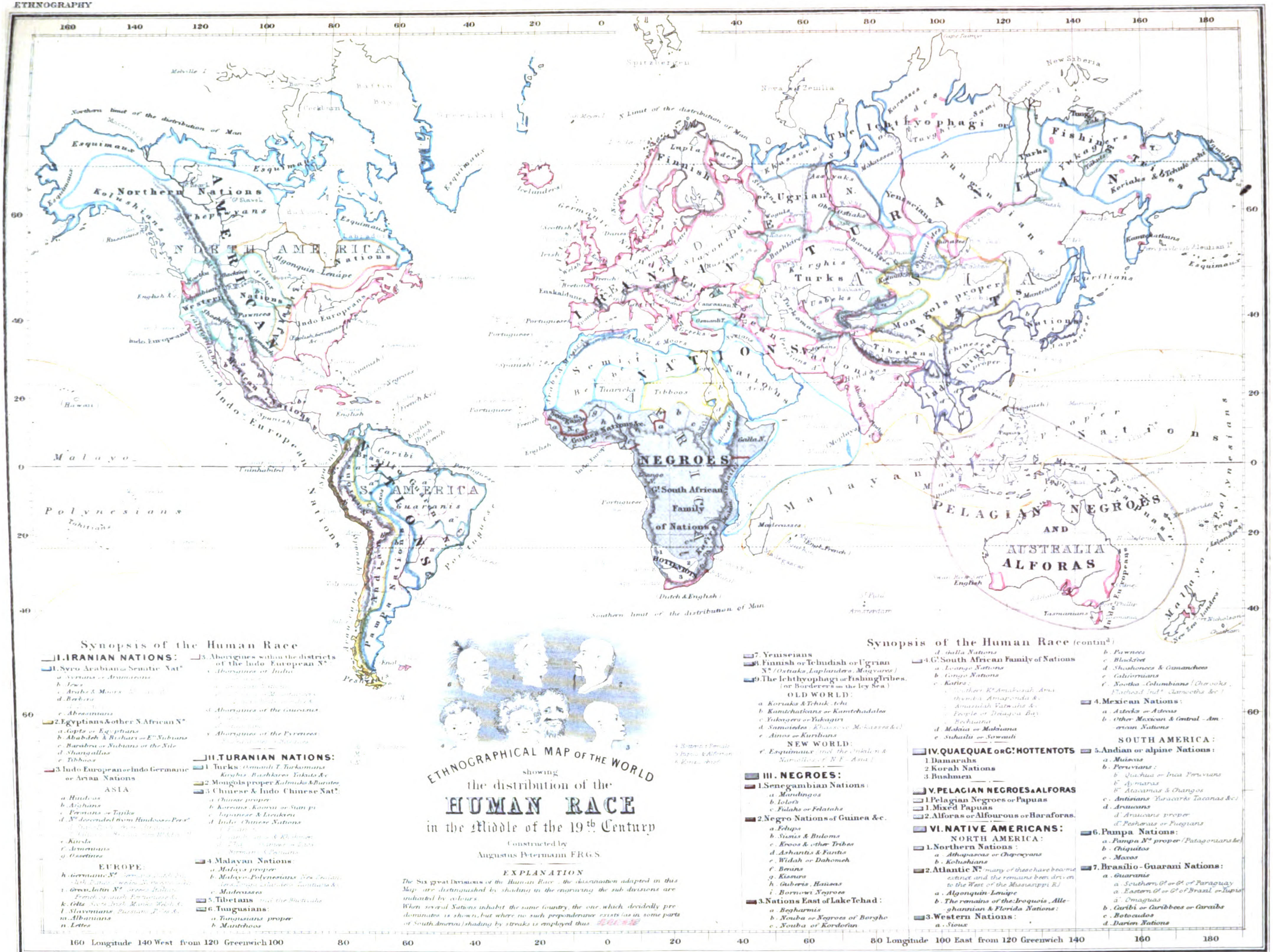

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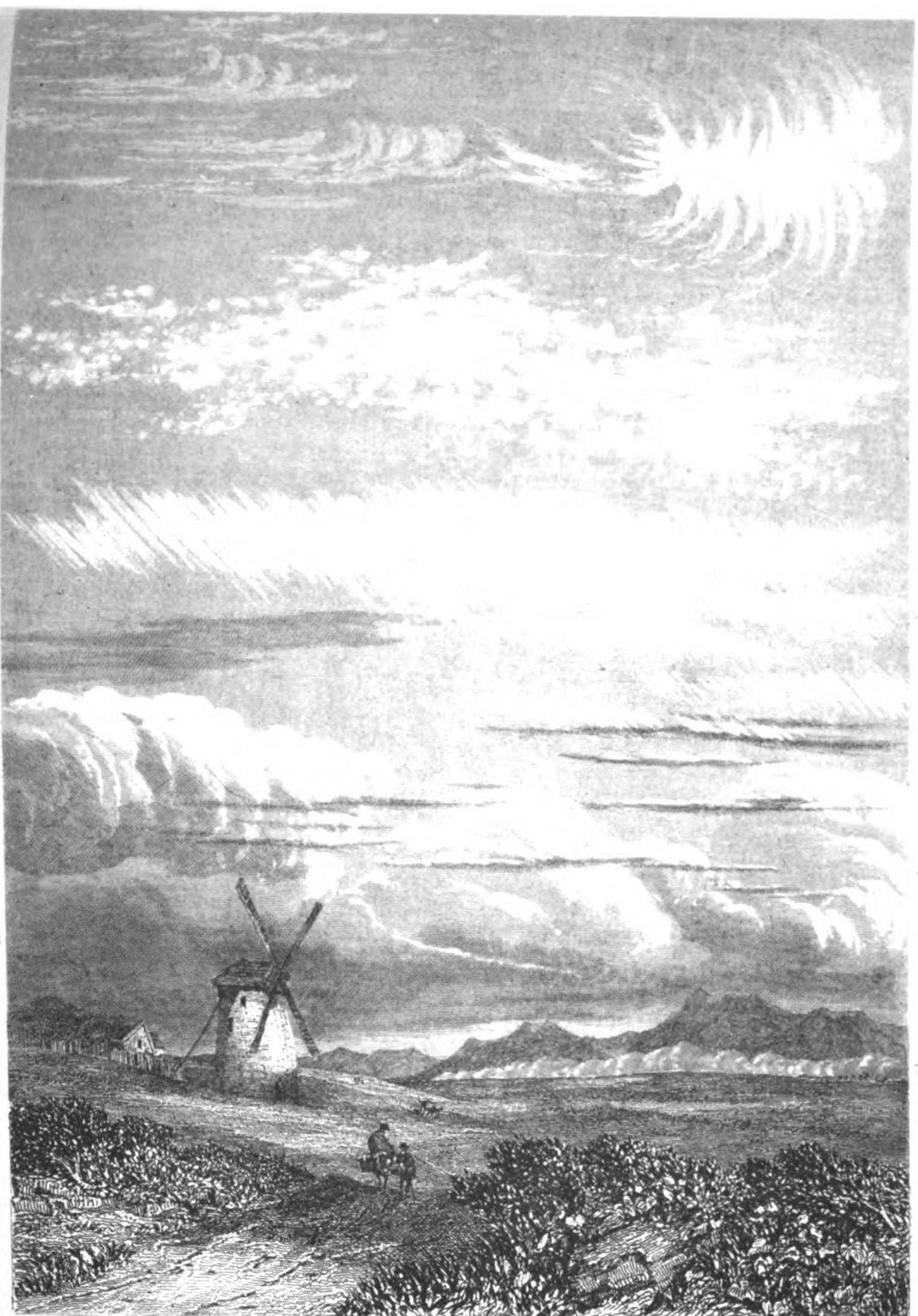
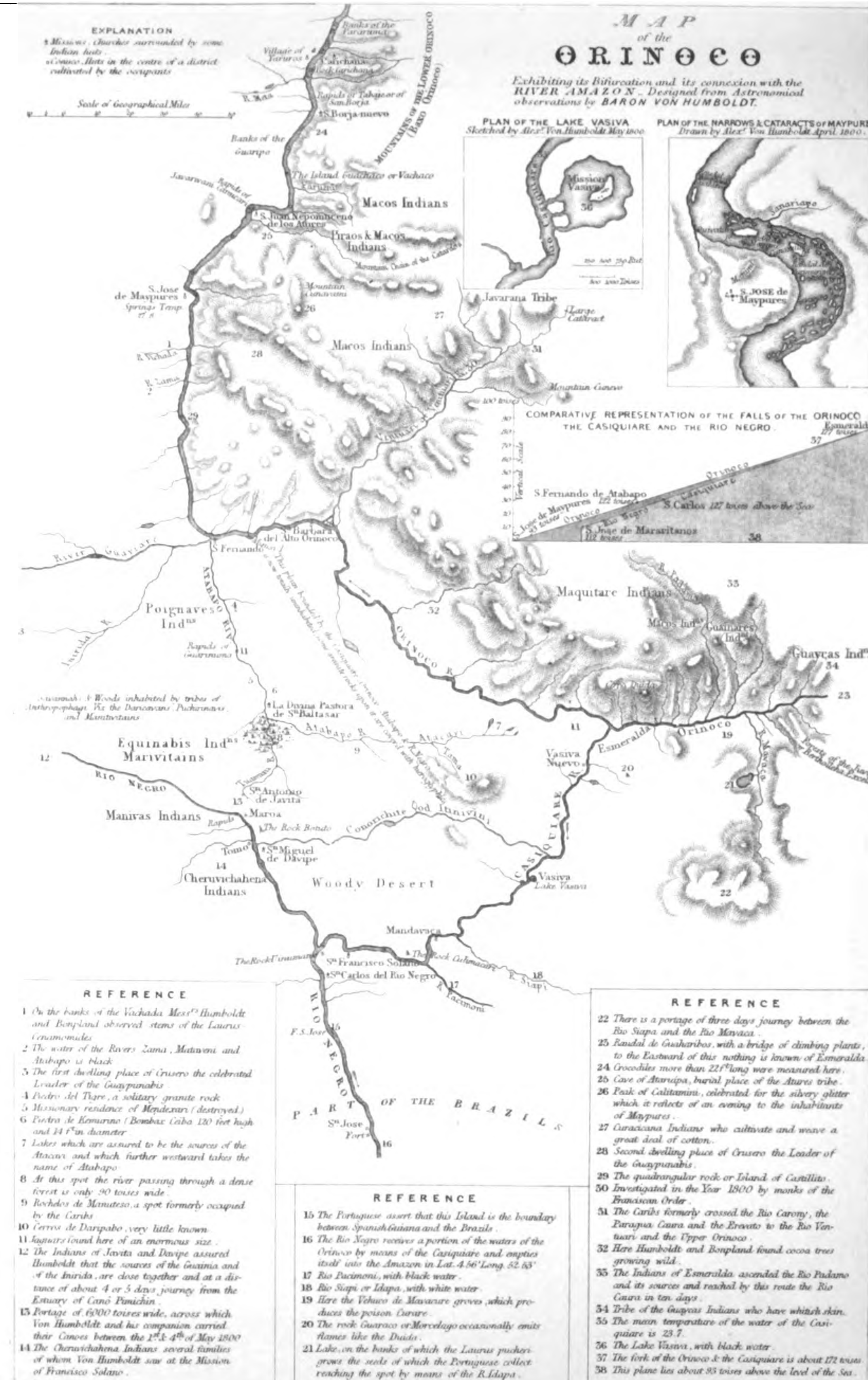


CLOUDS

1 Cirrus _ 2 Cirro Cumulus _ 3 Cirro Stratus _ 4 Cumulo Stratus.
5 Cumulus _ 6 Nimbus _ 7 Stratus.



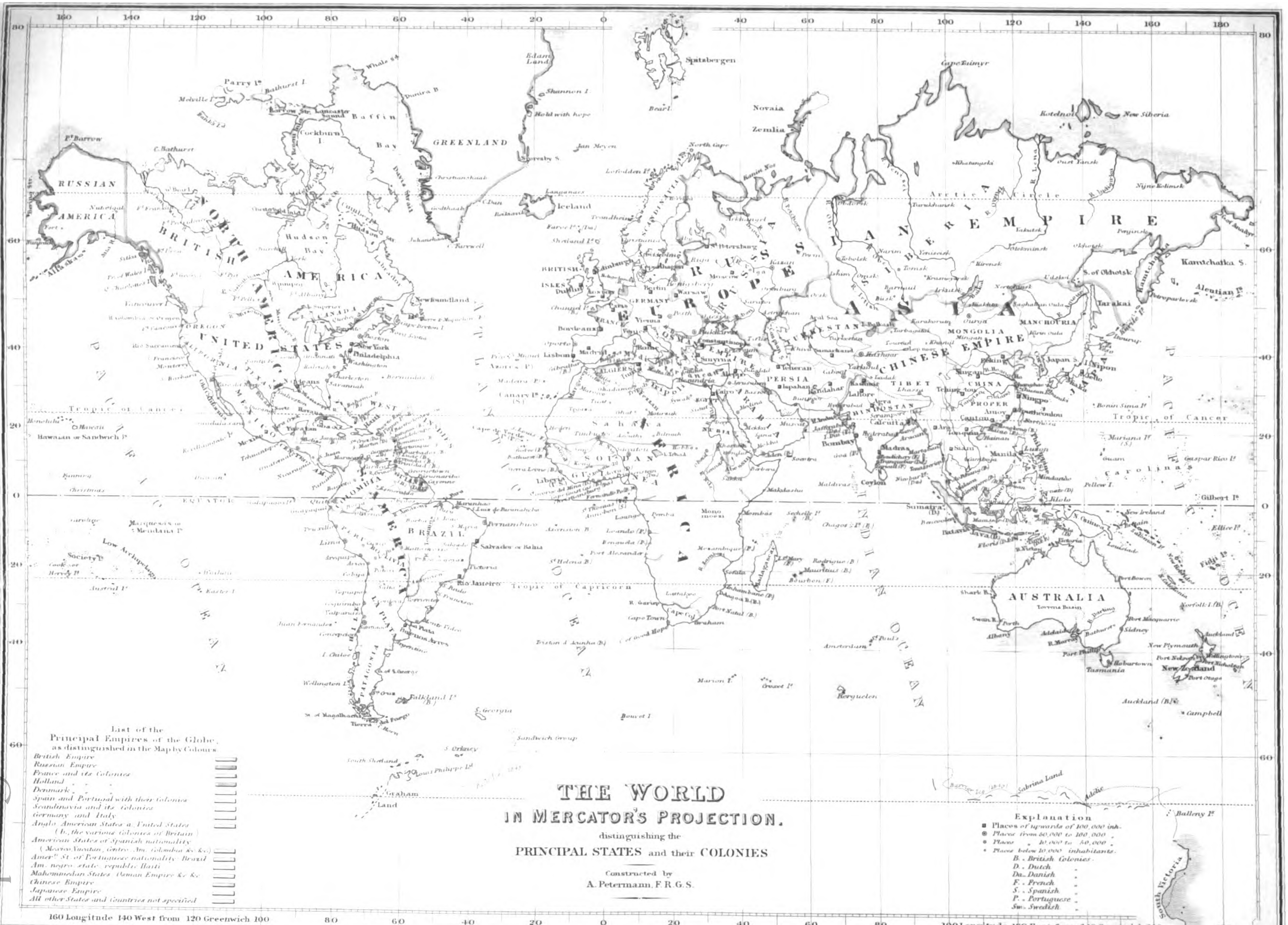
EASTERN HEMISPHERE.

Constructed by Augustus Petermann F.R.G.S.

London Published by Orr and Compy Amen Corner Paternoster Row.

WESTERN HEMISPHERE.

Constructed by Augustus Petermann, F.R.G.S.



London, Published by Orr and Comp.y Amen Corner, Paternoster Row.

POLITICAL GEOGRAPHY.

I. & II. EASTERN AND WESTERN HEMISPHERES. III. MERCATOR'S PROJECTION.

I. The only portions of the earth known with any degree of correctness to the civilized nations of antiquity, the Greeks and Romans, were chiefly those lying immediately adjacent to the Mediterranean, comprehending southern and south-western Europe, northern Africa, and south-western Asia. They had an acquaintance with more distant regions, but it was exceedingly obscure and inaccurate. The geographical work of Ptolemy, who flourished in the first half of the second century of the Christian era, may be regarded as exhibiting the final state of ancient knowledge in relation to the terrestrial surface. His extreme limits are: to the north, the Island of Thule, supposed to be the Shetlands, and some of the Baltic countries; to the south, the Niger and the sources of the Nile; to the west, the Fortunate Islands, or Canary group; and to the east, the city of Thinæ, the metropolis of the Sinæ, by which the Chinese are very probably meant. But while these remote points are referred to, the light of definite information fell far short of them, and the conceptions formed of some districts contiguous to the geographer were grossly erroneous. The attainment of adequate views respecting the extent of the globe, and the configuration of its various countries, has been the work of a very modern epoch, by no means yet fully accomplished.

CHRONOLOGICAL TABLE OF THE MORE IMPORTANT MARITIME AND INLAND DISCOVERIES OF MODERN TIMES.

Date.

861 *Faroe Islands*, discovered about this period by some Scandinavian pirates.

864 *Iceland* reached by some adventurers of the same nation, and circumnavigated; colonized in 874.

895 *North Cape* rounded, and the *White Sea* entered by Other, a Norwegian refugee at the court of Alfred the Great; and about the same time the east coasts of the Baltic, *Witland* (Prussia), river *Wisla* (Vistula), and *Estland* (Russia), were explored by Wulfsten, another refugee chieftain.

982 *Greenland* discovered by the Icelandic colonists, and peopled four years afterwards. The Greenland colonies perished in the early part of the fifteenth century, owing, as supposed, to a pestilence, and the massacre of the survivors by the Esquimaux.

1001 *Helluland, Markland*, and *Winenland*, (lands of stone, wood, and of the vine,) respectively the projecting shores of Newfoundland, Nova Scotia, and Massachussetts, discovered by the colonists of Iceland and Greenland.

1245 *Tartary* visited by John de Plano Carpini, who went by the Dnieper, Don, and Volga, on a mission to the Grand Khan, from Pope Innocent IV. Another mission, conducted by Asceline, went at the same time by the south of the Caspian, through Persia and Khorassan.

1253 *Mongolia* reached by William de Rubruquis, on a mission from St. Louis of France to the Mongol emperor.

1271 *China*, with the adjoining countries, and the Indian Archipelago, largely illustrated by the three Poli of Venice.

1318 *India, Ceylon, Sumatra, Java, Borneo*, and *China* traversed by Oderic, of Portenau.

1334 *Madeira* said to have been visited by Robert Macham, an Englishman, flying with the fair Anne Dorset, who died in the island.

1345 *Canary Isles* re-discovered by Spanish and Genoese seamen; known to the ancients.

1350 *Niger river, Soudan, Timbuctoo*, visited by Ibn Batuta.

1406 *Samarcand* visited by Gonzalez de Clavijo, as ambassador of Henry III. of Castile to Tamerlane.

1414 *Cape Nun*, on the coast of Africa, doubled about this time by the Portuguese.

1418 *Puerto Santo* discovered by Zarco and Vaz, Portuguese; and Madeira the following year by the same navigators.

1433 *Cape Bojador* doubled by Gilianez, a Portuguese.

1441 *Cape Blanco* doubled by Nuno Tristan, and shortly afterwards the Senegal river, Cape Verd, and the Gambia reached.

1448 *Azores* discovered by Gonzallo Vello, a Portuguese.

1449 *Cape Verd Islands* discovered by Antonio de Noli, a Genoese employed by Portugal.

Date.

1469 *Guinea Coast* explored, and the island of Fernando Po, in the Bight of Biafra, discovered by the navigator of that name.

1471 *Island of St. Thomas*, nearly under the Equator, discovered.

1484 *Zaire or Congo River* reached by Diego Cam, who proceeded some distance beyond it towards the southern tropic.

1486 *Cape of Good Hope* discovered by Bartholomew Diaz, called at first Cabo Tormentoso, the Cape of Tempests, from the violent storms encountered.

1492 *Bahamas* discovered by Columbus. He sailed from the port of Palos August 3, 1492, and returned thither March 15, 1493. The first island, St. Salvador, seen on the night of the 11th or 12th of October.

Cuba, St. Domingo, discovered during the same voyage.

1493 *Jamaica, St. Christopher's, Dominica*, discovered by Columbus in his second voyage.

1497 *Cape of Good Hope* doubled by Vasco di Gama, who passed through the Mozambique Channel, and across the Indian Ocean to the coast of Malabar.

Newfoundland discovered by John Cabot, a Genoese in the service of England, with some of the main land of North America.

1498 *South American continent*, near the mouth of the Orinoco, discovered by Columbus on his third voyage.

North American coast, from Newfoundland to Virginia, explored by Sebastian Cabot.

1500 *Gulf of St. Lawrence, Labrador*, discovered by Gaspar Cortereal.

Brazil accidentally reached by Alvarez de Cabral, with a fleet, in consequence of a tempest.

1502 *Gulf of Mexico* partially explored by Columbus on his last voyage.

St. Helena discovered by Jean de Nova, a Portuguese.

1506 *Ceylon*, known to the Romans, visited by the Portuguese.

Madagascar discovered by Tristan da Cunha.

1511 *Sumatra* examined by the Portuguese; the *Molucca* and *Sunda* isles discovered; and the following year the *Maldives*.

1512 *Hudson's Bay*, as it was afterwards named, reached by Sebastian Cabot.

1513 *Borneo* and *Java* became known to the Portuguese.

Pacific Ocean, or *South Sea*, first seen from the mountain tops near Panama, by Nunez de Balboa.

1516 *Rio Janeiro, Rio de la Plata*, discovered by Diaz de Solis, who perished at the mouth of the latter, with all his men, in a conflict with the natives.

1517 *China* reached by sea, by Fernand Perez d'Andrada, who entered the Gulf of Canton.

Bengal coast became known to the Portuguese.

1519 *Mexico* entered and conquered by the Spaniards under Cortez.

1520 *Straits of Magellan* discovered by Fernando de Magalhaens, in the service of Spain, who commenced the first voyage round the globe. He perished in a skirmish at the Philippines, but his vessel, the Vittoria, accomplished the enterprise, and returned to Spain by the Cape of Good Hope, after a voyage of three years' duration, in which upwards of 14,600 leagues of sea had been traversed.

1524 *United States coast* explored by Verrazano, the first French voyage of discovery.

1525 *Papua* or *New Guinea* discovered by the Portuguese.

1530 *Guinea coast* first visited by an English merchant vessel.

1535 *Canada* penetrated by Cartier, a Frenchman, who ascended the St. Lawrence to Hochelaga, an Indian town near the present Montreal.

California discovered by an expedition despatched by Cortes.

1537 *Chili* discovered by Diego d'Almagro, one of the conquerors of Peru.

1539 *Gulf of California* entered by Francisco de Ulloa, sent by Cortes.

1541 *India* first visited by an English ship, in order to attack the Portuguese.

1542 *Japan* reached by the Portuguese, Antonie de Meta, and Antonie de Peyxoto, driven thither by a tempest.

1545 *Potosi Mines* discovered by the Spaniards.

1552 *Spitzbergen* observed by the English, but mistaken for part of Greenland.

1553 *Nova Zembla* discovered by Sir Hugh Willoughby, who soon afterwards perished in the Arctic Ocean.

White Sea entered by his more fortunate comrade, Chancellor.

1563 *Juan Fernandez* discovered by a Spanish pilot of that name.

1567 *Solomon's Isles* discovered by Mendana, a Spaniard.

1577 *Frobisher's Strait* traversed by the navigator of that name.

1578 *New Albion* discovered by Drake during the second voyage round the globe, which commenced from Plymouth, December 13, 1577, and terminated at the same port, September 26, 1580.

at Paris, 51·4; London, 50·7; Edinburgh, 45·6; Brussels, 50·4; Berlin, 47·6; Vienna, 50·2; Cracow, 46·0; Odessa, 48·4; Astrachan, 47·7; Tambov, 41·0.

Northern Zone.—The space included between the preceding limits and the Arctic Ocean. The winter here is long and severe, attended with prodigious falls of snow, which remains for months upon the ground, while the lakes and rivers are firmly frozen. The summer is brief, but very warm; and the change from the one to the other is accomplished with astonishing rapidity, so as almost to exclude spring and autumn from the calendar of the seasons. Mean temperature at Bergen, 44·1; Stockholm, 42·1; Abo, 40·3; Petersburg, 38·2; Moscow, 38·5; Kasan, 35·8; Umea, 35·8; Archangel, 33·4; North Cape, 32·2.

IV. With a mean annual temperature, varying from 64° in the south to below the freezing-point in the extreme north-east, the vegetation remarkably varies in different countries of Europe. Professor Schow distinguishes four principal botanical regions. 1. The region of trees with ever-green foliage. It includes the southern peninsulas; comprises many tropical forms; and corresponds generally with the district in which the olive is cultivated, the northern limit of which is the parallel of the south of France. 2. Region of the chestnut and the oak. The northern limit of the chestnut coincides generally with that of the vine, the parallel of Berlin. It grows, indeed, in the warmer parts of Scotland, but the fruit seldom comes to maturity. Rich pastures and verdant fields, unknown in the land of the olive, characterise this district. 3. Region of the oak and the beech; extending northward nearly to the limit of the cultivation of wheat. The extreme northern range of the beech is about the parallel of 60°; that of the oak, 61°; and that of wheat, 64°; elms, limes, ashes, alders, birches, willows, poplars, and luxuriant green meadows, are general in this district. 4. Region of the pine and the birch, ascending to about the parallel of 70°; the extreme northern limit of the corn-plants, barley and rye, and of all cultivation. Further north, a few trailing shrubs, herbaceous plants, mosses, and lichens, comprise the vegetation.

V. The zoology of Europe is less remarkable than that of the other divisions of the globe. Confining attention to the land mammalia, and omitting all notice of the domesticated races, the following Table exhibits the gross number of species, with the number exclusively European:

	Whole No. of known Species.	No. of Species found in Europe.	No. of Species peculiar to Europe.	No. of Species common to Europe & other Continents.
Quadrumana	202	1	0	1
Cheiroptera	219	27	18	9
Carnivora	290	50	17	33
Marsupialia	123	0	0	0
Rodentia	604	35	12	23
Edentata	28	0	0	0
Pachydermata	39	1	0	1
Ruminantia	148	9	2	7
	1653	123	49	74

Thus no animal occurs belonging to the Edentata (toothless animals), and Marsupialia (pouched animals). There is one species of quadrumana (four-handed), the Barbary ape, naturalised on the rock of Gibraltar; and one species of pachydermata (thick-skinned) the wild boar, still common in the forests. The Cheiroptera (hand-winged), comprehends various races of bats, generally diffused. The most interesting of the Rodentia (gnawers) is the beaver, still lingering on the banks of the Rhone, Rhine, Danube, and other rivers. The carnivorous animals are mostly insignificant, excepting the bear, wolf, and lynx. The ruminants comprise the reindeer, generally domesticated, but wild in the extreme north, the elk, fallow-deer, red-deer or stag, roebuck, chamois, ibex, moufflon or musmon, and auroch. The two last are peculiar to Europe, and very confined in their range, the mufflon inhabiting the rocky heights of Sardinia and Corsica, and the auroch roaming in a few Russian forests under imperial protection.

VI. Europe is politically divided into upwards of fifty independent states, under various forms of government, which appear in the Table below, with their several areas; but existing events will probably issue in some new territorial arrangements, as well as in permanent changes of domestic policy. The states belonging to the Germanic Confederation are denoted by an asterisk:

STATES.	FORM OF GOVERNMENT, Etc.	POPULATION.	AREA IN SQ. MILES.
Andorre	Valley on the Spanish side of the Pyrenees. Republic, with two syndics and a council	15,000	144
Anhalt-Bernburg*	Duchies, with states having limited powers. Capitals—Bernburg, Coethen, Dessau	49,356	336
Anhalt-Coethen*		42,106	310
Anhalt-Dessau*		62,603	357
Austria*	Empire: comprising part of Germany and Italy, Hungary, Transylvania, &c. Absolute monarchy, till recently, in all states, except Hungary and Transylvania. Free constitution granted, 1849, but very unsettled. Standing army, 406,000. Capital—Vienna	37,662,486	255,226
Baden*	Grand Duchy: limited sovereignty, with two chambers. Capital—Carlsruhe	1,379,747	5,712
Bavaria*	Kingdom: limited monarchy, with two chambers. Capital—Munich. Army, 57,000	4,440,327	28,435
Belgium	Kingdom: limited monarchy, with two chambers. Army, 90,000. Capital—Brussels	4,298,562	12,569
Bremen*	Republic: council and convention	76,000	67
Brunswick*	Duchy: limited sovereignty, with one chamber. Capital—Brunswick	270,090	1,525
Cracow	Republic: senate and chamber of representatives. Controlled by Austria	124,000	493
Denmark	Kingdom: limited monarchy, with provincial legislatures. Army, 39,000. Capital—Copenhagen	2,202,074	59,762
France	Republic: established 1848; president and national assembly, both elected by universal suffrage. Army, 397,396. Capital—Paris	35,400,486	202,125
Frankfort	Republic: senate and legislative assembly. Capital of the Germanic Confederation	65,524	91
Great Britain and Ireland	Kingdom: limited monarchy, with two houses of parliament. Army, 100,700. Capital—London	27,019,578	120,872
Greece	Kingdom: limited monarchy. Capital—Athens	956,000	10,206
Hamburg*	Republic: senate and common council	155,000	151
Hanover*	Kingdom: limited monarchy, with two chambers. Capital—Hanover	1,759,440	14,600
Hesse-Cassel*	Electorate: limited sovereignty; one chamber. Capital—Cassel	746,704	4,586
Hesse-Darmstadt*	Grand Duchy: limited sovereignty; two chambers. Capital—Darmstadt	852,679	3,198
Hesse-Homburg*	Landgraviate: absolute sovereignty. Capital Homburg	24,373	154
Hohenzollern-Hechingen*	Principality: limited sovereignty, with one chamber. Capital—Hechingen	20,226	136
Hohenzollern-Sigmaringen*	Principality: limited sovereignty, with one chamber. Capital—Sigmaringen	45,430	383
Holland with Duchy of Luxemburg	Kingdom: limited monarchy, with two chambers. Capital—Amsterdam	3,414,374	13,890
Ionian Islands	Republic: council and one chamber; under British protection. Capital Corfu	205,567	998
Lichtenstein*	Principalities: limited sovereignty. Capitals—Lichtenstein, Detmold, Buckeburg	6,350	52
Lippe-Detmold*		108,236	432
Lippe-Schauenburg*		31,870	205
Lubeck*	Republic: senate and common-council	47,300	142
Marino, San	Republic: senate and council of ancients	8,100	21
Mecklenburg-Schwerin*	Grand Duchies: limited sovereignties, with one chamber. Capitals—Schwerin, New Strelitz	516,980	4,701
Mecklenburg-Strelitz*		96,590	1,094
Modena and Massa	Duchy: absolute sovereignty, but unsettled. Capital—Modena	512,290	2,073
Monaco	Principality: controlled by Sardinia	6,800	50
Nassau*	Duchy: limited sovereignty, with two chambers. Capital—Wiesbaden	417,708	1,736
Oldenburg*	Grand Duchy: Capital—Oldenburg	74,883	2,470
Parma	Duchy. Capital—Parma	485,826	2,184
Portugal	Kingdom: limited monarchy, with chambers of representatives. Capital—Lisbon	3,412,500	34,500
Prussia*	Kingdom: limited monarchy, with two chambers. Army, 121,916. Capital—Berlin	16,112,948	106,302
Reuss*—Elder	Principalities: forming one member of the Germanic Confederation. Capitals—Greitz, Schleitz	32,000	145
Reuss*—Junior		80,000	448
Russia	Empire: absolute monarchy. Army, 674,000. Capital—Petersburgh	62,257,700	2,041,809
Sardinia	Kingdom: limited monarchy. Capital—Turin	4,001,182	29,000
Saxony*	Kingdom: limited monarchy, with two chambers. Capital—Dresden	1,757,800	5,705
Saxe-Altenburg*	Duchies. Capitals—Altenburg, Gotha, Meiningen, Weimar	147,125	491
Saxe-Coburg and Gotha*		156,930	790
Saxe-Meiningen-Hildburghausen*		257,573	880
Saxe-Weimar-Eisenach*		268,891	1,403
Schwarzburg*	Two Principalities	118,500	756
Sicilies, The Two	Kingdom: limited monarchy. Capital—Naples	8,400,000	41,521
States of the Church	Ecclesiastical and elective sovereignty. Unsettled. Capital—Rome	2,914,115	17,048
Spain	Kingdom: limited monarchy, but unsettled. Capital—Madrid	13,000,000	176,480
Sweden and Norway	Kingdom: limited monarchy, with a diet and storthing. Capital—Stockholm	4,306,650	284,530
Switzerland	Confederation of republics, with a diet meeting successively at Zurich, Berne, and Lucerne	2,372,920	17,208
Turkey	Empire: absolute monarchy. Capital—Constantinople	12,200,000	183,140
Tuscany with Lucca	Grand Duchy. Capital—Florence	1,699,940	8,712
Waldeck*	Principality: limited sovereignty, with one chamber. Capital—Corbach	58,590	455
Wurtemburg*	Kingdom: limited monarchy, with two chambers. Capital—Stuttgard	1,761,813	7,568

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V. THE BRITISH ISLES.

I. The archipelago of the British Isles lies off the north-west coast of Europe, being separated from it by the German Ocean and English Channel, the waters of the Atlantic forming the remaining portion of the boundary. It ranges through 10° of latitude, from Lizard Point in Cornwall, the most southern projection, in 49° 57′ 30″ N., to Lamba-ness, in Uist, the most northern of the Shetlands, in 60° 49′; and through 12° of longitude, from the coast of Suffolk near Lowestoff, in 1° 46′ E., to Cape Sybil in Kerry, about 10° 20′ W. It includes Great Britain, Ireland, and numerous dependent islands, arranged in groups, or occurring solitarily.

II. Great Britain, comprising England, Wales, and Scotland, is the largest island of Europe. From the extreme northern promontory, Dunnet Head in Caithness, to the North Foreland in Kent, at the south-east angle, the direct distance is about 540 miles; from the same point to the Land's End in Cornwall, at the south-west angle, 600 miles; the two southern angles being about 320 miles apart. The breadth varies considerably, being at the greatest about 280 miles, from near St. David's Head in Pembrokeshire to the Naze in Essex; 62 miles from the head of the Solway Firth to the opposite coast of Northumberland; 30 miles between the Firths of the Clyde and the Forth; and not more than 24 miles between the head of Loch Broom and the Dornoch Firth. Almost the entire coast of Scotland is bold and rocky; the west coast of south Britain has also generally the same characteristic, though in a less degree; but some parts of its eastern shores are so low that artificial embankments are required to prevent the incursions of the sea. The entire length of the coast-line is enormous in proportion to the area of the island, owing to the deep and narrow inlets which mark the configuration of the north-western side. The following measurements of the circuit have been given, but they fall far short of the actual extent, as the estuaries and inlets are only included up to the salient points of their openings; for example,—the estuary of the Thames as far as the Nore Light, and of the Severn from the mouth of the Usk to that of the Bristol Avon. The direct distances occasionally cut through portions of land:

From Cape Wrath, north-west extremity of Scotland, to

	Direct Distance. Miles.	Distance following the Coast. Miles.
Duncansby Head, north-east extremity	72	108
Tarbat Ness, between the Dornoch and Murray Firths	57	90
Kinnaird's Head, Aberdeenshire	64	117
Fife Ness, Fifeshire	100	128
N. Sunderland Point, Northumberland	63	137
Flamborough Head, Yorkshire	115	138
Winterton Ness, Norfolk	122	216
South Foreland, Kent	107	184
Beachy Head, Sussex	56	68
Lizard Point, Cornwall	245	344
Land's End, ditto	23	36
Bull Point, Devonshire	103	132
Worm's Head, Glamorganshire	23	178
St. David's Head, Pembrokeshire	51	104
Carnel's Point, Anglesea	114	214
Rock Perch, mouth of the Mersey	65	82
St. Bee's Head, Cumberland	78	122
Mull of Galloway, Wigtonshire	53	147
Mull of Cantire, Argyleshire	61	170
Point of Airdnamurchan, ditto	93	122
Ru Rea, Ross	85	125
Cape Wrath	51	150
Total	1801	3112

The estimates of the superficial area of Great Britain exhibit great discrepancies, arising from the excessive irregularities of its outline; but assuming it to be about 83,817 square miles, the proportion of square miles of surface to one mile of coast will be only 26: whereas in the case of Europe generally it is 229; America, 437; Asia, 500; and Africa, 741. The highest inhabited sites are in North Britain. Leadhills in Lanarkshire, 1280 feet above the sea, is said to be the most elevated village; but according to the Ordnance Survey, some of the villages in the mountainous region of the Peak of Derbyshire closely approach this altitude—Chelmorton church being 1218, Taddington 1122, and Elton 1117 feet above low-water mark.

III. Ireland, separated from Great Britain by the North Channel, Irish Sea, and St. George's Channel, makes its nearest approach to Wales at Greenore Point in Wexford, 52 miles from St. David's Head; to Scotland, at Fair Head in Antrim, 12 miles from the Mull of Cantire; and to England at Ballyholbal in Down, about 70 miles from St. Bee's Head in Cumberland. Its general form is that of an oblique parallelogram. The longer diagonal stretches from Fair Head on the north-east to Mizen Head on the south-west, measuring somewhat more than 300 miles; the shorter, from Urris Head on the north-west to Carnsore Point on the south-east, extends about 208 miles. The longest line that can be drawn from north to south without cutting the sea coincides with the meridian of 8° W., from Horn Head in Donegal to near Poole Head in Cork, a distance of 230 miles; a similar line from east to west runs from Achris Point in Galway to the coast between Dublin and Drogheda, about 175 miles. As in the case of Great Britain, the eastern shores are comparatively regular and low, while those on the western side, exposed to the full fury of the Atlantic, are very much broken and deeply indented. The superficial area is estimated at 32,000 square miles.

IV. Connected with England and Wales, the most important islands are Anglesea and Holyhead, forming one of the Welsh counties, joined to the main land of Wales by the Menai suspension-bridge; Isle of Man, in the Irish Sea, nearly equidistant from England and Ireland, 30 miles long by 12 at the broadest, rising in Sneafell, the highest point, to the altitude of 2004 feet; Isle of Wight, 22 miles from east to west by 13 from north to south, off the south coast of England, from which it is separated by the channel of the Solent and the great naval road of Spithead; Scilly Islands, 30 miles W.S.W. of the Land's End, a group of 140 rocks, six of which are inhabited, St. Mary's, the largest, being 2½ miles long and nine or ten miles in circumference.

Holy Island, or Lindisfarne, about 9 miles in circumference, comprising 1020 acres, lies off the coast of Northumberland, from which vehicles pass to it at low water. Farn and Staple Islands, to the southward, nearly opposite to Bamborough Castle, are two groups of rocks, 17 in number, 3 miles off the shore, the sites of lighthouses. Coquet Island, containing 7 acres, is off the mouth of the river of that name at Warkworth. Isle of Sheppy, 9 miles long by 3 broad, is situated at the mouth of the Thames, and separated from Kent by the Medway and an arm of the sea, called the Swale. The anchorage of the Nore floating-light vessel is on a point of sandbank, nearly midway between the Isle of Sheppy and the coast of Essex. Lundy Island, a mass of granite, 2½ miles long by 1 broad, is at the entrance of the Bristol Channel, about 9 miles from Hartland Point. A number of small islets occur off the coast of Pembrokeshire.

V. The islands geographically belonging to Scotland may be arranged in five groups. 1. The Orkneys, 67 in number, of which only twenty-seven are inhabited, are N. by E. of Caithness, separated from it by the tempestuous channel of the Pentland Firth, 5½ miles across from Duncansby Head to the south point of Ronaldsha. Pomona, Sanday, Stronsay, and Hoy Island are the largest. The whole group extends from south to north about 45 miles, and comprises an area estimated at 281,600 acres. 2. The Shetlands, or Zetlands, N.E. of the Orkneys, are separated from them by a channel 48 miles wide, Fair Isle, a small inhabited spot, rising about midway to the height of 708 feet. Including rocks, the group consists of upwards of 100 members, of which only 32 are inhabited, their united superficial areas containing 563,200 acres. The Shetlands have been appropriately described as the "skeleton of a departed country," apparently only the harder and more indestructible rocks having withstood the fury of the Atlantic waves. The Orkneys have a similar character. 3. The Inner Hebrides, or those which more immediately adjoin the main land, include the large Islands of Skye, 48 miles long by 15 broad, belonging to Inverness-shire; Mull, Jura, Islay, Tiree, and Coll, belonging to Argyleshire; with Colonsay, Eig, Rum, Staffa, Iona, and many others of smaller dimensions. 4. The Outer Hebrides, properly the Western Isles, form a chain extending about 140 miles, separated from the Inner Hebrides by the Channel of the Minch, 20 miles across at the narrowest part between Skye and N. Uist. Lewis, the largest, 62 miles long by from 10 to 30 broad, belongs to Ross-shire; the rest are included in Inverness-shire. St. Kilda, the most western, is a small solitary mountainous islet, 3 miles long by 2 in extent at the most, and 50 miles from N. Uist, inhabited by a few families. 5. The fifth group comprises the islands in the Firth of Clyde; of which Bute, 18 miles by 5, Arran, 20 miles by 10, and a few others of insignificant extent, form the county of Bute.

The last three groups, comprising all the islands off the west coast of Scotland, contain upwards of 200, of which only about 80 are permanently inhabited, the rest being either too small or too sterile; though a few are tenanted in summer, and deserted on the approach of winter. There are no natural woods, but a considerable space has been planted. The shores are almost everywhere rocky, and deeply indented. The lakes are numerous, covering 25,000 acres of the Outer Hebrides. Their entire area is stated to comprehend 1,592,000 Scotch Acres, divided as follows:

	Acres.
Mountains, morasses, and lakes	600,000
Arable or meadow land	210,000
Poor pasture-ground, commonly on hills	70,000
Barren districts of shifting sand	25,000
Peat mosses	22,000
Kelp-shores, dry at low-water	30,000
Towns, villages, and undescribed spots	635,000

Including the Orkneys and Shetlands, the area of the islands of Scotland is estimated at 4224 square miles.

The Scottish islands are generally mountainous. The principal elevations are:

		Feet.
Shetlands—	Foula I.	1350
	Ronas Voe, N. of Mainland I.	1470
Orkneys—	Hills of Hoy I.	1590
Inner Hebrides—	Dun Can Hill, Raasay I.	1500
	Storr Hill, Skye I.	2100
	Ben Blaven, ditto	3000
	Cuchillin, ditto	3000
	Scuir of Eig, Eig I.	1339
	Oreval, Rum I.	1800
	Ben More, ditto	2310
	Gribon promontory, Mull I.	2000
	Ben na Chat, ditto	2294
	Ben More, ditto	3168
	Paps of Jura, Jura I.	2580
Outer Hebrides—	Conochan, St. Kilda I.	1380
	Clisseval, Lewis I.	2700
	Suaneval, ditto	2700
	Hecla, S. Uist I.	2240
	Heval, N. Uist I.	2010
Firth of Clyde Isles—	Ailsa I.	1098
	Goat-Fell, Arran I.	2865

VI. The islands connected with Ireland are almost entirely on the western side, but are not important either for number or size. Rathlin, a basaltic mass off the north coast of Antrim, is 6 miles long by ¾ broad; North Arranmore, off the west coast of Donegal, contains about 2000 acres; Achil, or Eagle Island, a resort of that bird, off Mayo, the largest of the Irish isles, has a circuit of about 30 miles, comprising 20,000 acres; South Arranmore, at the mouth of Galway Bay, includes 4600 acres; Valentia, off the coast of Kerry, remarkable for its fertility, has an extent of 5 miles by 2; and Cape Clear Island, 6 miles from the main land of Cork, has about 2000 acres of surface.

VII. The Norman or Channel Islands, geographical dependencies of France, are politically British Isles, having been possessions of the English crown since the eleventh century. The group includes, in the order of size, Jersey, Guernsey, Alderney, Sark, and Herm, with many points of rock which render the navigation difficult. Alderney, the nearest to the French coast, and also to England, is about 7 miles from Cape de la Hague, and 58 miles from Portland Bill.

VIII. The population of the British Isles, according to the latest enumeration, stands as follows:

England	14,995,138
Wales	911,603
Scotland	2,620,184
Army, abroad and in Ireland	89,230
Navy afloat	31,067
Merchant Seamen afloat	68,156
Islands in the British Seas	124,040
Great Britain	18,844,434
Ireland	8,175,124
United Kingdom	27,019,558

To afford as complete a view as possible of the population of the British Empire, the following returns are introduced:

European Possessions—	Gibraltar	15,000
	Malta, Gozo	123,000
	Heligoland	2,200
	Ionian Islands	208,100
		27,367,858
Trans-Atlantic—	Canada (1844)	1,177,248
	Newfoundland (1836)	74,705
	New Brunswick (1840)	156,162
	Prince Edward's Island (1841)	47,033
	Nova Scotia and Cape Breton (1838)	178,237
	West Indies (1829—1839)	829,684
		29,830,927
African—	Sierra Leone (1844)	44,935
	Gambia and Accra	8,000
	Cape Colony (1842)	166,408
	St. Helena	5,000
	Mauritius (1839)	135,197
		30,190,467
Asiatic—	Ceylon (1835)	1,241,825
	Bengal Presidency, with Agra	69,710,000
	Madras ditto	15,000,000
	Bombay ditto	8,500,000
	Scinde, portion ceded in 1842	1,000,000
	India beyond the Ganges	800,000
		126,442,292
Australasian—	New South Wales (1841)	128,718
	Van Diemen's Land (1838)	54,764
	Western Australia (1844)	4,350
	South Australia (1844)	17,366
	New Zealand	104,000
Grand Total for British Empire, exclusive of allied and tributary states in India		126,751,490

XI. The inhabitants of the British Isles belong to the Teutonic and Celtic divisions of the population of Europe. The races remain tolerably distinct, notwithstanding considerable fusion. Teutonic varieties occupy nearly the whole of England, the south and east of Scotland, the north-east and east of Ireland. The Celtic varieties occupy Cornwall, the Scilly Islands, Wales, Isle of Man, Highlands of Scotland, Outer Hebrides, and great part of Ireland. The relative numbers of each race, with the proportions of pure and mixed blood, are thus estimated by Dr. Kombst:

I. PURE BLOOD.

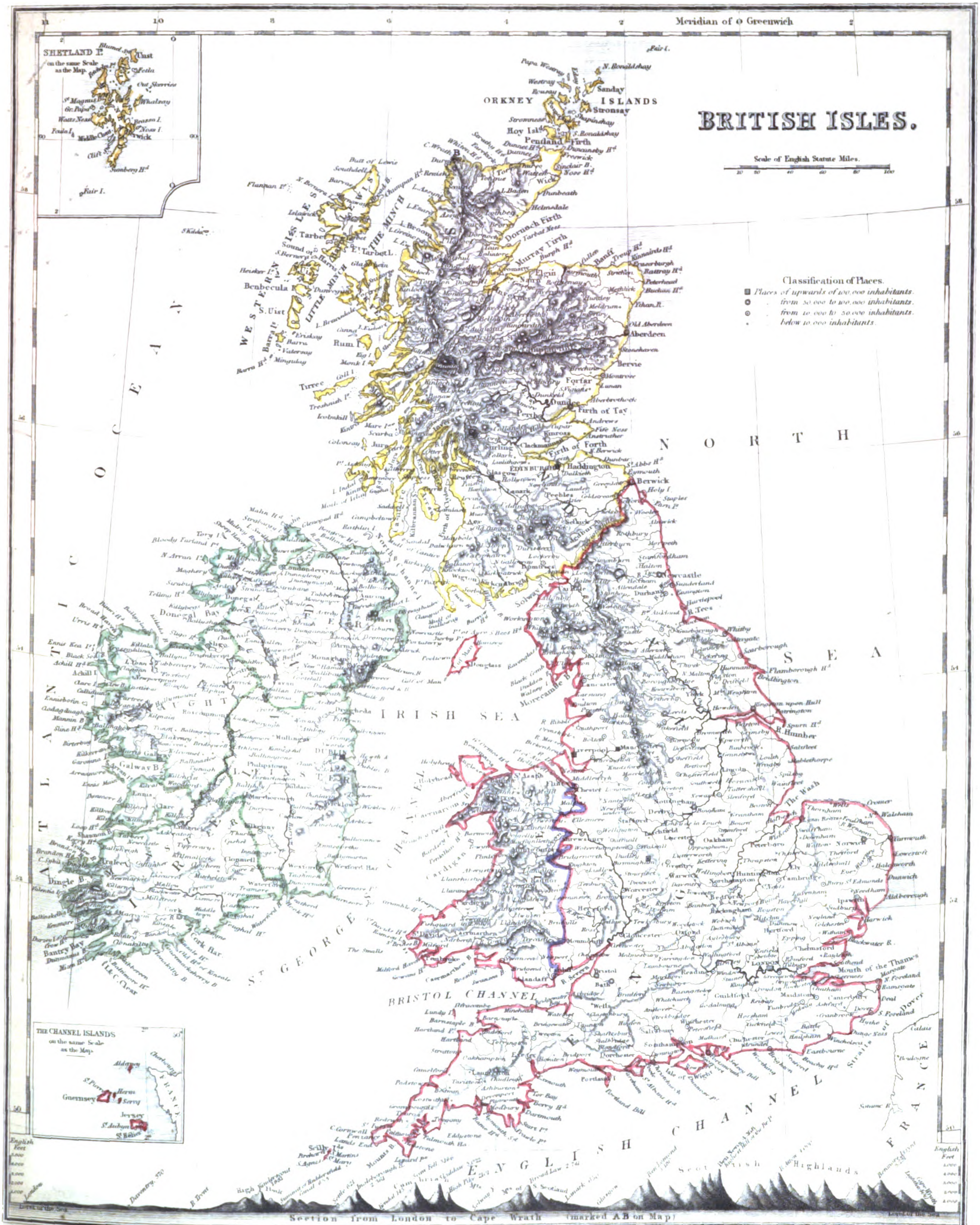
1. Teutonic, in England, Scotland, east and north-east of Ireland	10,000,000
2. Celtic, in Cornwall, Wales, the Scottish Highlands, and Ireland	6,000,000
	16,000,000

II. MIXED BLOOD.

1. Teutonic, (that is, with prevalent Teutonic character,) in England, Scotland, east and north-east of Ireland	6,000,000
2. Celtic, (that is, with prevalent Celtic character,) in Cornwall, Wales, the Scottish Highlands, and Ireland	4,000,000
	10,000,000

Total of Teutonic, pure and mixed	16,000,000
Total of Celtic, pure and mixed	10,000,000
	26,000,000

The languages at present spoken are referable to Teutonic and Celtic primitive stems.



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Drawn & Engraved by J. Dower, Pentonville.

I. TEUTONIC.

1. The English, of which the Anglo-Saxon is the base, now predominant in Ireland, largely spoken in Wales, and exclusively in England, since the Cornish expired. There are numerous dialects, forming, according to their affinities, several idiomatic groups:

Standard idiom, the language of the educated classes.

Saxonic idiom, comprising the dialects of the southern counties of England.

Anglic or Mercian idiom, comprising the dialects of the eastern and midland counties.

Northumbrian idiom, comprising the dialects of the six northern counties.

Hibernian idiom, comprising the dialects spoken in Ireland.

2. The Scotch, spoken by the Lowlanders of Scotland. The Scotch is by some considered as a debased Saxon idiom; by others, as a distinct language, but derived from the same stock, through the Teutonic-Scandinavian branch.

II. CELTIC.

1. The Gaelic, spoken in the Highlands of Scotland . . . } Gaelic Branch of Celtic.
2. The Manx, nearly extinct, spoken in the Isle of Man . . }
3. The Erse, or Irish, spoken in Ireland . . . . }
4. The Welsh, spoken in Wales . . . . Cymric Branch.

The Cornish, belonging to the Cymric branch of the Celtic, ceased to be a living language about the middle of the last century. The Welsh has rapidly been supplanted by the English in modern times. The Gaelic has entirely disappeared from several Highland valleys, where it was alone spoken within the memory of man. Nor is it for the improvement of society to endeavour to preserve the Celtic tongues from extinction.

The Thames, by Moonlight.

VI. ENGLAND AND WALES.

I. The southern portion of Great Britain, comprehending England and Wales, is separated from Scotland by a line which runs generally north-east from the head of the Solway Firth, along the river Liddle to the Cheviot Hills; and after following the course of that range, proceeds to the Tweed, that river forming the remainder of the boundary, except at its mouth; Berwick, on the north bank, being included in England.

Latitudinal Limits.—49° 57′ 30″ N. the Lizard, and 55° 50′ N. Berwick-upon-Tweed.

Longitudinal Limits—1° 46′ E. Suffolk coast, and 5° 42′ W. Land's End.

Extent.—Greatest length: 262 miles from Berwick to the Dorset coast. Greatest width: 280 miles from the Pembrokeshire to the Essex coast. Greatest linear extent: 367 miles from the Land's End north-east to Winterton Ness, Norfolk. Greatest contractions: from the head of the Thames' mouth to the outlet of the Bristol Avon, 130 miles; from the head of the Humber to the estuary of the Ribble, 80 miles; from the outlet of the Esk to that of the Tyne, 64 miles. Area: England, about 50,387 square miles; Wales, 7426.

II. The eastern, southern, and central districts, comprising the greater portion of the surface, consist of broad river-valleys, and tracts gently undulating, approaching to the character of plains, intersected with a few ridges of inconsiderable elevation; not a single eminence attaining the height of a thousand feet above the sea, except the Inkpen Beacon, which rises to 1011 feet, near the place where the counties of Hants, Wilts, and Berks converge. On the south-west, west, and north-west, the aspect of the country is bold, rugged, and mountainous. 1. From the south-west extremity of the Cheviot Hills, a range of high lands, known as the Pennine Chain, extends southward along the boundary line between the four northern counties, traverses the west of Yorkshire, forms the elevated region of the Derbyshire Peak, and terminates in the hills which lie on the western borders of that county. The north portion of this chain is narrow, and has no elevated summits. It subsides at points to an insignificant altitude, the line of the old Roman Wall, and of the Newcastle and Carlisle Railway, cutting one of the depressions. From Cross-Fell, the culminating point, near the junction of the counties of Cumberland, Westmoreland, and Durham, the range continues generally broad and high, and has some conspicuous masses in North Derbyshire. 2. Westward from the Pennine Chain, in about the parallel of Richmond, Yorkshire, the slate mountains, forming the Cumbrian group, extend through Westmoreland, North Lancashire, and South Cumberland, terminating a few miles from Whitehaven. The highest points of England are found in this system, and also its lake-district. These mountains on the south, with the Pennine Chain on the east, enclose the plain of Cumberland, extending about 30 miles north-east from Maryport, with a breadth in some places of 10 miles; Carlisle occupying a site near the centre. 3. The whole principality of Wales is mountainous, and comprises several well-defined and lofty chains, the principal of which are, Snowdonia, containing the culminating point of South Britain, extending from the mouth of the Conway south-west through Caernarvonshire, and south into Merionethshire; the Berwyn Range, stretching from near the junction of Cheshire, Salop, and Denbighshire, south-west to Cardigan Bay, above the mouth of the Dovey; the Plynlimmon Range, running from the mountain of that name, the source of the Severn, in the form of an arc along the southern side of its valley, to the borders of Salop; the Black Mountains, the principal chain in South Wales, extending almost due east, from the river Towy to the Usk near Abergavenny. 4. The South-western counties are occupied by a mass of high lands, which extend from the Land's End with little interruption to the granitic plateau of Dartmoor in Devon, and are prolonged by the north-coast range of that county into Somersetshire; the Blackdown Hills, south of Taunton, forming an outlier. The Cambrian and South-western systems have connecting links in the Malvern Hills of Hereford and Worcestershire, the Cotteswolds Hills in Gloucestershire, and the Mendips of Somerset.

	Heights.		Feet.
Pennine Chain—	Village of Glenwhilt—summit level of Newcastle and Carlisle Railway		446
	Kirkhope, Durham		2196
	Cross-Fell, Cumberland, culminating point		2901
	Shunnor-Fell, Yorkshire		2329
	Great Wharnside, ditto		2384
	Ingleborough, ditto		2361
	Pennigant, ditto		2270
	Pendle Hill, ditto		1805
	Holme Moss, ditto		1859
	Kinderscout, Derbyshire		1981
	Axe-Edge, ditto		1873
	Lord's seat, ditto		1751
	Summit level of Cromford and High Peak railway, do.		1290
Cumbrian System—	Inn at Buttermere, Cumberland		324
	Sparkling Tarn, Borrowdale-Fells, ditto		1900
	Red Tarn, Helvellyn, Westmoreland		2400
	Langdale Pikes, ditto		2400
	Coniston-Fell, Lancashire		2577
	Grassmere-Fell, Cumberland		2756
	Saddleback, ditto		2787
	Pillar, ditto		2893
	Skiddaw, ditto		3022
	Helvellyn, Westmoreland		3055
	Sca-Fell Pikes, Cumberland, culminating point		3166
Cambrian System—	Inn at Beddegelart, Caernarvonshire	(Snowdonia)	162
	Reival, ditto	(ditto)	1886
	Rhinog Fach, Merionethshire	(ditto)	2400
	Rhinog Fawr, ditto	(ditto)	2463
	Caern-y-David, Caernarvonshire	(ditto)	3427
	Caern-y-Llewellyn, ditto	(ditto)	3469
	Snowdon, ditto, culminating point	(ditto)	3571
	Cader-Ferwyn, Merionethshire	(Berwyn Range)	2563
	Arran-Fowdy, ditto	(ditto)	2955
	Arranig, ditto	(ditto)	2809
	Cader-Idris, ditto	(ditto)	2914
	Long Mountain, Montgomeryshire	(Plynlimmon Range)	1330
	Llandiman Mountain, ditto	(ditto)	1898
	Plynlimmon, Cardiganshire, ditto	(ditto)	2463
	Caermarthenshire Beacons	(Black Mountains)	2596
	Brecknockshire Beacons	(ditto)	2862
South-western System—	Land's End, Cornwall		100
	Brown Willy, ditto		1368
	Cawsand Beacon, Devonshire		1792
	Yestor, ditto, culminating point of S. England		2077

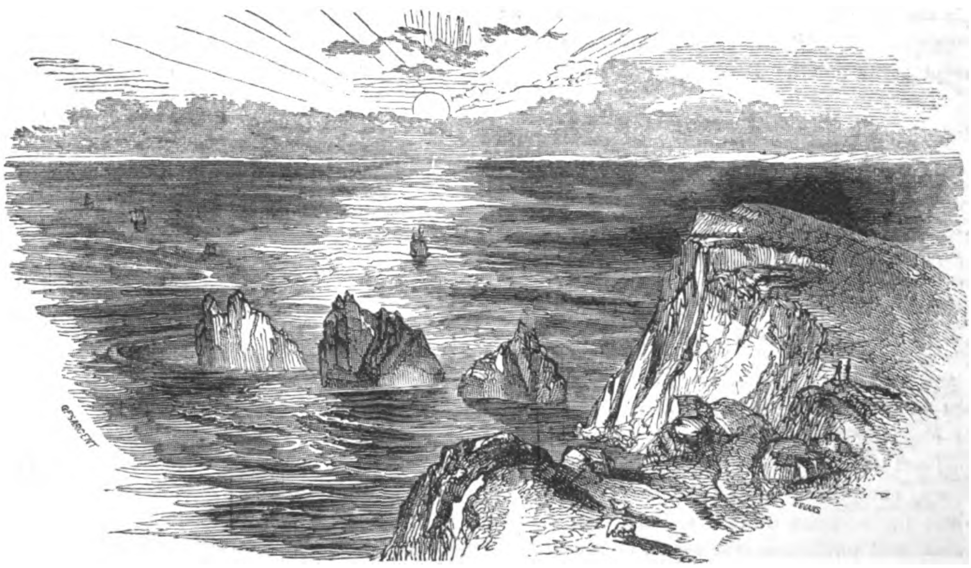
III. Two great hydrographical regions, the eastern and western, are formed by the Pennine Chain, and the rising grounds which extend circuitously from its southern extremities to the Cotteswold Hills. The eastern region, comprehending the greater proportion of surface, includes the most numerous and important rivers, of which the Humber, Thames, Tyne, and Tees are the chief, with the rivers of the Wash. The western region has the Severn, only inferior to the Humber, with the Towy, Dee, Mersey, and Eden, far inferior to the Thames.

	Area of Basin in square miles.	Length in miles.
Humber, including Trent and Ouse to Spurn Point	9550	—
Trent	—	144
Ouse	—	120
Estuary	—	40
Severn, including Wye, Usk, and Avon to Flat Holmes	8580	—
Severn	—	190
Wye	—	120
Thames, including Medway to Nore Light	6160	—
Thames	–	215
Rivers of the Wash	5000	—
Mersey, including the Weaver	1050	—
Mersey	—	62
Weaver	—	55
Eden	1100	72
Tyne	950	80
Tees	450	80

The lakes are exclusively western, and almost entirely confined to the Cumbrian Mountains,—all small, but renowned for picturesque beauty. The principal are embraced in the following tabular view:

	Greatest Length. Miles.	Greatest Breadth. Miles.	Greatest Depth. Feet.	Height above the Sea. Feet.
Winandermere	10	1	186	116
Coniston Water	6	¾	240	105
Ulles-Water	9	1	210	460
Derwent-Water	3	1½	72	288
Bassenthwaite-Water	4	1	68	210
Buttermere	1½	¼	90	
Crummock-Water	3	¾	·132	260
Wast-Water	3	½	270	160
Ennerdale	2½	½	80	
Lowes-Water	1	½	64	
Thirlmere	2¾	1	108	473

Bala lake, the only important example in Wales, is about 4 miles long by somewhat less than 1 broad. In the few counties of Eastern England some considerable pools occur; Whittlesea-mere, the largest, in North Huntingdonshire, being 2¼ miles long by 1¼ broad.



The Needles, Isle of Wight.

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Drawn & Engraved by J. Dower Pentonville London

FALL OF THE THAMES.

	County.	Length. Miles.	Height. Feet.	Fall per Mile. Feet.
From the Source, Thames' Head, 1½ miles N. of Kemble	Wilts.	—	376·3	—
To Confluence of Coln, 0·8 miles SW. of Lechlade Bridge	Gloucester.	22·0	243·1	6·1
Tadpole Bridge, near Bampton	Oxf. & Berks.	10·5	219·3	2·3
Skinner's Wear, ¾ mile S. from Ensham Bridge	,,	11·8	203·5	1·3
Oxford Bridge to Botley	,,	7·8	190·0	1·7
Abingdon Bridge	,,	9·2	168·8	2·3
Clifton Ferry	,,	6·5	158·0	1·7
Confluence of Kennet at Reading	,,	25·0	119·7	1·5
Henley Bridge	,,	8·1	106·0	1·7
Great Marlow, bridge	Berks & Buck.	8·0	94.2	1·5
Windsor Bridge	,,	13·7	65·6	2·1
Confluence of Coln, at Egham	Buck. & Surrey	7·5	52·1	1·8
Confluence of Wey, near Wey Bridge	,,	7·1	40·8	1·6
Teddington, first lock	Midd. & Surrey	13·2	21·0	1·5
London, London Bridge	,,	17·6	4·3*	0·9
The Sea, at Nore Light	Essex & Kent	47·2	·0	0·1
Total Length and Fall		215·2	376·3	

* This is the fall of the Thames at low water, (16 ft. 9 in. from Teddington); at high water it is only 1 ft. 6 in.

(A. Petermann, in "Hydrographical Map of the British Isles," 1849.)

FALL OF THE SEVERN.

	County.	Length. Miles.	Height. Feet.	Fall per Mile Feet.
Source (Blaen-r Hafren)	Montgomery.	—	—	—
Newtown, Canal at	,,	29·6	465·0	—
Welshpool, ferry	,,	16·5	225·0	14·6
Shrewsbury, Canal at	Salop.	35·7	192·0	0·9
Broseley, Canal at	,,	24·5	133·0	2·4
Stourport, mouth of Stour	Worcester.	25·4	59·0	2·9
Confluence of Salwarp	,,	8·0	48·0	1·4
Diglis, near Worcester	,,	4·6	40·0	1·7
Tewkesbury	Gloucester.	15·9	37·0	0·2
Gloucester, Sill of Lock	,,	13·1	27·6	0·7
Stroud Canal, Sill	,,	12·1	24·6	0·2
St. Tecla's Chapel	,,	27·6	—	0·5
Sea, at Flatholm	Glamor. & Somerset	26·5	—	
Total Length		239·5		

IV. England is politically divided into 40 counties, and Wales into 12; which may be conveniently arranged in eight districts:

	Area in Sq. Miles.	Statute Acres.	Population.	No of Persons to 100 Acres.	No. of Parishes.	Miles of Turnpike Road in 1829.	Annual Value of Real Property.*	County and Chief Towns.†
1. Northern Counties.							£	
Northumberland	1871	1,165,430	250,278	20·9	85	479	1,326,414	Newcastle, 69; N. Shields, 25; Morpeth, 7; Alnwick, 7.
Cumberland	1523	969,490	178,038	18·3	104	215	696,852	Carlisle, 20; Whitehaven, 15; Cockermouth, 6; Penrith, 5.
Durham	1097	679,530	324,284	46·2	76	359	931,348	Durham, 9; Sunderland, 52; S. Shields, 22; Gateshead, 19.
Westmoreland	762	485,990	56,454	11·6	32	284	266,335	Appleby, 1; Kendal, 11; Ambleside, 1.
Lancaster	1766	1,117,260	1,667,054	147·5	70	631	5,266,606	Lancaster, 14; Manchester with Salford, 296; Liverpool, 282; Bolton, 50; Preston, 50; Blackburn, 36; Wigan, 25; Rochdale, 24.
York	5836	3,669,510	1,591,480	45·0	613	1448	5,448,494	York, 30; Leeds, 151; Sheffield, 109; Bradford, 66; Hull, 65; Halifax, 26; Huddersfield, 24; Thirsk, 15; Doncaster, 10.
2. Eastern Counties.								
Lincoln	2611	1,663,850	362,602	21·7	632	538	2,127,307	Lincoln, 13; Boston, 14; Grantham, 8; Gainsborough, 7.
Norfolk	2024	1,292,300	412,664	31·9	730	271	1,893,824	Norwich, 60; Yarmouth, 27; King's Lynn, 15.
Cambridge	857	536,313	164,459	28·1	164	278	868,684	Cambridge, 23; Wisbeach, 9; Ely, 6.
Huntingdon	372	242,250	58,549	24·6	101	146	317,718	Huntingdon, 5; St. Ives, 3.
Suffolk	1515	918,760	315,073	32·5	510	279	1,297,956	Ipswich, 24; Bury St. Edmonds, 12; Stowmarket, 7.
Essex	1533	979,000	341,979	35·2	406	249	1,585,719	Chelmsford, 5; Colchester, 17; Maldon, 4; Harwich, 3.
Hertford	630	400,350	157,207	39·0	133	170	667,710	Hertford, 5; St. Albans, 6; Watford, 5.
Middlesex	282	179,590	1,576,636	873·6	190	158	7,293,369	London, including parishes and places forming the Metropolis, 1,873,676.
3. Midland Counties.								
Derby	1028	663,180	272,217	41·4	139	574	866,488	Derby, 32; Belper, 8; Chesterfield, 6; Cromford, 8.
Nottingham	837	525,800	249,910	46·7	211	302	856,675	Nottingham, 51; Newark, 10; Mansfield, 9.
Stafford	1184	736,290	510,504	67·4	142	630	2,006,760	Stafford, 9; Stoke, 67; Wolverhampton, 92; Walsal, 19.
Leicester	806	511,340	215,867	41·9	212	445	933,799	Leicester, 50; Loughborough, 11; Hinckley, 6.
Rutland	149	97,500	21,302	22·3	50	18	119,134	Oakham, 2; Stamford, 7.
Northampton	1016	646,810	199,228	30·6	303	358	910,395	Northampton, 20; Peterborough, 6; Wellingborough, 5.
Warwick	897	567,930	401,715	70·0	205	477	1,609,747	Warwick, 9; Birmingham, 181; Coventry, 30.
Worcester	723	459,710	233,336	50·4	171	565	995,242	Worcester, 26; Dudley, 31; Kidderminster, 15.
Gloucester	1258	790,470	431,383	53·6	339	840	1,782,197	Gloucester, 14; Bristol, 123; Stroud, 37; Cheltenham, 31.
Oxford	756	467,230	161,643	33·4	217	342	695,752	Oxford, 20; Banbury, 7; Woodstock, 7.
Buckingham	738	463,880	155,983	33·0	202	165	674,334	Buckingham, 7; Aylesbury, 5; Great Marlow, 6.
Bedford	463	297,632	107,936	36·4	123	238	495,396	Bedford, 8; Luton, 5; Leighton, 3.
4. Welsh Border Counties								
Chester	1052	649,050	395,660	58·8	88	349	1,423,835	Chester, 22; Stockport, 50; Macclesfield, 32.
Salop	1343	864,360	239,048	27·8	215	988	1,170,008	Shrewsbury, 17; Wenlock, 19; Ludlow, 5.
Hereford	863	543,800	113,878	20·9	219	553	681,235	Hereford, 11; Leominster, 4; Ross, 3.
Monmouth	496	324,310	134,355	42·3	125	315	421,050	Monmouth, 5; Newport, 10; Abergavenny, 4.
5. Southern Counties.								
Berks	752	473,920	161,147	33·5	154	319	732,116	Reading, 18; Windsor, 9; Newbury, 6.
Wilts	1367	868,060	258,733	29·6	300	768	1,175,616	Salisbury, 11; Trowbridge, 11; Devizes, 6.
Hants	1625	1,018,550	355,004	34·1	313	810	1,362,026	Winchester, 9; Southampton, 27; Portsmouth, 49.
Dorset	1006	627,220	175,043	27·2	268	347	735,234	Dorchester, 5; Poole, 8; Weymouth, 7.
6. South-Eastern Counties.								
Kent	1557	972,240	548,337	55·0	409	586	2,111,675	Canterbury, 15; Maidstone, 16; Dover, 17; Greenwich, 29; Deptford, 20; Chatham, 17.
Surrey	759	474,480	582,678	120·0	145	281	1,927,493	Guildford, 5; Southwark, 142; Croydon, 12.
Sussex	1466	907,920	299,753	31·9	311	623	1,169,230	Lewes, 9; Brighton, 48; Shoreham, 27; Hastings, 10.
7. South-Western Counties.								
Somerset	1645	1,028,090	435,982	41·4	475	746	2,050,516	Taunton, 12; Bath, 52; Bridgewater, 9.
Devon	2585	1,636,450	533,460	32·2	467	782	1,852,144	Exeter, 37; Plymouth, 35; Devonport, 40.
Cornwall	1330	854,770	341,279	39·8	205	318	909,479	Launceston, 6; Falmouth, 12; Truro, 9; Penzance, 9.
8. Welsh Counties.								
Anglesea	271	173,410	50,891		67	25	191,613	Beaumaris, 2; Holyhead, 2.
Caernarvon	544	348,160	81,093		71	129	153,166	Caernarvon, 7; Bangor, 5.
Denbigh	633	405,120	88,866	N. Wales, 19·4	59	165	335,539	Denbigh, 5; Wrexham, 5.
Flint	244	156,160	66,919		27	85	214,071	Flint, 2; Holywell, 5; St. Asaph, 1.
Merioneth	663	424,320	39,332		34	261	116,465	Dolgelly, 4; Bala, 2.
Montgomery	839	536,960	69,219		54	450	282,349	Montgomery, 1; Welshpool, 4; Llandilloes, 2.
Cardigan	675	432,000	68,766		65	250	167,111	Cardigan, 3; Aberystwith, 4.
Radnor	426	272,640	25,356		52	250	130,653	New Radnor, 2; Presteign, 1.
Brecknock	754	482,560	55,603	S. Wales, 19·0	67	169	242,663	Brecknock, 5.
Glamorgan	792	506,880	171,188		127	355	376,482	Cardiff, 9; Merthyr, 42; Swansea, 13.
Caermarthen	974	623,360	106,326		76	319	338,403	Caermarthen, 9; Llanelly, 6.
Pembroke	610	390,400	88,044		145	173	276,112	Pembroke, 7; Haverfordwest, 5.
	57,805	36,522,615	15,906,741		10,698	20,875‡	£62,540,030	

* Assessed to the Poor-rates for the year ending Lady-day, 1841. † The figures in this column denote the Population in round numbers of thousands.
‡ Total length at present is 22,324 miles, 3 furlongs, and 125 yards.

The annual value of the real property in England and Wales assessed to the Property and Income Tax for the year ending 5th of April, 1843, amounted to £85,802,735; the value of which, estimated at twenty-five years' purchase, amounts to £2,145,068,375; estates yielding less than £150 per annum being excluded. In addition to the turnpike roads, the parish or cross-roads include upwards of 100,000 miles. The canals and river navigation extend 4500 miles. The railways, to the close of 1848, comprise 3918 miles. The communication by electric telegraph embraces 1767 miles, 259 wires, 329 stations, and 446 instruments.

V. The geological structure of the country has probably been more carefully studied than that of any other portion of the globe. The primary stratified rocks belong chiefly to the clay-slate and Silurian systems, gneiss and mica-slate being almost unknown. These, with the older secondaries, the old red sandstone and carboniferous systems, are confined principally to the western districts; formations more recent than the carboniferous epoch occupying the midland, southern, and eastern counties, and immensely preponderating, covering about two-thirds of the entire area. The unstratified igneous rocks, though widely distributed, do not much exceed a hundredth part of the surface. Granite appears in the lake district of the north, Devonshire, Cornwall, the Scilly Islands, Lundy Isle, Anglesea, and the Isle of Man; sienite in the Malvern and Charnwood Forest Hills; trap in the Northern counties, Cornwall, Devonshire; the Silurian region, Derbyshire, south Staffordshire, north Worcestershire, and some other localities.

VI. The important mineral productions of the country, excluding iron, occur west of a line extending tortuously from the mouth of the Exe in Devonshire, northward by Taunton, Gloucester, Leicester, Nottingham, and York, to the mouth of the Tees. Silver, associated with lead, is obtained in the average proportion of about seven or eight ounces to the ton of lead. The lead mines are in the mountain limestone districts, the principal localities being Allendale in Northumberland, Alston Moor in Cumberland, upper valleys of the Tyne, Wear, and Tees, and the Derbyshire Peak, with the west of Salop, the north-east of Wales, and the Isle of Man. Tin is alone found in Cornwall and Devonshire, either in the form of veins intersecting the granite and slate-rocks, or of grains in the sands and gravel of the low grounds. Copper is procured in Anglesea, and other parts of Wales, Staffordshire, and Devonshire; but the great repository is Cornwall. Iron, very widely diffused, is derived in the greatest abundance from the coal formations of South Wales, Staffordshire, and Salop; next to which are those of Yorkshire, North Wales, and Derbyshire. Rock salt occurs in apparently inexhaustible beds in the new red sandstone of Cheshire; graphite, the material of lead pencils, in the slates of Borrowdale, Cumberland, the most celebrated mine in the world of the rare mineral; ores of zinc are obtained from the mines of Derbyshire, and of manganese from those of Cornwall. The chief mineral springs are the brine springs of Cheshire, in the rock salt district, and the variously mineralised medicinal waters of Bath, Bristol, Buxton, Matlock, Harrowgate, Cheltenham, Leamington, Epsom, and Tunbridge.

Silver has been obtained from one of the Cornish mines near Truro in the proportion of 100 ounces per ton of lead. The greatest quantity has been procured from the Beer Alston mines in Devonshire, amounting to 140 ounces per ton. In 1838, in Devonshire, about 6000 tons of copper ore were raised, producing 527 tons of metal; but in the same period the copper ore obtained in Cornwall amounted to 145,688 tons, yielding 11,527 tons of metal. In the Consolidated mines in Cornwall, which furnish the largest supply, the total amount of sinking is stated to be more than 12 miles of perpendicular depth, including of course the underground shafts, while the entire length of the horizontal galleries amounts to 40 miles. The magnitude of the Cornish mining operations may be appreciated from the statement that as much as 300 tons of powder are annually used in blasting; while in 1837, the total quantity of water discharged from the mines by steam-power was estimated at 37,000,000 tons. The following Table refers to the amount of iron produced in Great Britain in 1841:

	Staffordshire.	Salop.	Wales, with Monmouth.	Scotland.	Rest of Great Britain.	Total of Great Britain.
No. of Furnaces	129	Not stated	123	62	47	——
Tons made . . .	532,120	81,287	418,030	270,920	85,194	1,387,551

The relative abundance and value of the mineral produce of the British Isles and other European countries is thus given by Professor Ansted from M. Burat:

	Proportional Produce.	Tin. Tons.	Copper. Tons.	Mercury. Tons.	Zinc. Tons.	Lead. Tons.	Iron. Tons.	Silver. lbs.	Gold lbs.	Value in £'s sterling.
British Isles	1000	3000	12,000	—	2000	46,000	1,350,000	6,000	—	17,600,000*
Russia and Poland	285	—	3,300	—	4000	600	300,000	38,500	12,000	5,400,000
France	250	—	80	—	—	400	430,000	3,314	—	5,280,000
Austria	154	20	3,500	250	75	4,500	70,500	42,500	3,250	2,680,000
German Confederation	143	300	2,000	650	—	8,000	70,000	5,350	60	2,580,000
Spain	125	—	25	1750	85	20,500	15,000	—	—	2,160,000
Sweden and Norway	123	65	1,240	—	300	40	85,000	10,350	4	2,160,000
Prussia	111	—	540	—	500	6,000	70,000	10,000	—	1,960,000
Belgium	91	—	—	—	1750	325	162,000	350	—	1,600,000
Tuscany, Elba, &c.	32	—	—	—	—	—	24,000	—	—	600,000
Piedmont, Switzerland, Savoy, &c.	27	—	—	—	—	350	22,750	1,250	13	440,000
Denmark	20	—	700	—	—	—	12,000	—	—	360,000

* This is probably much overrated.

Mr. Tennant estimates the annual value of the chief mineral products of Great Britain as follows:

	£
Coal	9,100,000
Iron	8,400,000
Copper	1,200,000
Lead	920,000
Salt	400,000
Tin	300,000
Manganese	60,000
Silver	35,000
Alum	22,000
Zinc	8,000
Arsenic, antimony, bismuth, &c. . . .	25,000
	£20,470,000

The annual value of the entire mineral produce he states at about 25,000,000.

VII. There are four great coal regions: 1. The Pennine District, north of the Trent, comprehending seven fields, in Northumberland and Durham, west Cumberland, north Lancashire, north Yorkshire, south Lancashire, north Staffordshire, south Yorkshire extending towards Derby and Nottingham. 2. The Central District, with three fields, in Leicestershire, Warwickshire, and south Staffordshire. 3. The Western District, including four fields, in Anglesea, Flintshire, Coalbrook Dale on the Severn, and the plain of Salop. 4. The South-western District, comprising three fields, in South Wales, south Gloucester and north Somerset, and the forest of Dean between the Wye and the Severn.

The more important coal tracts are those of Northumberland and Durham, south Lancashire, south Yorkshire, south Staffordshire, and South Wales. In Northumberland and Durham coal is wrought only to a very small extent for the manufacture of metals, and almost wholly for sale, supplying those counties, contiguous parts of Scotland, the North Riding of Yorkshire, the whole of the eastern and southern coasts of England as far as Cornwall, including the metropolis, and the great south-eastern region, into which the sales of the inland coal districts do not penetrate, because of the greater cost of land carriage. The export to foreign parts is likewise very extensive. In the four years from 1841 to 1844 inclusive, from the three ports of Newcastle, Sunderland, and Stockton, the quantity shipped to foreign countries amounted to 5,446,190 tons. The south Yorkshire, Staffordshire, and South Wales tracts, besides supplying with fuel a vast surrounding region, are worked to an enormous extent for the purpose of smelting iron and other metallic ores. The south Lancashire coal field is remarkable for the extent to which its beds are worked, for the supply of the manufactures and the manufacturing and commercial population congregated in its neighbourhood, or upon the surface, though there is no manufacture of iron from native ores.

The Northumberland and Durham coal field extends from the river Coquet on the north nearly to the Tees on the south, and is intersected by the two navigable rivers of the Tyne and Wear. Its extreme length is about 48 miles by an extreme breadth of 24. The area is under 800 square miles. The coal is more bituminous, occurs in thinner beds, and at greater depths, than in the southern districts. At Wearmouth, near Sunderland, a shaft, commenced in 1826, had to be sunk 1578 feet before a valuable seam of coal was reached, and the sinking alone extended through nearly ten years at the cost of £100,000. The annexed statistical account of the collieries belonging to the principal proprietors on the Wear bears date 1843 :

Collieries.	Proprietors.	No. of Pits.	Depth. Feet.	Horse-Power	Coal raised per Annum Tons	Probable amount of Capital expended.
Wingate Grange	Lord Howden and Partners...	2	450 & 534	440	139,344	60,000
Hetton	Hetton Company..	8	600 to 912	1319	23[illegible],010	200,000
Pensher, Rainton, and Pitlington ...	Lord Londonderry	13	360 to 600	500	271,843	250,000
Lambton, Newbottle, Sherburn, Little Town, Shadforth	Executors of Countess of Durham	8	180 to 786	2260	318,948	300,000

VIII. Of 74 ports, 30 are connected with the east coast, 23 with the west, and 21 with the south. The most commercially important, estimated by the amount of Customs' duty collected in each, rank in the following order :

London.	Gloucester.	Chester.	Southampton.
Liverpool.	Plymouth.	Goole.	Portsmouth.
Bristol.	Whitehaven.	Yarmouth.	Dover.
Hull.	Sunderland.	Stockton.	Lancaster.
Newcastle.	Exeter.	Lynn.	Ipswich.

The annexed statistical returns, though comprising the United Kingdom, have a special reference to English ports, and sufficiently illustrate the vast commercial marine, and the foreign trade of the country :

Net produce of the Customs' duties for the year ending Jan. 5, 1847	£20,568,909

Number of vessels registered and entitled to the privileges of British ships, Jan. 1, 1847	24,002
Number of British vessels, exclusive of vessels in ballast and those employed in the coasting trade, which entered inwards in the year ending Jan. 5, 1848	18,771
Number, &c., cleared outwards	15,535
Foreign vessels, entered inwards in same time	10,790
Ditto, cleared outwards	10,029
Number of vessels employed in the coasting trade, which entered inwards in the year ending Jan. 5, 1848	142,525
Ditto, cleared outwards	158,922

Imports in the year 1846—Sugar	4,465,881 cwts.
Tea	46,728,208 lbs.
Coffee	26,805,230 „
Wool	65,255,462 „

	£
Declared value of iron and steel exports in 1847	5,272,942
woollen manufactures and yarn	7,885,709
cotton manufactures and yarn	23,339,590
Annual value of British produce exported, about	52,000,000

The royal navy comprises 636 ships afloat, in ordinary, and building, carrying in all 17,681 guns. The principal harbours, dockyards, and arsenals, are Deptford, Woolwich, and Sheerness, on the Thames; Chatham on the Medway; Portsmouth and Devonport on the Channel; and Milford Haven in South Wales.

IX. The manufactures include almost every variety of article; but the textile fabrics, cotton, woollen, flax, and silk, are the more important, as sources of employment and national wealth, with iron, hardware, and earthenware. The factories devoted to textile fabrics are chiefly north of the Trent, in the counties of Lancaster, York, Cheshire, Derby, and Nottingham; and in other parts of the kingdom, in those of Gloucester, Somerset, Wilts, and Norfolk. A late return enumerates 3552 mills, employing 455,042 operatives. Including the workmen not in mills, the persons actually employed represent a population approaching to 3,000,000 deriving subsistence from these branches. The total annual value of cotton, woollen, and silk produce is upwards of £60,000,000. The length of cotton yarn spun per annum is estimated at somewhat under 5,000,000,000 miles; the number of spindles at 15,554,619. Owing to the rapid extension of railways, the quantity of iron smelted of late has been enormous, the annual value of which, with iron manufactures, hardware, cutlery, etc., produced principally in Sheffield, Birmingham, and their neighbourhoods, approaches to £20,000,000. The earthenware made chiefly in north Staffordshire, with porcelain at Worcester, Derby, and a few other places, is valued at £2,350,000 per annum; glass at £2,000,000; and the various branches of the leather manufacture at £13,000,000.

X. The distribution of the surface in regard to cultivation has been estimated in square miles as follows :

	Arable and Gardens.	Meadows, Pastures, and Marshes.	Wastes capable of improvement.	Wastes incapable of improvement.	Summary.
England . .	16,020	24,030	5397	5089	50,536
Wales . . .	1,391	3,478	828	1727	7,424
	17,411	27,508	6225	6816	57,960

This gives nearly one-third as the amount of surface under cultivation, and nearly one half as the amount in pasture. But since the date of the calculation tillage or arable husbandry has increased; and at present, there are probably nearly 19,000 square miles under cultivation; or, according to Mr. M'Culloch, 12,000,000 acres, of which he makes the following distribution :

	Acres.
Wheat	3,800,000
Barley and rye	900,000
Oats and beans	3,000,000
Clover	1,300,000
Roots (turnips, potatoes, &c.) . . .	1,200,000
Hop-grounds and gardens of all kinds . .	150,000
Fallow	1,650,000
Total . . .	12,000,000

	£
Annual value of the crops raised, calculated from average productiveness	72,000,000
Added for the value of the produce of 17,000,000 acres of pasture-land, cattle, horses, dairy produce, &c.	59,000,000
Total annual value of the agricultural produce of England and Wales .	131,000,000

Arable husbandry is most extensive in the counties of Kent, Essex, Suffolk, Norfolk, Hants, Berks, Bedford, Surrey, Sussex, Herts, with part of Lincoln, York, Durham, and Northumberland. The principal dairy counties are Cheshire, Gloucester, Salop, Wilts, Buckingham, Essex, Suffolk, York, Derby, Cambridge, Dorset, and Devon. The cattle rearing and feeding districts are Lincoln, Leicester, Northampton, Hereford, Somerset, Teesdale in Durham, Cleveland and Holderness in Yorkshire. Wheat is grown chiefly in the south-eastern counties; barley in the eastern and midland; oats in the northern. Hops are cultivated most extensively in Kent, Sussex, and Hereford. The districts of the cider-apple are Hereford and Devon, with portions of the adjoining counties.

XI. The climate, owing to an insular position, is more temperate than in parallel continental regions, but much more changeable, cloudy, and humid. Its salubrity is, however, evidenced by the proportionate mortality being less than in other European countries :

	No. of Deaths to Population.		No. of Deaths to Population.
England . . .	1 in 46	Austria . . .	1 in 40
Denmark . . .	1 „ 45	Spain . . .	1 „ 40
Russia . . .	1 „ 44	Portugal . . .	1 „ 40
Belgium . . .	1 „ 43	Switzerland . .	1 „ 40
France . . .	1 „ 42	Prussia . . .	1 „ 39
Norway and Sweden	1 „ 41	Turkey . . .	1 „ 30

The temperature varies of course in different places, according to latitude, exposure, and elevation. The average mean annual temperature in connection with latitude, for places below the altitude of 300 feet, has been thus given :

Lat.	Temp.	Place.
50°—51°	51°	Penzance, Gosport, Isle of Wight.
51½—52	49¾	London, Bushey, Oxford.
53½	47½	Manchester.
54—55	47¾	Kendal, Carlisle.

In general, the harvest is a fortnight or three weeks earlier in the south than in the north. The successful cultivation of wheat extends to about 1000 feet above the level of the sea ; oats and barley succeed to 2000 feet, but cultivation at that height is exceedingly local. The prevailing winds are from the west and south-west, except in the eastern counties during the spring and early summer months, when cold and ungenial east winds are common. In 1848, at London, the number of days during which the respective winds prevailed was as follows:

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Variable or Calm.
15	44	17	45	10	123	32	53	26

The average annual quantity of rain is about 24 inches for the eastern, and 32 for the western districts. According to the calculations of Kaemtz the largest amount falls in autumn, and the least in spring, on both sides of the island; and next in point of abundance are the winter rains for the western side, and the summer rains for the eastern. Representing the whole quantity on each side by 100, the seasonal distribution is thus stated:

	West.	East.
Winter	26·4	23·0
Spring	19·7	20·6
Summer	23·0	26·0
Autumn	30·9	30·4
	100	100

XII. The English flora does not probably comprise more than 1450 species, and it has been said, that, on the average, a single county contains nearly one-half the whole number of species, and a single mile half the species of a county. The principal indigenous trees are the oak, elm, beech, ash, maple, lime, alder, birch, poplar, aspen, yew, and holly. The oak attains an immense size in the south, and the beech forms magnificent woods. Both flourish also in sheltered valleys in the north, but the oak becomes stunted at the height of 1500 feet, and the ascending limit of the beech does not reach that height. On the contrary, the birch, yew, and holly, attain a greater size in Northumberland, Cumberland, and Durham than in the southern counties. North of the Tees, the common elm is succeeded as a native by the mountain or wych elm. Among the wild animals the principal carnivora are the fox, badger, wild cat, otter, and several of the weasel tribe, some of which are now becoming rare. The ruminants comprise the fallow deer, of foreign origin, confined to parks; the red deer, or stag, a few of which are found on the borders of Cornwall; the goat, in Wales; and the wild ox, preserved at Chartley Park in Derbyshire, and Chillingham Castle, Northumberland. The common game animals are the hare, partridge, and pheasant, very generally distributed; with the red grouse on the northern moors, and the black cock of the southern and south-western counties, Hants, Dorset, Somerset, and Devon, plentiful also in Northumberland. The golden eagle and ptarmigan are only occasionally seen; the gosshawk and kite, once abundant, are scarce; the peregrine falcon is still common along the rocky parts of the coast; the wild duck abounds in the fens; the heron haunts the secluded brooks; the great bustard, formerly frequent on Salisbury Plain, the heaths about Newmarket, and the Yorkshire wolds, is now nearly extirpated. Of the migratory birds, the nightingale ranges as far north as Yorkshire, but is there uncommon; the turtle-dove appears principally in Kent; the crane and stork have ceased their visits, owing to the drainage of the marshes. Of the reptiles, none are venomous, except the viper.

SCOTLAND.

I. The northern portion of Great Britain, comprehending Scotland, is bounded on the south by England and the Irish Sea, on the east by the German Ocean, and on the north and west by the Atlantic. Its general aspect remarkably differs from that of the country below the Tweed, the coast being broken by innumerable firths, while the surface is far more irregular, presents bolder prominences, and comprises an extensive development of fresh-water lakes.

Latitudinal limits—54° 38′ N. the Mull of Galloway, and 58° 40′ 30″ N. Dunnet Head.

Longitudinal limits—1° 46′ W. Buchan Ness, and 6° 8′ 30″ W. Point Ardnamurchan.

Extent—Greatest length along a meridian without cutting the sea, 270 miles, from the north coast of Sutherlandshire to the south coast of Wigtonshire; greatest breadth, following a parallel, 150 miles, from Point Rownamoan in Ross-shire to Buchan Ness; greatest linear extent, 280 miles, north by east, from the Mull of Galloway to Duncansby Head. Area somewhat above 26,000 square miles, of which nearly 300 are lakes.

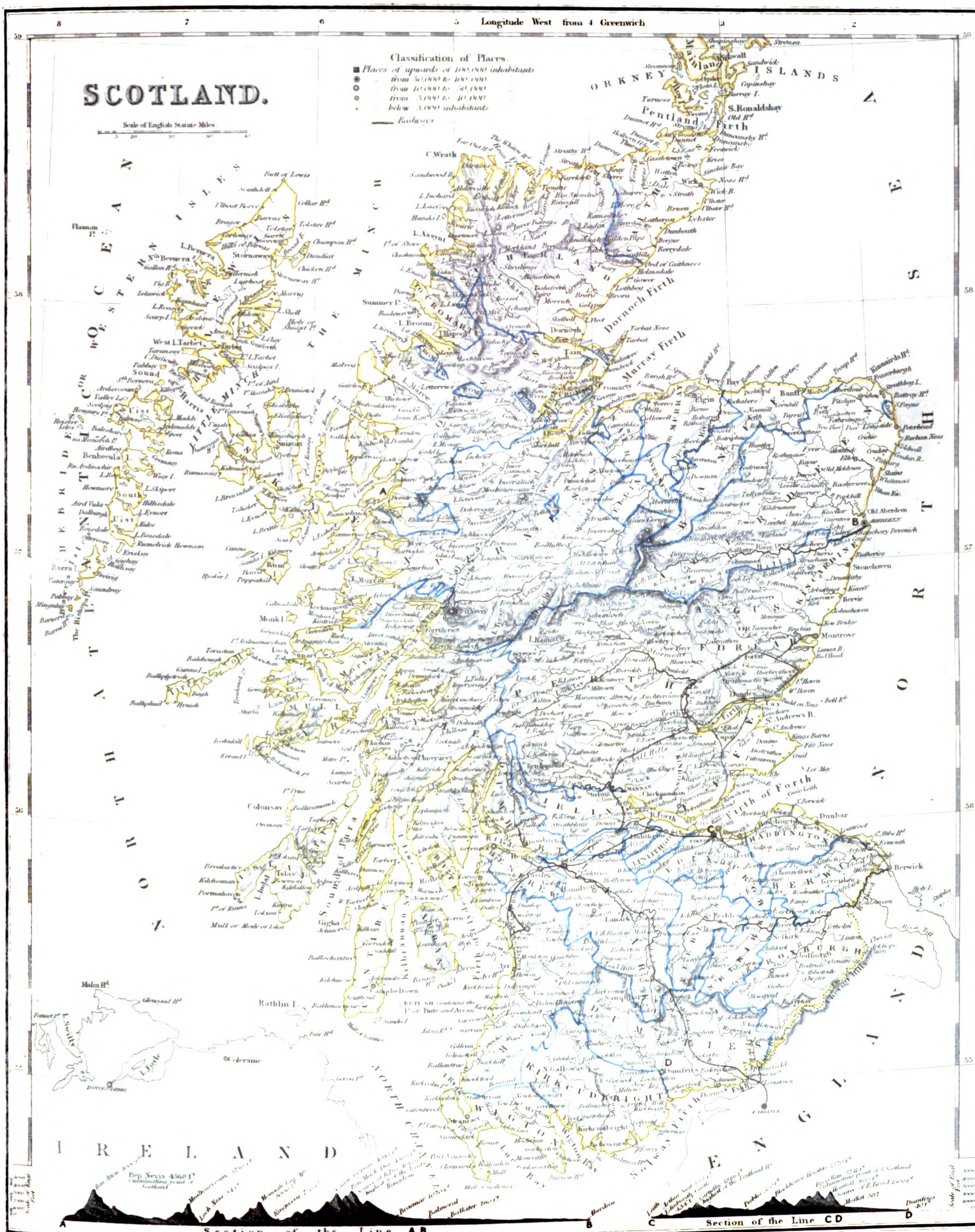
II. Scotland is naturally divided into three principal districts,—the southern, Central, and Northern. 1. The Southern District comprises the country between the English border and the Irish Sea on the south, and the Firths of Forth and the Clyde, with the intermediate plain traversed by the canal uniting the two estuaries, on the north. The surface exhibits many pastoral dales enclosed between green rounded hills, having their general direction east and west, with a few bold ranges, one of which is sufficiently elevated to be denominated the South Highlands. The Cheviot Hills, which form part of the border, divide Northumberland and Roxburghshire, and then run westerly through the latter county to the Lowthers, a high group, stretching west from the junction of the counties of Selkirk, Peebles, and Dumfries, through Lanark, towards the opposite coast. The Pentland Hills run from near Edinburgh south-west to the junction of Mid-Lothian, Peebles, and Lanark. Ridges, under the names of the Lammermoor and Moorfoot Hills, extend from the high promontory of St. Abb's Head in Berwickshire south-west into Peebles-shire. Isolated summits, often conical, or broken by abrupt rectilinear terraces, are scattered over the north-east portions of this district.

Heights.	Feet.
Summit level of the Forth and Clyde Canal	145
Edinburgh and Glasgow Railway	226
Edinburgh Castle Rock	434
Arthur's Seat, near Edinburgh	822

	Heights.	Feet.
Pentland Hills—	Pentland village, Edinburghshire	505
	Allenmuir Hill, ditto	1616
	West Cairn Hill, ditto	1764
	East Cairn Hill, or Harper's Rig, ditto	1802
	East Black Hill, highest point, ditto	1876
Lammermoor Hills—	Spartledown Hill, Haddingtonshire	1700
	Soutra Hill, ditto	1712
	Sayer's Law, Edinburghshire, highest point	1735
Moorfoot Hills—	Tod's Cairns, ditto	2000
	Brown Dod, ditto	2086
	Black Hope Scars, highest point, ditto	2196
Cheviot Hills—	Carter-Fell, Roxburghshire	1502
	Tudhope, ditto	1830
	Millewood-Fell, ditto	2000
	Whinhead-Fell, ditto	2000
	Cheviot, Northumberland, highest point	2680
Lowther Hills—	Source of the Tweed, Peebles-shire	1500
	Tweed at Peebles	500
	Tintoc, Lanarkshire	2306
	Culter-Fell, ditto	2440
	Hart-Fell, borders of Dumfries and Peebles-shire	2635
	Whitecombe Edge, ditto	2685
	Broadlaw, Peebles-shire, culminating point of South Scotland	2741

2. The Central District extends from the former to Glenmore, or the great Caledonian glen, running north-east from Loch Linnhe to the Murray Firth, traversed by a chain of lakes, connected by the line of the Caledonian Canal. A vast extent of this region is occupied by mountains, comprising the highest summits of the United Kingdom. On the south-east an inferior range extends from Forfarshire to near Dumbarton, called in different parts of its course, from north-east to south-west, the Sidlaw, Ochill, Campsie, and Kilpatrick Hills. The grand chain is the Grampians, stretching, with various ramifications, from the coast of Aberdeenshire to the opposite coast of the island, and extending southwards in irregular masses of highlands towards the estuary of the Clyde.

	Heights.	Feet.
Southern Grampians—	Loch Lomond	22
	Ben Lomond (the bare or naked mountain), Stirlingshire	3191
	Ben Voirlich (mountain of great flat stones), Perthshire	3180
	Meal Girdy (the rejoicing height), ditto	3364



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	Heights.	Feet.
	Schiehallion (female fairy mount), Perthshire	3514
	Ben Lui (fawn mountain), ditto	3651
	Ben Chruachan, Argyleshire	3670
	Stobinian, Perthshire	3794
	Ben More (great mountain), ditto	3818
	Ben Lawers (echoing mountain)	3945
Central Grampians—	Bridge of Banchory, over the Dee, Kincardineshire	172
	Mount Battock, ditto	3460
	Ben Uarn, Aberdeenshire	3589
	Ben Gloe (mountain of outcry), Perthshire	3690
	Loch na Gar, Aberdeenshire	3777
	Ben Aven (river mountain), ditto	3967
	Source of the Dee, ditto	4060
	Cairngorm (the blue cairn), Inverness-shire	4095
	Mount Braeriach, Aberdeenshire	4220
	Cairntoul (cairn or hill of holes), ditto	4245
	Ben Mack Dui (black boar mountain), ditto	4305
	Ben Nevis, Inverness-shire, culminating point of the United Kingdom	4368

3. The Northern District, extending from the former to the Pentland Firth, is generally mountainous and bleak, the fertile spots occurring on the eastern coast.

Heights.	Feet.
Summit level of the Caledonian Canal	90
Ben Armin (gold-dust mountain), Sutherlandshire	2307
Morven (great mountains), Caithness-shire	2334
Ben Hee (fairy mountain), Sutherlandshire	2853
Ben Klibreck (mountain of the skirmish)	3165
Ben More, Assynt, ditto	3231
Ben Dearg (red mountain), Ross-shire	3551
Ben Wyvis (mountain of terror), ditto	3720
Ben Attow (rush mountain), ditto	4000
Cape Wrath, north point of Sutherlandshire	600
Dunnet Head, north point of Scotland (lantern of the lighthouse)	346

III. The important rivers, in the order of magnitude, are the Tay, Tweed, Clyde, Spey, Dee, and Forth, all of which empty themselves into the German Ocean, except the Clyde. The estimated discharge of the Tay, in its mean state, amounts to 218,159 cubic feet of water per minute.

	Area of Basin in Square Miles.	Length in Miles.	Principal Affluents.
Tay	2250	130 including the estuary.	Dochart, Lochie, Lyon, Tumel, Brand, Isla, Almond, and Earn.
Tweed	1870	96	Lyne, Gala, Ettrick, Yarrow, Leader, Adder, Teviot, and Till.
Clyde	1580	98	Duneaton, Avon, Medwin, Calder, and Kelvin.
Spey	1190	96	Dulnain and Aven.
Dee	765	87	Guishachan, Geauly, and Feugh W.
Forth excluding the estuary	645	110 including the estuary.	Teith, Allan, Devon, and Bannockburn.

Several of the rivers, having their sources at a considerable elevation above the sea, exhibit interesting and imposing waterfalls along their courses, of which those of the Clyde, near Lanark, are celebrated.

FALL OF THE CLYDE.

	County.	Length. Miles.	Height. Feet.	Fall per Mile Feet.
From Source	Lanark.	—	1400	—
To Clydesburn, near Little Clyde House	,,	1·8	999	222 8
Bodsberryside	,,	3·0	872	42·3
Crawford	,,	3·7	807	17 6
Affluence of Duneaton Water	,,	5·0	734	14·6
Hardington Hall	,,	3·7	686	13·0
Wolf Clyde, bridge near Biggar	,,	6 0	632	9 0
Eastfield	,,	8 4	605	3·2
Bonnington Fall, above the Fall, (height of fall, 30 feet)	,,	10·0	400?	20·5
Corra Linn (height 84 feet), above the Fall	,,	0·7	305	7·1 †
Stonebyres Fall (height 80 feet, below the Fall*	,,	3 0	170	10·3 †
Redleewood, near Daldowie House	,,	20 2	46	7 6 †
Glasgow, Glasgow Bridge	,,	9·0	?	?
Sea at Dumbarton	Dumbarton.	23·5	0	1·4
Total Length and Fall		98·0	1400	

* There are two other falls of smaller dimensions, viz., the Dundaf Linn, ¼ mile below Corra Linn, 4 feet high; and one which is ½ mile below Bonnington Fall. The total descent of the river, from the first to the last fall, a distance of 3·7 miles, amounts to 230 feet.

† The Falls excluded.

(A. Petermann, in "Hydrographical Map of the British Isles," 1849.)

The other considerable streams are the Leven, Eden, S. Esk, N. Esk, Don, Ythan, Doveran, Findhorn, Nairn, Ness, and Oikel, on the east coast; the Ayr on the west; the Nith, Arran, and Esk, on the south. The prominent hydrographical feature of Scotland is its numerous lakes, all of Highland origin, of which Loch Lomond, 24 miles long by 7 at the greatest width, is the largest belonging to Great Britain. The area of the principal is as follows:

	Square Miles.		Square Miles.
Loch Lomond	45	Loch Earn	9
Awe	30	Naver	9
Ness	30	Stennis	8
Shin	25	Rannoch	8
Maree	24	Leven	7
Tay	20	Fuir	6
Arkeig	18	Lydoch	6
Shiel	16	Ken	6
Lochy	15	Loyal	6
Laggan	12	Glas	5
Morrer	12	Katrine	5
Fannich	10	Doon	4½
Ericht	10	Luichart	3

IV. Scotland is politically divided into Thirty-three Counties:

COUNTIES.	Area in Sq. Miles.	Area in Eng. Acres.	Population in 1841.	County and Chief Towns.*
Aberdeen	1985	1,254,400	192,387	Aberdeen, 64; Peterhead, 5; Fraserburgh, 3.
Argyle	3800	2,002,560	97,371	Inverary, 1; Campbeltown, 5; Oban, 1.
Ayr	1600	664,960	164,356	Ayr, 8; Girvan, 7; Kilmarnock, 19.
Banff	500	412,800	49,679	Banff, 3; Cullen, 1; Portsoy.
Berwick, or Lauderdale	446	282,880	34,438	Greenlaw, 1; Dunse, 3; Coldstream, 2.
Bute	257	103,040	15,740	Rothsay, 5; Brodick.
Caithness	618	439,680	36,343	Wick, 1; Thurso, 2.
Clackmannan	48	30,720	19,155	Clackmannan, 5; Alloa, 5.
Cromarty	with Ross	with Ross	with Ross	Cromarty, 1.
Dumbarton, or Lennox	230	145,920	44,296	Dumbarton, 3; Helensburgh, 2.
Dumfries, or Nithsdale	1800	801,920	72,830	Dumfries, 11; Annan, 4; Moffat, 1.
Edinburgh, or Mid-Lothian	360	226,560	225,454	Edinburgh, 132; Leith, 26; Portobello, 3; Musselburgh, 6; Dalkeith, 4.
Elgin, or Moray	840	302,720	35,012	Elgin, 3; Forres, 2; Fochabers, 1.
Fife	504	291,880	140,140	Cupar, 3; St. Andrews, 4; Dunfermline, 7.
Forfar, or Angus	840	568,320	170,520	Forfar, 8; Dundee, 60; Montrose, 13; Arbroath, 7; Brechin, 3.
Haddington, or East-Lothian	250	174,880	35,186	Haddington, 2; Dunbar, 3; North Berwick, 1.
Inverness	4600	2,594,560	97,799	Inverness, 9; Fort William, 1; Portree in Skye.
Kincardine, or Mearns	317	243,200	33,075	Stonehaven, 3; Bervie.
Kinross	83	46,080	8,763	Kinross, 2.
Kircudbright, or East Galloway	882	525,760	41,119	Kircudbright, 2; New Galloway.
Lanark, or Clydesdale	870	602,880	426,972	Lanark, 4; Glasgow, 255; Hamilton, 8.
Linlithgow, or West-Lothian	112	76,800	26,872	Linlithgow, 3; Queensferry, 3.
Nairn	200	124,800	9,217	Nairn, 2.
Orkney and Shetland	1325	819,200	61,065	Kirkwall, 2; Stromness, 2; Lerwick, 2.
Peebles, or Tweeddale	360	204,160	10,499	Peebles, 1; Inverleithen.
Perth	2588	1,656,320	137,390	Perth, 19; Dunkeld, 1; Dumblane, 1; Crieff, 3.
Renfrew	241	144,000	155,072	Renfrew, 2; Paisley, 48; Greenock, 36.
Ross and Cromarty	2836	1,846,400	78,685	Tain, 2; Dingwall, 1; Stornoway, 1.
Roxburgh, or Teviotdale	715	457,600	46,025	Jedburgh, 2; Kelso, 4; Hawick, 5.
Selkirk, or Ettrick Forest	263	168,320	7,990	Selkirk, 1; Galashiels, 2.
Stirling	489	312,960	82,057	Stirling, 8; Falkirk, 8; Bannockburn, 2.
Sutherland	1754	1,122,560	24,782	Dornoch.
Wigton, or West Galloway	451	288,[illegible]60	39,195	Wigton, 1; Stranraer, 3; Portpatrick, 2.
	31,164	18,944,000	2,620,184	
On Mainland	26,000	16,332,800	2,450,764	
On Islands	5,164	2,611,200	169,420	
	31,164	18,944,000	2,620,184	

* The figures denote the population in round numbers of thousands. Where no figures occur, the population is under a thousand.

Edinburgh, the capital, the emporium of literature, is in 55° 57′ 20″ N. lat., and 3° 10′ 30″ W. long. It contained in 1841, 132,977 inhabitants, exclusive of the port of Leith. The population of Glasgow, the chief commercial mart, amounted at the same date to 255,650.

V. Scotland remarkably contrasts in geological structure with England, the characteristic points of difference being the great predominance of igneous and metamorphic masses, and the almost entire absence of the more recent secondary and tertiary formations. The superficial area of the granitic rocks, which in England is under 300 square miles, is estimated at 1760 miles in Scotland; and, excluding the whole clay-slate, the metamorphic rocks, gneiss, quartz, and mica-slate, amount to more than 13,600 square miles, or nearly one-half the surface; while in England they are only about 600 square miles, or little more than a hundredth part. On the other hand the oolite, and formations more recent than the carboniferous epoch, which in England cover about two-thirds of the country, scarcely comprise 60 square miles in Scotland. The surface may be divided into three districts, each distinguished by the prevalence of a great and well-marked rock formation,—the Southern or Transition Region, the Central or Secondary, and the Northern or Primary, which differ in their limits from the three geographical divisions already noticed.

1. The Southern or Transition District comprehends the country between the English border and the northern base of the southern mountain-land, a line extending generally from about St. Abb's Head on the coast of Berwickshire south-west to near Girvan on the coast of Ayrshire. The characteristic rock is the clay slate, with which some tracts of old red sandstone are associated, a few carboniferous patches, and protruding masses of granite and trap. Area, about 1500 square miles.

2. The Central or Secondary District extends from the former to the southern base of the northern mountain-land, a line running generally from near Roseneath and Helensburgh on the Firth of Clyde, north-east by Aberfoyle and Dunkeld to Stonehaven on the coast of Kincardineshire. It forms a trough-shaped valley, composed of the older secondary strata, the old red sandstone and carboniferous formations. Among igneous rocks granite is wanting, but all the varieties of trap occur in the greatest force in this district, which have dislocated the strata, and tilted up the coal beds by their protrusion. Area, about 5000 square miles.

3. The Northern or Primary District embraces the country north and west of the preceding region. It consists principally of the metamorphic or primary stratified rocks, gneiss, and mica-slate, with various quartz tracts and fringes of the old red sandstone along the coasts. Among the igneous formations, granite occurs here most extensively, especially in Aberdeenshire. Area, about 16,000 square miles.

The relative extent of the prominent formations in each district, and in the whole mainland of Scotland, is thus approximately stated in square miles by Mr. Nicol:

	South.	Centre.	North.	Whole of Scotland.
Gneiss	—	—	9600	9600
Quartz rock	—	—	800	800
Mica-slate, &c.	—	—	3250	3250
Clay-slate	4100	—	650	4750
Old red sandstone	450	2050	2400	4900
Coal formation	250	1500	—	1750
Oolite	—	—	60	60
Total strata	4800	3550	16,760	25,110
Granite	160	—	1600	1760
Trap	200	1350	1200	2750
Total igneous rocks	360	1350	2800	4510

VI. Small grains of native gold have frequently been met with in the beds of streams, and also immediately under the vegetable soil, but not in sufficient quantities to render the search profitable. Yet it is related, that Sir David Bulmer, master of the Mint to Queen Elizabeth, employed 300 men for several summers in searching for the precious metal, who collected £100,000 worth; and it is well known to have been used at the Scottish Mint, though the amount is probably exaggerated. The largest specimen, weighing nearly eight sovereigns, obtained from the Breadalbane estate, near Glen Coich in Perthshire, is now in one of the Edinburgh mineralogical cabinets. Ironstone in beds and masses is found in considerable abundance in the coal-fields, and largely smelted. The richest lead mines are those of Leadhills and Wanlockhead in the Lowther Hills, on the borders of Lanarkshire and Dumfries-shire, which have called forth life and cultivation in a most bleak and mountainous situation. But excluding iron, the country is poor in metallic products, its mineral wealth consisting of coal and admirable building materials—sandstone, roofing-slate, granite, and variegated marble. The coal district extends in a succession of detached beds across the island from Fifeness on the east to the Ayrshire coast; also through the Lothians south and east of Edinburgh; small patches occurring in different parts of the south of Scotland. Near Dunfermline, coal appears from an old charter to have been wrought in the year 1291, probably the oldest record of it in Scotland, and only surpassed by two notices in England,—one about 1234, and the other 1284. The reddish-coloured granite of Aberdeenshire is extensively used in London for building and paving purposes; the serpentine of Portsoy has been exported to France to adorn the palace at Versailles; and various ornamental stones are yielded by the Cairngorum portion of the Grampians, magnificent topazes of a sky-blue colour, beryls, and the brilliant quartz crystals named after the locality.

Mineral Springs.—Saline, at Dumblane and Airthrey, near Stirling; Pitcaithly, near Perth; Innerleithen, near Peebles. Sulphurous, at Strathpeffer, in Ross-shire; Moffat, in the Vale of Annan, Dumfries-shire; St. Bernard's Well, near Edinburgh. Chalybeate, at Bonnington, near Edinburgh; Vicar's Bridge, in Stirlingshire; Hartfell Spa, near Moffat. The Starley Burn, a spring on the coast of Fifeshire, deposits considerable masses of semi-transparent sinter and calcareous tufa, incrusting shells, leaves, and plants. Scotland has no thermal springs.

VII. The prominent articles of productive industry are cotton and silk goods, Glasgow and Paisley being the principal seats of the manufacture; linens at Dundee, Dunfermline, and other places in the eastern counties: woollens at Aberdeen, Galashiels, and Kilmarnock; iron at Carron, near Falkirk, one of the largest establishments in the world; and the distillation of spirits. The northern whale fishery is as extensively prosecuted as in England. The salmon fisheries of the Tweed, Tay, Don, Dee, Spey, and Findhorn; and the herring fisheries of the coasts are important sources of employment and subsistence, the produce being chiefly sent to the London market. The chief ports, according to the amount of import duties collected, rank as follows: Leith, Glasgow, Greenock, Port Glasgow, Dundee, Aberdeen, and Montrose. In relation to cultivation, about three-fourths of the surface are unimproved, and largely incapable of improvement; and more than half the remaining fourth is in grass. The distribution has thus been estimated:

	Acres.
Arable and gardens	2,493,950
Meadows, Pastures, and Marshes	2,771,050
Wastes capable of improvement	5,950,000
Wastes incapable of improvement	8,523,930
	19,738,930

Annual Value of tillage produce	£ 13,355,875
" of grass lands	4,979,450
" of mountain pasture, waste land, and plantations	2,100,000
Total Annual value of land produce	£ 20,435,325

Oats are most extensively grown, oatmeal forming the chief food of the people. In no country is agriculture as a science better understood, and conducted upon more enlightened principles. The farming in the Lothians, the plain of Gowrie, and other parts, has become proverbial for excellence.

VIII. Scotland furnishes a remarkable example of rapid physical and social improvement. Half a century ago, owing to the natural difficulties presented by the Highlands to intercommunication, the great proportion of the people in those districts were strangers to the habits and conveniences of civilised life, and incompetent to manage the commonest industrial occupations. It was stated in relation to Sutherlandshire, before the Select Committee on Public Works, which sat during the Parliamentary session of 1835, that at the period in question it was necessary to get ploughmen from Elgin and that side of the Moray Firth, and that there was not a person who could build a stone wall, the ordinary mode of inclosing land in that country. But the Sutherlanders have become most industrious workmen in every department of agricultural labour, in common with others inhabiting the wilder and less accessible districts, addicted formerly to a lawless, unsettled life,—a result greatly owing to the facilities for intercommunication supplied under the auspices of Government. The Board of Works, between 1803 and 1835, caused the construction of nearly 900 miles of roads, and more than 1000 bridges in the Highlands. The entire length of the turnpike-roads of Scotland is now somewhat less than 4000 miles, and are admirably constructed, owing to the abundance of suitable materials. The railways extend 728 miles. The canals are not numerous, the irregular character of the surface opposing inland navigation. The two most important are the Great Canal, connecting the Firths of Forth and Clyde, and the Caledonian, a series of cuts and navigable lochs, extending from Corpach Basin, in the tideway of Loch Eil, near Fort William, to the Murray Firth on the west side of Inverness. The total length is $60\frac{1}{2}$ miles; of which 23 miles are artificial cutting, and 37 miles are natural lakes, which have been rendered navigable. There are 28 locks; 8 of which, situated at the eastern side, have received the name of Neptune's Staircase. The total cost of this magnificent work, intended to facilitate trade between the Baltic, the west ports of Scotland, and Ireland, amounted to £1,005,770. Along with physical improvement, the advantages of education, long enjoyed in the Lowlands, have been extended to the Highlands; and generally owing to the admirable institution of parochial schools, the instructional state of the lower orders is far superior to that of their southern neighbours. There are four Universities—at St. Andrews, the most ancient; and next in order of seniority, are the Universities of Glasgow, Aberdeen, and Edinburgh.

IX. The climate of Scotland is more rigorous than that of England, from its higher northern latitude, and the greater general elevation of the surface; but much more temperate than in parallel continental countries, the lakes, harbours, and estuaries being perfectly open, when the navigation of the Baltic and of the Elbe is closed by the ice. Mr. Watson gives the following results of observations respecting the progress of the seasons as indicated by that of the vegetation:

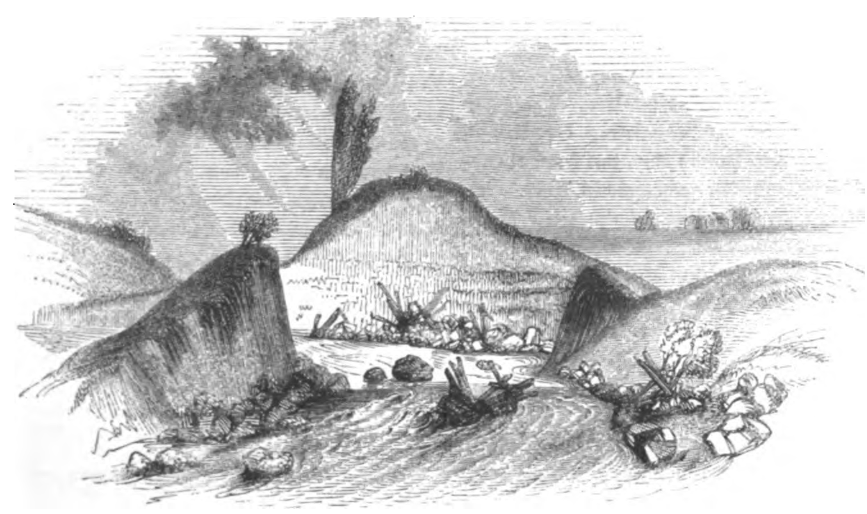
	Days.
Barnstaple in Devonshire earlier than Nairnshire by	12
than Elgin by	17½
than Strathpeffer by	30
Keswick in Cumberland earlier than Nairnshire by	6

The annual fall of rain is nearly twice as great on the western as on the eastern side; and hence the eastern districts are the best adapted for the ripening of grain. Wheat will not ripen further north than Inverness, nor in more southerly situations is its cultivation worth attending to above the elevation of 750 feet, while the barley produced is inferior in quality to the English product. Several fruits are rarely matured, and are never raised in the same perfection as in South Britain; but the berry-bearing plants, as the gooseberry, better adapted to cold than to warm climates, acquire a delicious flavour unknown in England. The hazel ripens its nuts in the latitude of the Grampians at the height of 500 feet.

X. The entire flora comprises about 1155 species. It corresponds generally to that of England in the low grounds, but presents in the Highlands a special vegetation to the botanist, different in every respect from that of the plains; the same type occurring, though much less plentifully, in the mountainous tracts of Cumberland and Wales. In Skye, Coll, and a few of the neighbouring islands of the Hebrides, the jointed pipewort (*eriocaulon septangulare*) is seen, which, excepting Ireland, is found nowhere else in Europe, but is common in Canada; and on Werron Hill in Glen Clova, Forfarshire, the three-toothed cinquefoil (*potentilla tridentata*) occurs, not known elsewhere in Europe, but abundant in arctic America. Numerous trees found in the mosses and marshy ground in various parts indicate that the country, generally deficient in old timber, was formerly covered with extensive forests. The common maple and beech are rare. Oaks of stunted growth form coppices in some of the Grampian glens. The aspen frequently occurs, and even at an elevation of 1500 feet above the level of the sea, on Ben More in Mull. Different species of willow, some of large size, are common; others of the herbaceous kind ascend to the summits of the mountains. The broad-leaved or wych elm is abundant; the drooping variety of the birch, "with long dishevelled hair," is also frequently met with in the Highlands; but the characteristic tree of that district is the pine, or Scotch fir, "moored in the rifted rock," where it constitutes vast natural forests. On ascending the loftiest mountains, nine-tenths of the species observed at the base cease to appear before reaching their summits; those which continue to attend the traveller are usually flowerless and dwarfed, as the effect of elevation; but new species are encountered, never found on the plains, flourishing in the fullest vigour, analogous to the vegetation on the coasts of polar lands, and on the snow-crowned crests of the Alps.

Of the Alpine plants of Scotland Dr. Balfour remarks: "Their comparative rarity, the localities in which they grow, and frequently their beautiful hues, conspire in shedding around them a halo of interest far exceeding that connected with Lowland productions. The Alpine veronica displaying its lovely blue corolla on the verge of dissolving snows; the forget-me-not of the mountain summit, whose tints far excel those of its namesake of the brooks; the woodsia with its tufted fronds adorning the clefts of the rocks; the snowy gentian concealing its eye of blue in the ledges of the steep crags; the Alpine astralagus enlivening the turf with its purple clusters; the lychnis choosing the stony and dry knoll for the evolution of its pink petals; the sonchus (*mulgedium*) raising its stately stalk and azure heads in spots which try the enthusiasm of the adventurous collector; the pale-flowered oxytropis confining itself to a single British cliff; the azalea forming a carpet of the richest crimson; the saxifrages with their white, yellow, and pink blossoms, clothing the sides of the streams; the sausurea and erigeron crowning the rocks with their purple and pink capitula; the pendant cinquefoil blending its yellow flowers with the white of the Alpine cerastimus and the bright blue of the stony veronica; the stemless silene giving a pink and velvety covering to the decomposing granite; the yellow hieracia, whose varied transition forms have furnished such a fertile cause of dispute among botanists; the slender and delicate grasses, the chickweeds, the carices, and the rushes, which spring up on the moist Alpine summits; the graceful ferns, the tiny mosses with their urn-like thecæ; the crustaceous dry lichens with their spore-bearing apothecia: all these add such a charm to Highland botany as to throw a comparative shade over the vegetation of the plains."

XI. The animal kingdom offers no important differences from that of England. The roebuck and red-deer are numerous in the Highlands, and rare apart from them, the roe not being known in South Britain. The golden eagle constantly rears its young in the northern and western isles; the osprey haunts most of the mountain lochs; the peregrine falcon and black cock are generally distributed; the ptarmigan is found on the higher ranges of hills; and owing to the spirited efforts of several landed proprietors procuring pairs of the capercaillie or wood-grouse from Norway and Sweden, that noble bird will probably be re-established in the forests, after a long period of banishment.



Moray Floods at the Rhymer's Hill.

IRELAND.

I. **Ireland** is bounded on the east by St. George's Channel, the Irish Sea, and North Channel; and on the western, northern, and southern sides by the Atlantic Ocean.

Latitudinal limits.—51° 25′ N. Mizen Head, Cork, and 55° 20′ N. Malin Head, Donegal.

Longitudinal limits.—5° 20′ W. Ballyholbal, county Down, and 10° 20′ W. Cape Sybil, Kerry.

Extent.—The linear measurements and area are given in connection with the British Isles. Embracing the estuaries as far as the tide penetrates, the coast-line is estimated at 2200 miles. The principal lines of communication between Great Britain and Ireland are as follows:

	Miles.
From Londonderry to Glasgow	161
Belfast to Glasgow	129
Belfast to Liverpool	156
Belfast to Fleetwood	120
Donaghadee to Portpatrick	23½
Dublin to Glasgow	223
Dublin to Liverpool	138
Dublin to Holyhead	73½
Dublin to Port-Dinnlleyn	70
Dublin to Bristol	222
Waterford to Milford Haven	90
Waterford to Bristol	219
Cork to Bristol	264
Cork to Plymouth	240

Estuaries and Inlets—The most numerous and important are on the south-west, west, and north-west coasts, comprising some of the finest harbours in the world. Cork Harbour, a magnificent land-locked basin, may be entered at any hour of tide by the largest vessels, close to the quays at Cove; and Bantry Bay is an equally admirable roadstead, sufficiently capacious to contain the entire naval force of Great Britain. Kinsale Harbour, formed by the estuary of the Bandon; Waterford Harbour, the estuary of the Suir, Noir, and Barrow; Kenmare River, a considerable arm of the sea; Dunmanus Bay and Dingle Bay; the estuary of the Shannon; Galway Bay, Kilkerrin Bay, Clew Bay, Sligo Bay, and Donegal Bay, with several others, are convenient and safe retreats for shipping. On the north coast, Lough Swilly, penetrating inward about 25 miles with deep water, and Lough Foyle, a very large oval basin, encumbered with sandbanks, are the principal Gulfs. Few inlets occur on the east coast; Wexford Harbour, Dublin Bay, Dundalk Bay, Carlingford Bay, Lough Strangford, and Belfast Lough, are the most important, but are either shallow or obstructed with bars and shoals at their entrances, except Lough Strangford, the mouth of which is rendered dangerous by sunk rocks, and the impetuous rush of the tide.

Capes.—Clogher Head, Howth Head, Wicklow Head, Greenore Point, and Carnsore Point, on the coast of Leinster; Brownstown Head, Helwick Head, Ardmore Point, Poole Head, Old Head of Kinsale, Cape Clear on Clear Island, Mizen Head, Crow Head, Brea Head on Valentia Island, Cape Sybil, Kerry Head, Loop Head, and Black Head, on the coast of Munster; Slyne Head, Achris Point, Achill Head on Achill Island, Urri's Head, and Rosskeragh Point, on the coast of Connaught; St. John's Cape, Telling Head, Bloody Farland Point, Horn Head, Malin Head, Giant's Causeway, Fair Head, Geron Point, and Cranfield Point, on the coast of Ulster.

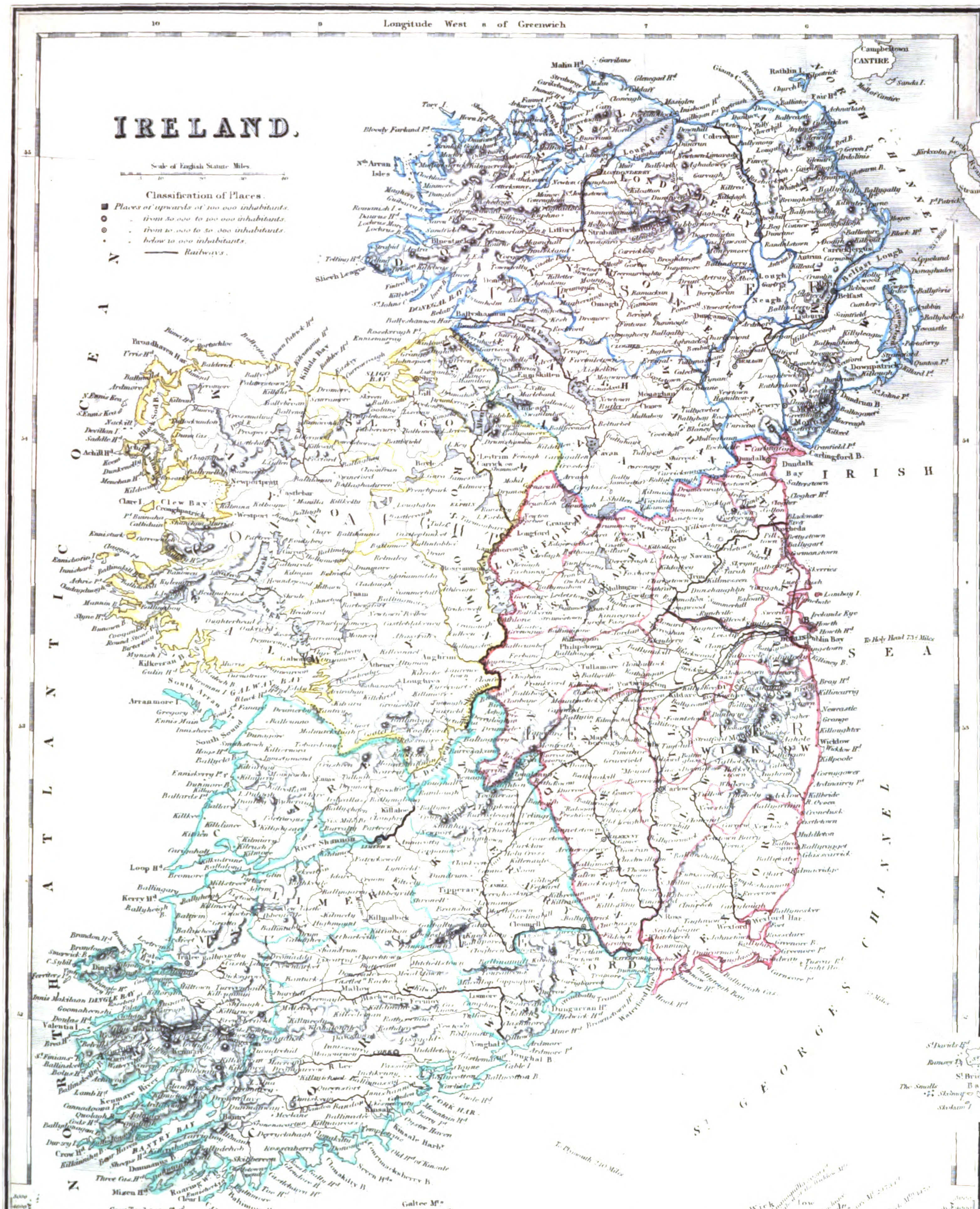
II. The general surface of the country consists of an immense central plain, with Alpine tracts situated external to it, or rising up on its borders. The plain extends east and west from sea to sea, almost everywhere undulating, Howth Hill rising 549 feet on the north side of the entrance to Dublin Bay, but from thence to Galway Bay, no eminence attains that height; Moat-a-grenogue in Westmeath, the most elevated point, being only 322 feet above the level of the sea. North and south it extends from the counties of Sligo and Fermanagh to the borders of Cork and Waterford. The mountains are of limited extent and height, and only retain the snow on their summits for an inconsiderable period. On the east coast are the Mourne Mountains, in the south of county Down, and the Wicklow Mountains, which stretch from near Dublin into Carlow. On the south and south-west are the Keeper and Galtee Mountains, detached ranges in Tipperary, with the Knockmeledown and other ridges extending, under various names, from Waterford to the Macgillicuddy Reeks in Kerry. On the north-west and north are the Carntogher Mountains bordering Londonderry and Tyrone, and extensive tracts of hilly country in Antrim, Donegal, Mayo, Sligo, and Galway.

Heights.		Feet.
Mourne Mountains	Slievecrood	1755
	Eagle Mountain	2084
	Slievedonard	2796
Carntogher Mountains	Carntogher	1521
	Benbradah	1530
	Slievegallion	1730
	Slievesawell	2236
Mountains of Donegal	Slieveleague	1965
	Slievenaght	2019
	Muckish	2190
	Bluestack	2213
	Erigal	2462
Wicklow Mountains	Great Sugar Loaf	1651
	Mount Croghan	2054
	Kippure	2473
	Lugnaquilla	3039
Knockmeledown Mountains		2700
Galtee Mountains		3000
Keeper Mountains		2265
Mountains of Cork	Mount Gabriel	2335
	Hungry Hill	2248
Mountains of Kerry	Knockline	2160
	The Paps	2280
	Mangerton	2754
	Slievemish	2799
	Mount Brandon	3120
	Carn Tual, culminating point of Ireland	3404
Mountains of Galway	Beinnocoire	2337
	Twelve Pins	2396
Mountains of Mayo	Slievemore, Achill Island	2184
	Mount Crogham, ditto	2250
	Croaghpatrick	2499
	Nephin	2639
	Mulrea	2680

III. The great central plain consists of carboniferous limestone, the most extensive rock formation of the island, occupying nearly two-thirds of the surface, largely overlaid with limestone,—gravel and clay forming a soil of remarkable fertility. The old red sandstone appears also in considerable force in the plain and in the mountain tracts; but the latter are principally composed of metamorphic sedimentary rocks, varieties of slate, with quartz and primary limestone; and of igneous masses, granite, sienite, greenstone, and trap. One of the most striking features of Irish geology is the vast deposit of trap on the north-east, occupying almost the whole county of Antrim, and a large portion of the east of Londonderry, on both sides of the valley of the Bann. Newer secondary formations, chiefly chalk, are here overlaid with tabular basalt, approaching in some places to 1000 feet in thickness, and averaging upwards of 500 feet, extending through an area of 800 square miles. On the coast, the basalt exhibits the columnar structure, and forms the celebrated Giant's Causeway. Decisive evidence appears of its having been erupted in a state of igneous fusion, from the metamorphic change of the secondary strata at the points of contact, sandstone having been converted into hornstone, clay-slate into flinty-slate, coal into cinders, and chalk into granular limestone. The Causeway bears a strong resemblance to an artificial mole projecting from the base of the cliff into the sea. The columns are chiefly hexagonal, but polygons of five, seven, and eight sides are frequent, and one triangular prism occurs. The important mineral products of Ireland include coal, iron, copper, and lead.

The coal districts of the south are in Kilkenny, Carlow, Queen's County, Tipperary, Clare, Limerick, Kerry, and Cork. There are also a few pits in the north, in Tyrone, in Roscommon, Monaghan, and Antrim. But generally, the coal of Ireland is of inferior quality, and the workable fields are of unimportant extent. Iron is abundant, but the want of good coal hinders its being worked. The most valuable copper and lead mines are in Waterford, Kerry, and Cork. Towards the close of the last century native gold in grains and masses was found in the alluvium of the Ballinvalley streams in Wicklow. Besides what was gathered by the peasantry the Government collected 950 ounces, valued at £3675; but the works were abandoned, as the supply did not meet the expenditure. The highly interesting question remains to be solved respecting the matrix or source of the gold, which might possibly amply repay further investigation.

IV. An immense extent of the surface is occupied with bogs, estimated in the whole to exceed 2,800,000 acres. They consist of vegetable matter, the *sphagnum palustre* and other mosses, the production of which is induced by



Drawn & Engraved by J. Dower Pentonville London

pent-up moisture. The lower part of the vegetation decomposing forms a soil, while the upper portion continues to flourish vigorously,—the whole assuming the state of a spongy mass of sufficient consistence to bear a considerable weight. The thickness is said to be nowhere less than 12 feet, nor more than 42, averaging 25 feet. In the Ordnance Survey one process of the formation of bog is thus explained:—"A shallow pool induced and favoured the vegetation of aquatic plants, which gradually crept in from the borders to the deeper centre. Mud accumulated round their root and stalks, and a spongy, semi-fluid mass was thus formed, well fitted for the growth of moss, which now, especially *sphagnum*, began to luxuriate. This, absorbing a large quantity of water, and continuing to shoot out new plants above, while the old were decaying, rotting, and compressing into a solid substance below, gradually replaced the water with a mass of vegetable matter. In this manner the marsh might be filled up, while the central and moister portion, continuing to excite a more rapid growth of the moss, it would be gradually raised above the edges, until the whole surface had attained an elevation sufficient to discharge the surface-water by existing channels of drainage, and calculated by its slope to facilitate the passage, when a limit would be in some degree set to its further increase."

A line drawn from Wicklow Head to Galway, and another from Howth Head to Sligo, would include the greater part of the bogs of Ireland. The district thus bounded forms a broad belt extending east and west, narrowest towards Dublin, and gradually expanding towards the Atlantic, intersected by the Shannon from north to south. The bogs not included in this district are either small, or mountain-bogs. They occur, north of the belt, in Antrim, Down, Armagh, Tyrone, and Londonderry; southwards, in Queen's County, Kilkenny, Tipperary, and Clare.

V. Few countries of the same extent possess so many facilities for inland navigation, and have an equal amount of water-power fitted for industrial purposes, afforded by rivers, lakes, and natural dams. The Shannon, the principal river, ranks third among the streams of the United Kingdom in regard to the extent of its basin, draining an area of 6,946 square miles, yielding only in this respect to the Humber and the Severn; but its line of navigation surpasses that of any river belonging to the British Isles, amounting to 213 miles from the entrance of the estuary, the navigation of the Thames extending only 193 miles from the Nore Light, and of the Severn 192 miles from its mouth. This noble stream has its source in a limestone cavern in the county of Cavan. It then passes through a series of lakes, some of the most capacious in the island, or rather forms them by its own expansions, dividing Leitrim, Longford, and Westmeath from Roscommon, Tipperary from Galway, and Limerick from Clare, on its way to the Atlantic, exhibiting the somewhat rare occurrence of its fall being the greatest in the lower parts of its course. Out of an entire fall of 345 feet in 225 miles, it descends 97 feet in about 17 miles, between Killaloe and Limerick, forming there the Rapids of Doonas, where the navigation is conducted by a lateral cut.

FALL OF THE SHANNON.

	County.	Length. Miles.	Height. Feet.	Fall per Mile Feet.
From Source, Legnashinna, the Shannon Pot	Cavan.	—	245·0	—
To Lough Allen, entrance	Leitrim.	11·6	161·0	15·9
Lough Allen, issue	Leit.& Roscom	7·0	161·0	—
Carrick-on-Shannon bridge	,,	11·5	155·0	0·5
Lough Boderg and Lough Bofin, entrance	,,	12·0	131·0	2·0
Lough Boderg and Lough Bofin, issue	,,	4·7	131·0	—
Lough Forbes, entrance	Ro.& Longford	4·6	128·0	0·7
Lough Forbes, issue	,,	2·2	128·0	—
Lough Ree, entrance, at the bridge of Lanesborough	,,	10·0	125·5	0·2
Lough Ree, issue, 1·8 miles above the bridge of Athlone	Ros.& Westmc	17·5	125·5	—
Shannon bridge	Ros.& King's C	16·7	116·0	0·6
Lough Derg, entrance, 1 mile S. from Portumna bridge	Galway & Tipp	22·6	110·5	0·2
Lough Derg, issue, 1·1 mile N. from bridge of Killaloe	Clare & Tipp	23·0	110·5	—
Castle Connel	Cla & Limerick	9·8	89·8	2·1
Castle Troy	,,	3·9	31·5	14·2
Limerick, Athlunkard bridge	Limerick.	3·4	13·5	6·2
The Sea, between Loop and Kerry Head	Clare & Kerry	64·5	·0	0·2
Total Length and Fall		225·0	345·0	

(A. Petermann, in "Hydrographical Map of the British Isles," 1849.)

The next important river-system is that of the Barrow, Suir, and Noir, sometimes called the Three Sisters, from their sources lying in the same ridge of mountains, and their junction, after a long separate course, before reaching the sea. They rise in the Slievebloom Mountains, drain Tipperary, Queen's County, Kilkenny, and Carlow, with part of King's County, Kildare, Wexford, and Waterford, and have their common estuary in Waterford Harbour. The Lee, which terminates its course in Cork Harbour; the Blackwater, in Youghal Bay; the Slaney, in Wexford Harbour; the Liffey, in Dublin Bay; the Boyne, below Drogheda; the Foyle, in Lough Foyle; and the Bann, which flows through Lough Neagh to the north coast of Antrim, are the other considerable streams.

VI. The lakes, principally situated in the northern and western districts, comprise a superficial area of 455,399 acres. Those of small dimensions are very numerous. The larger expanses are Lough Neagh and Erne in Ulster; Lough Corrib, Mask, and Conn, in Connaught; and Lough Ree and Derg, forming part of the boundary of Connaught, Leinster, and Munster.

Lough Neagh, the largest lake belonging to the United Kingdom, extends about 20 miles by 12, and covers 100,000 acres. Its waters are remarkable for their petrifying quality. Greatest depth, 102 feet. Height above the level of the sea, 48 feet. It has several affluents, and discharges itself by the single outlet of the Lower Bann. In the severe frost of 1740, it was frozen over so as to bear men on horseback, but several circular spaces remained free from ice, supposed to be the sites of subaqueous springs.

Lough Erne traverses the county of Fermanagh in two basins connected by a winding channel, their united area amounting to 40,000 acres. The northern and lower basin is by far the largest and deepest. Greatest depth, 230 feet. Height above low-water mark, 148 feet. The depth is singularly irregular, in one instance varying 120 feet in a few yards. Both basins are crowded with islands.

Lough Corrib in Galway extends 22 miles in length by from 2 to 12 in breadth, and covers 30,000 acres. It is separated by a narrow isthmus from Lough Mask and Carra. The three lakes present a surface of 64,000 acres, and have a coast line of 200 miles.

Lough Conn in Mayo extends 11 miles in length, has a coast line of 53 miles, and a surface of 14,000 acres.

Lough Ree and Derg are large expansions of the Shannon. The lakes of Killarney in Kerry, renowned for their beauty, are comparatively small.

VII. Ireland is divided into 4 provinces, and subdivided into 32 counties. The province of Ulster contains 9 counties; Leinster 12; Connaught 5; and Munster 6.

Counties.	Area in Statute Acres.	Population.	County and Chief Towns.*
1. ULSTER.			
Antrim	762,453	360,875	Carrickfergus, 3; Antrim, 2; Belfast, 75; Lisburn, 6.
Armagh	328,076	232,393	Armagh, 10.
Cavan	477,360	243,158	Cavan, 3.
Donegal	1,193,443	296,448	Lifford; Donegal, 1; Ballyshannon, 3.
Down	611,919	361,446	Downpatrick, 4; Newry, 11; Dromore, 2.
Fermanagh	457,195	156,481	Enniskillen, 5.
Londonderry	518,595	222,174	Londonderry, 15; Coleraine, 6.
Monaghan	319,757	200,442	Monaghan, 4; Clones, 2.
Tyrone	806,640	312,956	Omagh, 2; Dungannon, 3; Strabane, 4; Clogher.
Total for Ulster	5,475,438	2,386,373	
2. LEINSTER.			
Carlow	221,342	86,228	Carlow, 10.
Dublin	226,414	372,773	Dublin, 232; Kingstown, 7.
Kildare	418,436	114,488	Athy, 4; Kildare, 1; Naas, 3.
Kilkenny	509,732	202,420	Kilkenny, 19; Thomastown, 2.
King's County	493,985	146,857	Tullamore, 6; Philipstown, 1.
Longford	269,409	115,491	Longford, 4; Granard, 2.
Louth	201,906	128,240	Drogheda, 17; Dundalk, 10; Carlingford, 1.
Meath	579,899	183,828	Trim, 2; Kells, 4; Navan, 5.
Queen's County	424,854	153,920	Maryborough, 3; Portarlington, 3.
West Meath	453,468	141,300	Mullingar, 4.
Wexford	576,588	202,033	Wexford, 11; New Ross, 7.
Wicklow	500,178	126,143	Wicklow, 2.
Total for Leinster	4,876,211	1,973,721	
3. CONNAUGHT.			
Galway	1,566,354	440,198	Galway, 17; Tuam, 6; Loughrea, 5.
Leitrim	392,363	155,297	Carrick on Shannon, 1; Leitrim.
Mayo	1,363,882	388,887	Castlebar, 5; Westport, 4; Killala, 1.
Roscommon	607,691	253,591	Roscommon, 3; Elphin, 1; Boyle, 3.
Sligo	461,753	180,886	Sligo, 12.
Total for Connaught	4,392,043	1,418,859	
4. MUNSTER.			
Clare	827,994	286,394	Ennis, 9; Killaloe, 2; Kilrush, 5.
Cork	1,846,333	854,118	Cork, 80; Kinsale, 6; Fermoy, 6; Youghal, 9; Mallow, 6.
Kerry	1,186,126	293,880	Tralee, 11; Dingle, 3; Killarney, 7.
Limerick	680,842	330,029	Limerick, 48.
Tipperary	1,061,731	435,553	Clonmell, 13; Tipperary, 7; Thurles.
Waterford	461,553	196,187	Waterford, 23; Dungarvon, 8; Lismore, 3.
Total for Munster	6,064,579	2,396,161	
Connaught	4,392,043	1,418,859	
Leinster	4,876,211	1,973,721	
Ulster	5,475,438	2,386,373	
Total for Ireland	20,808,271	8,175,114	

* The figures denote the population in round numbers of thousands. Where no figures occur, the population is under a thousand.

A few entries occur in the Report of the Irish Census Commissioners for 1841, bearing on the relation between population and area, which are here inserted:

	Whole Area in Square Miles.	Pop. to Sq. Mile of Whole Area.	Area of Arable Land in Square Miles.	Pop. to Sq. Mile of Arable Land.
Leinster . . .	7595	202	6190	247
Munster . . .	9453	212	6054	332
Ulster	8547	253	5324	406
Connaught . .	6857	195	3407	386
	Total 32,452	Average 217	Total 20,975	Average 335

Dublin, the capital and seat of the Vice-regal court, occupies a plain on both sides of the river Liffey, at its entrance into Dublin Bay, 334 miles N.W. of London by Holyhead. The site, near the middle of the east coast of the island, is central with reference to the United Kingdom. Lat. of Dublin Castle, 53° 10′ 38½″ N.; long., 6° 17′ 29″ W.

VIII. Linen is the staple article of manufacture, introduced in the reign of Charles I. by the Earl of Strafford, who brought flax seed from Holland, and hired foreigners to teach the process of production. It is chiefly carried on in Ulster. Woollen, cotton, and muslin fabrics are also produced, but upon a small scale. The country is essentially pastoral and agricultural, supplying Great Britain with vast quantities of live stock, dairy produce, and other articles of provision. The principal commercial ports, in order of importance, are Belfast, Cork, Waterford, and Londonderry. The number of vessels registered in all the ports of Ireland on Dec. 31, 1847, was as follows:

		Tonnage.
Sailing-vessels under 50 tons	1075	30,717
above 50 tons	1140	211,072
Steam-vessels under 50 tons	12	417
above 50 tons	92	23,350

In 1847, the Earl of Clarendon, as Lord-Lieutenant, instituted an inquiry to ascertain as clearly as possible the actual amount of land under cultivation in Ireland that year, with the kinds and quantities of produce grown, employing the constabulary force on the vast and intricate enterprise. The country was divided into 60,760 sections, concerning each of which no fewer than twenty-four entries of facts were made, amounting to a grand total of nearly a million and a half of returns. Some results may be given:

	Acres.	Proportion to whole Area about
Extent of Land under crops of all kinds . . .	5,238,575	One-fourth.
under corn culture	3,313,579	One-sixth.
under oats	2,200,870	One-ninth.
meadow and clover	1,138,946	One-eighteenth.

Thus twice as much oats was cultivated as of all other kinds of grain together. Taking the produce in connection with the population at the last census, it was found that the cereal food produced gave 698lbs. for each individual, and the potatoes, 561lbs.,—equal to about 2lbs. of cereal food and 1½lbs. of potatoes per day per individual. The live stock amounted to the following numbers:

	Horses & Mules.	Asses.	Cattle.	Sheep.	Pigs.	Goats.	Poultry.
Leinster......	175,698	34,598	669,320	743,823	205,010	42,492	1,674,039
Munster......	160,305	32,289	729,819	608,124	261,243	60,999	1,684,775
Ulster.........	155,597	22,239	834,874	238,493	111,733	40,891	1,567,587
Connaught..	66,317	37,229	357,402	595,737	44,473	19,661	764,654
Total...	557,917	126,355	2,591,415	2,186,177	622,459	164,043	5,691,055

On comparing this enumeration with a similar return in 1841, there is a formidable diminution exhibited in the usual productions of the smaller holdings, amounting in the instance of poultry to upwards of two millions and a half, and of pigs to more than three-quarters of a million; a significant proof of the calamitous season of 1846.

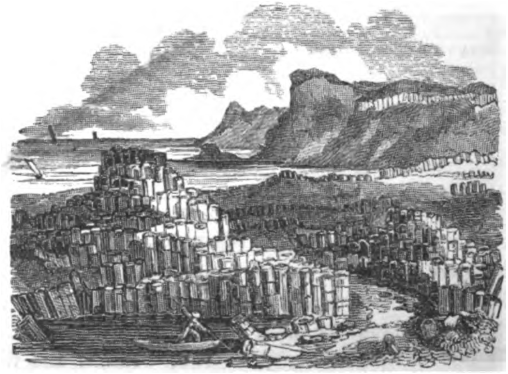
IX. The social and physical condition of the population presents the appalling features of a vast proportion pauperised, ill-clad, and wretchedly housed, subsisting on the extreme verge of the most ordinary natural supply, numbers perishing from absolute want. The case seems to defy the efforts of legislation and philanthropy to devise a remedy for its evils. The state of the southern and western districts is the most deplorable, the greatest number of mud hovels occurring in the counties of Cork, Kerry, Clare, and Mayo; the least number in Down, Monaghan, Kilkenny, and Wexford. On analysing the census returns, Mr. Chadwick has thus strikingly shown the effect of the physical condition of a people on the duration of life and on crime:

	The Four Counties containing the fewest Mud Hovels.	The Four Counties containing the most Mud Hovels.
Proportion per cent. of Families occupying Mud Hovels	29	61
Proportions of deaths from epidemic disease to every 10,000 of the population . . .	35·5	47·8
Average age of all who have died during the ten years ended 6th of January, 1841 . .	33·4	26·8
Average age of all the living, 1841	24·11	23·5
Proportions of births to the population . . .	1 in 33·4	1 in 29·9
Increase per cent. of the population since 1831	5	8·7
Per cent. of the population not reading or writing	42·8	69·7
Proportion of violent crimes to each 10,000 of the population	·32	·72

X. The climate is characterised by its mildness and extreme humidity, the cause of that freshness and verdure which has won for the island the epithet of the "Emerald Isle." The winters are not so rigorous as in England; the summers are cooler; and thunder-storms are more uncommon. The vegetation offers a few peculiarities. In the south-west, twelve plants, migrants from the north of Spain, have maintained themselves in a wild state, owing to the mildness of the winters, which are not found in the eastern districts; and in the south-east, a vegetation occurs analogous to that of the nearest coasts of France. Ireland, once clothed with almost impenetrable forests, the trunks of which are often met with in the bogs, now contains very little old timber, a deficiency which modern planting has endeavoured to supply. The plantations in 1841 were thus estimated:

	Acres.
Oak	29,536
Ash	6,042
Elm	1,417
Beech	3,274
Fir	25,239
Mixed	280,096
Total	345,604

The animal kingdom, while generally analogous to that of Britain has some distinct features. The common hare, squirrel, dormouse, and mole, are wanting. No venomous reptile occurs. The nightingale and ptarmigan are unknown. The capercaillie, once plentiful while the native forests remained, has long since become extinct, the last bird having been killed about a century ago; and the great bustard, an inhabitant of the open plain, disappeared about the same period. The golden eagle is now very scarce in its former stronghold, the mountains of Kerry; and the kite, formerly common, has only occurred for some time as an extremely rare visitant in any part of the island. Glen Veagh, in Donegal, with its towering cliffs, solitary lake, and surviving forest, is still the retreat of the red deer. That splendid and magnificent animal, now utterly extinct, the giant deer or Irish Elk, commonly referred to the tertiary epoch, appears from remains recently discovered in connection with those of domesticated animals, to have existed contemporaneously with man in Ireland.



Giant's Causeway.

IX. FRANCE.

I. **France**, one of the largest and most powerful states of Europe, is bounded on the north by the English Channel, on the west by the Atlantic Ocean, and on the south by the Pyrenees and the Mediterranean. On the east the frontier is marked by no persistant natural feature. The river Var, with the Maritime and Cottian Alps form the boundary from Sardinia; the Jura Mountains from Switzerland; the Rhine from Baden; and from the Rhine near Lauterbourg to the coast above Dunkirk, the frontier towards Belgium on the north-east, is a purely conventional line, determined by the treaty of Paris in 1815.

Latitudinal limits.—42° 25 N. frontier of the Eastern Pyrenees, and 51° 5′ N. coast near Dunkirk.

Longitudinal limits.—8° 17′ E. Rhine near Lauterbourg, and 4° 46′ W. coast opposite Ushant Isle.

Extent.—The area is estimated at upwards of 52,000,000 hectares, equal to about 204,000 English square miles. The greatest extent, due north and south, is about 600 miles; due east and west, somewhat less. But the longest straight line extends nearly 660 miles from the south-east point, the mouth of the Var on the Mediterranean, to the north-west extremity of the Atlantic coast. Measuring directly between the salient points of the coast and of the land frontier, excluding the minor irregularities, the circumscribing line extends 2157 miles, of which 714 miles belong to the eastern land frontier, 255 to the southern, 259 to the coast of the Mediterranean, 448 to that of the Atlantic, and 481 to the English Channel.

Islands.—Ushant, N.W. of Brest; Bellisle, opposite the mouth of the Vilaine; Noirmoutier, near the mouth of the Loire; Re, off Rochelle; Oleron, off Rochfort; and the Hyeres group, S.E. of Toulon, are the most important. Corsica, politically incorporated with France, and forming a department, geographically belongs to Italy.

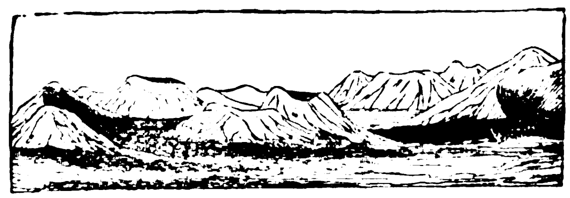
II. The immense proportion of the surface consists of lowlands and levels, often dreary, generally tame, but comprising beautiful and picturesque localities, chiefly in Normandy and Limousin, on the banks of the Seine below Rouen, and of the Loire westward of Orleans. From the estuary of the Garonne to the base of the Pyrenees, vast sandy downs or landes stretch inland from the coast, in some cases naked, in others clothed with heath or with pine forests, interspersed with fens and marshes. The heaths and landes are computed to include 5,676,188 hectares, or nearly one-ninth of the entire area. The mountainous districts, principally in the south-east, are estimated at 4,268,750 hectares, or nearly one-twelfth of the entire area. The most elevated land is in the department of the Upper Alps, where the Grand Pelvoux, N.W. of Briançon, rises 13,440 feet; and Mont Olan, N.E. of the valley of Godemard, on the upper waters of the Drac, 13,831 feet, the highest point. Some of the French Pyrenees nearly equal the culminating points of that chain on the Spanish side, as Vignemalle, at the head of the valley of Cauteret, 11,001 feet; Pic de Cascade, in the pass of Gavarnie, 10,745; and Pic d'Estats, 10,611. The Jura Mountains have their most elevated summits in Switzerland, the loftiest within the frontier of France being Mont d'Or, 4,797 feet, S. of Pontarlier, near the source of the Doubs. The prominent ranges confined to the country are those of the Cevennes, of Auvergne, and the Vosges.

The Cevennes Mountains, under various names, run from S.W. to N.E., bounding the great valley of Languedoc, and extending from the neighbourhood of Toulouse to the north of Lyons. They separate the waters that flow towards the Atlantic from those that run into the Mediterranean. Highest point, Mont Mezene, in the department of the Upper Loire, near the sources of the river, 5,820 feet.

The Auvergne Mountains, branching off from the former into the centre of France, attain a greater elevation. Highest point, the Puy de Sancy, one of the summits of Mont d'Or, to the S. of Clermont, 6,221 feet.

The Vosges form the boundary between the old provinces of Lorraine and Alsace. Highest point, the Ballon de Sulz, in the department of the Upper Rhine, 4690 feet.

III. The geological formations include almost every kind of stratified and unstratified rock, from the oldest to the most recent. Tertiary strata, consisting of alternate marine and fresh-water deposits, occupy six extensive districts, one of which, the Paris basin, extending for several miles in every direction round that city, is peculiarly interesting, owing to the numerous remains of mammiferous quadrupeds disentombed from it, and restored by the anatomical genius of Cuvier, all of extinct species, but allied to the existing races. The cretaceous group, chalk and green sand, forms a nearly continuous belt around the Paris basin, of varying breadth, but stretching northwards to the coast of the Channel, where it fronts the chalk cliffs of Kent and Sussex. The oolitic system appears exterior to the cretaceous on the east, west, and south, and constitutes the great mass of the Jura Mountains, stretching also along the foot of the Pyrenees. The new red sandstone is nowhere locally important, except towards the Vosges. Carboniferous strata occur in the departments bordering on Belgium, also in Normandy and other places, but most abundantly in the country between the Loire and the Rhone. The older sedimentary rocks, varieties of slate and gneiss, are largely developed along the flanks of the Alps and Pyrenees, with granite and other igneous masses. The most remarkable geological site in France is the central province of Auvergne, where granite is the prevailing rock, capped with the cones of extinct volcanoes, and the formations that have arisen from them, trachytes, basalts, and lavas. The date of the activity of these craters is ante-historic, but post-tertiary.



Extinct Volcanoes of Auvergne.

Coal occurs in 30 departments, inferior in quality and quantity to that of Britain, with the further disadvantage of the ironstone districts not being immediately adjacent to it. The amount raised in 1845 was as follows:

	Metriques Quintaux.
Beds of the Loire	14,055,298
Valenciennes	9,458,027
Alais	4,158,675
Creuzot and Blanzy	3,003,799
Aubin	1,654,600
Commentry	1,036,544
Other Places	8,633,976
	42,000,919 = 3,976,980 tons English.

Iron is produced in 69 departments. The quantity amounted to 439,000 tons in 1845.

Other mineral products are antimony, quicksilver, manganese, chromate of iron, cobalt, nickel, bismuth, arsenic, copper, tin, lead combined with silver, silver alone, gold in some of the streams, rock-salt, and sea-salt largely obtained by evaporation on the south and south-west coasts; but with the exception of iron, the quantity of the other metals produced is unimportant. There are altogether about 400 mines.

The number of mineral springs is stated at 240, of which upwards of 150 are collected in baths for the use of invalids.

IV. A triple distribution may be made of the rivers: 1. Those which entirely belong to France, having their rise, course, and termination within its limits, as the Loire, the most important; the Garonne, forming with the Dordogne the estuary of the Gironde; the Adour, Charente, and Vilaine, flowing into the Atlantic; the Seine, Somme, and Orne, running into the English Channel; and the Herault and Aude, entering the Mediterranean. 2. Those which rise in France, and flow beyond the frontier, of which the principal examples are in the north-east, the Scheldt, the Meuse, with its affluent the Sambre, and the Moselle. 3. Those which have a foreign origin, but the greater part of their course in France, of which the only examples are in the south-east, the Rhone and its affluent the Isere. The Doubs, one of the French contingents to the Rhone, makes a short detour into Switzerland; and the Var, an independent stream, flows from France into Sardinia, but returns to constitute the frontier through the rest of its course to the Mediterranean.

Principal Rivers.		Length. Miles.	Length of Tributaries. Miles.
Loire		600	—
Tributaries—	Allier	—	250
	Cher	—	215
	Vienne	—	207
	Creuse, affluent of Vienne	—	166
Garonne		360	—
	Dordogne	—	293
	Tarn	—	207
	Lot	—	166
Seine		470	—
	Marne	—	268
Adour		194	—
Charente		235	—
Vilaine		124	—
Somme		110	—
Orne		82	—
Rhone, whole course		525	—
	Saone	—	304
	Doubs, affluent of Saone	—	250
	Isere	—	190
	Durance	—	220

V. The old civil division of the country comprehended 32 provinces, but by the States-General in 1789 the present division into departments was introduced, which are styled after some leading natural feature, a mountain, river, or part of a river, in the respective localities. The largest department, that of the Gironde, is about equal to the united area of Cornwall and Devon; the smallest, that of the Seine, somewhat exceeds the county of Rutland; but generally the departments correspond in size much more than the English counties. The local government of each is conducted by a prefect, appointed by and responsible to the minister of the interior. The departments are further divided into arrondissements, invariably named after chief towns, and superintended by sub-prefects. Each arrondissement is distributed into cantons, each canton consisting of a number of communes, analogous to our parishes. France at present comprises 86 departments, 363 arrondissements, 2845 cantons, and 38,623 communes.

Old Provinces.	Corresponding Departments.	Capitals of Departments.
1. French Flanders	The North	Lille.
2. Artois	Pas de Calais	Arras.
3. Picardy	Somme	Amiens.
4. Normandy	Lower Seine, Eure, Calvados, Orne, La Manche	Rouen, Evreux, Caen, Alençon, St. Lo.
5. Isle of France	Seine, Oise, Seine and Oise, Seine and Marne, Aisne	Paris, Beauvais, Versailles, Melun, Laon.
6. Champagne	Ardennes, Marne, Upper Marne, Aube	Mezieres, Chalons, Chaumont, Troyes.
7. Lorraine	Moselle, Meurte, Meuse, Vosges	Metz, Nancy, Bar le Duc, Epinal.
8. Alsace	Lower Rhine, Upper Rhine	Strasburg, Colmar
9. Franche Comté	Doubs, Upper Saone, Jura	Besançon, Vesoul, Lons.
10. Burgundy	Cote d'Or, Yonne, Saone and Loire, Ain	Dijon, Auxerre, Macon, Bourg.
11. Orleanois	Loiret, Eure and Loire, Loire and Cher	Orleans, Chartres, Blois.
12. Maine	Mayenne, Sarte	Laval, Le Mans.
13. Brittany	Finisterre, Ille and Vilaine, Morbihan, Cotes du Nord, Lower Loire	Quimper, Rennes, Vannes, St. Brieux, Nantes.
14. Anjou	Maine and Loire	Angers.
15. Touraine	Indre and Loire	Tours.
16. Berri	Cher, Indre	Bourges, Chateauroux.
17. Nivernois	Nievre	Nevers.
18. Bourbonois	Allier	Moulins.
19. Lyonois	Rhone, Loire	Lyons, Montbrison.
20. Auvergne	Cantal, Puy de Dome	Aurillac, Clermont.
21. La Marche	Creuse	Gueret.
22. Poitou	Vienne, Two Sevres, Vendee	Poitiers, Niort, Bourbon-Vendee.
23. Annis and Saintonge	Lower Charente	Rochelle.
24. Angoumois	Charente	Angouleme.
25. Limousin	Upper Vienne, Correze	Limoges, Tulle.
26. Guienne & Gascony.	Gironde, Dordogne, Lot and Garonne, Tarn and Garonne, Lot, Aveiron, Landes, Gers, Upper Pyrenees	Bordeaux, Perigueux, Agen, Montauban, Cahors, Rodez, Mont de Marsan, Auch, Tarbes.
27. Bearn	Lower Pyrenees	Pau.
28. Comté de Foix	Arriege	Foix.
29. Rousillon	Eastern Pyrenees	Perpignan.
30. Languedoc	Upper Garonne, Aude, Tarn, Herault, Gard, Ardeche, Lozere, Upper Loire	Toulouse, Carcassonne, Alby, Montpellier, Nismes, Privas, Mende, Le Puy.
31. Dauphiny	Isere, Drome, Upper Alps	Grenoble, Valence, Gap.
32. Provence	Mouths of the Rhone, Var, Lower Alps	Marseilles, Draguignan, Digne.
Comtat d'Avignon*	Vaucleuse	Avignon.
Corsica†	Corsica	Ajaccio.

* Part of Provence, but subject to the Pope until its cession to France in 1791.
† Corsica formed no part of the ancient provinces.

Paris, the capital, on the banks of the Seine, is in lat. 43° 51′ N., and long. 22° 0′ E. The population is upwards of 900,000, exclusive of the garrison and strangers. It is the second city of Europe in size, but the first in the number of its attractions, consisting of superb public edifices and palaces, gardens, promenades and fountains, museums, galleries, and libraries. The entire population of France exceeds 34,000,000. The foreign possessions of the country include Algeria and settlements on the west coast of Africa; Martinique, Guadaloupe, and other islands in the West Indies; Cayenne and part of Guiana in South America; the islands of Bourbon and St. Mary in the Indian Ocean; Pondicherry and other detached territories in India.

VI. The leading manufactures are woollen, silk, and cotton fabrics, paper, porcelain, and wine. Articles of jewellery, ornamental works, and scientific instruments, are produced in great perfection; and the French especially excel in all products requiring beauty of design, great artistic skill, and the application of chemical knowledge. The lace of Valenciennes, the linens of St. Quentin, the tapestry of the Gobelins, the porcelain of Sievres, the paper of Annonay, and the silks of Lyons, have long been in high repute. Besides the raw silk imported, a large quantity is produced in the country. The mulberry-tree, necessary for the support of the worm, was first planted in the fifteenth century near Tours, the earliest seat of the silk manufacture. It has since been extended to twelve departments, but is most abundantly grown in those of Gard, Drome, Vaucleuse, and Ardeche. The entire number of trees is probably not less than 15,000,000. The ancient provinces of Champagne, Burgundy, but more particularly Provence, Languedoc, Roussillon, and Guienne, are the principal wine regions. Marseilles, Havre, Bordeaux, Nantes, Rochelle, Dunkirk, and Boulogne, are the chief commercial ports. The foreign trade of France, though crippled by social disturbances and a restrictive policy, is very extensive. It may be appreciated from the number of vessels entered inwards and cleared outwards from the various ports in 1846:

	With Cargo.	In Ballast.
French vessels entered inwards	8,184	1039
Foreign ditto	12,113	1380
	20,297	2419
French vessels cleared outwards	5,595	2922
Foreign ditto	6,623	6621
	12,218	9543

EXPORTED VALUES.

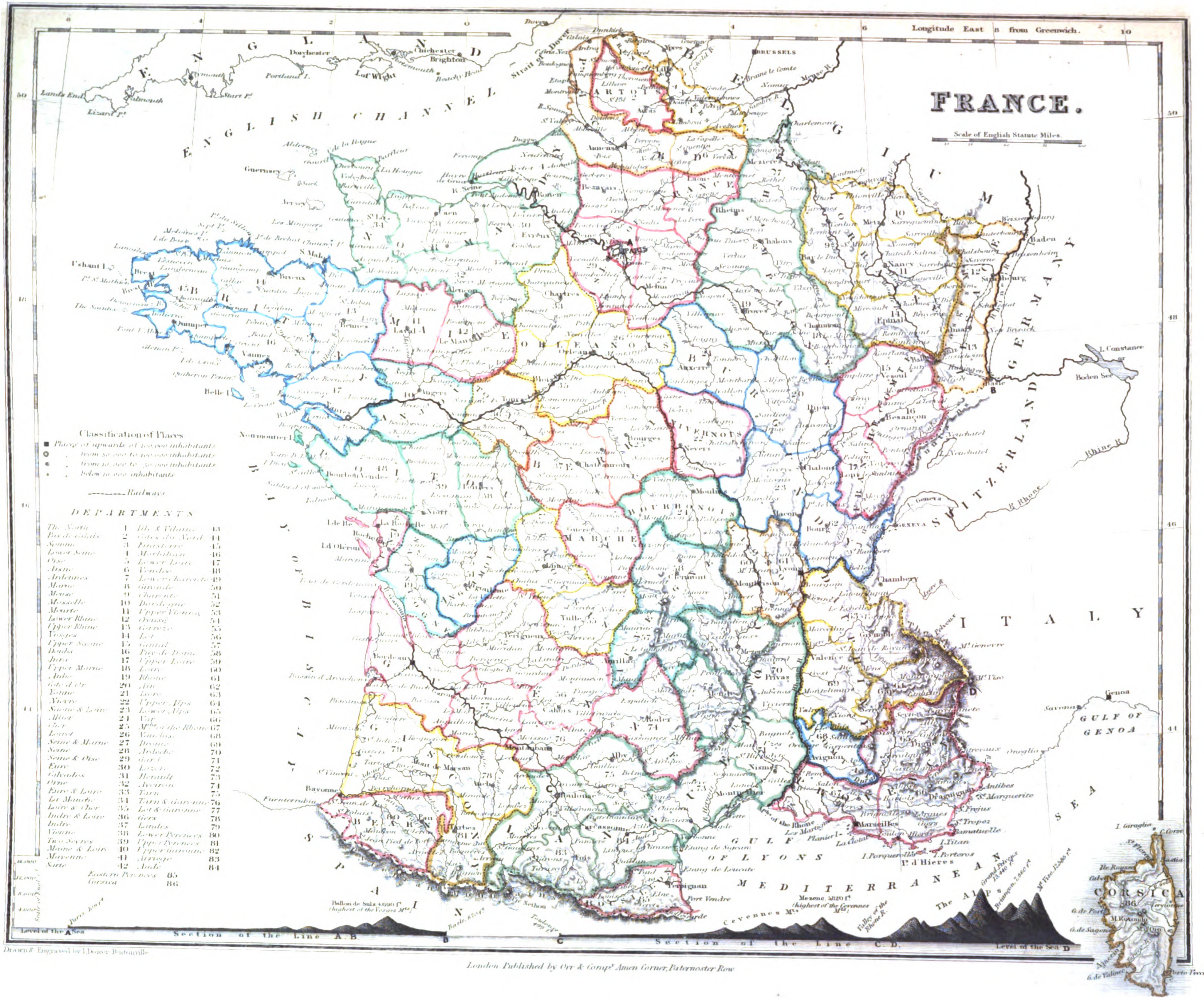
	Francs.	
Raw materials	186,000,000	
Manufactures	666,300,000	
	852,300,000	at 25 francs = £34,092,000

Agriculture, the employment of the great proportion of the people, is successfully conducted, owing to the fine climate and excellent soil more than to the skill of the producers, primitive methods of tillage and husbandry, and rude implements, prevailing. The country is distributed into an immense number of small occupancies, a holding of 200 acres, or a rental of £200 per annum, constituting a first-class farmer. The holdings from 10 to 50 acres are computed at not less than 3,000,000. The corn-plants, wheat, oats, and rye, are most abundantly cultivated, next to which is the vine, barley, buckwheat, and in smaller quantities, potatoes, maize, chestnuts, hemp, olives, flax, mangel-wurzel, madder, and tobacco. The *Statistique Territoriale* thus states the area and value of the crops:

	Area. Hectares.		Value. Francs.
Primary Crops.—Wheat, oats, rye, barley, maslin, potatoes, buckwheat, maize, spelt	15,473,474		3,130,000,000
Improved Crops.—Vineyards, gardens, pulse, mangel-wurzel, hops, rape, hemp, flax, tobacco, madder, olives, chestnuts, meadows	7,740,264		962,000,000
	23,213,738	—about 57,351,588 acres.	4,092,000,000—£163,680,060

About one-eighth of the whole area of the country is occupied with woods and natural forests. The facilities for inland trade and intercommunication by canals, roads, and railways, are far inferior to those enjoyed in England.

The most important canal is the *Canal du Midi*, or Canal of the South, called also the *Canal Royal*, and Canal of Languedoc, connecting the Garonne with the Medi-


FRANCE.
Scale of English Statute Miles.
Longitude East from Greenwich.
Classification of Places
Places of upwards of 100,000 inhabitants
from 50,000 to 100,000 inhabitants
from 10,000 to 50,000 inhabitants
below 10,000 inhabitants
Railways
DEPARTMENTS
ENGLAND
ENGLISH CHANNEL
BAY OF BISCAY
BELGIUM
GERMANY
SWITZERLAND
ITALY
SPAIN
MEDITERRANEAN SEA
GULF OF LYONS
GULF OF GENOA
CORSICA
PARIS
BRUSSELS
Section of the Line A.B.
Section of the Line C.D.
Level of the Sea
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terranean. It commences near Toulouse, passes that city, and entering a depression between the Pyrenees and Cevennes, follows the valley of the Aude to Beziers, joins the lagune of Thau, which communicates with the Mediterranean to the south of Montpelier. It extends more than 151 miles, and was opened in 1681, in the reign of Louis XIV. At the close of the last century, the whole extent of the canals was very little beyond 500 miles. Eleven lines have since been completed, or nearly so, extending 1250 miles:

			Miles.
1	Rhone and Rhine Canal ...	From St. Jean de Losne to Strasburg	203
2	Somme ditto	St. Limin to St. Valery	91½
3	Ardennes ditto	Douchery to Neufchatel and Vouziers	61
4	Burgundy ditto	Roche sur Yonne to St. Jean de Losne	141
5	Nantes and Brest ditto	Nantes to Brest	218
6	Ille and Rance ditto	Rennes to Dinan	50
7	Blavet ditto	Pontivy to Hennebon	34½
8	Arles and Bouc ditto	Arles to Bouc	27½
9	Nivernois ditto	Auxere to Decise	103
10	Berri ditto	Rhimbé to Saucoins, Tours, and Montluçon	186
11	Loire ditto	Dégoin to Briare	134
			1249½

The roads of all kinds,—*routes royale*, maintained by the government; *routes departmentales*, kept up at the cost of the departments; and the by-ways, *chemins vicinaux*,—are computed at 70,000 miles. Railway communication subsists from the capital to the channel coast at Havre, Dieppe, Boulogne, Calais, and Dunkirk; to the Belgian frontier at Lille and Valenciennes; to Orleans, Tours, and Saumur; to Versailles, Corbeil, and St. Germain. Other railways connect Strasburg, and Basle; Lyons, St. Etienne, and Roanne; Marseilles, Avignon, Nismes, Montpelier, Cette, and Alais.

VII. The climate of the north of France corresponds to that of the south of England. The difference between the mean annual temperature at Paris, 51·4°, and at London, does not amount to 1° of Fahrenheit; but the sky is far less cloudy, the atmosphere more clear, and the weather not so variable. The effect of the sea in preventing violent seasonal contrasts is strikingly exemplified on comparing the winter, spring, summer, and autumn temperatures at Strasburg, with a continental climate, and at Cherbourg, in nearly the same latitude, with a maritime climate:

	Lat.	Winter.	Spring.	Summer.	Autumn.	Annual Mean.
Strasburg . .	48° 35′	34·5	50·0	64 6	50·0	49 6
Cherbourg . .	49° 39′	41·5	50 8	61·7	54·3	52·1

Proceeding southerly towards Poitiers on the west, and Lyons on the east, the increase of heat becomes very sensible, and further south the climate gradually approximates to that of Italy and Spain, the winters being mild and brief, and the summers oppressively hot, especially in the inland districts, which are frequently visited with destructive hailstorms. Some of the south-eastern districts in the valley of the Rhone are chilled at intervals by a biting wind in winter, the *vent de bise*, which blows from the Alps and the mountains of Auvergne. Receding from the west coast into the interior, the number of rainy days in the year decreases, but the showers are heavier, and the annual quantity of rain is greater at Strasburg and Mulhausen than at Rochelle and Bordeaux.

VIII. Vegetable productions in the northern districts, including the ancient provinces of Brittany, Normandy, Picardy, and French Flanders, exhibit no important difference from those of our southern counties, except that several fruits are more regularly matured, and brought to greater perfection. With a line extending obliquely from the mouth of the Loire to Mezieres on the Meuse, ascending from about lat. 47° on the west coast to near lat. 50° on the eastern side, the vine becomes a prominent object of culture, passing further north in the east than in the west, owing to a higher summer temperature. For the same reason maize or Indian corn ascends to near Strasburg in the east, lat. 48½°, but has its northern limit in the west at the mouth of the Garonne, lat. 45°. In the southern departments, the vine and maize become general; in the south-east, chiefly between Narbonne and Grenoble, the olive appears, often injured by the *vent de bise*; and in the warmer localities, the pistachio, lemon, and orange occur.

The common forest trees are the oak, elm, ash, beech, birch, aspen, white and black poplar, larch, and pine. The cork-tree (*quercus suber*) is cultivated in the south-west; a small black wild cherry abounds in the Vosges, furnishing a cheap spirit; firs and pines flourish in the same range, and in the Jura. Between the mouth of the Garonne and the Adour the following interesting experiment has been tried with complete success. The sand-downs which are washed from the sea being carried by the west wind into the interior, large districts of the land were converted into a kind of Sahara. After many futile attempts to arrest the movement of the sand, the sound plan was hit upon in the year 1789 of planting the sand-hills with coniferous trees. This not only put a stop to the invasion, but converted a profitless waste, to the extent of many thousands of acres, into a pine forest. Lower Normandy, the department of Ardennes, and the eastern parts of Central France, have the largest amount of woodland.

IX. Several wild animals occur not known in Britain. The black and brown bear have their haunts in the French Pyrenees; the lynx is found, though rarely, in the Upper Alps; the wolf is common in the larger forests; the ermine is seen in the Vosges; the yellow martin, marmot, and chamois inhabit the higher Alps and Pyrenees; and the beaver lingers by the Rhone. Among the wild birds of passage, hoopoes, loriols, and others, visit the south; with the flamingo on the shores of the Mediterranean. Of the reptile class, the common lizard is general, and several species of vipers occur in the wooded districts. Among insects, a kind of tarantula spider is found along the Mediterranean coast; and the Spanish fly is sufficiently abundant in the southern departments to form an article for exportation.

X. BELGIUM.

I. The frontiers of Belgium are arbitrary lines determined by political considerations, except on the north-west, where the North Sea forms the limit, supplying a coast-line extending about 40 miles, consisting of low sandy downs. The other boundaries are, Holland on the north; the Prussian states of the Rhine on the east, with parts of Limburg and Luxemburg, still connected with Holland; and France on the south and south-west.

Latitudinal limits.—49° 30′ N. south of Luxemburg, and 51° 27′ N. north part of Antwerp.

Longitudinal limits.—2° 31′ E. coast between Dunkirk and Nieuport, and 6° E. Prussian frontier, S E. of Verviers.

Extent.—Greatest length, from N.W. to S E., 190 miles; greatest breadth, from S.W. to N.E, 112 miles; area, somewhat under 11,400 square miles, about one-fifth that of England and Wales.

II. The general surface is low and level, but its aspect is rendered agreeable by high cultivation and the evidences of a dense and enterprising population. Towards the coast and the estuary of the Scheldt, the land is below the level of the sea, and is only preserved from inundation by artificial dykes and the natural formations of sand-hills on the shore. The south-eastern districts are hilly. High ground occurs towards the French department of Ardennes, rising on the right bank of the Meuse 1800 feet; and a plateau of the mean height of 1000 feet extends from thence through the provinces of Luxemburg and Liege, terminating in the wild tract of Hohe-veen on the Prussian frontier, which attains an elevation of 2290 feet, the greatest in Belgium. The mineral products include admirable building-stone, copper, lead, zinc, iron, and coal.

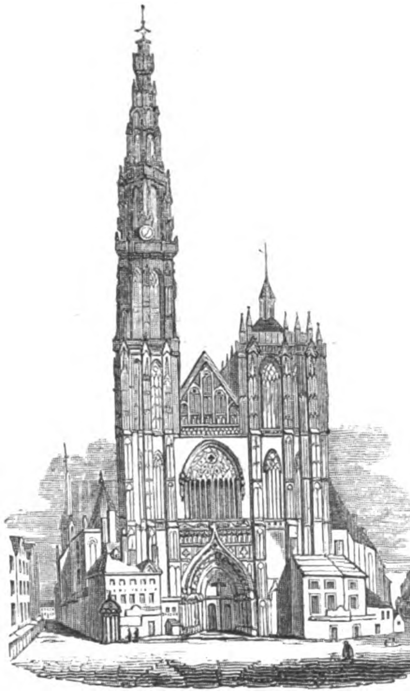
Belgium is richer in coal than any other European country after Great Britain. It occurs in the provinces of Limburg, Liege, Namur, and Hainault. Mons, Charleroi, Liege, and Clermont, are great centres of coal production. The coal-basins are remarkable for the enormous derangements exhibited, the strata having not only been violently contorted, but often elevated through an angle greater than a right angle, so as to be actually inverted. The quantity annually raised is upwards of 3,200,000 tons. Other minerals were returned as follows, in 1838:

Provinces.	Mineral.	Quantity raised. Tons.
Hainault	Iron	51,826
	Lead	348
Namur and Luxemburg	Iron	231,665
	Lead	26
Liege	Zinc	17,721
	Iron	71,347
	Alum slate	4,028

III. The kingdom consists of nine provinces, subdivided into arrondissements and communes after the French model:

Provinces.	Chief Towns.
South Brabant	Brussels, Louvain, Tirlemont.
Antwerp	Antwerp, Mechlin or Malines.
East Flanders	Ghent, Aust, Oudenarde.
West Flanders	Bruges, Ostend, Courtray.
Hainault	Mons, Tournay, Charleroi.
Namur	Namur, Dinant, Philippeville.
Liege	Liege, Verviers, Spa.
Limburg	Hasselt, Tongres, St. Trou.
Luxemburg	Arlon, Bastogne, Neufchateau.

The population somewhat exceeds 4,000,000. Brussels, the capital, in lat. 50° 50′ N., and long. 4° 20′ E., upon the banks of the small river Senne, contains upwards of 120,000 inhabitants; Ghent, a principal seat of manufacturing industry, 90,000; Antwerp, the chief maritime and commercial port, 75,000; Liege, 64,000.



Antwerp Cathedral.

IV. No country is more amply furnished with the means of intercommunication. The two leading rivers, the Meuse and Scheldt, are navigable through the whole of their course in Belgium. The Meuse rises in France, crosses the frontier soon after passing Charlemont, flows through the provinces of Namur and Liege, the finest scenery of the kingdom lying along its course, and after forming the boundary between the Belgian and Dutch portions of Limburg, it leaves the country to join the Rhine in Holland. It receives its principal affluents, the Sambre at Namur, and the Ourthe at Liege. The Scheldt has its source likewise in France, passing the frontier on the south of Tournay. It flows through the west of Hainault, divides that province from West Flanders, traverses East Flanders, and forms its boundary from the province of Antwerp, leaving the kingdom below Fort Lillo for the estuary of the East and West Scheldt. Its chief affluents are the Lys at Ghent, the Dender near Dendermonde, and the Rupel near Rupelmonde. The tide ascends the Scheldt to Ghent, but the water is quite fresh at Antwerp, where the river is 1440 feet wide, with a mean depth of 48 and 32 feet at high and low water. The navigation by the rivers extends nearly 600 miles; by canals 286 miles; besides which the common roads are far superior to those of France, and the railways form the most perfect system at present in continental Europe.

The Belgian Government was the first on the continent to appreciate the importance of railway communication. The Act, authorising the construction of a complete system, was proposed by the Ministers of the Crown in 1833, and adopted by the Legislative Chambers May 1, 1834. The railways constructed by the Government and worked for the benefit of the state, are as follows:

	Miles.	Cost. £	Cost per Mile. £
Line of the North—Brussels to Antwerp	27¼	305,042	11,194
„ West —Malines to Ostend	76¼	618,728	8,114
„ East —Malines to Prussian frontier	82¾	1,691,577	20,445
„ South—Brussels to French frontier	51	613,585	12,031
Ghent to French frontier and Tournay	48	349,422	7,280
Braine-le-Comte to Namur	41	536,000	13,000
	326¼	£4,114,354	£12,620

The cost returned does not include the buildings for stations, locomotive engines, and other items. Including these expenses, the total outlay of the Government, when the whole of the lines were opened for traffic, amounted to £5,373,200, or £16,470 per mile. The line between Liege and the Prussian frontier, a distance of 24 miles, required the removal of 1,700,000 cubic yards of earth, and the construction of 27 bridges, 124 viaducts, and 18 tunnels excavated through the solid rock.

V. Belgium has long been celebrated for its manufactures. The more important are lace at Brussels and Mechlin; cottons at Ghent and Antwerp; cloths at Verviers; carpets at Brussels and Tournay; iron, steel, copper, and brass wares at Liege, Namur, and Charleroi. The people are also excellent cultivators of the soil, surpassed by few states in the variety, quantity, and quality of their agricultural produce. The yield of wheat is often 16 grains for 1, which seldom amounts to more than 8 or 10 for 1 in Britain. A vast proportion of the surface is under cultivation, computed at nine-elevenths, while only about six-tenths of the area of England is cultivated. Of the uncultivated land, amounting to no more than 15 per cent. of the whole area, a large space is productive, being occupied by towns, roads, canals, and forests. The forests are in the provinces of Liege, Namur, and Luxemburg, portions of the ancient forest of Ardennes.

XI. HOLLAND.

I. Holland is inclosed by the North Sea on the west and north; by Hanover and the Rhenish provinces of Prussia on the east; and by Belgium on the south.

Latitudinal limits—51° 13′ N., south part of the province of Zealand, and 53° 28′ N., north part of Groningen.

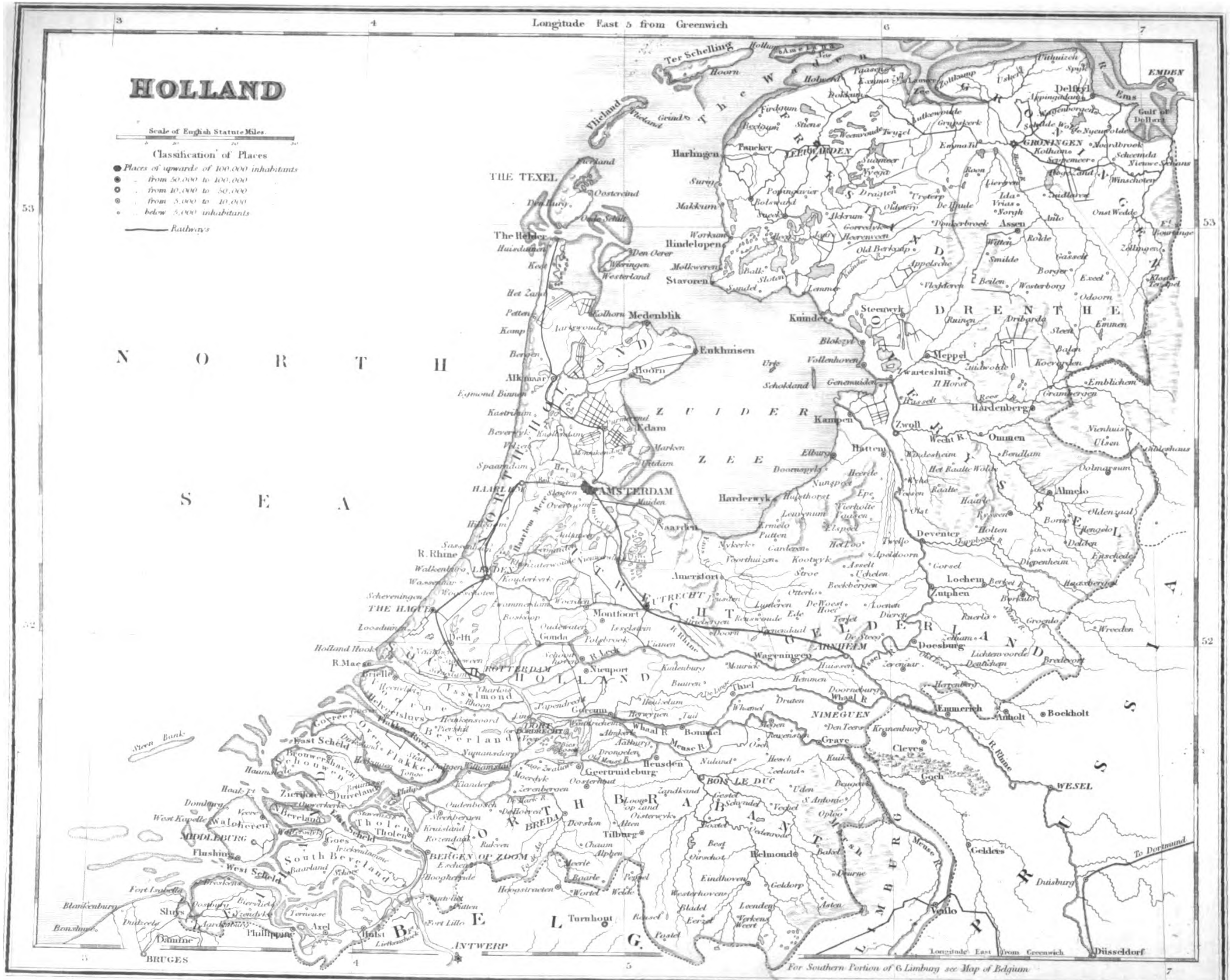
Longitudinal limits.—3° 21′ E., near Sluys in Zealand, and 7° 10′ E., Groningen, south of the Gulf of Dollart.

Extent.—From N.E. to S.W. nearly 200 miles, by 120 miles from E. to W. The superficial area is upwards of 13,000 square miles.

Islands.—Walcheren, Schouwen, S. Beveland, N. Beveland, and Tholen, in the estuary of the Scheldt; Over Flakkee, Voorne, Ysselmond, Beyerland, and others, in the estuary of the Meuse; the Texel, Vlieland, Ter Schelling, and Ameland, opposite the mouth of the Zuider Zee and the coast of Friesland; Wieringen, Urk, Schokland, and Marken, in the Zuider Zee.

II. A great portion of the country is considerably below high-water mark, but protected from inundation by the downs which line the sea-coast. These sand-hills have been formed under the action of the sea-winds, drifting inland and variously heaping up the loose particles deposited by the sea upon the beach. They form a complete barrier against its encroachments, and are occasionally so elevated as to conceal the ocean from view, even at the tops of the neighbouring spires. The incursions of the sand to an inconvenient extent inland are prevented by planting it with grasses and firs. Where circumstances have not favoured the formation of these natural barriers, enormous artificial mounds, or dykes, answer the purpose of keeping the sea in check, and evince the enterprise and energy of the people. They are also constructed along the banks of the rivers, whose beds are frequently higher than the surrounding country.

The great dyke of the Helder, a village at the north extremity of the province of North Holland, is one of the most remarkable of these constructions, nearly 6 miles



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in length, 40 feet broad at the summit, on which there is a good roadway. It descends to the sea by a slope of 200 feet at an angle of 40°. Enormous buttresses, proportionably broad and high, project at certain intervals several hundred yards into the sea. The whole of this artificial coast consists of immense blocks of Norwegian granite. Another great dyke protects the west side of the island of Walcheren. The sea has, however, repeatedly broke bounds, and asserted its mastery over Holland, permanently submerging extensive tracts, and making havock of life and property. The Zuider Zee (South Sea) was formed by an incursion of the ocean in the year 1225. The gulf of Dollart is the offspring of an inundation in 1277. The lake of Haarlem was formed in like manner. A terrible irruption in 1491 overwhelmed 72 villages, 100,000 persons, and formed the Biesbosch, a lake near Dort.

III. Holland, being almost an unbroken flat, has a very monotonous aspect, and would be excessively uninteresting but for the evidences of a highly cultivated soil, the neat towns and villages, the numerous canals and rivers fringed with trees. The Rhine enters it from the Prussian territories, a single stream, 2000 feet broad. It divides into two branches soon after crossing the frontier. The southern branch, the Whaal, is the most important, and ought to retain the name of the parent stream. It joins the Meuse from Belgium and receives its name, splits into several divisions after passing Gorcum, one of which passes by Rotterdam to the sea. The Rhine, after the detachment of the Whaal, sends off a second branch, the Yssel, flowing to the Zuider Zee, and afterwards a third, the Leck, which runs to the network of waters south and east of Rotterdam. Still retaining the original name, but less than any of its branches, the river proceeds to Utrecht and Leyden, and enters the sea; but a very small portion of the great body of water forming the Rhine being discharged by the channel so called. The Meuse enters the country near Maestricht, traverses the province of Limburg, and forms for a considerable space the boundary between North Brabant and Gelderland, before its junction with the Whaal. The lakes and marshes are numerous, and in some instances extensive, the Haarlem-Meer extending 14 miles in length by 8 in breadth. Holland is almost everywhere intersected with canals, which for number have been compared to the roads of England.

The Haarlem-Meer has repeatedly extended its boundaries, and entailed a large annual outlay in works for the defence of the adjacent districts. On the 9th of November, 1836, a furious hurricane from the west drove its waters upon the city of Amsterdam, and drowned upwards of 10,000 acres of low land in the neighbourhood; and on the 25th of December following another hurricane from the east drove the waters in the opposite direction upon the city of Leyden, the lower parts of which were submerged for 48 hours, and 19,000 acres of land were inundated. The enormous loss occasioned by these two storms determined the Dutch government to undertake the drainage of the lake—a project often contemplated—for which a credit of 8,000,000 florins was voted by the States-General, and a Commission appointed to superintend the work in May, 1840. This measure, the greatest hydraulic operation of modern times, requiring vast preliminary arrangements, is now in process of execution by gigantic steam power.

The Helder, or Great Ship Canal, is the principal work of the kind in Holland, and one of the greatest achievements of our time. It connects the port of Amsterdam with the harbour of Niew-Diep, near the Helder, by which the North Sea and the commercial capital are brought into communication, and the dangerous navigation of the Zuider Zee, the old route, is avoided. The canal is about 50 miles long, 24 feet deep, and 120 feet wide at the surface; capable therefore of bearing the largest merchantmen, and ships of the line of 74 guns. It was commenced in 1819, and completed in 1824, at an outlay of about £1,000,000 sterling. The canals are to a considerable extent the roads of Holland, used for the conveyance of passengers as well as for the transit of goods; but a great number are formed simply for the purpose of drainage.

IV. The kingdom is divided into provinces, districts, and cantons; and contains a population of nearly 3,000,000.

Provinces.	Capitals.	Other Chief Towns.
North Holland......	Haarlem	Amsterdam, Hoorn, Alkmaar, Naarden.
South Holland......	The Hague	Rotterdam, Leyden, Delft, Dort, Helvoetsluys.
Zealand	Middleburg	Flushing, Sluys, Sas-de-Gand.
Utrecht	Utrecht	Amersfort, Montfoort.
North Brabant......	Bois-le-Duc	Breda, Bergen-op-Zoom.
Gelderland	Arnheim	Nimeguen, Zutphen, Loo.
Overyssel	Zwoll	Hardenburg, Almelo, Deventer.
Drenthe...............	Assen	Meppel.
Friesland	Leeuwarden	Franeker, Harlingen.
Groningen...........	Groningen...........	Delfzyl.
Limburg	Maestricht	Venloo, Stephanswerd, Ruremonde.
Luxemburg*	Luxemburg	Echternach, Diekirch.

* Luxemburg forms no part of Holland, but belongs to the Germanic Confederation, governed by the King of Holland as Hereditary Grand Duke of Luxemburg.

Amsterdam, the commercial metropolis, and the largest city in the kingdom, is the most singularly constructed city of Europe. Occupying a marsh on the Y, or Wye, an arm of the Zuider Zee, it is built upon piles, and so intersected with canals that upwards of 90 islands are formed by them, communicating by nearly 300 bridges. The population exceeds 220,000. The Hague, the residence of the Court and the seat of Government, is the political capital, in lat. 52° 5′ N., and long. 4° 20′ E.,—a comparatively small but elegant city, containing about 60,000 inhabitants. Rotterdam ranks after Amsterdam in commercial importance. Leyden, Groningen, and Utrecht are the seats of universities.

The foreign possessions of Holland consist of several settlements on the Guinea coast, in Africa; Java, part of Sumatra, and the Moluccas, in the Indian Archipelago; Dutch Guiana, in South America; the islands of Curaçoa, Oruba, Buen Ayre, Aves, Los Roques, and Orchilla, off the coast of Venezuela; and St. Martin's, St. Eustatius, and Saba, among the West India Islands.

V. The inhabitants of the kingdom engage in the herring, cod, and Greenland whale fisheries, but not so largely as formerly. They excel in ship-building, the manufacture of paper and earthenware, and all branches of horticulture; but the manufactures are at present quite unimportant, the people being essentially agricultural and commercial. They raise an immense amount of dairy produce for the English and other markets, the humid and foggy climate being more adapted for pasturage than for the ripening of grain; and carry on an extensive trade with all nations, receiving and re-exporting the wines of France and Spain, the timber of the Baltic, and the manufactured goods of Germany and England. Possessing exclusively the Moluccas, it is through Holland that most of the spices, cloves, nutmegs, and mace, find their way into Europe. The Hollanders include the German population of Limburg, the Frisians of West Friesland and the adjacent islands, and the Dutch, who form the great bulk of the people, all belonging to the Teutonic family of nations, and speaking dialects of the German. Protestantism is the prevailing religious profession.

XII. NORTHERN GERMANY. XIII. CENTRAL GERMANY. XIV. SOUTHERN GERMANY.

I. The entire territory included under the name of Germany occupies a large area of central Europe. Its boundaries are the North Sea, Denmark, and the Baltic, on the north; Prussian, Russian, and Austrian Poland, with Hungary, on the east; the Adriatic Sea, Lombardy, and Switzerland on the south; France, Belgium, and Holland on the west. It has been called the labyrinth of geography, owing to the number of its separate states, their involved territories, and political connection in various instances with adjoining countries.

Latitudinal limits.—45° 10′ N., south extremity of Illyria, and 54° 50′ N., north-east point of Pomerania.

Longitudinal limits.—5° 45′ E., west side of Luxemburg, and 19° 20′ E., east side of Silesia.

Extent.—About 680 miles from west of Luxemburg to east of Silesia, by 600 miles from the north of Holstein to the borders of Lombardy. The area approaches to 250,000 square miles.

Islands.—Rugen, the largest, and Dars, off the north-west coast of Pomerania, with Usedom, at the mouth of the Oder, belonging to Prussia; Heligoland, off the mouth of the Elbe, belonging to Great Britain; and Norderney, with a chain of small islands along the coast of East Friesland, belonging to Hanover.

II. A general view of the country at large will appropriately preface a notice of the separate sections to which the maps refer. Germany may be divided into four divisions, defined by well-marked natural features, consisting of two mountain regions and two plains: 1. The south-east mountain region of the Tyrolese Alps and their branches, extending towards Vienna and Trieste, and culminating in the Ortler Spitz, at the height of 12,850 feet. 2. The elevated plain or table-land of the south, occupying Bavaria and Wirtemberg, intersected by the Danube, extending about 180 miles northwards from the Alps, with a breadth of 120 miles, and a mean elevation of from 1500 to 2000 feet. 3. The central mountain region, which bounds the southern table-land on the east, north, and west; including, eastward, the ranges which nearly inclose the great valley of Bohemia; northward, the Thuringerwald and other groups, stretching into Hanover and to the borders of the Rhine; and westward, the Schwarzwald, or Black Forest group, and the Odenwald, which may be called the Rhenish mountain-system, as running parallel to the river in its course from Basle to Mayence. 4. The low plain of the north, a part of the great plain of Europe, extending from the preceding district to the North Sea and the Baltic, and comprising almost the whole of Hanover, Prussia, and Saxony.

The first district exhibits very different climates and vegetable productions. The olive groves, maize-fields, and vineyards of Trieste, flourish in close contiguity to the glaciers of the Tyrol.

The second district is somewhat cold and sterile in the more elevated sites, but comprises many river-valleys, and sheltered regions of high fertility.

The third district is remarkable for its metalliferous deposits, one of its ranges, the Erzgebirge (metallic mountains), deriving its name from that circumstance.

The last natural division contains the largest proportion of infertile land in Germany. West of the Elbe, the country presents a succession of moors, treeless, but clothed with heath and juniper, connected by tracts of sand almost entirely without vegetation, the cultivable soil occurring in small and distant oases. East of the Elbe, the low plain has its moors and sandy tracts, but the latter are generally covered with pine woods, and the fertile districts are more numerous and extensive.

III. Germany contains some of the most considerable river-systems of Europe, either wholly or in part,—those of the Danube, Rhine, Elbe, Oder, Weser, and Ems. There is no important lake besides the Boden-see, or Lake of Constance, which belongs chiefly to Switzerland; but small lakes are very numerous in Mecklenburg and Prussia; and, in the south of Bavaria, mineral springs are more abundant than in any other part of the continent. The thermal waters of Aix-la-Chapelle, Pyrmont, Carlsbad, Toplitz, Baden-Baden, Kissengen, Wiesbaden, and the Austrian Baden; the acidulous springs of Seltzer and other places; and the saline waters of Seidlitz, are sufficiently well known. Brine springs extend along the northern base of the Alps, from which large quantities of common salt are obtained. Except in the north-west, and some parts of Bavaria, the country is remarkably well wooded, the forests supplying timber for export and furnishing the ordinary fuel. Among the cultivated plants, wheat and barley are the principal crops in the south; maize is abundantly raised in the south-east; the vine is general in the valleys of the Danube, Rhine, Necker, Maine, and Moselle; and the olive appears near Trieste. The wild animals comprise varieties of deer and swine, numerous in the forests; the wolf, now rare; the beaver, very scarce; the lynx, common; and the bear and chamois in the Tyrol.

The Danube rises in the Black Forest in Baden, at the height of 2200 feet above the sea-level, flows generally N.E. to Ratisbon, and from thence E. by S. to Vienna, soon afterwards leaving the country for Hungary, being there 417 feet above the level of the Black Sea, thus descending 1783 feet in its course through Germany. At Ulm the breadth of the river is 200 feet; at Ingolstadt 500; at Ratisbon, 600; at Passau, 750. Its leading German affluents are: on the left bank, the Wernitz, Altmuhl, Naab, and Regen; on the right bank, the Iller, Lech, Isar, and Inn, all in Bavaria.

The Rhine enters Germany from Switzerland after passing the Lake of Constance, but only flows along the frontier from thence to some distance below Strasburg, where it divides the Palatinate from Baden, and proceeds through the Prussian states to Emmerich, near Cleves, where it enters Holland. Its chief affluents on the right bank are the Neckar, Maine, Lahn, and Lippe; and on the left bank, the Moselle. At the issue from the Lake of Constance, it is about 1300 feet above the sea-level; at Basle, 765 feet; opposite Strasburg, 450; at Mayence, 270; at Cologne, 110. At the great fall near Schaffhausen, the river is about 210 feet wide; at Basle, 590; near Mayence, 1700; at Cologne, 1200; below Wesel, 1450; and at the issue into Holland nearly 2000.

The Elbe is the largest exclusively German river, and descends from the loftiest source, the Elb-brunnen, in the east of Bohemia, being 4260 feet above the sea-level. It descends from the Great Bohemian valley through a gorge of the Erzgebirge, and flows generally N.E to Hamburg, at the head of the long and broad estuary by which it reaches the North Sea. The breadth of the river at the Bohemian frontier is 400 feet; at Konigstein, 540; at Dresden Bridge, 960; below Meissen, 1100.

The Oder rises at the base of the Carpathians near the source of the Vistula, and flows N.E. by Breslau, Glogau, Custrin, and Stettin, to the Baltic.

The Weser is formed in the south of Hanover, by the junction of the Werra and Fulda, and flows in a winding course nearly due north by Minden and Bremen to the North Sea.

The Ems has its source in Westphalia, and runs north to the Gulf of Dollart.

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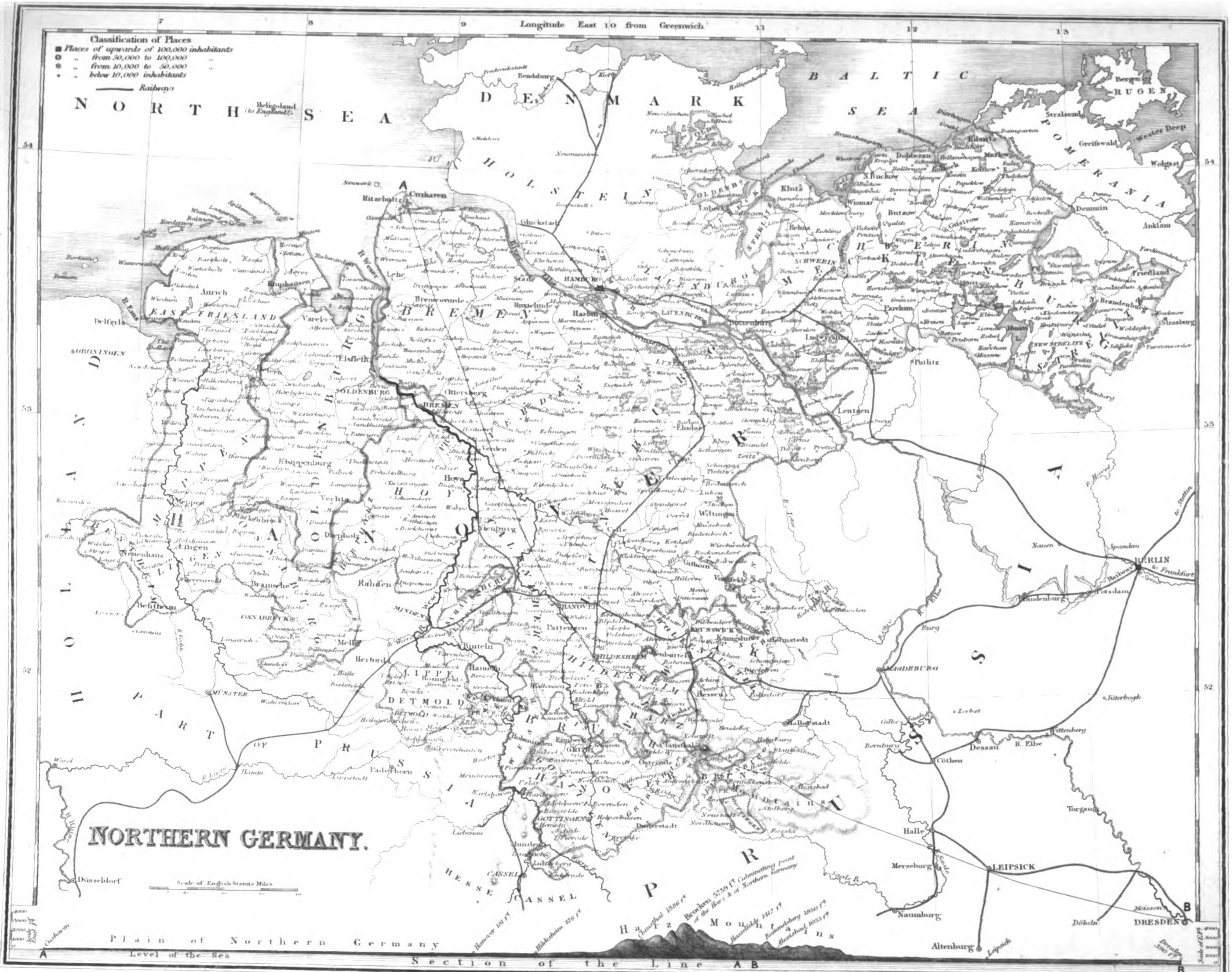

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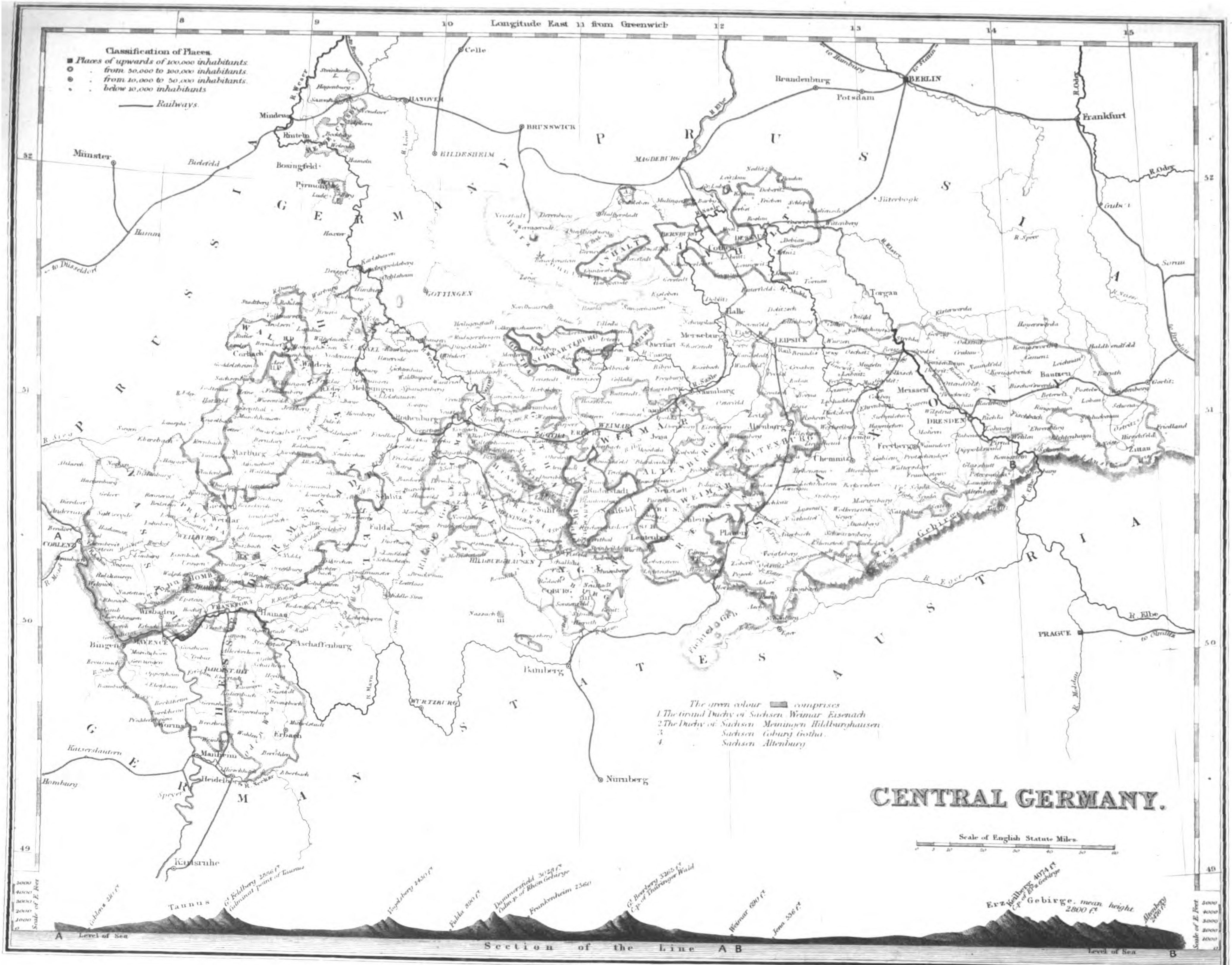

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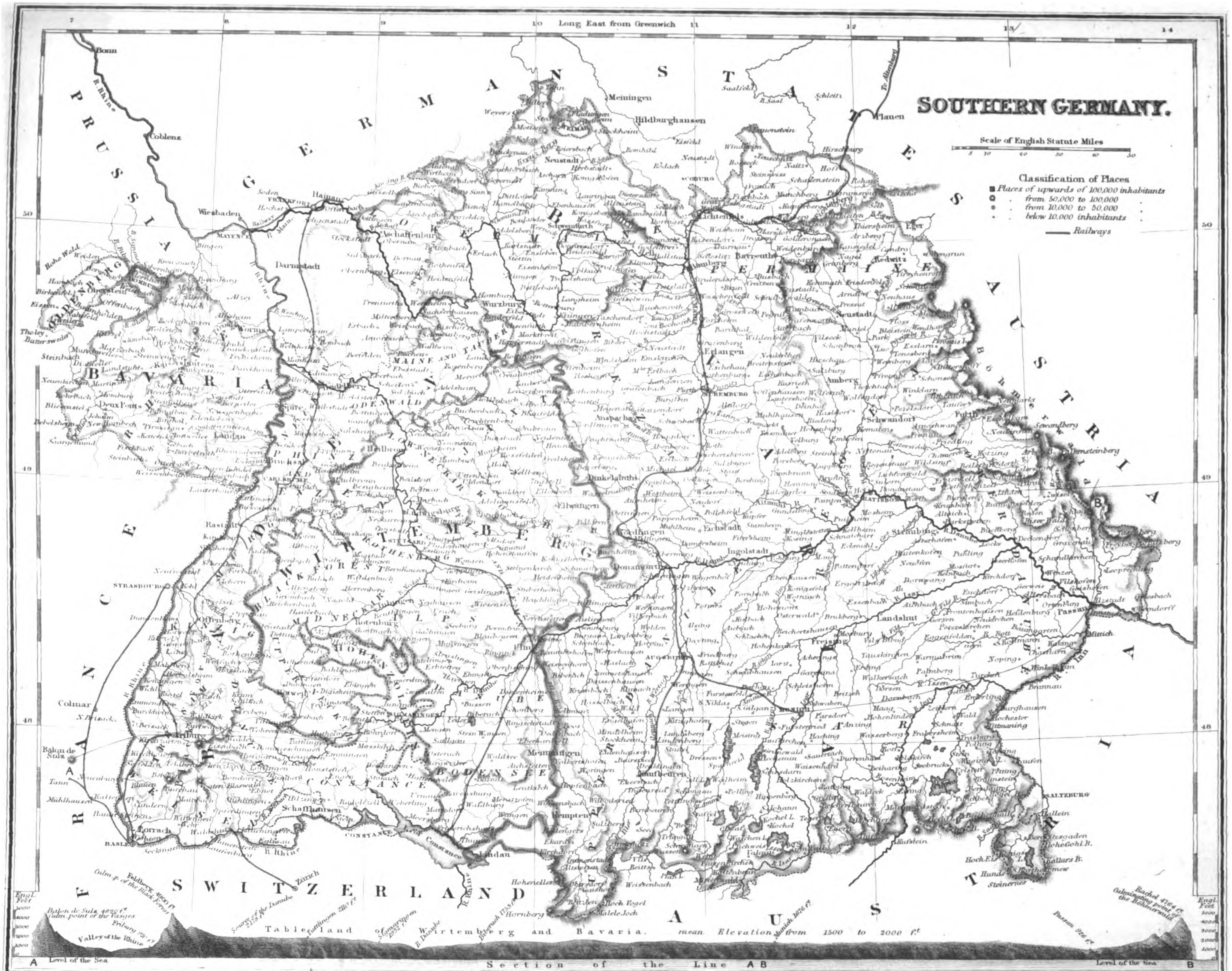

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in length, 40 feet broad at the summit, on which there is a good roadway. It descends to the sea by a slope of 200 feet at an angle of 40°. Enormous buttresses, proportionably broad and high, project at certain intervals several hundred yards into the sea. The whole of this artificial coast consists of immense blocks of Norwegian granite. Another great dyke protects the west side of the island of Walcheren. The sea has, however, repeatedly broke bounds, and asserted its mastery over Holland, permanently submerging extensive tracts, and making havock of life and property. The Zuider Zee (South Sea) was formed by an incursion of the ocean in the year 1225. The gulf of Dollart is the offspring of an inundation in 1277. The lake of Haarlem was formed in like manner. A terrible irruption in 1491 overwhelmed 72 villages, 100,000 persons, and formed the Biesbosch, a lake near Dort.

III. Holland, being almost an unbroken flat, has a very monotonous aspect, and would be excessively uninteresting but for the evidences of a highly cultivated soil, the neat towns and villages, the numerous canals and rivers fringed with trees. The Rhine enters it from the Prussian territories, a single stream, 2000 feet broad. It divides into two branches soon after crossing the frontier. The southern branch, the Whaal, is the most important, and ought to retain the name of the parent stream. It joins the Meuse from Belgium and receives its name, splits into several divisions after passing Gorcum, one of which passes by Rotterdam to the sea. The Rhine, after the detachment of the Whaal, sends off a second branch, the Yssel, flowing to the Zuider Zee, and afterwards a third, the Leck, which runs to the network of waters south and east of Rotterdam. Still retaining the original name, but less than any of its branches, the river proceeds to Utrecht and Leyden, and enters the sea; but a very small portion of the great body of water forming the Rhine being discharged by the channel so called. The Meuse enters the country near Maestricht, traverses the province of Limburg, and forms for a considerable space the boundary between North Brabant and Gelderland, before its junction with the Whaal. The lakes and marshes are numerous, and in some instances extensive, the Haarlem-Meer extending 14 miles in length by 8 in breadth. Holland is almost everywhere intersected with canals, which for number have been compared to the roads of England.

The Haarlem-Meer has repeatedly extended its boundaries, and entailed a large annual outlay in works for the defence of the adjacent districts. On the 9th of November, 1836, a furious hurricane from the west drove its waters upon the city of Amsterdam, and drowned upwards of 10,000 acres of low land in the neighbourhood; and on the 25th of December following another hurricane from the east drove the waters in the opposite direction upon the city of Leyden, the lower parts of which were submerged for 48 hours, and 19,000 acres of land were inundated. The enormous loss occasioned by these two storms determined the Dutch government to undertake the drainage of the lake—a project often contemplated—for which a credit of 8,000,000 florins was voted by the States-General, and a Commission appointed to superintend the work in May, 1840. This measure, the greatest hydraulic operation of modern times, requiring vast preliminary arrangements, is now in process of execution by gigantic steam power.

The Helder, or Great Ship Canal, is the principal work of the kind in Holland, and one of the greatest achievements of our time. It connects the port of Amsterdam with the harbour of Niew-Diep, near the Helder, by which the North Sea and the commercial capital are brought into communication, and the dangerous navigation of the Zuider Zee, the old route, is avoided. The canal is about 50 miles long, 24 feet deep, and 120 feet wide at the surface; capable therefore of bearing the largest merchantmen, and ships of the line of 74 guns. It was commenced in 1819, and completed in 1824, at an outlay of about £1,000,000 sterling. The canals are to a considerable extent the roads of Holland, used for the conveyance of passengers as well as for the transit of goods; but a great number are formed simply for the purpose of drainage.

IV. The kingdom is divided into provinces, districts, and cantons; and contains a population of nearly 3,000,000.

Provinces.	Capitals.	Other Chief Towns.
North Holland......	Haarlem	Amsterdam, Hoorn, Alkmaar, Naarden.
South Holland......	The Hague	Rotterdam, Leyden, Delft, Dort, Helvoetsluys.
Zealand	Middleburg	Flushing, Sluys, Sas-de-Gand.
Utrecht	Utrecht	Amersfort, Montfoort.
North Brabant......	Bois-le-Duc	Breda, Bergen-op-Zoom.
Gelderland	Arnheim	Nimeguen, Zutphen, Loo.
Overyssel	Zwoll	Hardenburg, Almelo, Deventer.
Drenthe...............	Assen	Meppel.
Friesland	Leeuwarden	Franeker, Harlingen.
Groningen............	Groningen...........	Delfzyl.
Limburg	Maestricht	Venloo, Stephanswerd, Ruremonde.
Luxemburg*	Luxemburg	Echternach, Diekirch.

* Luxemburg forms no part of Holland, but belongs to the Germanic Confederation, governed by the King of Holland as Hereditary Grand Duke of Luxemburg.

Amsterdam, the commercial metropolis, and the largest city in the kingdom, is the most singularly constructed city of Europe. Occupying a marsh on the Y, or Wye, an arm of the Zuider Zee, it is built upon piles, and so intersected with canals that upwards of 90 islands are formed by them, communicating by nearly 300 bridges. The population exceeds 220,000. The Hague, the residence of the Court and the seat of Government, is the political capital, in lat. 52° 5′ N., and long. 4° 20′ E.,—a comparatively small but elegant city, containing about 60,000 inhabitants. Rotterdam ranks after Amsterdam in commercial importance. Leyden, Groningen, and Utrecht are the seats of universities.

The foreign possessions of Holland consist of several settlements on the Guinea coast, in Africa; Java, part of Sumatra, and the Moluccas, in the Indian Archipelago; Dutch Guiana, in South America; the islands of Curaçoa, Oruba, Buen Ayre, Aves, Los Roques, and Orchilla, off the coast of Venezuela; and St. Martin's, St. Eustatius, and Saba, among the West India Islands.

V. The inhabitants of the kingdom engage in the herring, cod, and Greenland whale fisheries, but not so largely as formerly. They excel in ship-building, the manufacture of paper and earthenware, and all branches of horticulture; but the manufactures are at present quite unimportant, the people being essentially agricultural and commercial. They raise an immense amount of dairy produce for the English and other markets, the humid and foggy climate being more adapted for pasturage than for the ripening of grain; and carry on an extensive trade with all nations, receiving and re-exporting the wines of France and Spain, the timber of the Baltic, and the manufactured goods of Germany and England. Possessing exclusively the Moluccas, it is through Holland that most of the spices, cloves, nutmegs, and mace, find their way into Europe. The Hollanders include the German population of Limburg, the Frisians of West Friesland and the adjacent islands, and the Dutch, who form the great bulk of the people, all belonging to the Teutonic family of nations, and speaking dialects of the German. Protestantism is the prevailing religious profession.

XII. NORTHERN GERMANY. XIII. CENTRAL GERMANY. XIV. SOUTHERN GERMANY.

I. The entire territory included under the name of Germany occupies a large area of central Europe. Its boundaries are the North Sea, Denmark, and the Baltic, on the north; Prussian, Russian, and Austrian Poland, with Hungary, on the east; the Adriatic Sea, Lombardy, and Switzerland on the south; France, Belgium, and Holland on the west. It has been called the labyrinth of geography, owing to the number of its separate states, their involved territories, and political connection in various instances with adjoining countries.

Latitudinal limits.—45° 10′ N., south extremity of Illyria, and 54° 50′ N., north-east point of Pomerania.

Longitudinal limits.—5° 45′ E., west side of Luxemburg, and 19° 20′ E., east side of Silesia.

Extent.—About 680 miles from west of Luxemburg to east of Silesia, by 600 miles from the north of Holstein to the borders of Lombardy. The area approaches to 250,000 square miles.

Islands.—Rugen, the largest, and Dars, off the north-west coast of Pomerania, with Usedom, at the mouth of the Oder, belonging to Prussia; Heligoland, off the mouth of the Elbe, belonging to Great Britain; and Norderney, with a chain of small islands along the coast of East Friesland, belonging to Hanover.

II. A general view of the country at large will appropriately preface a notice of the separate sections to which the maps refer. Germany may be divided into four divisions, defined by well-marked natural features, consisting of two mountain regions and two plains: 1. The south-east mountain region of the Tyrolese Alps and their branches, extending towards Vienna and Trieste, and culminating in the Ortler Spitz, at the height of 12,850 feet. 2. The elevated plain or table-land of the south, occupying Bavaria and Wirtemberg, intersected by the Danube, extending about 180 miles northwards from the Alps, with a breadth of 120 miles, and a mean elevation of from 1500 to 2000 feet. 3. The central mountain region, which bounds the southern table-land on the east, north, and west; including, eastward, the ranges which nearly inclose the great valley of Bohemia; northward, the Thuringerwald and other groups, stretching into Hanover and to the borders of the Rhine; and westward, the Schwarzwald, or Black Forest group, and the Odenwald, which may be called the Rhenish mountain-system, as running parallel to the river in its course from Basle to Mayence. 4. The low plain of the north, a part of the great plain of Europe, extending from the preceding district to the North Sea and the Baltic, and comprising almost the whole of Hanover, Prussia, and Saxony.

The first district exhibits very different climates and vegetable productions. The olive groves, maize-fields, and vineyards of Trieste, flourish in close contiguity to the glaciers of the Tyrol.

The second district is somewhat cold and sterile in the more elevated sites, but comprises many river-valleys, and sheltered regions of high fertility.

The third district is remarkable for its metalliferous deposits, one of its ranges, the Erzgebirge (metallic mountains), deriving its name from that circumstance.

The last natural division contains the largest proportion of infertile land in Germany. West of the Elbe, the country presents a succession of moors, treeless, but clothed with heath and juniper, connected by tracts of sand almost entirely without vegetation, the cultivable soil occurring in small and distant oases. East of the Elbe, the low plain has its moors and sandy tracts, but the latter are generally covered with pine woods, and the fertile districts are more numerous and extensive.

III. Germany contains some of the most considerable river-systems of Europe, either wholly or in part,—those of the Danube, Rhine, Elbe, Oder, Weser, and Ems. There is no important lake besides the Boden-see, or Lake of Constance, which belongs chiefly to Switzerland; but small lakes are very numerous in Mecklenburg and Prussia; and, in the south of Bavaria, mineral springs are more abundant than in any other part of the continent. The thermal waters of Aix-la-Chapelle, Pyrmont, Carlsbad, Toplitz, Baden-Baden, Kissengen, Wiesbaden, and the Austrian Baden; the acidulous springs of Seltzer and other places; and the saline waters of Seidlitz, are sufficiently well known. Brine springs extend along the northern base of the Alps, from which large quantities of common salt are obtained. Except in the north-west, and some parts of Bavaria, the country is remarkably well wooded, the forests supplying timber for export and furnishing the ordinary fuel. Among the cultivated plants, wheat and barley are the principal crops in the south; maize is abundantly raised in the south-east; the vine is general in the valleys of the Danube, Rhine, Necker, Maine, and Moselle; and the olive appears near Trieste. The wild animals comprise varieties of deer and swine, numerous in the forests; the wolf, now rare; the beaver, very scarce; the lynx, common; and the bear and chamois in the Tyrol.

The Danube rises in the Black Forest in Baden, at the height of 2200 feet above the sea-level, flows generally N.E. to Ratisbon, and from thence E. by S. to Vienna, soon afterwards leaving the country for Hungary, being there 417 feet above the level of the Black Sea, thus descending 1783 feet in its course through Germany. At Ulm the breadth of the river is 200 feet; at Ingolstadt 500; at Ratisbon, 600; at Passau, 750. Its leading German affluents are: on the left bank, the Wernitz, Altmuhl, Naab, and Regen; on the right bank, the Iller, Lech, Isar, and Inn, all in Bavaria.

The Rhine enters Germany from Switzerland after passing the Lake of Constance, but only flows along the frontier from thence to some distance below Strasburg, where it divides the Palatinate from Baden, and proceeds through the Prussian states to Emmerich, near Cleves, where it enters Holland. Its chief affluents on the right bank are the Neckar, Maine, Lahn, and Lippe; and on the left bank, the Moselle. At the issue from the Lake of Constance, it is about 1300 feet above the sea-level; at Basle, 765 feet; opposite Strasburg, 450; at Mayence, 270; at Cologne, 110. At the great fall near Schaffhausen, the river is about 210 feet wide; at Basle, 590; near Mayence, 1700; at Cologne, 1200; below Wesel, 1450; and at the issue into Holland nearly 2000.

The Elbe is the largest exclusively German river, and descends from the loftiest source, the Elb-brunnen, in the east of Bohemia, being 4260 feet above the sea-level. It descends from the Great Bohemian valley through a gorge of the Erzgebirge, and flows generally N.E to Hamburg, at the head of the long and broad estuary by which it reaches the North Sea. The breadth of the river at the Bohemian frontier is 400 feet; at Konigstein, 540; at Dresden Bridge, 960; below Meissen, 1100.

The Oder rises at the base of the Carpathians near the source of the Vistula, and flows N.E. by Breslau, Glogau, Custrin, and Stettin, to the Baltic.

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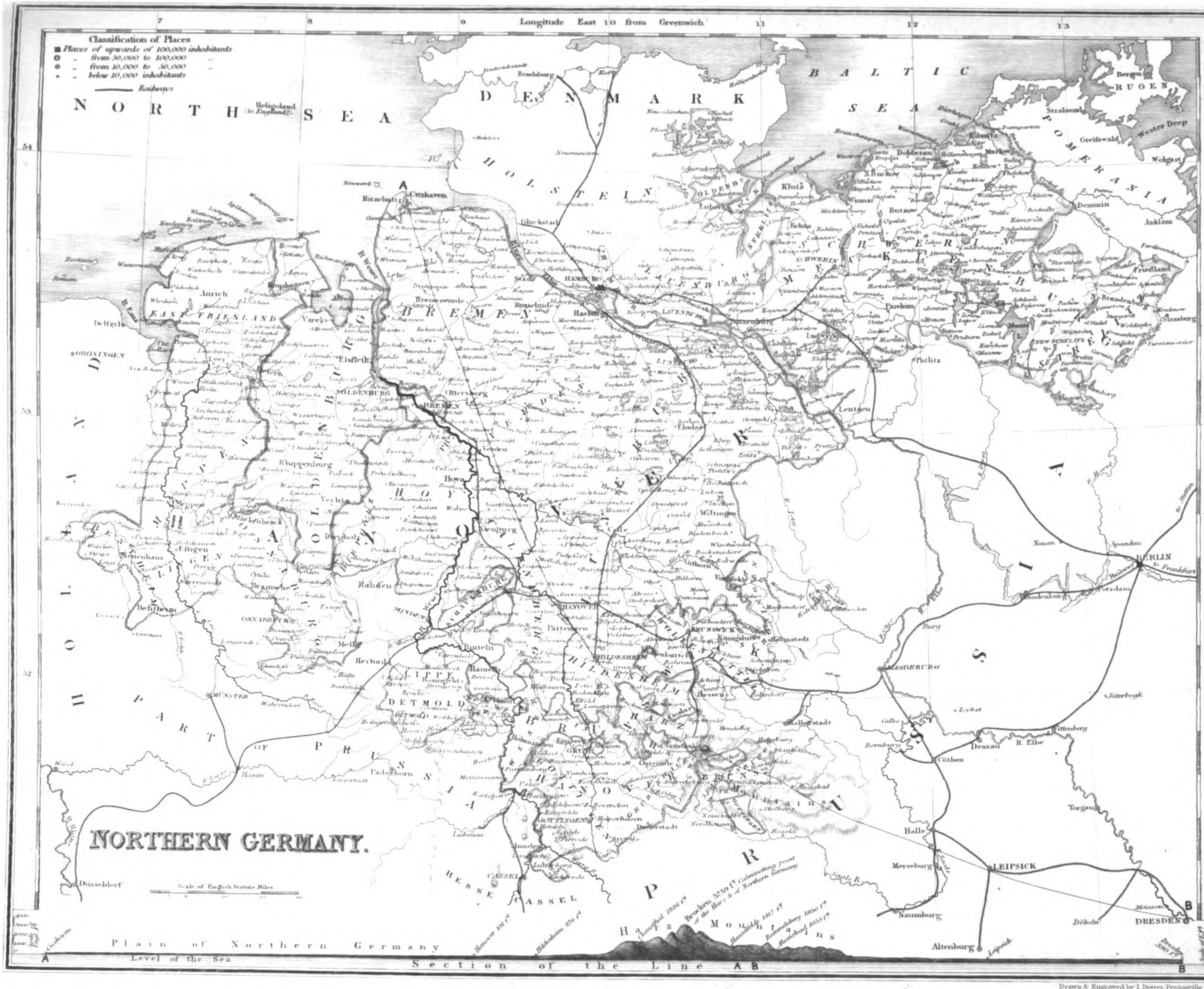

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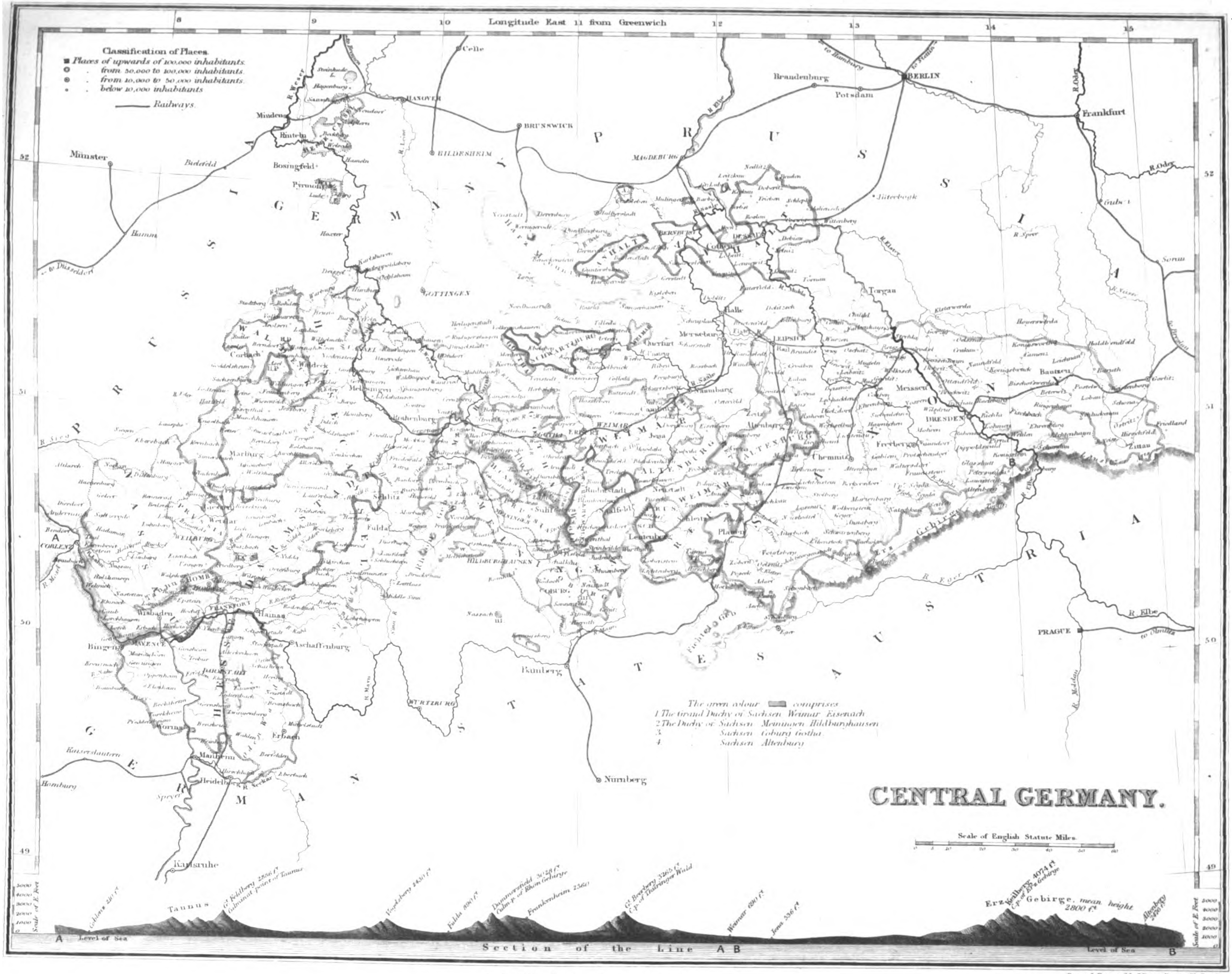

Longitude East 11 from Greenwich
Classification of Places.
Places of upwards of 100,000 inhabitants.
from 50,000 to 100,000 inhabitants.
from 10,000 to 50,000 inhabitants.
below 10,000 inhabitants.
Railways.
CENTRAL GERMANY.
The green colour comprises
1 The Grand Duchy of Sachsen Weimar Eisenach
2 The Duchy of Sachsen Meiningen Hildburghausen
3 Sachsen Coburg Gotha
4 Sachsen Altenburg
Scale of English Statute Miles.
Section of the Line AB
Level of Sea
BERLIN
Brandenburg
Potsdam
Frankfurt
MAGDEBURG
BRUNSWICK
HANOVER
HILDESHEIM
Celle
Minden
Münster
Hamm
GOTTINGEN
LEIPSICK
Halle
DRESDEN
Meissen
Chemnitz
Freyberg
Bautzen
Zittau
Torgau
Merseburg
Naumburg
Weimar
Jena
Erfurt
Gotha
Fulda
Marburg
Wetzlar
Wiesbaden
MAYENCE
FRANKFORT
Hanau
Aschaffenburg
DARMSTADT
Mannheim
Heidelberg
Worms
Bingen
COBLENZ
Kaiserslautern
Karlsruhe
Speyer
Bamberg
Nurnberg
WURTZBURG
Coburg
Plauen
Eger
PRAGUE
R. Elbe
R. Oder
R. Moldau
R. Eger
R. Main
R. Saale
to Hamburg
to Stettin
to Breslau
to Olmütz
to Düsseldorf
P R U S S I A
G E R M A N Y
A U S T R I A
Erz Gebirge
Taunus
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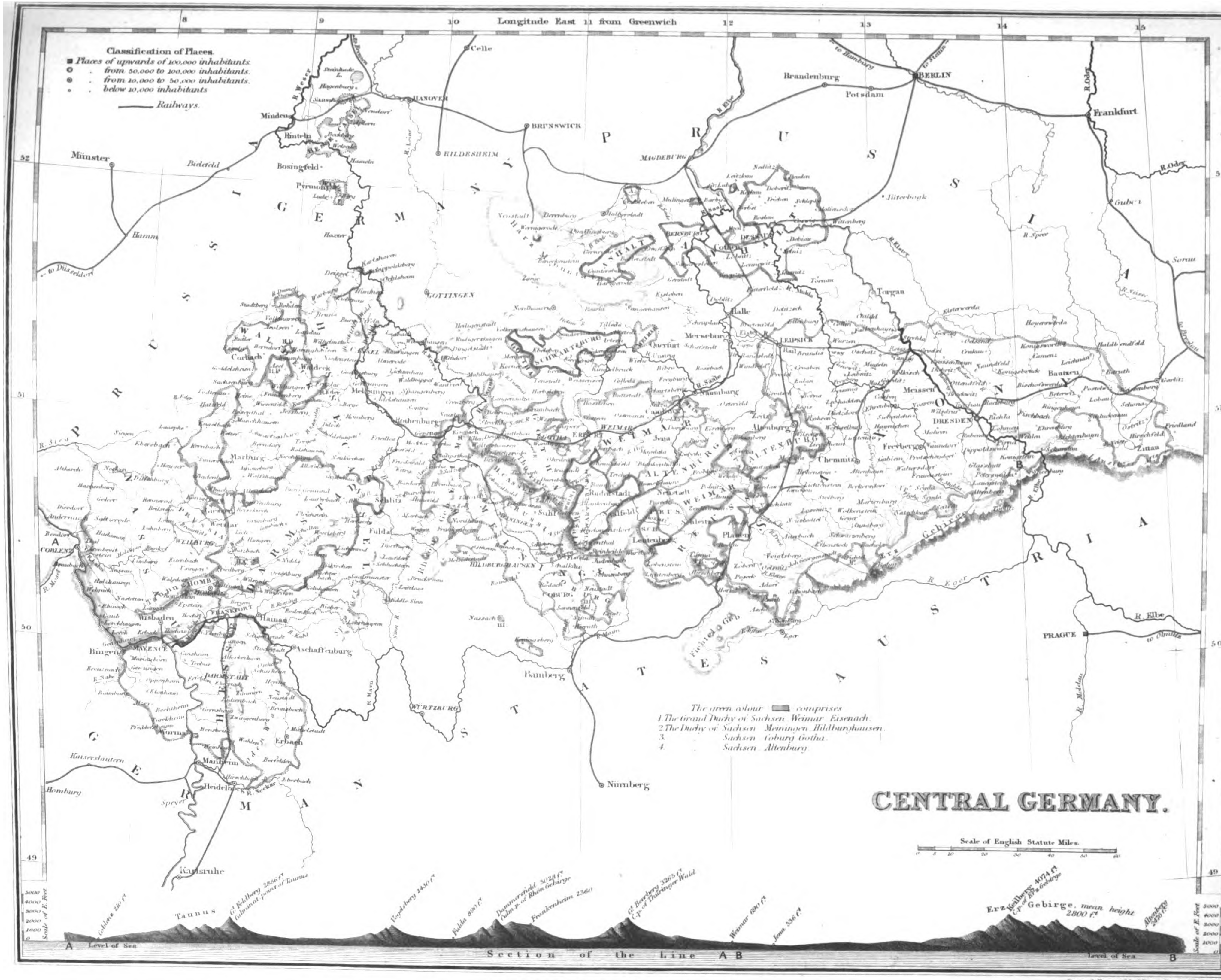

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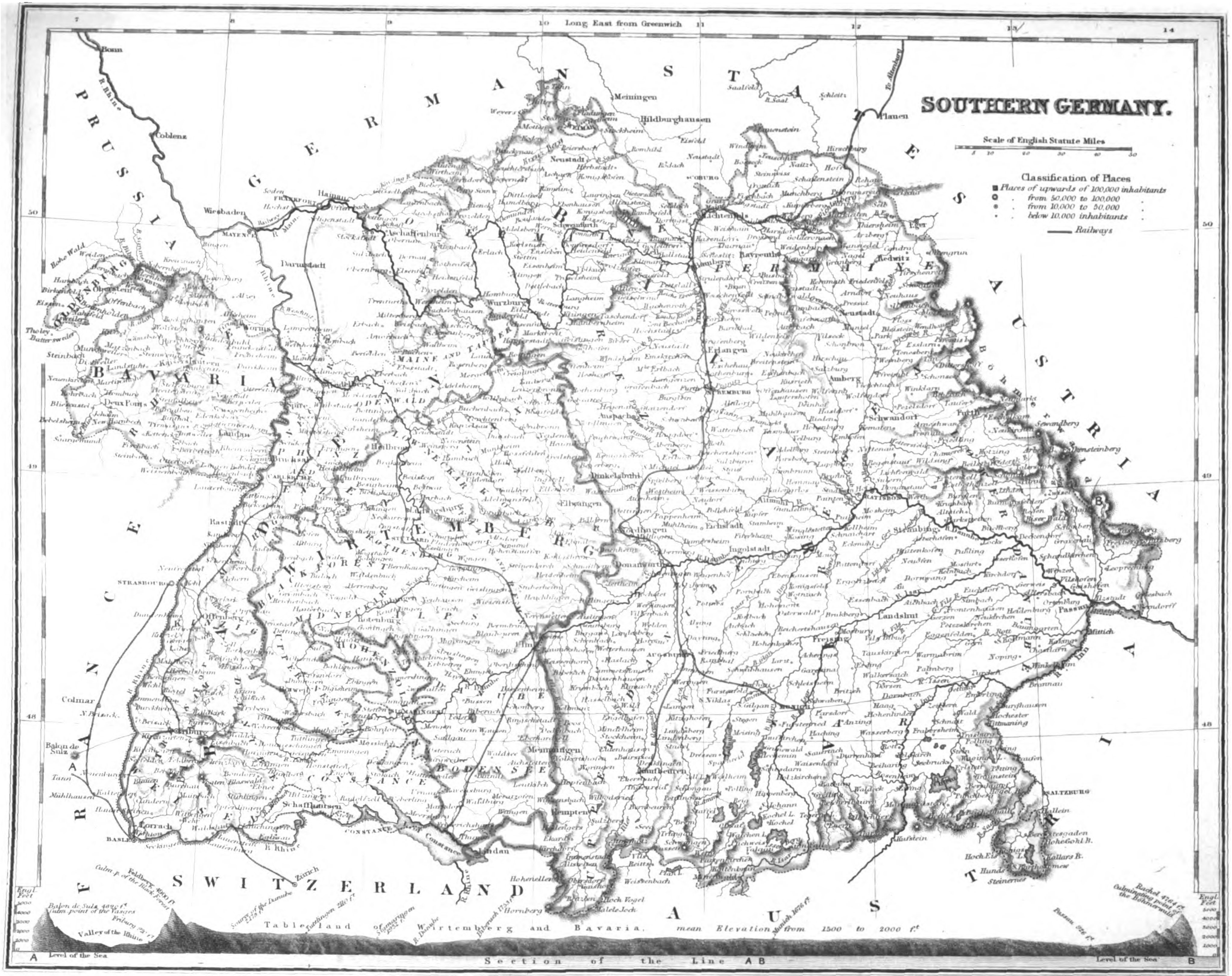

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through it N. by W., into two unequal portions. The mountainous parts are highly metalliferous. The plains and valleys are largely clothed with vineyards and orchards, and sustain the flocks from which the fine Saxon wool is derived. The people are among the most intelligent and enterprising in Germany, and rank foremost in mining and manufacturing skill. Dresden, the capital, a magnificent city centrally situated on both banks of the Elbe, is renowned for its works of art; population, 70,000. Leipsic, on the Elster, celebrated for its university and great annual fairs; Freyburg, on the Mulda, noted for its silver mines, mining academy, and rich mineralogical collections; and Chemnitz, the chief manufacturing site, are the most important provincial places.

1. *Electorate.*—Hesse-Cassel consists of four separate districts, the largest of which is traversed nearly through its whole extent from south to north by the river Fulda. On its banks, Cassel, the capital, is seated; population, 31,000.

2. *Duchies.*—Grand Duchy of Hesse-Darmstadt, consists of two principal portions divided by a part of Hesse-Cassel and the territory of Frankfort. The southern portion extends along both banks of the Rhine from near Manheim to below Mayence. It contains the capital, Darmstadt, population 23,000; and the pleasing and picturesque range of the Odenwald.

Saxe-Weimar comprises several tracts, the largest of which contains the capital, Weimar, population 10,000, finely situated in the valley of the Ilm, a tributary of the Saale.

Duchy of Nassau occupies the angle formed by the Maine and Rhine, and extends along the latter river from the Darmstadt frontier near Mayence to the neighbourhood of Coblentz, where it enters the Prussian states. The country is highly beautiful and fertile, diversified in the south by the mountainous tract of the Taunus, which rises in the Gross-Feldberg, N.W. of Frankfort, 2886 feet. Its mineral waters, at Wiesbaden, the capital, population 7000, Ems, and Seltzer, are justly celebrated.

Saxe-Altenburg is divided into two portions; the eastern, bordering on Saxony, containing the capital Altenburg, near the river Pleisse, population 12,000.

Saxe-Meiningen is a long winding tract on the north border of Bavaria, with several separate patches. Meiningen, the capital, is on the Werra, population 6000.

Saxe-Coburg-Gotha consists of two principal divisions separated by Meiningen. Gotha, the largest and most northerly, bounded by the Thuringian Mountains, has for its capital the city of that name on the Leine, population 11,000. Coburg, the southern division, is on the borders of Bavaria. Its capital, of the same name, is on the Itz, population 9000.

Anhalt, a territory between Magdeburg and Leipsic, watered by the Elbe and its affluents, the Mulda and Saale, constitutes with some detached districts the three duchies of Anhalt-Dessau, Anhalt-Coethen, and Anhalt-Bernburg. Capitals—Dessau, near the junction of the Mulda and the Elbe, population 11,000; Coethen, on the Ziethe, population 6000; and Bernburg, near the Saale, population 6000.

3. *Principalities.*—Waldeck, N.W. of Hesse-Cassel, with which a very small detached track on the S.W. border of Hanover, celebrated for the mineral waters of Pyrmont, is connected. Capital, Corbach, on the Itter, population 2200.

Reuss, a territory on the S.W. borders of Saxony, consists of two detached portions, and forms two principalities. Gera is the capital of the northern, population 9000; Greitz of the southern, population 6500.

Schwartzburg-Sondershausen and Schwartzburg-Rudolstadt, two principalities, comprise three detached districts, intermingled with the Saxon duchies. Sondershausen, on the Wipper, is the capital of the former, population 3800; and Rudolstadt, on the Saale, of the latter, population 5000.

4. *Landgraviate.*—Hesse-Homburg, consists of two insignificant tracts, one N.W. of Frankfort, and the other on the west of the Rhine. Homburg, in the former, is the chief town, population 3000.

5. *Free City.*—Frankfort-on-the-Maine, one of the most ancient cities of Germany, and a centre of its inland trade, population 55,000. Its territory includes about 85 square miles.

VII. Southern Germany,—excluding the Austrian dominions, to which a special Map is devoted,—comprehends the kingdoms of Bavaria and Wirtemburg, with 1 duchy, and 3 principalities. Bavaria ranks after Austria and Prussia in importance among the German states. It consists of two perfectly distinct districts separated by Darmstadt and Baden. The smaller, called the Palatinate, or the territory of the Rhine, lies along the west bank of the river, and forms part of the north-eastern frontier of France. The larger is called the territory of the Danube and Maine, and contains 7 out of the 8 provinces of the kingdom. The whole area comprises about 28,500 square miles. Bavaria receives the Danube soon after its passage by Ulm, and loses it below Passau, after a course generally N.E. and S.E. of about 270 miles. The Maine originates within its limits, and after a remarkably winding course enters the Hessian states. The surface consists extensively of highlands, but intersected with numerous river-valleys, inclosed by the spurs of the Alps on the south, the Bohemian forest chain on the east, and the Fichtelgebirge (pine mountains), Rhongebirge, and Spessart, on the north. Munich, the capital, on the southern table-land, at the height of 1676 feet above the sea-level, is, after Madrid, the most elevated of the great cities of Europe, population 106,000. The small kingdom of Wirtemburg, between Bavaria and Baden, has Stutgard, near the Necker, for its capital, population 38,000.

1. *Duchy.*—Grand Duchy of Baden, a long strip of territory chiefly on the Rhine, and extending on the right bank from below Manheim to the Lake of Constance. Capital, Carlsruhe, population 20,000.

2. *Principalities.*—Hohenzollern, a small district inclosed by Wirtemburg and Baden, the cradle of the royal family of Prussia. It forms two principalities, named after their chief towns, Hechingen, population 3000; and Sigmaringen, population 1400.

Lichtenstein, or Stein, the least of the independent states of Germany, containing only 53 square miles, lying on the right bank of the Rhine between Schaffhausen and the Lake of Constance.

VIII. The Germanic Confederation, formed at the Congress of Vienna in 1814, a union, for purposes of mutual security, of the several states, represented by their plenipotentiaries in a general diet under the presidency of the Austrian representative, is now practically abolished; but what other arrangements will follow is quite uncertain. A great commercial league, the Zollverein or Customs' Union, intended to secure a free system of internal trade, and foster the manufacturing industry of the country by heavy duties on foreign competing articles, was formed by Prussia in 1831, and has been adopted by all the states under the influence of that power. Including Austria and Prussia, the entire German territory possesses about 2400 miles of completed railway communication, the total length of complete and unfinished lines amounting to nearly 6000 miles.

XV. PRUSSIA.

I. Prussia properly designates only a fractional portion of the monarchy, or the eastern province stretching around the mouth of the Vistula, which, together with the province of Posen, is beyond the pale of Germany,—both having, at different times, formed part of the former kingdom of Poland. But the name is currently applied to the Prussian dominions in general, consisting of two principal portions separated by Hanover, Brunswick, and Hesse-Cassel, with several isolated districts of very insignificant extent. The eastern and larger portion is bounded by the Baltic on the north; by Russia on the east; by Hanover, Saxony, the Saxon duchies, and several of the other minor German states on the west and south. The western portion, commonly called Rhenish Prussia, with the Westphalian province, is entirely inland. It embraces the country along both sides of the Rhine; on the left bank from near Bingen, and on the right bank from the vicinity of Coblentz, to the frontier of Holland.

Latitudinal limits.—49° 10′ N., south extremity of Rhenish Prussia, and 55° 50′ N., coast of the Baltic above Memel.

Longitudinal limits.—6° E., frontier towards Belgium near Aix-la-Chapelle, and 22° 30′ E., frontier towards Russia.

Extent.—Greatest length, from N.E. to S.W., neglecting the intervening territories of other powers, nearly 800 miles; greatest breadth, from S. to N., closely coinciding with the meridian of 18°, about 420 miles. The entire area somewhat exceeds 107,000 square miles.

II. The eastern portion of the Prussian monarchy belongs principally to the great plain of Europe. It contains no elevated land excepting the south-west angle, which is penetrated by the Thuringian Mountains and the Harz; and the south-eastern province of Silesia, where the Sudetic range and Riesengebirge (giant mountains) form the boundary from the Austrian states. The Harz culminate in the Brocken, famed for its spectral illusions, at the height of 3739 feet, just within the frontier; and Germany, north of the Danube, attains its highest point in the Prussian territories, Schneekoppe (snow-summit), a mountain-mass of the Riesengebirge, rising to the elevation of 5253 feet. The highest inhabited house of Prussia, Hampelbaude, 4320 feet, is on the latter range; and also the highest town, Gottesburg, 1982 feet. Lakes, morasses, forests, heaths, and sterile tracts, are prominent features of the surface, and occupy a great proportion of its area; but the borders and mouths of the rivers are fertile, especially the delta of the Vistula; and the Silesian province, with Posen, the vicinity of Tilsit, and the government of Magdeburg, contain rich soil, fitted for all the purposes of agriculture. Ranges of naked sand-hills mark the Pomeranian coast of the Baltic, extending some miles inland, and through a considerable interior space those erratic blocks of granite are found imbedded in the surface, which have so much attracted the attention of geologists as having been primarily derived from the Scandinavian Mountains. The Oder, Elbe, Vistula, and Niemen, are the important rivers, of which the former alone has its course almost entirely Prussian. They have a very slow current, consequent upon a slight declination to the sea, and hence frequently overflow their banks, forming the lakes and morasses which are so abundant.

The Oder enters the country from the Austrian states, traverses the provinces of Silesia, Brandenburg, and Pomerania, falling into the Lake of Damansch near Stettin and the Stettiner-haff, a large fresh-water expanse, communicating with the Baltic by three channels, formed by the islands of Usedom and Wollin, and the Pomeranian shore.

The Elbe has its course through Prussia, from above Torgau to the Hanoverian frontier, entirely in the province of Prussian Saxony.

The Vistula, the great outlet for the corn of Poland, crosses the frontier above Thorn, flows through Prussia Proper, and discharges itself by a principal channel into the Gulf of Dantzic, near the city of that name, previously sending off two branches to the sea through the Frische-haff.

The Niemen or Memel rises in Russian Poland, and runs through the east of Prussia Proper, by Tilsit, to the Curische-haff.

The Pregel, also a considerable stream, confined to Prussia Proper, discharges into the Frische-haff at Konigsberg.

The lakes, enumerating those of small dimensions, amount to upwards of a thousand. Prussia Proper has 450; Brandenburg, 680; Pomerania and Posen also a considerable number. The Spirding Lake, the largest, has a surface of 70 square miles; the Mauer Lake, 40; and many of the remainder are from 5 to 15 square miles in extent. The haffs, or bays along the coast, are spacious sheets of fresh water, nearly land-locked, connected with the sea by narrow channels.

III. Rhenish Prussia, with Westphalia, constitutes the western division of the kingdom, divided into two nearly equal parts by the Rhine. It contains a considerable space of high land on the south, through which the river runs in a narrow valley from Bingen to Bonn, celebrated for its castellated hills and picturesque scenes. The northern part belongs to the European plain. The river-valleys are fertile, and are thickly clothed with the vine along their slopes. The flat of the lower Rhine produces rich crops of grain; but the larger proportion of the surface consists of poor or unproductive land. A district between the Moselle and Bonn, stretching westward towards Belgium, the Eifelgebirge, is remarkable for its physical character, presenting unequivocal evidences of volcanic action in conical hills, crater-like basins converted into small lakes, tracts of lava, basaltic and trachytic formations.

A small detached section of territory on the river Lahn enclosed by the possessions of Darmstadt and Nassau, belongs to Prussia, with two others surrounded by the Saxon duchies.

IV. The monarchy is divided into 8 provinces, and subdivided into 25 governments.

Provinces.	Capitals.
Prussia Proper, divided into East and West	Konigsberg, Dantzic.
Posen	Posen.
Silesia	Breslau.
Pomerania	Stettin.
Brandenburg	Berlin.
Saxony	Magdeburg.
Westphalia	Munster.
Rhine Province	Cologne.

The entire population amounts to about 15,000,000. Berlin, the metropolis, in lat. 52° 30′ N., long. 13° 18′ E, occupies a very unfavourable site in the midst of a sandy plain, and contains, exclusive of the garrison, upwards of 280,000 inhabitants. The towns next in order of population are Breslau, Cologne, Konigsberg, Dantzic, Magdeburg, Aix-la-Chapelle, Stettin, Posen, and Dusseldorf.

V. Agriculture is the main dependence of the people, and the principal source of the national wealth; but manufacturing and mining pursuits give employment to an extensive number. Woollen and cotton fabrics are produced chiefly in the Rhenish province; linen in Silesia; mining industry characterizing also the latter province and the region of the Harz. The annexed return refers to steam-engines working in Prussia in 1845:

	No.	Horse-power.
In corn, oil, and paper-mills	102	1,260½
Spinning and weaving-mills	215	2,981½
Mines and foundries	317	9,807
Machine factories	71	640
Railways	149	6,875½
Steamboats and dredgers	79	4 319
All other purposes	158	1,358½
	1091	27,242

The mineral products include iron, zinc, lead, copper, silver in small quantities, salt from mines of rock-salt and brine springs in great abundance, coal, and amber. Amber is far more plentiful in the province of Prussia Proper than in any other part of the world. Though found in mines, much the larger portion is cast up by the sea, especially around Dantzic and near Pillau, on the narrow neck of land which bounds to seaward the Frische-haff. The right of collecting it is farmed from the government.

XVI. AUSTRIAN EMPIRE.

I. The empire of Austria comprises an extensive territory near the centre of Europe, inhabited by various nations of dissimilar race, language, and habits. Excepting a narrow tract along the east shore of the Adriatic, the country forms a compact oblong mass; and generally the frontier coincides with boundary lines defined by nature. Prussia and Russian Poland lie on the north; Russia and Moldavia on the east; Wallachia, Turkey, the Adriatic, and Italy below the Po, on the south; Sardinia, Switzerland, and Bavaria, on the west.

Latitudinal limits.—42° N., Castle of St. Stephen, below Cattaro in Dalmatia, and 51° N., northern extremities of Bohemia and Galicia.

Longitudinal limits.—8° 30′ E., hamlet of Engera, at the south extremity of the Lago Maggiore in North Italy, and 27° E., entrance of the Dniester into Bessarabia.

Extent.—870 miles from the Russian frontier on the east to the Lago Maggiore on the west; 690 miles from the northern limits of Bohemia to the south point of Dalmatia. The area is estimated at upwards of 258,000 square miles, and the circuit at 4400 miles. Of the latter, the land frontier includes about 3750 miles, the remaining 650 miles belonging to the coast of the Adriatic. The empire is the third among the European states in size, being exceeded by the territories belonging to the Swedish crown, and vastly inferior to Russia.

II. The Austrian dominions contain a large amount of lowland country, comprehending the principal portion of the great valley of the Danube, the caldron-like plain of Bohemia, the extensive levels north of the Carpathians in Galicia, the expanse of Central and Southern Hungary consisting of exuberantly fertile flats in connection with arid sandy wastes and immense marshes, and the magnificent plain of Lombardy. But highland districts and mountain chains occupy a more considerable area, of which three leading divisions may be made: 1. The Alpine system of the west and south-west. The Rhætian Alps, after traversing the Swiss canton of the Grisons, and forming the north border of Lombardy, enter the Tyrol, and extend in a north-easterly direction to its opposite extremity, terminating at the Drey Herren Spitz, or Three Lords' Peak. The Noric Alps commence at this point, and continue in the same direction towards the neighbourhood of Vienna, gradually subsiding into the Hungarian plain. The Carnic Alps run from the south of the Tyrol into Illyria, and are prolonged under the name of the Julian Alps eastward into Sclavonia; while another branch, with many ramifications, the Dinaric Alps, stretches parallel to the Adriatic into Dalmatia, and enters Turkey. 2. The Carpathian system of the east and north-east. This great chain, sending out

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numerous wide-spreading branches, extends in the form of an arch from the vicinity of the Danube eastward of Vienna, around Hungary and Transylvania, bending from N.E. to S E. and S.S.W., approaching the Danube again, after a vast detour, near Old Orsova on the Wallachian frontier. 3. The Sudetic and Bohemian Mountains of the north and north-west. The Sudetes include the Giant Mountains of Bohemia (Riesengebirge), and other subdivisions, which stretch from the right bank of the Elbe at its outlet from that country to the Carpathians, and divide principally the Austrian from the Prussian territories. The other Bohemian ranges are the Metallic Mountains (Erzgebirge), which extend from the left bank of the Elbe along the frontier towards Saxony; and the Bohmerwald, or Bohemian forest chain, which forms the boundary towards Bavaria.

The Rhætian Alps contain the highest point of the empire, the Ortler-Spitz, 12,850 feet; and the highest carriage-road of Europe, 8850 feet, across the pass of Monte Stelvio, close to the Swiss frontier. The Three Lords' Peak, at the termination of the chain, rises 10,122 feet. The Noric Alps culminate in the Gross Glockner, 12,230 feet, near the boundary between the Tyrol and the Archduchy of Austria. The Carnic and Julian Alps are comparatively low, though some summits attain 11,000 feet. The highest point of the Dinaric Alps, Monte Dinara in Dalmatia, which gives its name to the chain, is only 7458 feet.

The Carpathians attain their greatest general elevation towards the centre of the chain, where the Tatra Mountains, a stupendous mass of granite, have several peaks exceeding 8000 feet.

The loftiest of the Sudetic range, Schneekoppe, belongs to Prussia. On the Austrian side Altvater rises 4896 feet. The Metallic Mountains of Bohemia culminate in Keilberg, at the height of 4074 feet; and the Bohmerwald in Mount Rachel, 4764 feet.

III. The inland waters of the empire are connected with the basin of the Adriatic by the Po, Adige, Brenta, Piave, and other rivers of Lombardy; with the North Sea by the Elbe and its affluents in Bohemia, and the Rhine which separates the Tyrol from the Swiss cantons of St. Gall and Appenzell; with the Baltic by the Oder rising in Moravia, and the Vistula which has its source in Austrian Silesia, receives considerable tributaries from Galicia, and forms the boundary between that province and Russian Poland; but the superficial drainage is chiefly conducted to the basin of the Black Sea by the Dniester from the northern base of the Carpathian Mountains, and the Danube, intersecting the country from west to south-east, and forming, with its subsidiary rivers, the prominent watercourse. Lakes abound in almost every part of the Austrian possessions, some of which are considerable expanses. The Platten See, or Lake Balaton, in the west of Hungary, is the largest example, occupying with its bordering swamps an area of 504 square miles. The shallow Neusiedler See, in the same district, fringed with incrustations of salt, soda, and vitriol, contains 120 square miles of surface. Behind the peak of Lomnitz in the central Carpathians, the Grune See, or Green Lake, is remarkable for its generally dark surface, being interspersed with a number of green spots, an appearance supposed to be the effect of shallows, where the bottom consists of white sand and particles of mica. In Illyria, the Zirknitz See, a lake of 63 square miles, disappears and refills according to the season, its bed being connected with subterranean cavities or reservoirs. Transylvania, Bohemia, the archduchy of Austria, the Tyrol, Illyria, Croatia, and Dalmatia, are extensively supplied with lakes of small dimensions, and Austrian Italy shares the Lago Maggiore with Sardinia and Switzerland, and exclusively possesses the lakes of Como and Garda,—the latter the largest in the peninsula. Lagunes extend along the coast of the Adriatic, formed by the rivers which flow into it, and called "dead" or "living," according as their waters are at rest or in motion.

The Danube has a course of more than 600 miles in the Austrian territory, through nearly the whole of which it is navigable, though rapids and other obstacles impede the navigation at various points. It enters the country below Passau about 750 feet wide, flows generally eastward towards the centre of Hungary, where it abruptly makes a great southern bend, running nearly due south to its junction with the Drave, and south-east from thence to the Turkish frontier, where it quits the empire; being 2000 feet wide at Buda, and 2540 at Belgrade. Just before its exit, the river enters the narrow mountain-valley of the Iron Gate, formed by offsets of the southern Carpathians on one side and of the Balkan on the other, where rapids interrupt for upwards of a mile all water communication between Hungary and Turkey. The Danube in passing through Hungary forms several very large islands, one of which, the Grosse-Schut, extends 50 miles from Pressburg to Comorn. Its principal affluents in the Austrian dominions are the March, Waag, Gran, Eupel, and Theiss, on the left bank; the Inn, Enns, Raab, Drave, and Save, on the right. The Theiss, the largest tributary, has a remarkably tortuous course, estimated at 740 miles.

A vast number of sheets of water, or small lakes, individually insignificant, but important in the aggregate, occur in Bohemia, Moravia, and Galicia. They have been estimated at between 20,000 and 30,000.

IV. The Austrian monarchy comprises 1 archduchy, 1 duchy, 1 county or princely earldom, 1 margraviate, 7 countries to each of which the name of kingdom is applied, and 1 principality:

	Area. Square Miles	Population.	Cities and Towns.	Market Sites and Villages.
Archduchy of Austria	15,079	2,267,194	52	11,425
Duchy of Styria	8,687	975,309	20	3,643
Princely Earldom of the Tyrol	11,003	839,755	22	1,731
Margraviate of Moravia and Austrian Silesia	10,268	2,166,638	118	3,733
Kingdom of Bohemia	20,245	4,174,168	278	11,926
Kingdom of Galicia and Lodomir, including the Bukowina	36,566	4,797,243	95	6,145
Kingdom of Illyria	10,980	1,240,730	62	6,865
Kingdom of Hungary, with Croatia, Sclavonia, and the Military Frontier	104,308	13,299,807	62	12,279
Kingdom of Dalmatia	5,076	394,028	9	1,002
Kingdom of Lombardy and Venice	17,550	4,716,529	56	11 434
Principality of Transylvania	21,426	2,079,000	25	3,356
	258,188	36,950,401	799	73,539

These portions of the empire may be conveniently arranged in four divisions, consisting of the Germanic, Polish, Hungarian, and Italian countries. The latter, embracing the Lombardo-Venetian kingdom, is noticed under the head of Northern Italy.

V. The Germanic states of the monarchy comprise the archduchy of Austria, the hereditary possession of the reigning house, Styria, Moravia, and Silesia, the Tyrol, Bohemia, and Illyria, containing upwards of 11,500,000 of the entire population. The Austrian archduchy is divided by the river Enns into the two provinces of Upper and Lower Austria. The latter contains the capital of the empire, Vienna, in lat. 48° 12′ N., long. 16° 23′ E., situated on the right bank of the Danube, but at a short distance from the main stream, with a population of about 350,000. Prague, the chief city of Bohemia, ranks after the capital in Austrian Germany; and Trieste next, at the head of one of the Illyrian governments, situated on the Adriatic, the principal and almost the only commercial port. The Polish countries consist of Galicia and Lodomir, formerly part of the kingdom of Poland, with the Bukowina, a portion of Moldavia ceded by the Turks in 1777, the whole lying north and east of the Carpathians, containing nearly 5,000,000 of people. Lemburg, the Galician capital, has about 60,000 inhabitants, a considerable proportion being Jews. The Hungarian countries embrace Hungary, now struggling for independence, in which Croatia and Sclavonia are included. Transylvania, Dalmatia, and the military frontier, consisting of a narrow strip of territory extending along the boundary towards Turkey, forming a separate province; the whole comprising a population approaching to 16,000,000. Buda, the Hungarian capital, called also Ofen (Oven) from its hot mineral waters, on the right bank of the Danube, and Pesth on the left, constitute one town, united by a bridge of boats, with upwards of 100,000 inhabitants between them.

The province of the military frontier running along the entire south of the Austrian territory eastward from the Adriatic, was formed when Turkey was a formidable power, as a measure of security. It is occupied by a chain of guard-houses, and has several strong fortresses. The inhabitants render military service in lieu of taxes, and as a quit-rent for portions of land held under the crown. A certain number of them are obliged to be constantly under arms, even in peace, and in war the whole male population may be ordered out.

VI. The empire contains an amount of mineral wealth superior to that possessed by any other section of Europe, including all the important metals except platina. The Bohemian mountains, Transylvania, and the north of Hungary, are the richest districts, yielding a supply of the precious metals, gold and silver, estimated at the annual value of half a million sterling. Hungary furnishes copper, lead, and iron in abundance; Bohemia, lead, iron, and the only tin; but the greatest quantity of lead is obtained in Illyria, and of iron in Styria. The quicksilver mine of Idria in Illyria is, after that of Almaden in Spain, the richest in Europe. Coal occurs in almost every province, but only an inconsiderable quantity is raised, the forests supplying the ordinary fuel. Rock-salt, in massive beds of enormous magnitude, extends along both sides of the Carpathians, and is largely worked in Galicia. The mineral waters of various kinds amount to upwards of 1500 distinct springs.

Of three towns in the Hungarian metalliferous district, it is proverbially said, indicating the abundance of the respective metals, that Neusohl is surrounded with walls of copper, Schemnitz with walls of silver, and Kremnitz with walls of gold.

The rock-salt mines in the north-west of Galicia are the largest in the world. The celebrated mine of Wieliezka, about 12 miles south-east of Cracow, has been worked since the year 1253. It descends 1000 feet below the surface, contains upwards of 1000 chambers, one of which forms a chapel dedicated to St. Anthony, and has galleries and winding passages excavated in the bed of salt, the aggregate extent of which is said to exceed 30 miles.

Of the mineral waters in the Austrian dominions, Hungary contains 352 springs, and Bohemia 150. Several of the latter have acquired a European reputation, as the waters of Carlsbad, Toplitz, Eger, Marienbad, and Seidlitz.

VII. Possessed of almost every diversity of soil and climate, the vegetable productions correspondingly vary. But except in a few districts, the efforts of nature are little aided by the skilful husbandry of man, the produce of the soil falling far short of its capability under an enlightened application of capital and labour. The farming implements are of rude construction, and scientific agriculture is unknown. In addition to the common food plants, rice and maize are cultivated in the southern provinces; and Hungary has been styled "the paradise of the melon," the fruit being extensively raised there in open fields, and eaten by all classes. The lime, or sour lemon, is a produce of the Tyrol; olive-grounds appear in Illyria and Dalmatia; vineyards are most abundant in Hungary, where in the north-east, under the shelter of the Carpathians, the grape yields the celebrated Tokay, "the king of wines;" and in that country entire forests consist of plum and damson-trees, from the fruit of which a brandy spirit is extracted, a favourite beverage of the Sclavonians. Flax and hemp are grown in all the provinces; hops rank among the exports of Bohemia; tobacco is raised to a large amount in Southern Hungary; liquorice is a common article of culture in Moravia; and the vegetable known as Iceland-moss is collected for medicinal purposes in considerable quantities from the Carpathian Mountains. In manufactures and commerce, Austria lags behind other German states.

More than one-fourth of the entire area of the empire is occupied by forests and woodlands, containing some of the finest oaks in Europe. Bohemia, Transylvania, Galicia, and the Bukowina, are eminently woodland countries; and Hungary, with great plains without tree or bush, has also vast forests, the Bakony Forest extending above 50 miles in length by from 10 to 25 in breadth. The woods shelter the bear, wolf, and lynx, not uncommon in several districts, though their numbers have been very much reduced. In Galicia, between the years 1812 and 1814, in consequence of rewards being offered, the peasantry destroyed 41 bears, and 4938 wolves; and in the Tyrol, in 1819, a lynx, 39 bears, and 12 wolves were slaughtered.

The Austrian territory labours under physical disadvantages in relation to foreign and inland trade, arising from a scanty command of sea-coast, the distance of some of the provinces from a port, and the obstacles presented by formidable lines of mountains to intercommunication. The cost of conveying produce from one district to another is unfavourable to commercial transactions, and operates as a check upon production. At Lemburg, one of the principal corn-markets of Galicia, wheat was selling for 15*s.* 2*d.* per quarter in November, 1838; when its price at the same time at Dantzic was 41*s.* 6*d.*,—the difficulty and expense of transport occasioning the difference of 26*s.* 4*d.* Provisions are generally twice as cheap at Lemburg as at Vienna. Great efforts have been made by the Government since the peace of 1815 to facilitate communication by the construction of good roads; more recently by railways.

VIII. The subjects of the monarchy consist of several distinct races, variously split up into tribes and nations. 1. The people of Sclavonic extraction form the preponderating race in number, comprising somewhat more than half the population, being estimated at about 18,500,000. They consist of the Czeches, or aboriginal Bohemians in that country and parts of Moravia; the Wendes in Illyria and Styria; the Dalmatians in Dalmatia; the Croats in Croatia; the Sclavons in Sclavonia; the Sclowaks in Moravia, Austrian Silesia, and Hungary; the Poles in Galicia; the Russniaks in Galicia, Hungary, and Transylvania. 2. Germans, numerically inferior, amounting to about 6,000,000, are the predominating race as to political power, and are perhaps entitled to the first rank in relation to intelligence and industry. They compose the principal part of the population in the Austrian archduchy, occupy largely Styria, the Tyrol, and Bohemia, and occur as colonies in Galicia, Hungary, and Transylvania. 3. Græco-Latins, computed at rather more than 6,000,000, comprehend the Italians of Austrian Italy, the south of the Tyrol, and the Adriatic shores, with the Wallachians, numerous in the Bukowina, Transylvania, Hungary, and along the military frontier. 4. Magyars, amounting to 4,500,000, a people who migrated from the Asiatic side of the Volga, in the ninth century, are the dominant race in Hungary, occupying chiefly the central districts. 5. Gipsies, Jews, Armenians, and Greeks, scattered over Bohemia and the eastern provinces, constitute the residue of the population. The vast majority profess the Roman Catholic religion. A considerable section belongs to the Greek church, the rest being Protestants, Jews, or attached to no communion. Education is the highest among the Germans and Italians, many of the Sclavonic tribes and the lower classes of the Magyars being in a semi-barbarous condition. The administration of the empire, till recently a perfect despotism in general, is now in a state of complete confusion, and existing disturbances point to the ultimate, if not the speedy, dismemberment of its various elements.

XVII. SWITZERLAND.

I. SWITZERLAND, one of the few important states of Europe entirely inland, is enclosed by Italy on the south, France on the west, and the Germanic countries on the north and east.

Latitudinal limits.—45° 60′ N., south extremity of the canton of Tessin, near the Lake of Como; and 47° 49′ N., north point of Schaffhausen, bordering on Baden.

Longitudinal limits.—6° E., issue of the Rhone from the canton of Geneva into France; and 10° 35′ E., issue of the Inn from the canton of the Grisons into the Tyrol.

Extent.—208 miles from the west side of the canton of Vaud to the east of the Grisons; 156 miles from the north of Schaffhausen to the south of Tessin. Area, upwards of 15,000 square miles.

II. The northern part of the country is occupied by a long, narrow, and somewhat level plain, extending from the neighbourhood of the Lake of Constance to that of the Lake of Geneva; but almost everywhere else the surface consists of high mountains and deep valleys, formed by the main ridge of the Alps, its branches, and secondary ranges. 1. The main ridge enters Switzerland from the Sardinian states, immediately after passing Mont Blanc, under the name of the Pennine Alps. It runs along the frontier nearly east to Mont Rosa, where it takes the name of the Lepontine or Helvetian Alps, proceeding on the frontier north-east to the junction of the cantons of Uri, Tessin, and Valais, where the chain becomes interior, and bends eastward to Mont Bernadine in the Grisons. It acquires here the name of the Rhætian Alps, which follow the same direction through the Grisons into the Austrian empire. 2. Huge offsets diverge in various directions from this principal axis, separating the upper basins of the Inn, Rhine, and Rhone, and extending their ramifications over great part of the Swiss territory. The most important branch is that of the Bernese Alps, which diverges from the mountain knot near the St. Gothard, proceeds towards the west, forming the north inclosure of the waters of the Rhone from its source nearly to the Lake of Geneva. This branch also walls in on the north the Valais canton, the great longitudinal valley of the system of the Alps. 3. The Jura Mountains are the leading secondary chain, which enter Switzerland from France, and extend in several ranges from the south of the canton of Vaud to the confluence of the Aar and Rhine in Aargau. Soglio, the highest village of Europe, 6714 feet, is in the Grisons. The culminating point of Switzerland, apart from the frontier, is the Finster-Aar-Horn, 14,106 feet, one of the Bernese Alps.

The elevation of the principal summits and passes of the Alps, the main chain, is given in the section on the Map. The branch of the Bernese Alps, though containing no heights equal to Mont Blanc and Monte Rosa, comprises mountains of more imposing mass and continuous elevation than the component parts in general of the great ridge. Besides the Finster-Aar-Horn, the Eiger rises 13,075 feet; the Grindelwalder, 13,321; the Schreckhorn, 13,386; Le Monch, 13,498; the Jungfrau, 13,718: and six other peaks attain upwards of 12,000 feet.

Of the passes, that of the Great St. Bernard, is the route between Martigny or Martinach, in the lower Valais, and Aosta in Piedmont, by the valley of the Drance: the Simplon leads from Brieg in the upper Valais into Italy by the Val d'Ossola; the St. Gothard connects the cantons of Uri and Tessin; the Bernardine and Splugen connect the Rheinwald portion of the Grisons with Tessin. The pass of the Cervin, east of the Great St. Bernard, is the loftiest in Europe, nearly 11,000 feet, but is not practicable for carriages. The geological constitution of the Alps embraces almost every variety of formation. Primitive rocks form the nucleus and the highest summits; transition rocks usually occur lower; and secondary rocks lower still,

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though frequently at a great elevation. Dislocations of strata evidence successive upheavals with intervening periods of repose, some of which appear to have occurred since the epoch of the existing marine creation.

III. The hydrographical features of the country are not less remarkable, comprehending numerous and in some instances extensive lakes, waterfalls, furious torrents, and rapid rivers, fed by the snows and glaciers of the elevated regions. By far the greater part of the superficial drainage is carried off by the Rhine, and conducted to the German Ocean. The next proportions flow by the Rhone to the Mediterranean; by the Inn through the Danube to the Black Sea; and by the Ticino through the Po to the Adriatic. The larger lakes in order of magnitude are the Lake of Geneva, to which the preference is given by some for picturesque beauty, Constance, Neuchatel, Lucerne, and Zurich. Those of Thun, Brienz, and Zug, are much smaller, but, with several others of inferior dimensions, eminent for scenical effect. Magnificent waterfalls are formed by the Aar in its course from the Bernese Alps, and by the Reuss in its descent from the St. Gothard; but the most important, from the great volume of water, is that of the Rhine near Schaffhausen, where, after a series of rapids produced by its rocky bed, the river rushes in three branches over a precipice about 80 feet in height. The falls of the Reichenbach in the vale of Meyringen, and the cascade of Staubach in the valley of Lauterbrunnen, are particularly admired.

1. The Rhine originates in the canton of the Grisons from three branches, called the Vorder (fore), Mittler (middle), and the Hinter (back) Rhine. The Fore or Lower Rhine is accounted the principal source. It takes its rise from a small lake north-east of the St. Gothard group, at the height of 7650 feet. The fall of the river from thence to the Lake of Constance is almost 6360 feet, and from thence to Basel 480,—making an entire descent of 6840 feet before leaving Switzerland, a sufficient intimation of its rapid current. Its principal tributary, the Aar, flows through the Lakes of Brienz and Thun, passes Berne, and joins the Rhine in the canton of Aargau, being nearly equal to it in its volume of water. The Aar receives the Reuss, which passes through the Lake of Lucerne, and the Limmat, which brings down the waters of the Lakes of Zurich and Wallenstadt; the confluence of both rivers with it taking place within little more than a mile of each other in Aargau.

The Rhone rises from the Rhone glacier at the base of Mont Furca, in the upper Valais, at the height of 5500 feet. It flows through the middle of that canton, and leaves it by a narrow gorge at St. Maurice, entering the Lake of Geneva, and passing into France soon after emerging from it, having descended about 4300 feet.

2. The extent, elevation above the sea, and greatest depth of the principal lakes, are thus given:

	Area in sq. miles.	Elevation in feet.	Depth in feet.
Geneva	336	1229	900
Constance	290	1289	2334
Neuchatel	114	1437	426
Lucerne	99	1439	600
Zurich	76	1279	600

IV. Owing to the difference of level in the surface, almost every variety of temperature exists, from the most extreme heat of Italy and Spain to the cold of the polar zone. In the deep pent-up valleys the summer warmth is tropical; but at the mean height of from 8500 to 9000 feet, the inferior limit of perpetual snow occurs, vast glaciers filling up the ravines and gorges below, and variously protruding into the lower valleys, forming together a field of ice estimated at 1000 square miles between Mont Blanc and the Tyrol. There is consequently great diversity in the vegetable kingdom,—the olive, almond, pomegranate, and vine, flourishing in districts where the more elevated sites are either destitute of vegetation, or only capable of sustaining a few hyberborean plants.

V. Switzerland is divided into 22 cantons of very unequal extent,—Zug and Geneva, the smallest, containing under 100 square miles, and the Grisons, the largest, upwards of 3000. The cantons are mutually independent in the management of their own internal affairs, but form a diet composed of deputies, each canton having one vote. This body presides over the internal and external interests of the country, and legislates in all important transactions with foreign states. The representative form of government prevails in all the cantons, but some have a more democratic constitution than others. They may be considered as so many republics, except Neuchatel, where the executive government is vested in the king of Prussia, who is bound however to conduct it in harmony with established cantonal usage. The confederation comprises a population of about 2,250,000.

The Swiss Diet meets for periods of two years at Zurich, Berne, and Lucerne, each of which becomes in succession the federal capital. But as the foreign ambassadors reside at Berne, and only temporarily remove to the other places when the Diet happens to be in session there, that city is usually deemed the capital of Switzerland. Berne, in lat. 46° 57′ N., and long. 7° 28′ E., is situated on the Aar, commanding a fine prospect of the Bernese Alps. It contains upwards of 20,000 inhabitants, and is somewhat exceeded by Geneva in population.

VI. The Swiss people are principally of two stocks. The vast majority are Germans, and speak dialects of that language. The rest are chiefly Græco-Latins, comprehending French and Italians, the former in the greatest numbers. In the Grisons and a few other places there is a race of uncertain origin, often called Romans, Rhætians, or the Romance, who speak a language strongly resembling the Latin. A line drawn through the canton of Friburg to the main chain of the Alps will separate generally the French, to the westward, from the German population; and another line traversing the main ridge laterally will divide the Italian, to the southward, from the French and German races. Agriculture is more or less followed through the whole country; but, in addition, manufactures of silk and cotton distinguish the German Swiss; while jewellery, horology, and other artistic products, engage the French Swiss. In religion, about three-fifths of the people are Protestants, and two-fifths Roman Catholics. The cantons of Zurich, Bern, Basel, Schaffhausen, Vaud, and Neuchatel, are almost exclusively Protestant; those of Lucerne, Uri, Schweitz, Underwald, Tessin, and Valais, are as eminently Roman Catholic. The two communions variously prevail in the other cantons.

XVIII. NORTH ITALY. XIX. SOUTH ITALY.

I. Italy, one of the southern peninsulas of Europe, is everywhere inclosed by the Mediterranean and its branches, except on the north, where the border is formed by France, Switzerland, the Tyrol, and Illyria. The largest European islands after Great Britain geographically belong to it,—Corsica, Sardinia, and Sicily, with Elba, Ischia, the Lipari and Maltese groups.

Latitudinal limits.—36°. N., the Maltese Islands, and 46° 50′ N., the north extremity of Lombardy.

Longitudinal limits.—5° 40′ E., western side of Savoy, and 18° 30′ E., the coast near Otranto.

Extent.—Length of continental Italy, upwards of 700 miles, from Mont Blanc to Capo di Leuca, at the extremity of the south-eastern prong. Breadth, 360 miles in the north; 100, the average for the centre; diminishing to 20 miles in the extreme south. Area, including the islands, 120,000 square miles.

II. The main chain of the Alps forms great part of the northern frontier, the western curve being the most Italian, as chiefly traversing the interior. It consists of the Maritime Alps, commencing at the fine pass of the Col de Tende, the high-road from Nice to Turin, and extending to Monte Viso, which attains the height of 12,586 feet; the Cottian Alps, from thence to Mont Cenis, 11,460 feet; the Graian or Grecian Alps, from thence to the Col du Bonhomme, culminating in Mont Iseran, 13,274 feet; and the Pennine Alps, from thence to the Swiss border, containing the culminating point of Europe, Mont Blanc, 15,750 feet. But the Apennines, a far lower range, form the peculiar mountain-system of the country, running from the Maritime Alps at the Col de Tende north-eastward round the Gulf of Genoa, and traversing the entire length of the peninsula, dividing it into two unequal parts. None of the summits reach the line of perpetual snow, though it remains for nine months of the year upon the loftier peaks. The central portions of the chain, which bound the Roman plain on the east, are the most elevated, the highest point being the Gran Sasso d'Italia, or Great Rock of Italy, 9523 feet. Between the Apennines and Alps, on the north, lies the greatest extent of low land, the plain of Lombardy; one of the most fertile and best cultivated in Europe. A considerable tract of level country, distributed by low ridges into separate plains, stretches from the Arno to the Neapolitan territory, forming the Tuscan and Roman Maremme, enclosed between the Sub-Apennines and the sea. The rivers, though numerous, are not individually important, except the Po, which ranks with the great streams of transalpine Europe. The largest lakes are at the base of the Alps; the central districts of the peninsula contain a considerable number of smaller size; and several extensive lagoons mark the Adriatic coast.

The Po has its principal source in the Cottian Alps, on the east side of Monte Viso, and flows through the greatest breadth of Italy, discharging itself into the Adriatic by several mouths. Its principal affluents are the Dora Baltea from the Pennine Alps, the Ticino from the Lake of Maggiore, the Adda from the Lake of Como, and the Mincio from the Lake of Garda, on the left bank; the Tanara from the Maritime Alps, the Trebia, Taro, Secchia, and Reno, from the Apennines, on the right bank. The Po has originated great physical changes by the vast quantity of fine sand and mud which the current brings down. By the deposition of this matter the coast-line of the Adriatic has been so sensibly advanced, that Adria, a sea-port in the time of Augustus, and a station for the fleet, is now more than 15 miles from the nearest point of the shore. It is calculated that the delta is at present advancing at the annual mean rate of upwards of 200 feet. Deposition also along the channel of the river has so raised its bed that high artificial embankments are required to keep its waters in place. It traverses the plain of Ferrara on the top of a high mound like an aqueduct, its surface being more elevated than the roofs of the houses. The other chief rivers are the Adige, which descends from the Tyrol to the Adriatic, and has similar features to the Po; the Tiber, flowing west and south-west from the Apennines to the Mediterranean below Rome; and the Arno, which rises near the Tiber, winds westward to Florence, where its lower valley commences, Val d'Arno Inferiore, one of the most lovely scenes in Italy, extending from thence to its outlet into the Mediterranean below Pisa.

The larger lakes, Garda and Maggiore, have respectively areas of 183 and 152 square miles; and with the somewhat smaller Lake of Como, are connected with the finest scenes of Northern Italy. The largest of the central lakes, the ancient Fucinus, now the Lake of Celano, has an area of about 100 square miles. It has no natural outlet, but the surplus waters are led off by a tunnel excavated by order of the emperor Claudius, and recently reopened. A more ancient work, a canal, executed during the censorship of M. Curius Dentatus, conducts the outlet of the small Lake Velinus to the precipice, where the celebrated Cascade delle Marmore is formed, or the Falls of Terni, in the estimation of Byron, "worth all the cascades and torrents of Switzerland put together."

III. The most physically peculiar and interesting portion of the country is the volcanic zone of the south-west coast, extending from the borders of Tuscany to the south side of the Bay of Naples. It contains a number of ancient craters, extinct before the historic era, now mostly occupied with small lakes; the oscillating region around Puzzuoli; the Grotto del Cane, continually giving out an irrespirable gas; the trachytic hill of the Solfatara, emitting aqueous vapour and gaseous exhalations; and Vesuvius, the only active volcano of continental Europe. The island of Ischia, at the north entrance of the Bay of Naples, crested with Monte Epomeo, a volcano in eruption in the fourteenth century, is a prolongation of the zone. It reappears in the volcanic group of the Lipari Islands, where Vulcano and Stromboli are sites of igneous activity; is grandly developed in the north-east of Sicily by the gigantic cone of Etna, in action from the earliest times; and may be traced to the islet of Pantellaria, half-way between Sicily and Africa, a huge mass of lava, pumice, and scoriæ.

Etna rises from a base of about 87 miles in circumference, 1000 feet above the line of perpetual snow; but for more than half the year a large portion of its upper regions is covered with it, forming a store of what is almost a necessary of life during the hot summers of Naples, Sicily, and Malta. The ascent from Catania is about 24 miles. The height of the mountain has been very carefully measured:

	Feet.
Grotto of the Goats	5,345
Great Glacier	7,412
Philosopher's Tower	9,482
Snow-line	9,500
The English House	9,587
Foot of the cone	9,790
Summit	10,882

IV. North Italy and the central district politically consist of the Lombardo-Venetian kingdom; the larger continental portion of the Sardinian monarchy; the Papal States; the Grand Duchy of Tuscany; the small duchies of Parma, Modena, and Lucca; and the little republic of San Marino. 1. The Lombardo-Venetian kingdom, in the north and north-east, a part of the Austrian empire, is one of the most fertile districts of Europe, possessing a deep alluvial mould, principally belonging to the basin of the Po. Its fine roads and bridges, numerous cities and towns surrounded with well-irrigated fields, evidence great material prosperity; but unhappily, the political intolerance of the government, and the disappointed national feelings of the people at being dependent upon a foreign power, have been fruitful of social discord, ending in the calamities of war. Venice, the capital of the eastern division, with its suburbs, contains upwards of 100,000 inhabitants; and Milan, at the head of the western, 150,000. 2. The Sardinian monarchy, in the north-west, consists of the principalities of Piedmont and Nice, and the duchies of Savoy and Genoa, with which the island of Sardinia, a geographical dependency of Southern Italy, is politically connected. Turin, the capital, a noble city on the Po, with celebrated literary and scientific establishments, contains a population amounting to 120,000. Genoa the Superb, built upon the slope of a hill, rising up from the bay, has upwards of 100,000. The island of Sardinia extends 160 miles from north to south, by 90 miles from east to west at the greatest, and includes an area of 9000 square miles. 3. The Papal States extend in a north-easterly direction from the Mediterranean to the Adriatic side of the peninsula, and northwards to the south bank of the Po. Rome, the capital, deemed from its historic celebrity the metropolis of Italy, in lat. 42° N., and long. 12° 30′ E., comprises upwards of 150,000 inhabitants.

The Grand Duchy of Tuscany, on the west side of middle Italy, contains the richly cultivated garden valley of the Arno; highland tracts formed by the spurs of the Apennines, covered with broad woods of chestnuts; and the Maremme, a district along the coast from Leghorn to the southern frontier, embracing a considerable extent of inland country, rendered uninhabitable through great part of the year by the prevalence of malaria. Florence, the capital, contains about 100,000 inhabitants. Leghorn, a flourishing port, absorbs most of the maritime commerce of Italy.

The duchies of Parma, Modena, and Lucca, inclosed by the preceding states, have no territorial importance. The small republic of San Marino, in the Papal States, near Rimini, consists only of the town of that name and a few villages. It has existed for upwards of thirteen centuries, and owes its origin to a hermit, Marinus, who fixed his abode upon a mountain in the ancient duchy of Urbino, attracted others to the spot, who gradually formed a republican settlement, which has subsisted to the present, under papal protection and influence.

V. South Italy, with Sicily, constitutes the Kingdom of Naples, also called the Kingdom of the Two Sicilies, the largest of the Italian states, a fine highland region in the interior, intersected with numerous valleys, which slope into rich plains along the coast, possessing abundant agricultural and mineral resources, almost wholly neglected, owing to the misrule of the government, the indolent and brigand habits of the people. Naples, the capital, connected with scenery which has been fondly described as "a piece of heaven fallen down upon earth," is the largest of the Italian cities, and also of the south-European after Constantinople, containing a population of 360,000. Palermo, the Sicilian capital, has 180,000.

South of Sicily, at the distance of about 60 miles, are the Maltese Islands, belonging to Great Britain. The group consists of Malta, the largest; Gozo on the north; the small islet of Cumino intermediate; and a few adjoining rocks. Malta, of importance owing to its central position in the Mediterranean, the fine harbour and strong fortifications of Valetta, the capital, has an area of 90 square miles. The Maltese are of mixed Italian and Arabic descent.

VI. Italy, continental and insular, contains a population of 23,000,000, of which nearly 8,000,000 belong to Naples, and nearly 5,000,000 each to the Lombardo-Venetian kingdom and Sardinian monarchy; the Papal States and Tuscany ranking next. The population is the most dense in the duchy of Lucca; the least so in the island of Sardinia. The productive industry of the country includes raw silk, manufactured silks, rice, and the famed but improperly called Parmesan cheese, in the north; straw-plait and olive-oil in Tuscany; the latter product and ordinary cereals generally through the south. The culture of the vine prevails more or less everywhere; but the best wines are produced in the south, where various tropical fruits are raised in perfection. Iron is obtained chiefly in the island of Elba, which has been celebrated for it from remote antiquity. Quarries near Carrara, a town of Modena, yield the famous statuary marble. The sulphur mines of Sicily supply nearly all Europe with that mineral.

The production of raw silk extends in the north from the frontier of France to that of Austrian Germany, the extensive plantations of the white mulberry for the support of the worm giving a peculiar character to the landscape.

Rice is cultivated in the low flats contiguous to the Po, which can be readily laid under water, owing to the elevation of its bed above the surrounding country.

The cheese known throughout Europe as the Parmesan is produced in the district between the Ticino and the Adda, a part of the Milanese territory.

VII. The country, proverbially celebrated for its lucid atmosphere, deep blue cloudless skies, has great climatic differences and disadvantages. In the north frost and snow are of common occurrence in winter, the thermometer falling 20°

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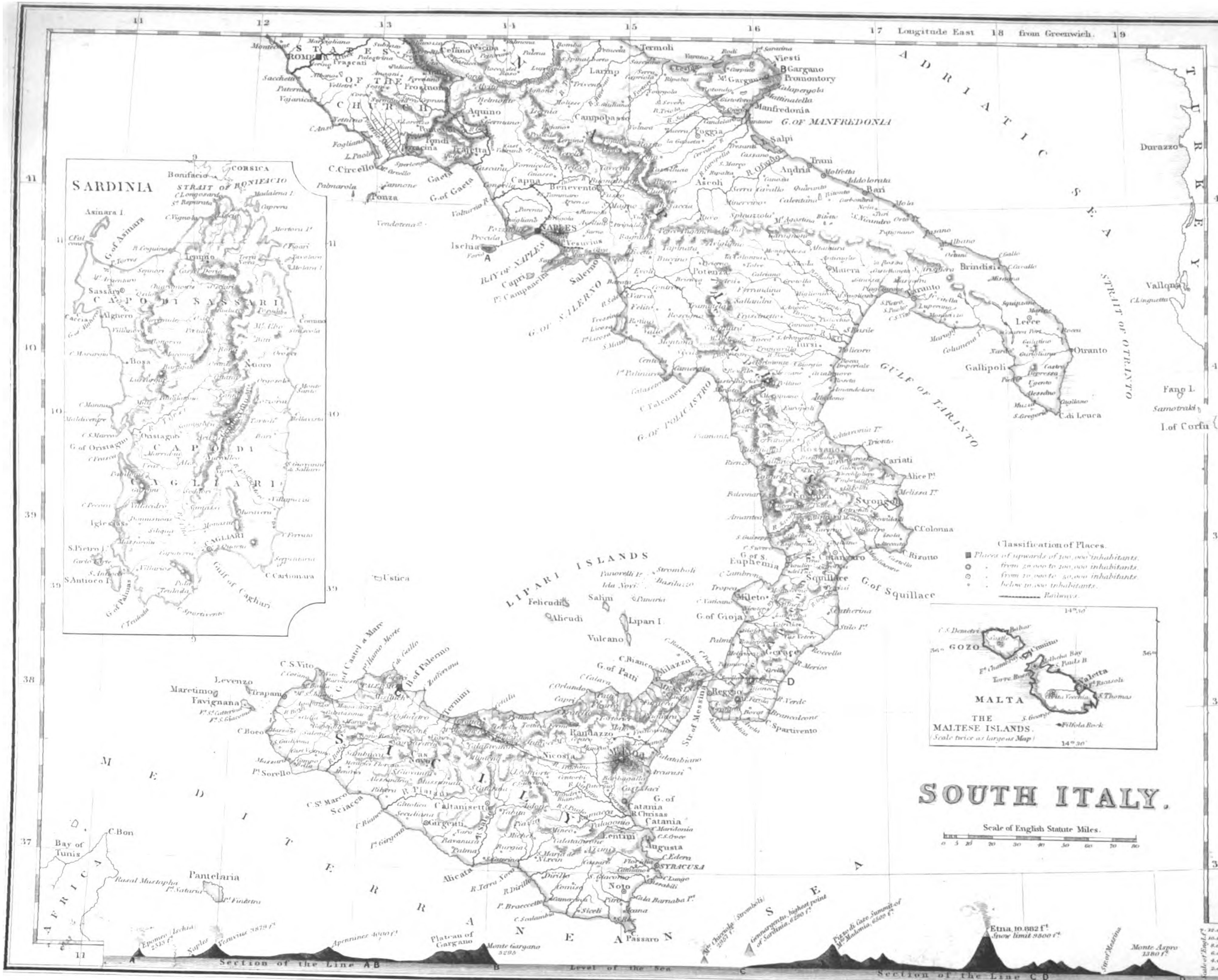

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below the freezing point, and the snow remaining a fortnight upon the ground; while in summer the north wind brings down a chilling cold from the icy summits of the Alps. In this region the olive does not succeed, except in such sheltered spots as the Riviera of Genoa, which the back-ground of the Apennines protects from the northern blast. Hot summers and mild winters characterise the rest of Italy on the lowlands, and become more marked in the south, especially in Sicily, where the severest winter seldom depresses the thermometer to the freezing point. The olive, lemon, and orange luxuriate in this climate; the cotton-plant and sugar-cane can be grown; the aloe grows wild as a fence around the fields; the Indian fig comes to maturity; and the date-palm impresses an African physiognomy upon the landscape. The climate has a serious draw-back, that of an excessive change of temperature, when the breeze blowing sharply from the cold tops of the Alps and Apennines alternates with the sirocco, a hot south-east wind, remarkable for its distressing effects upon the human frame. The long droughts followed by perfect deluges of rain, and the intense development of insect life in the summer months, are other disadvantages. The zoology of Italy embraces among its larger animals, the buffalo, imported from Africa in the seventh century; a colony of camels in the plain of Pisa, brought over in the time of the crusades; herds of wolves, and the wild boar, in the Abruzzo.

XX. SPAIN AND PORTUGAL.

I. The Spanish peninsula, including Portugal, bounded on the north-east by France, and inclosed in other directions by the waters of the Atlantic and Mediterranean, contains the most western and southern points of Europe. The isthmus traversed by the Pyrenees, extending about 230 miles, connects it with the main mass of the continent; and the Strait of Gibraltar, scarcely 15 miles wide at the narrowest part, separates it from the nearest points of Africa.

Latitudinal limits.—36′ N., Cape Tarifa, near Gibraltar, and 43° 40′ N., Cape Ortegal in Galicia.

Longitudinal limits.—9° 30′ W., Cape Roca in Portugal, off the mouth of the Tagus and 3° 20′ E., Cape Creuz in Catalonia, the north-east point of Spain.

Extent.—630 miles from east to west, and 530 from north to south at the greatest. The area is estimated at 216,000 square miles, and the circuit at 2200 miles.

II. The coast of the peninsula is generally rocky, marked with few considerable inlets, and deficient in commodious harbours. The interior has prominent and remarkable physical features, consisting of important mountain ranges, and an extensive central mass of elevated table-land. 1. The chain of the Pyrenees, which forms the frontier towards France, running from south-east to north-west, extends far beyond the limits which the name commonly indicates, being continued without interruption by the Mountains of Asturias, which follow a westerly direction through the entire north, parallel to the Bay of Biscay, and terminate at Cape Finisterre, the extreme western point of Spain. 2. Towards the centre of this northern rampart, an inferior range stretches south-east, and high ground extends southward, with various divergencies, to the coast of Granada, dividing the peninsula into two great hydrographical regions, the western and larger region sending its waters westward to the Atlantic, and the eastern in an opposite direction to the Mediterranean. 3. Four parallel chains strike off from the water-parting, and traverse the western region to the ocean, the Sierra Guadarrama, Sierra de Toledo, Sierra Morena, and Sierra Nevada; bounding with the Mountains of Asturias, the basins of the chief Atlantic rivers. 4. The country west of the prime water parting, between the parallel chains north of the Sierra Morena, does not subside into lowlands, but constitutes the central table-land, having an elevation varying from 2000 to 3000 feet, descending with a somewhat gradual slope towards the Atlantic.

The Sierra Nevada contains the culminating point of the peninsula. Cerro de Mulhacen, to the south-east of Granada, rising 11,665 feet, upwards of 1500 feet above the snow-line in that latitude. But the Pyrenees have the greatest continued elevation. The Pic Nethon, a summit of Mount Maladetta, 11,427 feet; Pic Posets, 11,279; and Mont Perdu, 11,030; all within the Spanish frontier, are the highest points; but more than 20 peaks attain upwards of 10,000 feet.

Madrid, on the table-land, is 2170 feet above the level of the sea. The palace of the Escorial, at the head of a seeming plain, stands at the height of 3520 feet. The summer residence of royalty at La Granja, or San Ildefonso, has an elevation of 3943 feet, being 60 feet higher than the top of Vesuvius.

III. The larger rivers flowing into the Atlantic are the Douro, which has its basin between the Asturian Mountains and the Sierra Guadarrama; the Tagus, between the Sierra Guadarrama and the Sierra de Toledo; the Guadiana, between the Sierra de Toledo and the Sierra Morena; and the Guadalquiver, between the Sierra Morena and the Sierra Nevada. The eastern slope of the peninsula, of far inferior dimensions to the western, contributes only one important river, the Ebro, to the Mediterranean.

The Tagus ranks first in magnitude, then the Douro, Ebro, Guadiana, and Guadalquiver. The Ebro and Guadalquiver belong exclusively to Spain. The Guadiana has the principal part of its course in Spain, but leaves it for Portugal below Badajoz, returning to it from the frontier towards its mouth. The Tagus and the Douro, after traversing Spain, have the lower parts of their course entirely confined to Portugal, exactly where their commercial value is the greatest. The Tagus is the only river which has a considerable estuary, seven miles wide above Lisbon, contracted to two at that city. The rivers of the peninsula are generally scanty of water in summer, and rapid in their flow when filled by rains or melted snow, so as not to be available to any great extent for navigation. Owing to the dryness of the climate, they are not of the magnitude which might be expected in a country so extensive and mountainous.

IV. Spain includes about five-sixths of the peninsula, or nearly 180,000 square miles, and contains a population of 12,000,000, with a slow tendency to increase. Madrid, the capital, on a small affluent of the Tagus, in lat. 40° 25′ N., long. 3° 35′ W., stands nearly in the centre of the kingdom, in a barren uninteresting neighbourhood, and has upwards of 200,000 inhabitants. Barcelona, Seville, Granada, Valencia, Cadiz, Cordova, and Malaga, among the provincial cities, rank next in population, which ranges from 50,000 to 120,000. The maritime lowlands of the south and east are very fertile, flourishing with the olive, orange, lemon, and vine. The high central nucleus comprises around the Douro a large extent of rich wheat country, deemed the granary of Spain. But the great proportion of the table-lands consists of uninclosed, sterile, and naked wastes, constantly increasing in aridity, because from the strange aversion of the people to trees, they prevent their growth, and thus expose the surface to the full power of evaporation. The mineral wealth of the country is very important; but formerly the gold from the colonies, and more recently political troubles, have hindered the development of native resources. Iron, in great profusion, occurs in the north; lead in the south, more abundantly than in any other part of Europe; and quicksilver at Almaden, in New Castile, which has the richest mine of that metal in the world, the property of the government. Wine and fruits are the chief articles of foreign commerce, largely in the hands of foreigners. Inland trade is discouraged by scanty facilities for intercommunication. Pride, ignorance, and indolence on the part of the people, and bad government, have contributed to render Spain, naturally a highly favoured region, one of the most poverty-stricken and wretched countries in Christendom.

The Rock of Gibraltar, near the extreme south point of Spain, is an important possession of Great Britain, commanding the entrance of the Mediterranean, as Malta does the centre. It was taken by Sir George Rooke in 1704. The rock, rising to the height of 1500 feet, is about three miles long from north to south, three-quarters of a mile wide at the broadest part, and seven miles in circumference. It terminates to seaward with Europa Point, and is connected with the Spanish mainland by a low narrow isthmus of sand. The higher points of the rock are occupied by a colony of monkeys, the Barbary ape. the only animals of the kind wild in Europe. The town of Gibraltar contains, exclusive of the garrison, about 15,000 inhabitants.

The islands which form parts of Spain are the Isle de Leon, on which Cadiz is situated, close to the Andalusian coast; the Balearic group, off the coast of Valencia, of which the important members are Majorca, Minorca, and Iviça; and the Canary Islands, which geographically belong to Africa, but constitute one of the 49 provinces into which the kingdom was divided by royal decree in 1837.

The foreign possessions of Spain include Ceuta and a few other places on the Barbary coast; Cuba and Porto Rico in the West Indies; and a portion of the Philippine and Ladrone Islands in the Pacific.

V. Portugal, inclosed by Spain and the Atlantic, comprehends about one-sixth of the peninsula, or rather more than 36,000 square miles, and contains a population of 3,500,000. Lisbon, the capital, finely situated on several hills near the mouth of the Tagus, in lat. 38° 40′ N., long. 9° 10′ W., has upwards of 260,000 inhabitants. There is but one provincial city of consequence, Oporto, on the right bank of the Douro, which exports vast quantities of wine produced from the vintages along the river. The description of the neighbouring kingdom applies to this, and still more forcibly. Portugal supplies other nations with the luxuries of life, wine and fruits, but depends upon them for an adequate supply of its necessaries, the cereal grains, which require greater industry; and while the pride of the Spaniard enables him so far to conquer his indolence as to keep up a decent appearance, the Portuguese are notorious for filth.

Portugal possesses the Azores, a group of nine volcanic islands, geographically European, in the Atlantic; Madeira and Porto Santo, off the north-west coast of Africa; the Cape Verde Islands, on the western coast of Africa; a few settlements in Southern Africa; Goa, Damaun, and the island of Diu, in the East Indies; and Macao in China.

XXI. DENMARK.

I. Denmark consists of a peninsula and an archipelago, bounded on the west by the North Sea; on the north and north-east by two of its gulfs, the Skager Rack and Cattegat; on the east and south-east by the Sound and the Baltic; and on the south by the Elbe, parts of the territories of Hamburg, Hanover, Mecklenburg, and Lubeck.

Latitudinal limits.—53½° N., south portion of Lauenburg, and 57° 44′ N., the Skaw, or Cape Skagen, the north extremity of Jutland.

Longitudinal limits.—8° E., island of Heligoland in the North Sea, and 15° 20′ E., island of Bornholm in the Baltic.

Extent.—Length of the continental portion, 304 miles, from the Skaw to the south border of Lauenburg, by 106 miles, the greatest breadth of Jutland. Including the entire archipelago, the area is estimated at 23,000 square miles.

II. Continental Denmark, one of the few peninsulas of the globe which project towards the north, has a very extensive coast-line, owing to the number of deep inlets or fiords; but the want of good harbours, and the general shallowness of the water along shore, deprive it largely of maritime value. A remarkable formation of downs extends along the whole north-west coast, consisting of two systems parallel to each other; the inner one, eastwards, indicating the margin of the sea at an earlier and ante-historical period; the outer one forming the present boundary of the waves. The interior of the country belongs to the great plain of Europe. It contains few woods, numerous small lakes, no mountains, but a range of low hills traverses the peninsula from south to north, nowhere rising to the height of a thousand feet. Sands, heaths, moors, and marshes are characteristic features of the surface, especially in the north; luxuriant undulating meadows and fertile fields, interspersed with sheets of water, distinguishing the south. The climate is temperate for the latitude, owing to the proximity of the sea and the prevalence of inland waters. The same cause produces frequent rains and fogs, which render the atmosphere dull, but are highly advantageous to vegetation in a country where the soil is of a sandy nature, keeping up through the summer a fresh bright green on the landscape. Storms are common and very violent.

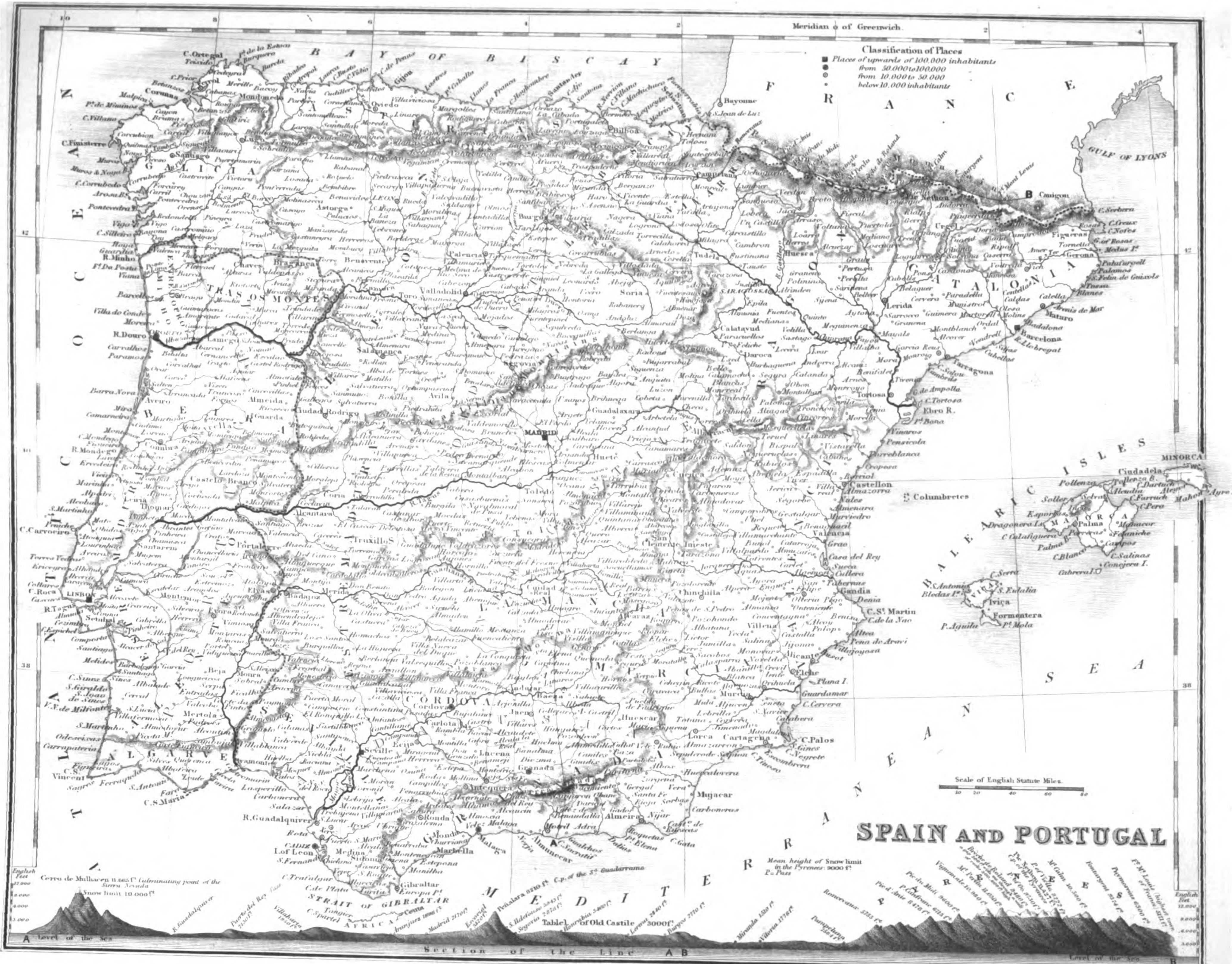
The largest inlet of the coast, the Lüm Fiord, has an area of 250 square miles. It extends at first like a canal from the Cattegat, but expands into a broad basin in the interior, containing a great number of islands. Before 1825 it intersected North Jutland from the Cattegat nearly to the North Sea, a narrow isthmus of sand-downs forming the boundary between them. But in that year, during a violent storm, the sea cut a passage through the isthmus, and projected the whole mass of the intervening downs into the Lüm Fiord, greatly lessening its depth. This irruption converted the fiord into a sound, and the north part of Jutland into an island. It caused other striking changes, the sudden mortality of nearly all the fresh-water fishes which previously inhabited the fiord, a celebrated fishing-ground. "Millions of fresh-water fishes," says Professor Forchhammer, "were driven on the land, partly dead, partly dying, and were removed by the inhabitants in numerous wagons, and only a few have remained at the spots where fresh-water streams flow into the Lüm Fiord. The eel alone has become gradually accustomed to these altered circumstances, and has again become an inhabitant of the whole fiord; while the salt water of the sea would seem to have been unbearable to the other fresh-water fishes. It is more than probable that the masses of sand which were borne in with the sea-flood in many places cover layers of dead fishes, and have thus formed beds of fossils similar to those which we find in the older formations."

III. The important portions of insular Denmark are the islands of Zealand and Funen, situated between the peninsula and Sweden, the Cattegat, and the Baltic. Zealand, the largest, is separated from Sweden by the Sound, 4602 yards wide between the harbour of Elsinore on the Danish, and that of Helsingburg on the Swedish side, but somewhat less in the narrowest part. It is the usual passage between the North Sea and the Baltic, annually traversed by nearly 20,000 vessels, each of which, excepting those of Sweden, pays toll to the Government of Denmark. Funen lies between Zealand and the peninsula, separated from the former by the Great Belt, the widest, and from the latter by the Little Belt, the narrowest of the three gates of the Baltic. The Sound is occasionally frozen over, so as to be passable in severe winters; and in 1658, Charles X. marched his whole army, with their heavy artillery, across the ice of the Little Belt.

Laland, Langeland, and Moen, are considerable islands, south of Zealand and Funen, small islets occurring on all sides. Bornholm, in the heart of the Baltic, politically a part of Denmark, geographically belongs to Sweden. A number of islands lie off the south-west coast in the North Sea, of which Heligoland has belonged to Great Britain since the year 1807. Insular Denmark also includes the Faroe Islands, an archipelago in the North Atlantic, 185 miles north-west of the Shetlands, 320 south-east of Iceland, and about 400 west of Norway. The cluster consists of 25, of which 17 are inhabited, the others being only barren rocks, or grassy holms on which sheep are pastured in summer. They rise high and precipitous from the ocean, and are remarkably wild in their aspect, haunted by prodigious swarms of sea-fowl. The highest point, Slattare Tind, in Oesteröe, attains an elevation of nearly 3000 feet. No wood now grows in the islands, but birch-trees found embedded in the mosses prove that they formerly grew there. Barley is the only cereal which can be cultivated, the extreme height of its growth being about 400 feet; potatoes grow at a point considerably higher; pastures attain 2000 feet; the mountain tops have only mosses and lichens.

IV. The kingdom consists of four principal divisions,—the provinces of Jutland, Sleswick, Holstein, and Lauenburg, each of which is subdivided into bailiwicks. Jutland constitutes the kingdom of Denmark Proper, consisting of the north and larger portion of the peninsula, with almost the whole archipelago, and the bailiwick of the Faroe Islands. Sleswick, a duchy, comprises the central and narrowest portion of the peninsula, with a few adjacent islands. Holstein and Lauenburg, two duchies, occupy the south from the Eyder river to the Elbe, and belong to the Germanic Confederation. The population amounts to upwards of 2,000,000. Copenhagen, the capital, in lat. 55° 40′ N., long. 12° 35′ E., is a strongly fortified city, on the east coast of the island of Zealand, containing 120,000 inhabitants, a valuable library and museum, the principal depôt of northern literature and antiquities.

The foreign possessions of the Danish crown consist of Iceland; the west coast of Greenland; the islands of Santa Cruz, St. Thomas, St. Peter, and St. John, in the West Indies; several factories on the coast of Guinea; Serampore in Bengal, and Tranquebar in the Carnatic; and the Nicobar Islands, north-west of Sumatra. Iceland, in the North Atlantic, cut by the Arctic circle at its extreme northern points, is the most important in territorial extent, embracing a much greater area than the mother country, vaguely estimated at 38,000 square miles. The inhabited and the habitable districts form a very small proportion of the surface, only about one-ninth.



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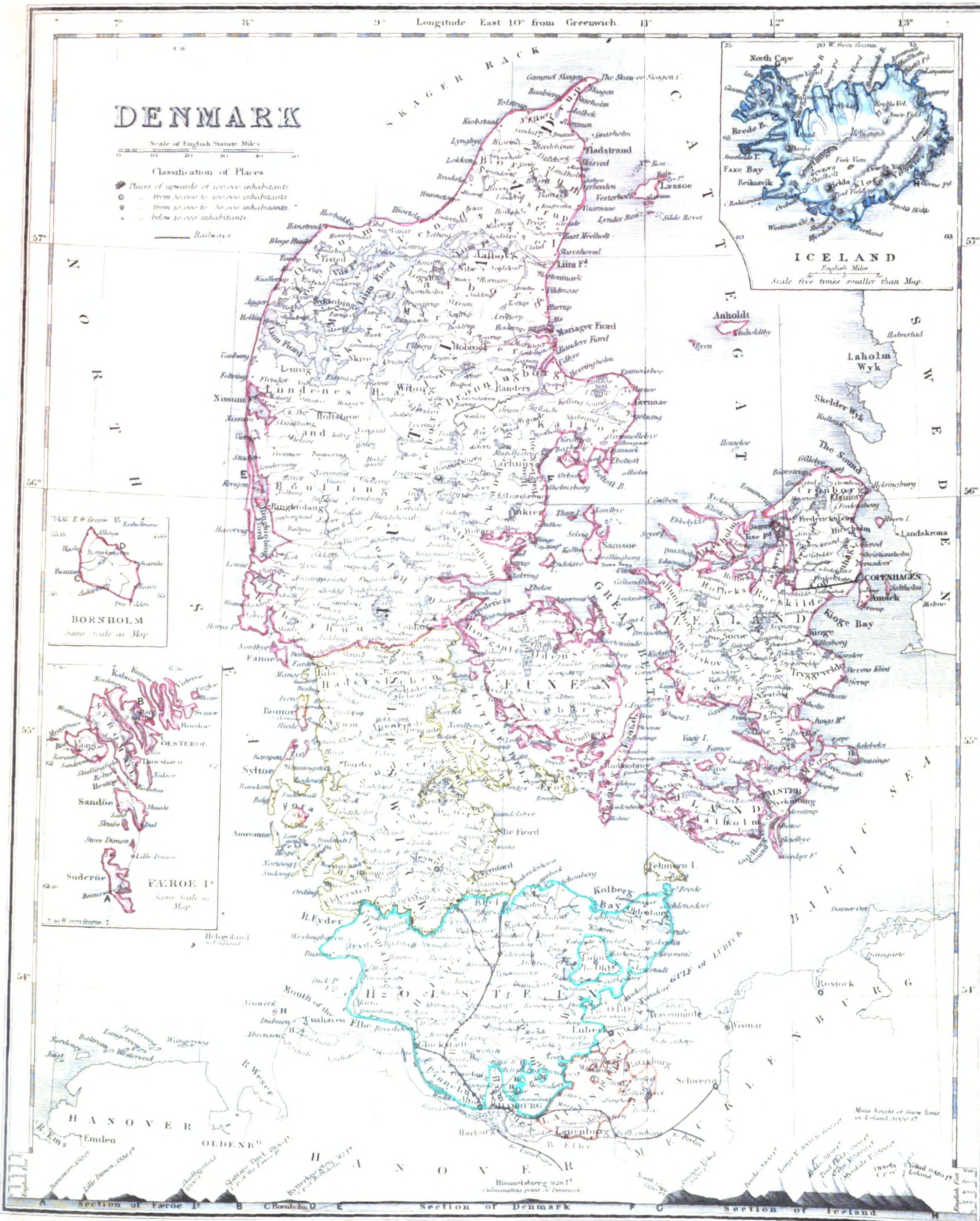

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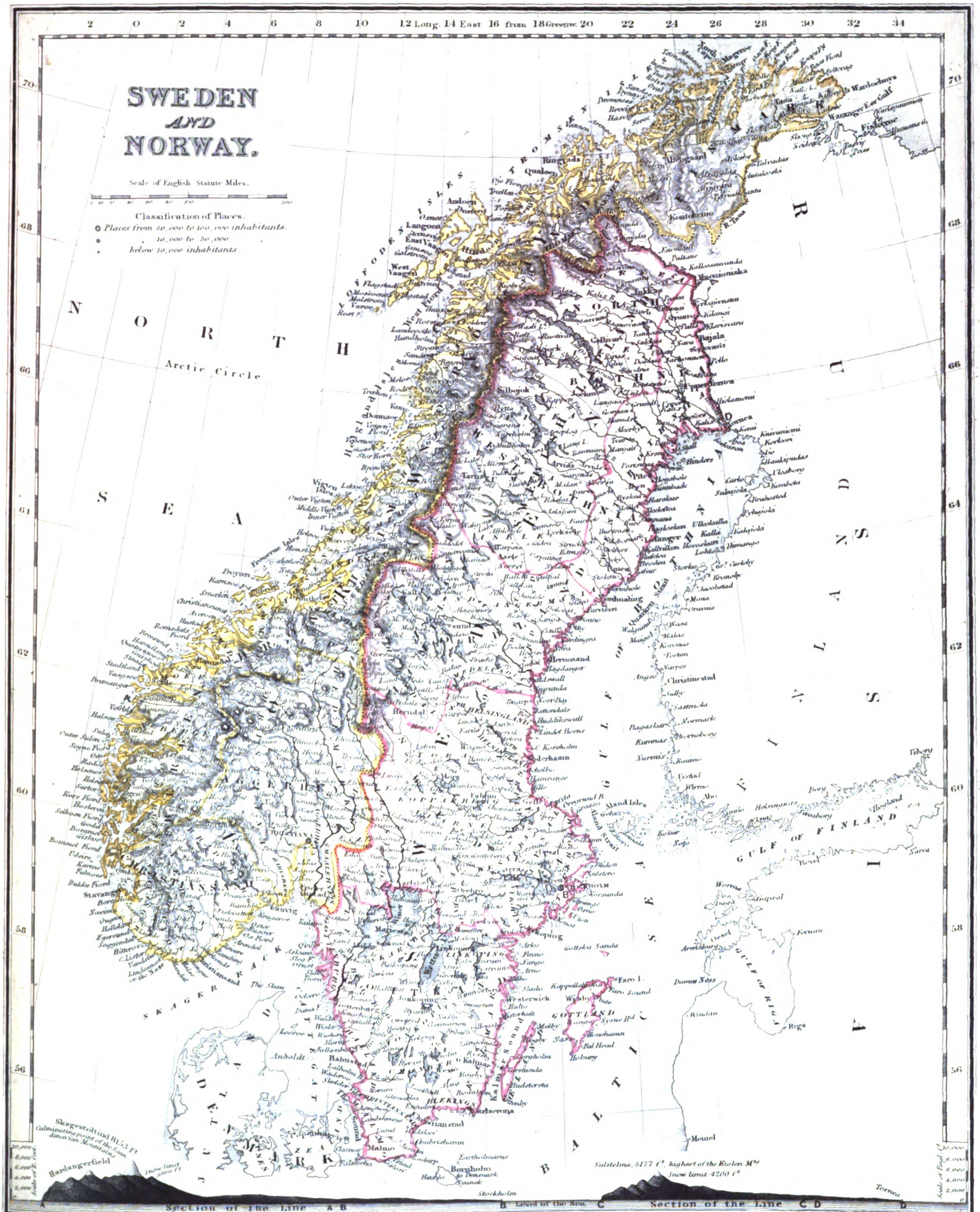

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the remainder consisting of naked mountains of ice and snow, or of plains and valleys rendered desolate by the stony floods which, age after age, its volcanoes have poured forth. Reikiavik, the capital, and the largest town, on the south-west coast, contains only two streets, consisting chiefly of wooden houses enclosed by turf walls, with a population of about 700.

V. The Danes have been celebrated from the earliest times as bold navigators, and are still excellent seamen; but in almost all other respects they have not kept pace with the progress of European civilization. The manufactures are unimportant, foreign commerce, the fisheries, and agriculture (the latter especially) employing and sustaining the population. The inferior cereals are chiefly grown but only a limited area is devoted to them, the rich pasture grounds rendering dairy produce, the rearing of horned cattle and horses, the main objects of attention, which are largely exported from Holstein. Notwithstanding n elaborate system of national education, great popular ignorance exists. The kingdom possesses two universities, seated at Copenhagen and Kiel, and a marine school at Gluckstadt. Lutheranism is the established religion, and is professed by the great bulk of the people.

XXII. NORWAY AND SWEDEN.

I. The great geographical region occupied by Norway and Sweden, forming the Scandinavian peninsula, and constituting, with a prodigious swarm of adjoining islands, a single monarchy, has the Arctic Ocean on the north; the Skager Rack, Cattegat, and Baltic on the south; the North Sea and North Atlantic on the west; the Baltic, Gulf of Bothnia, and Russian Lapland on the east.

Latitudinal limits.—55° 40′ N., south extremity of Sweden, and 71° N., the North Cape in the island of Mageroe.

Longitudinal limits.—4° 30′ E., western isles of Norway, and 31° E., the north-east extremity of Finmark, or Norwegian Lapland.

Extent.—Nearly 1200 miles long from the south point of Sweden to the north extremity of Norway, and somewhat more than 450 miles broad at the widest part, under the parallel of Christiana and Upsal. The area, including the islands, is estimated at upwards of 292,000 square miles.

II. The Norwegian shore exhibits a remarkably involved physical conformation, consisting of an almost uninterrupted series of long, narrow, and winding fiords inclosed by lofty threatening rocks, naked where exposed to the fury of the gales from the ocean, but under shelter clothed with forests of pine, fir, and juniper, the deep and beautifully clear water distinctly reflecting the surrounding objects. The interior country is almost entirely occupied with table-lands and mountains, stretching 1100 miles through the entire length of Norway, under the names of the Thulian Chain, in the south; the Dovre-field, or Dofrines, towards the centre; and the Koelen, in the north, forming the water-parting between the basins of the Atlantic and the Baltic. In North Bergen the highest point occurs, at the elevation of 8153 feet, which is more than 3000 feet above the line of perpetual snow in that latitude. But an entire area of the peninsula, amounting to upwards of 3500 square miles, is estimated to be above the snow-line, the greater part of which belongs to Norway. From about the parallel of 61°, the mountains form the boundary northwards between that country and Sweden, and variously penetrate the Swedish territory with spurs, gradually declining into hilly ranges towards the lowlands which skirt the Gulf of Bothnia. Sweden is for the most part a hilly region, with low granite rocks peering above the surface, except in the extreme south, which corresponds in character to the north German flats on the opposite side of the Baltic. The principal Norwegian lowland district lies opposite to the north projection of Denmark, around the Christiana Fiord.

The islands of Norway, precipitous, and mostly uninhabited, or only used as fishing stations, may be regarded as submarine extensions of its mountain system. The two largest groups are the Loffoden Isles, north of the Arctic circle, in which the celebrated whirlpool of the Maelstrom is formed by tidal currents; and the Tromsen Isles, extending along the extreme north coast. This last group terminates with the island of Mageroe, which contains the little village of Kelvig, occupied by a few families, and the celebrated North Cape, an enormous mass of bare rock, shattered by the winds and waves, rising boldly from the Arctic Ocean to the height of 1150 feet. To the south-west lies the island of Hvaloe, containing the town of Hammerfest, with about 100 inhabitants, in lat. 70° 40′ N., the most northerly town belonging to Europe.

Sweden, with many insignificant islets, possesses two territorially extensive and also productive insular tracts: Gottland, a great level in the centre of the Baltic, stretching 80 miles from north to south by 30 from east to west; and Œland, a narrow tract, rich in pasturage, but extending 86 miles along the south-east coast of the peninsula.

III. Rivers and lakes are prominent features in the physical geography of the country, and contribute a grand element to its scenery, chiefly occuring on the Swedish side of the peninsula. Descending from the central mountains where they are fed from the snows and glaciers, the rivers are furious torrents in the upper portions of their course, and frequently form splendid waterfalls, those at Trollhatten in Sweden, between Lake Wener and the sea, being among the finest in Europe. Upon the melting of the winter's snow in spring, or after great rains, the rivers acquire immense volume and rapidity, and often spread in destructive inundations over the adjoining districts. The two largest examples, the Glommen disembogues from Norway into the Skager Rack, and the Gotha from Sweden into the Cattegat; but the vast proportion of the drainage is conducted by an immense number of smaller streams to the Baltic, contributing to the freshwater character of that sea. In point of size, Lake Wener ranks third among the inland waters of Europe, covering an area of 2100 square miles; and Lakes Wetter and Mælar, all in the south of Sweden, yield only to the great expanses of Russia in extent.

The water of the Baltic is much less salt than that of the North Sea, owing to the great amount of fresh water which it receives; and the water of the Gulf of Bothnia, where the inflowing streams are most abundant, contains less salt than that of other portions of the Baltic. The quality appears to vary with the season. At Midsummer a much less quantity of salt will be obtained from the same proportion of water than at midwinter. The effect is referible to the larger amount of drainage from the land, through the rapid melting of the snows at the commencement of the summer.

IV. Norway, the smaller portion of the peninsula, comprises an estimated area of 122,000 square miles, and contains a population of 1,200,000. It consists of three principal regions, denominated from their geographical position, and subdivided into districts or counties: Sondenfields, or the southern ranges of hills; Nordenfields, the northern ranges of hills; and Nordland, the north land, which includes Finmark. Christiana, the capital, at the head of an extensive fiord on the south-east coast, is the seat of a university, and has upwards of 23,000 inhabitants, who are said to consist of a greater proportion of well-educated people than can be found in any British town of similar size. Farming is prosecuted in the valleys of the south, and along the slopes where there is any cultivable soil, but the cereal and other agricultural produce is not sufficient for domestic consumption. Fishing is the chief occupation in the north, but followed in the creeks and fiords along the whole coast through the summer, and at the Loffoden Isles in the herring season,—the produce forming a staple article of food, and an important export. The preparation of timber from the forests in saw-mills for foreign markets, and its transit abroad, with the native mines of silver, lead, copper, and iron, are other sources of subsistence. In the wild region of the extreme north, herds of reindeer contribute to the support and clothing of a thin and scattered population.

Norway enjoys an independent free constitution, while under the Swedish crown, to which it was annexed by cession from Denmark in 1814. Denmark obtained in lieu Swedish Pomerania, and subsequently exchanged it with Prussia for the duchy of Lauenberg and a pecuniary indemnity.

V. Sweden has a superficial extent of about 170,000 square miles, and contains a population of 3,100,000. It consists of three large regions, subdivided into governments and districts: Gottland, in the south; Svealand, or Sweden Proper, in the centre; and Nordland, including Swedish Lapland, in the north.

Stockholm, the capital, in lat. 59° 20′ N., and long. 18° E., situated on the strait which connects Lake Mælar with the Baltic, contains about 80,000 inhabitants, and has been called the Venice of the north, from being partly built on islands. More than half the surface is covered with forests, from which a large amount of timber is annually transferred to the ports of Europe. The country furnishes iron in great abundance, and of very superior quality, also a considerable quantity of copper; the number of mines amounting to nearly 600. In the Baltic, the Gulf of Bothnia, and the rivers, extensive fisheries are conducted. But agriculture is the chief occupation of the people; and notwithstanding disadvantages from soil, climate, and imperfect cultivation, a sufficient supply of grain is raised for home wants and an important export trade. The kingdom possesses two universities, seated at Upsal and Lund. The principal naval stations are at Stockholm, Carlscrona, and at Gottenburg. Lutheranism is the established religion of both Norway and Sweden, from which there is only a very small number of dissentients.

The only foreign possession of the Swedish monarchy is the island of St. Bartholomew in the West Indies.

VI. Ranging through 15° of latitude, the Scandinavian peninsula has a varying climate, but much milder than what is experienced at corresponding latitudes in other parts of the globe. The climate of Norway, apart from the mountains, is also less rigorous than that of Sweden. Generally, long and severe winters alternate with short hot summers, so rapidly interchanging as to constitute the only seasonal divisions of the year. In the most southern districts, the vegetation corresponds to that of midland Europe; but the far north stretches beyond the zone of the hardiest woods and cereals, and the signs of vegetable life are chiefly confined to the dwarf birch, trailing shrubs, and cryptogamia. The native wild animals include the bear, wolf, glutton, beaver, lemming, and elk. Of the domesticated kind, the ass is unknown; sheep extend toward the Arctic circle, and are there superseded by goats; the horse goes beyond that limit; reindeer and dogs range to the most northern site.

XXIII. RUSSIA IN EUROPE.

I. This vast country, occupying the entire east of Europe, has the Arctic Ocean on the north; Norwegian and Swedish Lapland, the Baltic with its branches, and part of the Prussian, Austrian, and Turkish dominions on the west; the Black Sea, Caucasus, and Caspian on the south; and Asia on the east.

Latitudinal limits.—41° N., east extremity of the Caucasus, and 70° N., the north point of Russian Lapland.

Longitudinal limits.—18° E., west boundary of Russian Poland, and 68° E., the sources of the River Kara, north of the Ural or Oural Mountains.

Extent.—1800 miles from north to south, measured along the meridian of 45°, and 1700 miles from east to west, following the parallel of 52°. Area, upwards of 2,000,000 square miles; more than half the area of Europe.

II. European Russia possesses a considerable length of coast-line, but its maritime value is not commensurate with its extent. It commands the Arctic Ocean from the Varanger Fiord on the west to the mouth of the river Kara on the east, with the deep indentation of the White Sea, penetrating upwards of 300 miles inland, and covering an area of 40,000 square miles. But the whole of this region is ice-bound through the greater part of the year, the harbour of Archangel being commonly closed from October to May, while the more easterly districts are rigorously locked up by the winter for a longer period. The Baltic supplies the next extensive line of coast, from Tornea at the head of the Gulf of Bothnia to a little northward of Memel, including the Gulfs of Finland and Riga; and here maritime operations are subject to a similar periodical interruption, St. Petersburg being blocked with ice upon an average for five months, from the beginning of November to March. The fine expanse of the Black Sea, from the mouth of the Danube to where the Caucasus leaves the coast, with its gulf, the Sea of Azov, belongs to Southern Russia, and is subject to the same disadvantage, though in a less degree. The shallow Sea of Azov, the connecting Strait of Enikale, and the ports between the Crimea and Odessa, are almost always frozen up during the months of January and February, the drift-ice rendering navigation dangerous around the harbour of Odessa, and generally suspending it for an interval. In the south-east the Caspian, forming the boundary from the Caucasus to the River Ural, being without an outlet, is only important for its fisheries.

The principal insular dependencies of European Russia in the Arctic Ocean are the two islands of Nova Zembla, or Novaia Zemlia, divided by a narrow strait, extending in the form of a curve N. and N.E. about 400 miles, with an average breadth of 50. They are sterile mountainous tracts, completely inaccessible in winter, and so beset with ice in summer that the north-east coast has not been yet explored. The Spitzbergen group, the most northerly known land, is claimed by Russia. The cluster consists of three large and several small islands, whose shores are coated with glaciers, the dismemberment of which periodically loads the northern seas with immense masses of floating ice.

The chief Baltic islands belonging to Russia are Œsel, at the entrance of the Gulf of Riga, and Aland, a naval station, guarding the entrances of the Gulfs of Bothnia and Finland.

III. Excepting a few districts, the inland country is an enormous plain, and forms the principal part of the great central plain of Europe. It presents a few slight elevations and low hills, but in many places a dead flat extends hundreds of miles; and the surface dips below the level of the sea towards Astrachan, where the Caspian is depressed 84 feet below the Black Sea. Millions of acres are covered with natural forests of pine, fir, and deciduous trees, chiefly occupying the central districts. Bogs and marshes include a considerable area. An immense swamp, the largest in Europe, and not far inferior in size to the whole of England, extends along the parallel of 52°, nearly covering the basin of the Pripet, an affluent of the Dnieper. In the far north also, beyond the zone of the woods, the surface consists largely of mossy grounds, which become morasses in summer, but are frozen hard as iron in the winter season. A broad belt of the finest mould, consisting entirely of decomposed vegetable matter, from three to six feet deep, more than equalling the united area of Great Britain, France, and Spain, stretches across the country from the Dnieper north-eastwards to the Urals, inclosing Moscow, in which the most abundant crops of grain are grown with little culture. The southern part of the great plain embraces the peculiar region known as the steppes; vast treeless, undulating, monotonous tracts, consisting of two principal divisions,—the High Steppes, westward of the Don, overgrown with coarse rank grass, pasturing immense droves of horses; and the Low Steppes eastward, with a much more scanty vegetation, the surface being extensively covered with fine sand strongly impregnated with saline matter, and containing numerous salt lakes. Rocky heights scattered over Russian Lapland, Finland, and Olonetz, on the north-west; the low hills of Valdai, south of Novgorod; with offsets stretching westward from the Urals; and the northern part of the Caucasus, are the chief elevations.

The Urals form great part of the boundary between Europe and Asia, but as the principal portion of the range is included in the European Russian governments of Perm and Orenburg, they may here properly be noticed. The chain has a meridional direction, and extends upwards of 1200 miles from the borders of the Arctic Ocean to the sources of the river Ural. It culminates in Mount Konjakoski, to the north-east of Perm, in lat. 59½° N., at the height of 5391 feet,—which is about 600 feet above the snow-line in that latitude. The whole region is highly metalliferous, producing iron, copper, gold, and platinum, a great source of wealth to the empire. West of the range a vast deposit of coppersand ore occurs, extending 480 miles northwards from Orenburg, by a breadth of 280 miles, comprehending an area of 100,000 square miles, through which the mineral has been found of perfectly uniform quality. Immediately east of the range are the rich alluvial auriferous deposits of the Miass River, in which a mass of native gold was found in 1836, weighing 10 killogrammes, upwards of 22lbs., of which there is a plaster model in the Museum of Natural History in Paris. But in the same district, Nov. 7, 1842, at the depth of three yards

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in the sands, an enormous mass of gold was discovered, weighing 36 killogrammes, or about 80lbs., now in the collection of the *Corps des Mines* at Petersburg. Erman gives for the yearly total of metal raised on the Urals a value of

Roubles.	
15,000,000	for iron.
5,490,000	for copper.
15,000,000	for gold and platinum.
35,490,000 = about £5,397,000.	

The Caucasus similarly marks by its ridge-line the boundary between Europe and Asia on the south, and consequently belongs in part to European Russia, but is more immediately identified with Asia by its southern prolongations.

IV. The surface, notwithstanding its flatness, comprises two great slopes, inclining N.W. and S.E., which conduct the drainage generally in those directions, but so slight is the declination that the rivers have a very feeble current, often overflow their banks, forming the numerous marshes, and occupy an enormous space in meandering. The more important are the Petchora, Mezene, and Dwina, flowing to the Arctic Ocean; the Tornea, Neva, Duna or southern Dwina, Niemen, and Vistula, entering the Baltic and its branches; the Dniester, Dnieper, and Don, connected with the Black Sea; the Ural and the Volga, belonging to the basin of the Caspian. The Volga, the largest river in Europe, has its origin in a small lake on the east slope of the Valdai plateau, at the height of about 550 feet above the level of the ocean. It has a course of 2300 miles, but the direct distance from source to mouth is not more than 900, thus occupying 1400 miles in meandering. Adding the depression of the Caspian to the height of its source, gives to the river an entire fall of but 634 feet, showing the very gentle inclination of its bed. Swelled by the melting of the winter snow and ice, it has a width of nearly five leagues towards its termination, where it divides into eight branches, which inclose 70 islands, and discharges itself by 65 mouths, contributing in its mean state to the Caspian, 1,000,000,000 cubic feet of water per hour. This noble river, traversing the heart of the empire, is of immense importance for the facility afforded to inland trade and foreign commerce by its navigation, being connected by canals with the rivers which proceed to the Baltic and the Arctic Ocean. Russia possesses many thousands of lakes, the largest European expanses occuring in the north-west, salt lakes abounding in the south-east.

The great basins of Lakes Ladoga and Onega, the largest in Europe, with those of the Saimas and Ilmen, have areas respectively of 6338, 3280, 1602, and 275 square miles. The Ladoga receives the surplus waters of the other three, besides having other feeders. The Neva is the common outlet of the four lakes, and carries into the Gulf of Finland 116,000 cubic feet of water per second. This result was very accurately ascertained in the year 1826, in order to have the data requisite for devising means of securing the capital from the disastrous effects of the inundations of the river. The low site of St. Petersburg exposes it to peculiar danger when a strong wind blowing from the Gulf of Finland, and the breaking up of the ice, interrupt the egress of the waters, and forcibly impel them towards the city. In 1824, an inundation swept away 8000 persons.

V. Apart from the small southern peninsula of the Crimea the climate is characterised by an extraordinary range of temperature, especially in the central and eastern districts, where a polar winter follows a tropical summer, the duration of the cold season proportionably lengthening and its intensity increasing with an advance of latitude. The mean annual temperature is also much lower than in the corresponding latitudes of western Europe. But everywhere the interchange between winter and summer is exceedingly rapid. At St. Petersburg in little more than a month after the Neva has been a hard pavement of ice, the birch-trees are in leaf, and in a week more the flowers of *Syringa vulgaris* and *Robinia caragana* open. In the south a violent north-east wind, called *mitel*, is a frequent and much-dreaded visitant, forcing everything before it but the most solid objects.

The temperature ranges frequently at Astrachan from 100° Fahrenheit to 30° below zero.

The mean annual temperature at Tambov is 41°, and at London, in nearly the same latitude, 50·7°.

The winter at St. Petersburg is reckoned commonly to include 230 days, during 160 of which the navigation is stopped by the ice.

During the prevalence of the *mitel* the flocks of sheep and herds of horses in the steppes cluster together in a circle, so as to present a compact mass to its force. But on the shores of the Caspian and Black Seas they have been seen to yield to the overpowering strength of the wind, which has driven them in a mass into the waves. The waters of the Caspian are sometimes impelled over an immense tract of the low plains that form its shores, and vessels have been borne by the overflow many miles inland, where they have been left stranded in the heart of the steppes.

VI. European Russia is divided into fifty governments or provinces, named, with a few exceptions, after their chief towns,—two of which, Perm and Orenburg, extend into Asia; while a portion of territory north of the Caucasus, belonging to Europe, is included in the Asiatic province on the south. The gross population is estimated at upwards of 62,000,000. St. Petersburg, the capital, in lat. 60° N., long. 31° E., occupies principally the left bank of the Neva, between the Lake Ladoga and the Gulf of Finland, and contains rather more than 470,000 inhabitants. Moscow, the old metropolis, with 350,000 inhabitants, remarkable for its oriental character, is on the navigable river Moskva, an affluent of the Volga, nearly in the centre of the country, the chief emporium of internal commerce, and the holy city of the Russian empire. Inland trade is largely carried on at fairs; the most important of which is held at Nishni Novgorod, the capital of the government of that name, favourably situated for the purpose at the confluence of the Oka with the Volga. The articles of foreign commerce consist of vast exports of raw material, timber, corn, tallow, and hides, and of imports of fine manufactured goods. Petersburg, Riga, Odessa, and Archangel, are the chief ports.

The great annual fair of Nishni Novgorod, the largest in Europe, lasts two months. It was formerly held at Makarief, 50 miles lower down the Volga, but transferred from thence in 1817, in consequence of the destruction of the place by fire August 17, 1816. The works on the new site requisite for the accommodation of traders were executed under the direction of General Betancour. The permanent market is of stone, and contains 2522 store-rooms, to each of which is attached a chamber for the owner of the goods to live in. Besides these, the number of temporary booths is enormous. Buyers and sellers, caravan-drivers and common labourers, frequenting the fair average 600,000,—consisting of Armenians, Bokharians, Tartars, Bashkirs, Greeks, and different European nations, who disappear totally when the fair is over; their foreign tongues during its continuance completely overpowering the Russian.

VII. No European state contains such a variety of races, impossible to be particularised in the brief space to which we are limited. The Muscovites or Russians proper, densely grouped around Moscow, vastly predominate in numbers, amounting to nearly three-fifths of the population, and are of Sclavonic origin, along with the Poles, inhabiting the former kingdom of Poland. The Finns and Lapps in Finland and Russian Lapland, with various tribes scattered over the north, constitute the Finnish or Tschoudic stock, belonging to the Mongolian variety of mankind. The Esthonians, Lettons, and Kures, in the maritime provinces south of the Gulf of Finland, are mixed Finnish and Sclavonic. The German branch of the Teutonic family is represented by colonies on the Lower Volga, and towards the Crimea, as well as along the Baltic; while the Scandinavian branch contributes an important element to the population of Finland in a considerable number of Swedes. Various Turkoman and Kalmyk tribes occupy the south-eastern steppes, and Jews abound in Poland. The Russians belong to the Greek Church; the Poles are chiefly Roman Catholics; the Turkomans are Mohammedans, and the Kalmyks Lamaists; the Germans, Swedes, and Finns in part, are Lutherans; and some Finnish tribes in the north-east are Pagan.

XXIV. GREECE. XXV. TURKEY IN EUROPE.

I. THE European portion of the Ottoman empire, and Greece, occupy the great south-eastern peninsula of Europe, which is surrounded on every side by the sea, except on the north, where it is bounded by the dominions of Austria and Russia. The maritime frontier consists of the Adriatic on the west, the Mediterranean on the south-west and south, the Archipelago, Sea of Marmora, and Black Sea, with their connecting straits, on the east.

Latitudinal limits.—36° 20′ N., Cape Matapan, south extremity of Greece, and 48° 15′ N., the northern border of Moldavia.
Longitudinal limits.—16° E., west extremity of Turkish Croatia, and 29° 30′ E., mouths of the Danube.
Extent.—Greatest breadth, about 700 miles, from the west of Croatia to the mouths of the Danube; greatest length, about 840 miles, from the south extremity of the Morea to the north border of Moldavia. Area, with the islands, nearly 200,000 square miles.

II. TURKEY, the principal portion of the peninsula, comprising nearly 180,000 square miles of the area, extends north of a tortuous line stretching from the Gulf of Volo on the east to that of Arta on the west, which forms the boundary of Greece in that direction, as finally determined by the Commissioners of the three allied powers, Great Britain, France, and Russia, in 1832. The coasts on the east and west have large and deep inlets; but the eastern seaboard presents the most remarkable points, consisting of the Strait of the Dardanelles, which connects the Archipelago, or ancient Ægean Sea, with the Sea of Marmora, and the northern outlet of the latter, now called the Channel of Constantinople, but anciently the Thracian Bosphorus. These Straits are renowned for their beautiful shores, and historic associations, and are highly important as completely commanding communication between the two great expanses of the Mediterranean and Black Seas.

The Archipelago, an offset of the Mediterranean, extends northwards about 380 miles, varying in breadth from 80 to 240 miles, studded with islands, of which the principal belonging to European Turkey are, Candia in the south, Samothraki, Thasos, Imbros, and Lemnos in the north. Candia, the ancient Crete, is the most considerable, 160 miles long, but not more than 35 miles broad where the width is the greatest, and only six at one point. The surface is rugged and bold, rising in the famed Mount Ida, now called Psilorati, near the centre of the island, to the height of 7674 feet.

The Strait of the Dardanelles, or the Hellespont, extends from south-west to north-east upwards of 45 miles, being 10 miles across near the Sea of Marmora, gradually narrowing to two miles opposite the town of Gallipoli, and to less than one towards the south extremity. A strong current runs through it into the Archipelago, and the set of the wind is very commonly in the same direction, rendering the navigation tedious to sailing vessels.

The Sea of Marmora, having only two very narrow outlets, resembles a great inland lake. Its general direction is nearly due east and west, extending upwards of 150 miles by nearly 50 from north to south, where the greatest expansions occur. It derives its name from one of the islands, Marmora, so called owing to the abundance of its marble. The depth is very considerable, no bottom having been found with a line of 355 fathoms off Marmora Island.

The channel of Constantinople, or the Bosphorus, runs nearly due north from the Sea of Marmora about 20 miles, varying in breadth from ¾ to 2¼ miles. Its winding course and picturesque coasts, overspread with towns and villages, render it one of the most attractive sites in Europe.

III. The interior of the country consists of an extensive central nucleus of elevated plains and rugged towering highlands, connected in the north-west with the Dinaric Alps, and thus linked to the great Alpine system of Europe. The culminating point of the surface is, in this direction, Mount Kom, rising near the junction of Servia, Bosnia, and Albania, to the height of 9500 feet. A descending series of table-lands extends generally from the central nucleus towards the coasts, intersected by various ranges of mountains emanating from the same point. Eastward, the Chain of the Balkan (the ancient Hæmus) stretches to the bold headland of Cape Emeneh on the shore of the Black Sea; south-eastward, a loftier ridge, the Rilo Dagh and Despoto Dagh (Rhodope) runs into the plains bordering the north coasts of the Archipelago; and southward, a range follows the direction of the peninsula into Greece, denominated the Southern or Hellenic Chain, of which the classical mountains, Pindus, form the southern extremity, Olympus, Pelion, and Ossa, being offsets, on the Gulf of Salonica. The lowlands are chiefly maritime, consisting of narrow slips of territory, except on the north-east, where the vast levels of Wallachia and Moldavia stretch northwards from the Danube, skirt the base of the Carpathian Mountains, and join the great plain of Europe. The lower course of the Danube from its issue out of Hungary to its junction with the Pruth belongs wholly to Turkey, below which it divides into several branches, and enters the Black Sea by seven mouths, the northern belonging to Russia. This great stream with its affluents, the Save on the Austrian frontier, the Pruth on the Russian, the Morava from Servia, and the Sereth from Moldavia, with the Maritza, draining the plain of Adrianople and falling into the Archipelago, are the important rivers. On the banks of the Lower Danube, there are extensive marshes and lagoons; and in Albania some spacious lakes occur.

The principal Albanian lakes are Ochrida (ancient Lychnitis), Scutari, and Janina. The latter has acquired celebrity in modern times from its connection with the fortunes of Ali Pacha. It is a mountain expanse, said to be 2500 feet above the sea-level, 10 miles long by 3 broad, communicating through a subterraneous channel with the River Kalama.

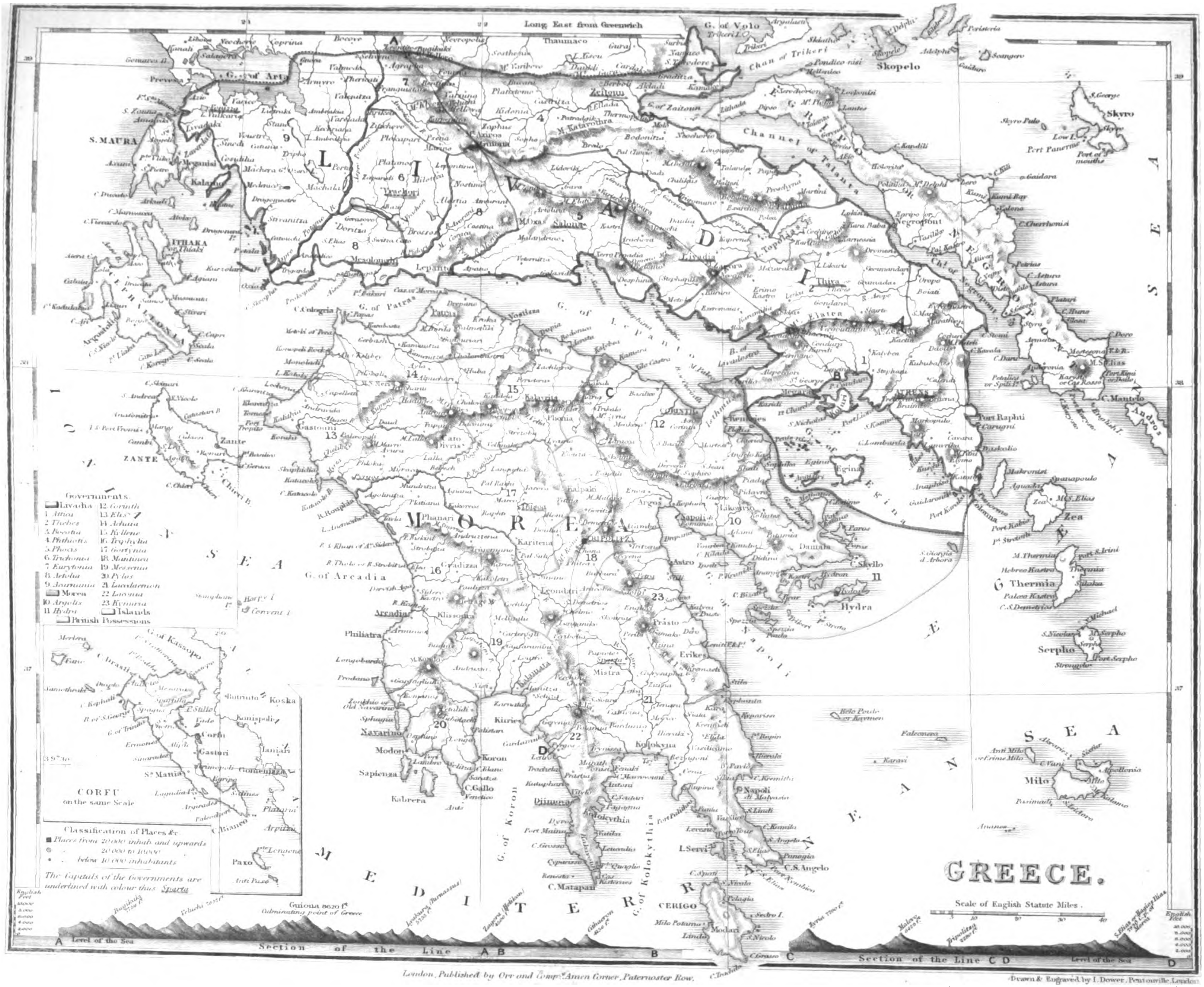
IV. Exclusive of the large principalities of Moldavia, Wallachia, and Servia, with the small state of Monte Negro, which have little beyond a nominal connection with the Ottoman empire, the remaining countries of European Turkey under its direct control are distributed into four eyalets or governments, in the two larger of which the Sultan is represented by pashas of the highest rank, and in the two smaller by pashas of an inferior grade. The eyalet of Roumili includes Western Roumelia, Thessaly, and Albania; the eyelat of Silistria comprises Eastern Roumelia, Bulgaria, and the fortress of Belgrade; the eyalet of Bosnia consists of Herzegovina, Croatia, and Bosnia; and the eyalet of the Islands comprehends all the islands belonging to Turkey in the Archipelago and the Levant, the government of which is always held by the Capitan Pasha, the highest naval officer. Constantinople, the metropolis, in lat. 41° N., long. 28° 55′ E., finely situated on the west shore of the Thracian Bosphorus at its junction with the Sea of Marmora, is remarkable for its magnificent harbour, superb environs, and motley population, amounting probably to upwards of 600,000, being the third of the European capitals in point of size. Including the principalities, the population of the whole country is supposed to exceed 12,000,000, consisting of the Osmanli race, politically dominant but numerically small; Sclavonic races of Moldavians, Servians, Bulgarians, Bosnians, and Croats; and Græco-Latin races of Greeks, Wallachians, and Albanians. The Osmanli and the major part of the Albanians are Mohammedans. The other races belong principally to the Greek Church.

Moldavia and Wallachia are governed by sovereign princes under the title of Hospodars, who pay a small annual tribute to the Sultan, are appointed by him for life out of a list of nominees furnished by the nobles of those states, but really dictated by Russia, whose influence is predominant.

Servia likewise pays a small tribute, and has a Turkish garrison at Belgrade under the pasha of Silistria; but is in all affairs of internal government a separate state, under Russian protection.

Monte Negro also is only connected with the Turkish empire by a trifling tribute, regulating its own affairs in alliance with Russia.

V. GREECE, at the south extremity of the oriental peninsula of Europe, with the islands connected with it, comprises an area of about 20,000 square miles. Its southern district forms a peninsula upon a minor scale, connected with the northern by the narrow isthmus of Corinth. Northern Greece, or Hellas proper, extends about 150 miles from east to west by 40 from north to south, and everywhere abounds with interesting remains of antiquity. It includes the ancient states of Acarnania, Ætolia, Doris, Locris, Phocis, Bœotia, Attica, and Megara. The surface is to a great extent mountainous, but the high lands inclose many fertile basin-shaped plains and valleys. The principal heights extend in a north-west direction from the plain of Athens to the Turkish frontier,—Mount Elatea (Cithæron), 4156 feet; Zagora (Helicon), 4500; Lyakura (Parnassus), 5755; and Guiona (Axiros), 8620, the culminating point of Greece. Southern Greece, the ancient Peloponnesus, now called the Morea, extends about 140 miles from north to south by 120 between the extreme east and west shores. It comprises the ancient territories of Achaia, Elis, Messenia,



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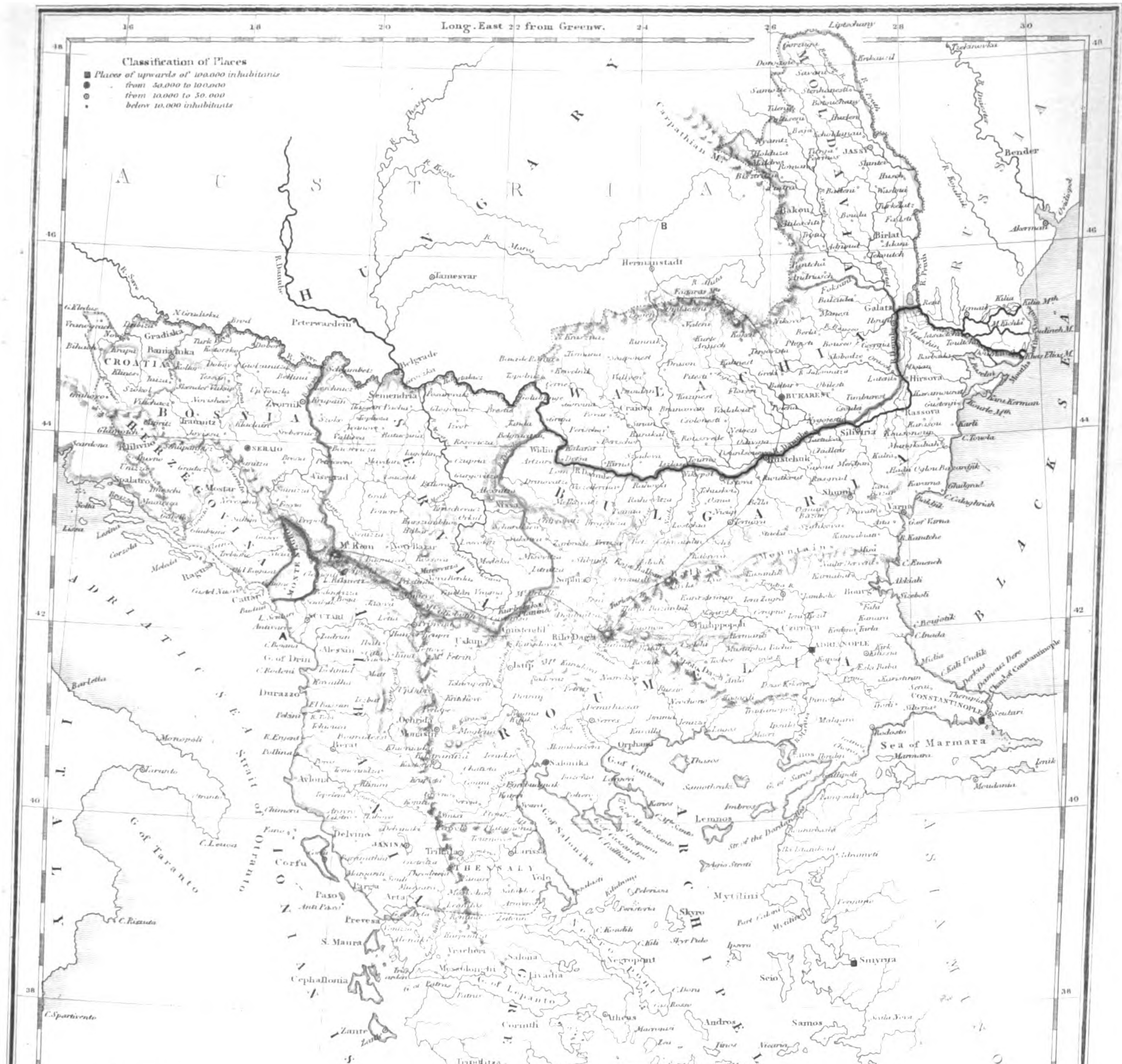

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Laconia, Argolis, and Arcadia, and is the most densely peopled and highly cultivated portion of the modern kingdom. The rivers of both divisions are very unimportant streams in size, and are often dried up in summer; but derive interest from their classical associations. Insular Greece includes the large island of Negropont (Eubœa), which approaches the main land at one point so closely as to have a bridge across the channel; all the Cyclades; with the Western and Northern Sporades.

The inhabited islands, besides Negropont, are as follows: *Northern Cyclades*—Andros, Zea, Thermia, Tinos, Mykoni, Syra, the most flourishing of the isles of Greece. *Central Cyclades*—Naxos, Paros and Antiparos,—the former celebrated for its marble, and the latter for its grotto; Siphnos, Seriphos, Milo, Kimolos, Polikandro, Sikino, Nio, Amorgo. *Southern Cyclades*—Santorin, a volcanic formation, Anophi, Astypalsa. *Northern Sporades*—Skyros, Skiathos, Kilidromi, Scopelos. *Western Sporades*—Hydra, Spezzia, Salamis, Angistri, Poros, Ægina, containing on the summit of a hill near the south-east extremity the ruins of the temple of Zeus Panhellenios, the Jupiter of all the Hellenes.

VI. The kingdom of Greece is divided into twenty-four governments, and is supposed to embrace a population of 956,000,—which includes the inhabitants of the islands, amounting to nearly 200,000. Athens, the metropolis, in lat. 37° 58′ N., long. 23° 46′ E., containing somewhat more than 20,000 inhabitants, is only remarkable for its historic fame, and the existing monuments of its ancient grandeur. The Greeks, proud of their ancestry, have resumed the name of the Hellenes, but they are the offspring largely of a crossing with foreign blood, Latin and Sclavonic; and the Albanian race is numerous both on the continent and in the islands. However degenerate the present inhabitants of the soil in comparison with the people who fought at Marathon, Salamis, and Thermopylæ, reared the temples that lie in ruins, and produced a literature which in various departments the moderns accept as a model, many of the natural productions of the region maintain their former celebrity. The orange, citron, vine, and myrtle flourish luxuriantly; the Corinthian currant is still produced in the greatest perfection on the southern shores of the Corinthian Gulf; the olives of Attica are distinguished as in former times for their excellence; and Mount Hymettus vindicates its ancient fame for aromatic shrubs, flowers, and honey.

Greece remained subject to Turkey till the year 1820, when the war of independence commenced; a bloody struggle, which lasted for ten years, terminated by the interference of the great European powers. In 1829 the Sultan assented to its loss. In 1832 the boundary-line towards Turkey was finally settled, and the kingdom was formally constituted by the disposal of the crown to its present possessor. In 1834 Athens was declared the capital, Nauplia having previously been the seat of government.

VII. The Ionian Islands, on the south and west coasts, of which Corfu, Santa Maura, Cephalonia, Ithaca, Zante, and Cerigo, are the principal, form an independent state under the protection of Great Britain, the government being administered by a Lord High Commissioner appointed by the British crown. The islands contain about 200,000 inhabitants. Corfu is the capital.

XXVI. ASIA.

I. This great division of the globe is wholly maritime on the north, east, and south, being inclosed in those directions by the Arctic, Pacific, and the Indian Oceans. On the west, Europe and a small part of North Africa form the boundaries, with their eastern waters, the Caspian, Black Sea, Archipelago, Levant, and Red Sea.

Latitudinal limits.—1° 20′ N., south extremity of the peninsula of Malacca, and 78° 16′ N., Cape Severo-Vostochnoi, north extremity of Siberia.
Longitudinal limits.—26° 10′ E., north-west coast of Asia Minor, and 170° W., Tschuktschi-noss, or East Cape, Behring's Strait.
Extent.—5400 miles from north to south near the meridian of 100° E.; 5600 miles from west to east, following the parallel of 40° N.; and 6700 miles in a diagonal direction from Behring's Strait to the head of the Red Sea. The superficial area is estimated at 17,500,000 square miles; and the linear extent of coast at 35,000 miles.

II. Asia includes every physical diversity of the terrestrial surface developed upon a gigantic scale, but a brief reference to its leading highlands and lowlands, still but imperfectly known, must suffice. The meridian of 80° E., intersecting the surface from the alluvial plains of the Ganges to the cold shores east of the Gulf of Obi, crosses the most colossal mountains and the loftiest plateau of the globe, constituting the peculiar region known from its position and elevation as Central and High Asia. Its general limits are,—on the west, the Bolah Tagh, or Cloudy Mountains, running in the direction of the meridian northwards from the Punjaub to about lat. 45½°; on the north, the Altai Chain, connected by offsets with the preceding, but following a transverse course eastwards to the Sea of Okhotsk; and on the south, the mighty Himalaya, culminating in Dhawalagiri at the height of upwards of 5¼ miles, and extending with its prolongations from Afghanistan on the west into China on the east. The two parallel chains of the Kouenlen and Thian Chain, diverging eastwards from the meridional axis, are intermediate to the Himalaya and Altai. These mountains inclose and bound high and extensive table-lands. Between the Himalaya and the Kouenlen lies the plateau region of Little Thibet, with a height varying from 12,000 to 17,000 feet; and between the Kouenlen and Thian Chain, stretching from thence through Mongolia is the vast sandy desert of Gobi, the general elevation extending from 2500 to 4200 feet. Western Asia comprises another system of mountains and plateaus, which, though not independent of the former, is rendered distinct by the narrowness of the connecting highland isthmus, and a generally inferior elevation. It includes the table-lands which occupy the centre of Asia Minor and Persia, with a mean elevation of from 3000 to 4000 feet, and the mountain ranges which diverge in every direction from Armenia as a central nucleus, and form the Tauro-Caucasian system.

The great lowland regions are everywhere external to the highlands, and form extensive countries, some of which have been occupied from remote antiquity with mighty empires and a dense population. They vary in their character from true arid deserts, corresponding to the African Sahara, to districts of the richest vegetation, and from a burning temperature to one which keeps the subsoil perpetually frozen. Syria and Arabia, Northern India, Cambodia and Siam, China, Siberia, and Independent Tartary, include the most important lowlands.

III. The inland waters of Asia form the largest rivers of the Old World, and the greatest expanse apart from the ocean, the Caspian Sea, a true lake, territorially belongs to this division of the globe. From High Asia, the northern slope descending very gently to the Arctic Ocean, is languidly traversed by the Obi, Yenessei, and Lena; the eastern slope, declining to the Pacific, bears to that basin the Amour, Hoang-Ho, and Yang-tse-Kiang; the southern slope, descending to the Indian Ocean and Chinese Sea, has the Cambodia, Meinam, Irawaddy, Brahmapootra, Ganges, and Indus; and the western slope, sinking into the low tracts of Independent Tartary, conducts the Sir or Sihoon, and Amoo or Jihoon, into the Sea or Lake of Aral. The highlands of western Asia give rise to two great streams, the Euphrates and Tigris, which flow from the mountains of Armenia to the Persian Gulf.

	Length in miles.
Obi	2670
Yenessei	3230
Lena	2770
Amour	2740
Hoang Ho	2300
Yang-tse-Kiang	3320
Meinam	1080
Brahmapootra	2000?
Ganges	1940
Indus	2260?
Euphrates	1720
Amu	1610

The Caspian Lake covers a surface computed at nearly 160,000 square miles, occupying an immensely deep cavity, its bed descending in one part upwards of 2000 feet. Lakes Aral, Baikal, Van, and Uramia, are also considerable expanses; besides which a great number occur in Central Asia, with brackish and intensely salt pools in the west, and marshes in the north.

The Sir-i-Kol, on the table-land of Pamir, is remarkable for its elevation, 15,000 feet, nearly the height of Mont Blanc, being the highest lake on the globe. The Dead Sea is celebrated for the intensely saline character of its water, and the great depression of its surface, 1312 feet below the level of the Mediterranean.

IV. Asia, extending within 2° of the Equator, and nearly 12° beyond the Arctic Circle, has the greatest climatic extremes within its bounds. The northern and western countries, comprising half the surface, are distinguished by a much colder temperature than the localities in Europe and America at corresponding latitudes. This arises in part from the high wall of the Himalaya Mountains, preventing the heated air of the tropical countries from travelling to the north, and partly from flat lands forming the shores of the Arctic Ocean, and offering no barrier to the cold polar winds. Vegetation, which in the south appears in equinoctial luxuriance, in all the well-watered districts, is only represented through a large area of the north by the dwarf birch, Arctic bramble, creeping willows, and coarse rushes, and in the extreme north by mosses and lichens. In the number and importance of its zoological productions Asia stands unrivalled, and has contributed to the civilized nations of the globe those animals capable of domestication which are most useful in the economy of human society, the species, in several instances, still running wild on its plains and highlands.

The vegetable productions used as food for man, or as luxuries, peculiar to Asia, or characteristic of its botany, include the tea-plant in China, Japan, and Upper Assam; coffee on the highlands of Yemen in the Arabian peninsula; bananas in the tropical districts; rice all over the south; sugar-cane in China; pepper on the Malabar coast, the Malay peninsula, and Siam; cinnamon in Ceylon and Cochin China; and the cocoa-nut extensively in India. The vine and most of our important fruits are importations into Europe from Asia, as well as the corn-plants, though the latter have not been found in a wild state.

Among the animal tribes of Asia, the gavial of the Ganges is the prominent saurian; the great python of India, and the deadly cobra-de-capello of Ceylon, the principal ophidians. The birds are remarkable for numbers, variegated and brilliant plumage. In the woods of India the stock of our domesticated fowls run wild, with the peacock and pheasant; and in China, the gold and silver pheasants of European aviaries are indigenous. Of larger species, the cassowary occurs in the Malay peninsula, and the ostrich in Arabia. The mammalia, including the mammal inhabitants of the islands, comprise 422 species, of which 134 belong in common to Asia and other continents, leaving 288 exclusively Asiatic. The latter number is thus distributed:

Quadrumana	39
Cheiroptera	41
Carnivora	60
Marsupialia	3
Rodentia	75
Edentata	2
Pachydermata	8
Ruminantia	46
Cetacea	14
	288

Among the carnivora alone found in Asia, the tiger, the type of the sanguinary development, is the most formidable, occurring in the south-eastern countries,—his range extending westward to Persia, and northward to Lake Baikal.

V. The population of Asia can only be the subject of a probable estimate, but it may be assumed to reach 500,000,000, very irregularly distributed over the surface, vast tracts being wholly uninhabited, or tenanted with scattered and wandering tribes, while excessively dense groups are collected in other districts, the greatest density occurring in China Proper and British India. The predominant political bodies include one native empire, the Chinese, and two foreign, the Russian and British; the Turkish, Persian, Birmese, and Siamese powers rank next; the small states of Muscat, Afghanistan, Beloochistan, Bokhara, and a few others, having no weight beyond the limits of their respective territories.

XXVII. TURKEY IN ASIA.

I. Asiatic Turkey consists of that part of Western Asia which extends along the south coast of the Black Sea, the east coast of the Archipelago, and from thence along the shore of the Mediterranean to the south of Palestine, including several important islands. It stretches inland to the mountains which bound the basin of the Upper Tigris on the east, and to its confluence with the Euphrates down to the Persian Gulf, having for its continental frontier, Arabia on the south, Persia on the east, and the Caucasian provinces of Russia on the north-east.

Latitudinal limits.—30° N., head of the Persian Gulf, and 42° N. Russian frontier on the Black Sea.
Longitudinal limits.—26° E., Cape Baba, west point of Asia Minor, and 48° E., head the Persian Gulf.
Extent.—1400 miles from Constantinople S.E. to the mouth of the joint Tigris and Euphrates; 1100 miles from the south of Palestine to the north extremity of the eyelat of Trebisond.

II. The country thus indicated is invested with the highest sacred and classical interest, as the scene of most of the important transactions recorded in the Scriptures, and the seat of the great Assyrian and Babylonian empires, connected with the exploits of Cyrus and Alexander, and largely with the learning and arts of Greece. For convenience of description, it may be viewed as consisting of four great districts,—Asia Minor, Turkish Armenia and Kourdistan, Algezira with Irak Arabi, and Syria with Palestine.

The chief islands are, Cyprus, and Rhodes, in the Levant, decayed and desolate; Samos, Scio (*Chios*), and Mytiline (*Lesbos*), in the Archipelago.

III. Asia Minor forms an extensive peninsula projecting like a bridge from the main mass of the continent towards Europe. The surface consists of a series of elevated plains, which occupy great part of the interior, intersected and bounded by ranges of mountains, leaving only narrow lowland tracts between them and the shores. The plain of Kutaiah is 6000 feet above the sea, but the mean elevation of the table-lands ranges from 3000 to 4000 feet. The mountains diverge from the highlands of Armenia, and extend their ramifications westward to the borders of the Archipelago, branches stretching through the central parts of the peninsula in various directions. Taurus, running from east to west, parallel to the Mediterranean, throwing out bold headlands to the shore, is the best defined chain, connected with the interior range of the Anti-Taurus, which has one of its offsets for the culminating point, Erjish-dagh (*Argæus*), a volcanic cone rising 13,100 feet. Of the classical mountains, Ida, in the Troad, south-east of the Dardanelles, has an elevation of 5435 feet; and Olympus, south of the Sea of Marmora, 9100 feet. Volcanic rocks, trachyte, lava, and scoriæ, occur abundantly in the west, especially in the region of ancient Sardis and Philadelphia, called by the ancients the "burnt-up region" (*Katakecaumene*), on account of its monuments of past eruptions, extinct craters, streams of lava, and mounds of ashes. The lofty table-lands are treeless, though forming fine pastures; but the inferior crests of the mountains are richly clothed with noble woods, which occupy their slopes, and largely overspread the maritime lowlands. The rivers are all inconsiderable, but celebrated in history. The Kizil Irmak (*Halys*), Bartin (*Parthenius*), and Sakaria (*Sangarius*), descend from the elevated interior plains northwards to the Black Sea; the Mendereh (*Scamander*), Bakir (*Caicus*), Sarabat (*Hermus*), and Meander, westward to the Archipelago; the Ghiuk (*Calycadnus*), Tersus (*Cydnus*), Sihoon (*Sarus*), and Jyhoon (*Pyramus*), southward to the Mediterranean.

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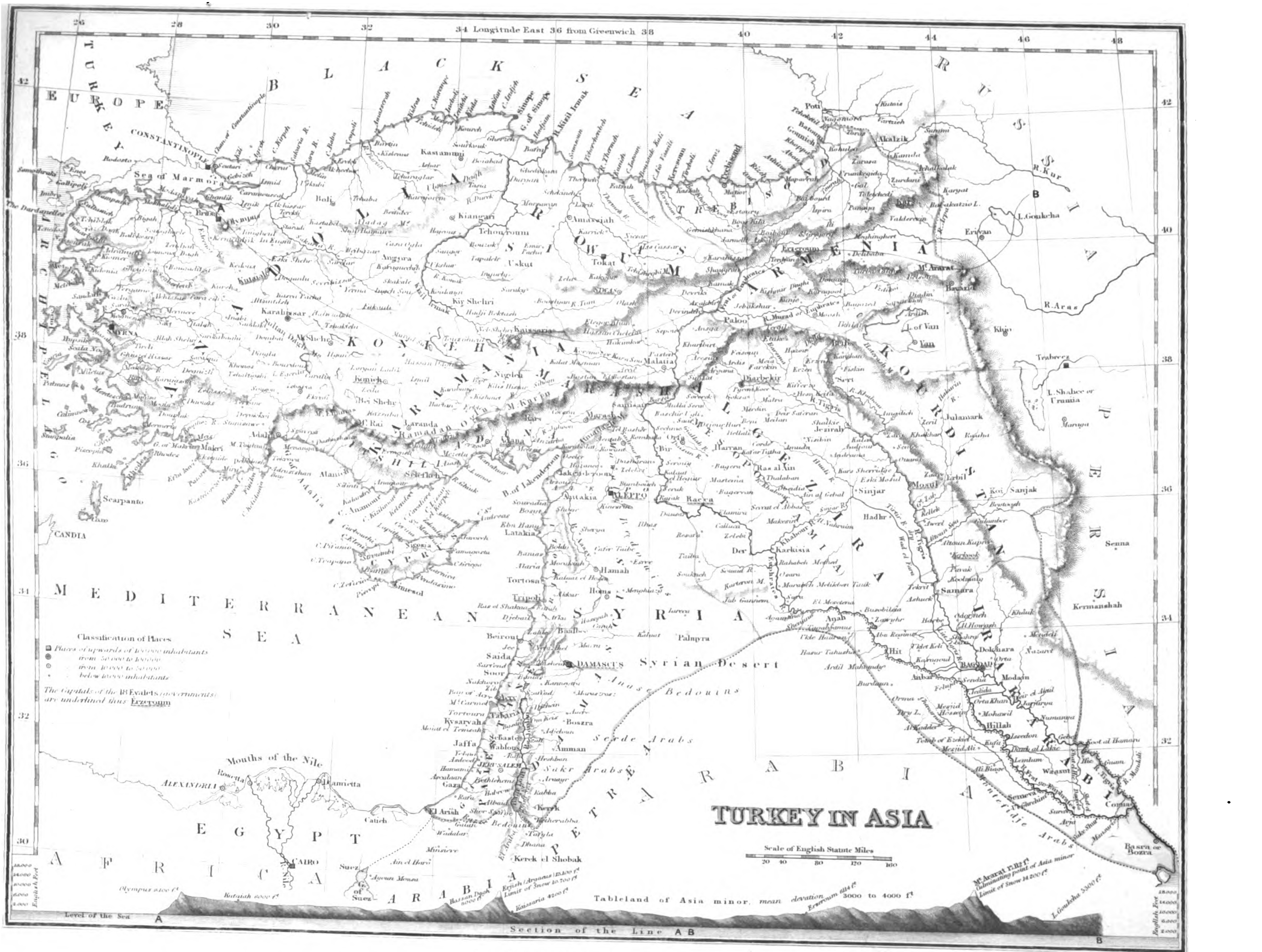

TURKEY IN ASIA
34 Longitude East 36 from Greenwich 38
Scale of English Statute Miles
Classification of Places
Places of upwards of 100000 inhabitants
from 50,000 to 100000
from 10,000 to 50,000
below 10000 inhabitants
The Capitals of the 18 Eyalets (governments) are underlined thus Erzeroum
Tableland of Asia minor, mean elevation 3000 to 4000 ft
Section of the Line AB
Level of the Sea
BLACK SEA
MEDITERRANEAN SEA
ARCHIPELAGO
EUROPE
TURKEY
RUSSIA
PERSIA
ARABIA
EGYPT
AFRICA
SYRIA
Syrian Desert
CONSTANTINOPLE
Sea of Marmora
SMYRNA
ALEPPO
DAMASCUS
JERUSALEM
ALEXANDRIA
CAIRO
BAGDAD
Mouths of the Nile
CANDIA

Asia Minor is divided into six eyalets or governments:

Eyalets.	Cities and Remarkable Places.
Anadolia	Kutaiah (*Cotyæum*), Smyrna, Brusa, Scutari, Karahissar, Adalia, Scala Nova (site of Ephesus), Sart (*Sardis*), Pergamo (*Pergamos*), the Troad.
Karamania	Konieh (*Iconium*), Laranda, Kaissaria (*Cæsarea ad Argæum*), Great Touzla Salt Lake.
Adana	Adana, Tersoos (*Tarsus*), Selefkeh (*Seleucia*).
Marash	Marash, Bostan (*Comana*), Malatia (*Melitene*).
Siwas	Siwas (*Sebaste*), Tokat (*Eudokia*), Amassiah (*Amasia*), Samsoun (*Amisus*), Nicsar (*Neo Cæsarea*).
Trebisond	Trebisond (*Trapesus*), Keresoun (*Cerasus*).

Smyrna, called Ismir by the Turks, and celebrated as "Ismir the Lovely," the "ornament of Asia," the "crown of Ionia," at the head of the gulf of the same name in the Archipelago, is the most important city, trading with all parts of Europe in dry fruit, the annual export of which is enormous. The population, amounting to near 150,000, consists of Turks, Greeks, Armenians, Jews, and individuals of almost all European nations.

IV. Turkish Armenia and Kourdistan occupy the north-east and east. The surface of the former is composed of lofty plateaus with intervening valleys and mountainous ridges, overlooked by the towering volcanic cone of Ararat, the culminating point of Western Asia. It rises to the height of 17,112 feet just without the Turkish frontier, but near its converging point with the Russian and Persian territories, the colossal boundary-stone of three great empires. The Tigris and the Euphrates have their sources in the highlands of this district, and annually overflow their banks in the level countries to which they descend, from the melting of the snows in spring which a long and severe winter accumulates upon the elevated plains. Turkish Kourdistan, to the south, corresponds generally in its superficial features to Armenia, being traversed by mountains diverging from it, and forming high table-lands, one of which is occupied by the great Lake of Van, renowned among the orientals for its beauty, upwards of 200 miles in circumference, and 5467 feet above the level of the sea.

Civil divisions—the four eyalets of Erzeroum, Kars, Van, and Kerkook.

Erzeroum, the only place of importance, is supposed to contain 70,000 inhabitants. It stands on an extensive plain, at the great elevation of 6114 feet. On this account, notwithstanding its southern position, the climate is severe, as with the other high regions of Armenia. Tournefort found the wells here thinly frozen over during a night in July, and the vegetation no farther advanced than at Paris towards the close of April. Schulz, the German traveller, in June, 1827, passed over deep snow between Trebisond and Erzeroum.

V. Algezira, or Mesopotamia, includes the country between the Tigris and the Euphrates, from their upper courses, where they are most apart, to the district where they begin to approach each other, Irak Arabia extending from thence to the confluence of the rivers, and stretching along the west bank of the Shat-el-Arab, the name of the joint stream, to its entrance into the Persian Gulf. They form one geographical region, mountainous where it borders on Armenia and Kourdistan; forests of oak, fir, pine, maple, chestnut, and terebinth clothing the hills; but for the most part consisting of a series of levels, the renowned plains of ancient Assyria and Babylonia. The character of the plains varies from alluvial deposits on the banks of the rivers periodically overflowed, to permanent marshes, and to sandy and stony tracts, often impregnated with bitumen or salt, true deserts, inhabited by the roving Arab, wild ass, and ostrich. On the sides of the Tigris and Euphrates, once the seat of high culture, and the residence of mighty kings, the spectacle is now most melancholy, consisting of the relics of ancient greatness, in the ruins of fortresses, mounds, and dams, erected for the defence or irrigation of the country; the date-groves, vineyards, and gardens of antiquity, being chiefly represented by a boundless growth of reeds, rushes, and sedges, herds of buffaloes tenanting the jungle.

Eyalets.	Cities and Remarkable Places.
Diarbekir	Diarbekir (*Amida*), Sert (*Tigranocerta?*), Mardin.
Racca	Racca (*Nicephorium*), Bir, Orfa (*Ur of the Chaldees, Edessa*), Haran (*Charræ*).
Mosul	Mosul, Ruins of Nineveh.
Bagdad	Bagdad, Hillah, Ruins of Babylon, Nisibin (*Nisibis*), Karkisia (*Circesium*), Hit (*Is*), Ruins of Ctesiphon and Seleucia, Corna, Busra or Bassora.

Bagdad, on the Tigris, about 300 miles from the Persian Gulf, formerly the capital of the great empire of the caliphs, has vastly declined from its ancient importance, but remains the largest city in this part of Ottoman Asia. It is remarkable for its excessive summer temperature, the thermometer sometimes reaching 140°.

VI. Syria, including Palestine, extends along the whole eastern shore of the Mediterranean, its inland boundaries being formed by the Euphrates in the north, and the great Arabian desert in the south. A narrow lowland strip on the coast, and vast inland plains assuming more of the desert character as they become interior, with an intermediate range of mountains, characterise the surface. Lebanon, the name of the grand chain, divides into the two branches of Libanus and Anti-Libanus, inclosing between them the valley denominated Hollow Syria (*Cœlosyria*), which terminates on the northern border of Palestine. The latter district, the subject of a special Map, will not here be characterised.

Civil Divisions.—The four eyalets of Aleppo, Tripoli, Damascus, and Acre.

Aleppo, at the commencement of the present century, was second only to Constantinople in the Ottoman empire; but two successive earthquakes in 1822, and a third in 1830, largely reduced its population. It is still the chief emporium of northern Syria, and gradually recovering its former prosperity.

Damascus, a place of the highest antiquity, may be regarded as the capital of southern Syria, numbering upwards of 100,000 inhabitants.

VI. Turks, Greeks, Armenians, Kurds, Arabs, Syrians, and Jews, adhering to Mohammedanism, Judaism, and oriental forms of Christianity, compose the population of Asiatic Turkey, supposed to amount to 10,000,000.

XXVIII. RUSSIA IN ASIA.

I. Asiatic Russia includes that vast tract of the continent extending through its entire length under the general name of Siberia, with some dependent islands, and the detached territory of the Caucasian provinces, occupying the isthmus between the Black and Caspian Seas.

Large tracts of land lie off the mouth of the Lena, with the islands of Kotelnoy, Fadeefskoy, and New Siberia, to the north-east in the Arctic Ocean, about 150 miles distant from the nearest points of the main shore. These northern islands had long been visited by the native tribes of Siberia in dog-sledges across the ice of the intervening strait, before their existence was known to the Russian government. They are remarkable for hills 250 or 300 feet high, composed of drift wood, and especially for ivory, which there, in connection with skulls and entire skeletons of elephants, rhinoceroses, bisons, and other extinct species of pachyderms, mysteriously occupies the strata of the frozen soil.

II. Siberia formerly consisted only of a small Tartarian state, on the banks of the Obi and Irtish, which had the town of Siber for its capital. Upon this state falling into the hands of the Russians, they indefinitely extended the name to the whole of their Asiatic conquests eastwards, and included under the same denomination the great Tartarian kingdoms of Astrachan and Kasan in Europe. The name is now confined to the country extending from the Ural Mountains on the west to Behring's Strait and the Pacific Ocean on the east, and from the Chinese empire on the south to the Arctic ocean on the north.

Latitudinal limits.—44° N., western offsets of the Altai Mountains, and 78° N., Cape Severo-Vostochnoi.

Longitudinal limits.—60° E., Ural Mountains, and 170° W., East Cape, Behring's Strait.

Extent.—Upwards of 4000 miles, the extreme length from west to east; 1900 miles, the greatest breadth from north to south; 5,300,000 square miles, the estimated area.

III. The greater part of Siberia consists of an immense and low plain, connected at the south extremity of the Urals with the great plain of Europe. This lowland surface ascends from the shores of the Polar Ocean, but with such a gradual inclination as to be scarcely perceptible. So slight is the elevation, that at the distance of 1000 and 1400 miles in a direct line from the sea the height scarcely exceeds 1200 feet. Treeless steppes, producing only a coarse grass; barren sands, impregnated with salt and overspread with salt lakes; large sluggish rivers, with cultivable tracts along their upper courses; marshes and swamps; and forests of birches, larches, and pines, are prominent among the physical features of this region. Its southern borders are occupied by the highly metalliferous range of the Altai, culminating at the height of 11,063 feet, near the source of the Obi, in the government of Tomsk. This range, with connected ridges, forms a continuous chain of mountains, separating the Russian and Chinese empires. It extends from the basin of the Upper Irtish eastward to the Pacific Ocean at the Sea of Okhotsk, a distance of 2400 miles, and is prolonged north-eastward to Behring's Strait, a distance of about 2000 more, descending southward to the extremity of the peninsula of Kamschatka, a remarkable site of volcanic activity. All the great river-systems of the district have their origin in this chain of mountains,—the Obi with its affluent the Irtish, the Yenessei, Lena, and Kolyma, travelling to the Arctic Ocean; and on its slope lies the crescent-shaped Lake Baikal, near Irkutsk, covering an area of 12,000 square miles.

The majestic peak of Bieloukha, the highest point of the Altai, rises in two horns entirely covered with snow, and perfectly inaccessible. A glacier similar to those in Switzerland, terminated by huge and ancient moraines, gives birth to the River Kutania.

Kamschatka contains 21 volcanoes, more or less active, lining the east coast, one of which has an elevation of 15,763 feet, about the height of Mont Blanc, forming the loftiest volcanic mountain of the Old World.

IV. Northern Siberia, lying within the Polar Circle, is beyond the boundary of the cultivable world. So intense is the cold of its long winter, that according to Gmelin, 72° below zero of Fahrenheit is not very unusual, and it has been known as low as 120° below zero, birds and animals as well as man perishing beneath this terrible temperature. Southwards, through a large area, while the summer thaws the surface soil so as to admit of the vegetable mould being cultivated, the inferior stratum at no great depth remains perpetually frozen, and graves are ordinarily excavated with the aid of fire. In the mildest districts, the reign of winter is still remarkable for its rigour; yet the external world is not without its charms, a highly transparent atmosphere displaying vividly the deep blue sky overhanging the boundless wastes of brilliant snow. Siberia derives importance from vast numbers of land animals of the fur-bearing tribes, immense quantities of fish in the rivers, and marine mammalia along the shores; but especially its mineral treasures constitute it one of the most valuable portions of the Russian dominions.

The layer of permanently frozen soil at Yakutsk has been found to extend 382 feet in vertical depth, but the surface thaws in summer to the depth of about three feet, upon which various kinds of vegetables and grain are raised.

In Southern Siberia the interesting zoological fact occurs of the juxtaposition of a tropical and polar animal. The royal tiger, the very same species which inhabits the tropical regions of India and Ceylon, is found in the Altai Mountains, and advances towards the north in summer, into the country of the reindeer and elk.

The mineral wealth of Siberia was known before its European colonization, as mines have been discovered in the neighbourhood of the Yenessei, worked at some unknown period, by an unknown nation. The tools employed have also been met with, consisting of huge stone hammers, and copper instruments resembling pickaxes and wedges. The minerals found in the Altai Mountains and the adjacent districts include vast quantities of iron and copper, a considerable amount of silver, some gold, with porphyries employed in the arts, celebrated for their variety and beauty, and many precious stones. The mines are worked by the government. At the small town of Kolyva there is an immense establishment for cutting and polishing the pure granites, jaspers, and porphyries of the Altai, which are worked into tables, vases, chimney-pieces, columns, &c., and transferred to Europe. The fine jasper porphyries of Revennaja Sopka (Mountain of Rhubarb) have furnished the imperial palaces of St. Petersburg with candelabra eight feet seven inches high, with columns from ten to twelve and a half feet, and with an elliptical basin eight and a half feet in diameter, and four feet five inches deep. The block of jasper out of which this basin was cut weighed 28,000 pounds, and in 1818 was transported in eight days by 400 workmen across the roughest mountains, to the works at Kolyva. It required three years for cutting the block and polishing the vessel. Notwithstanding the moderate wages of the workmen, it cost the establishment 35,000 francs, without reckoning the expense of carriage to the capital, a distance of 2100 miles.

V. Down to the year 1822, Siberia was exclusively superintended by the Russian military. It then received a civil administration, and was divided into two great provinces with subordinate governments, under the control of Governors-General, residing at Tobolsk and Irkutsk. But a portion of the country near the Urals forms part of the governments of Perm and Orenburg, and is thus included in European Russia.

Provinces.	Governments.
Western Siberia . .	Tobolsk, Tomsk, Omsk.
Eastern Siberia . .	Irkutsk, Yenisseisk, Yakutsk, Okhotsk, Kamschatka, Tschukchi.

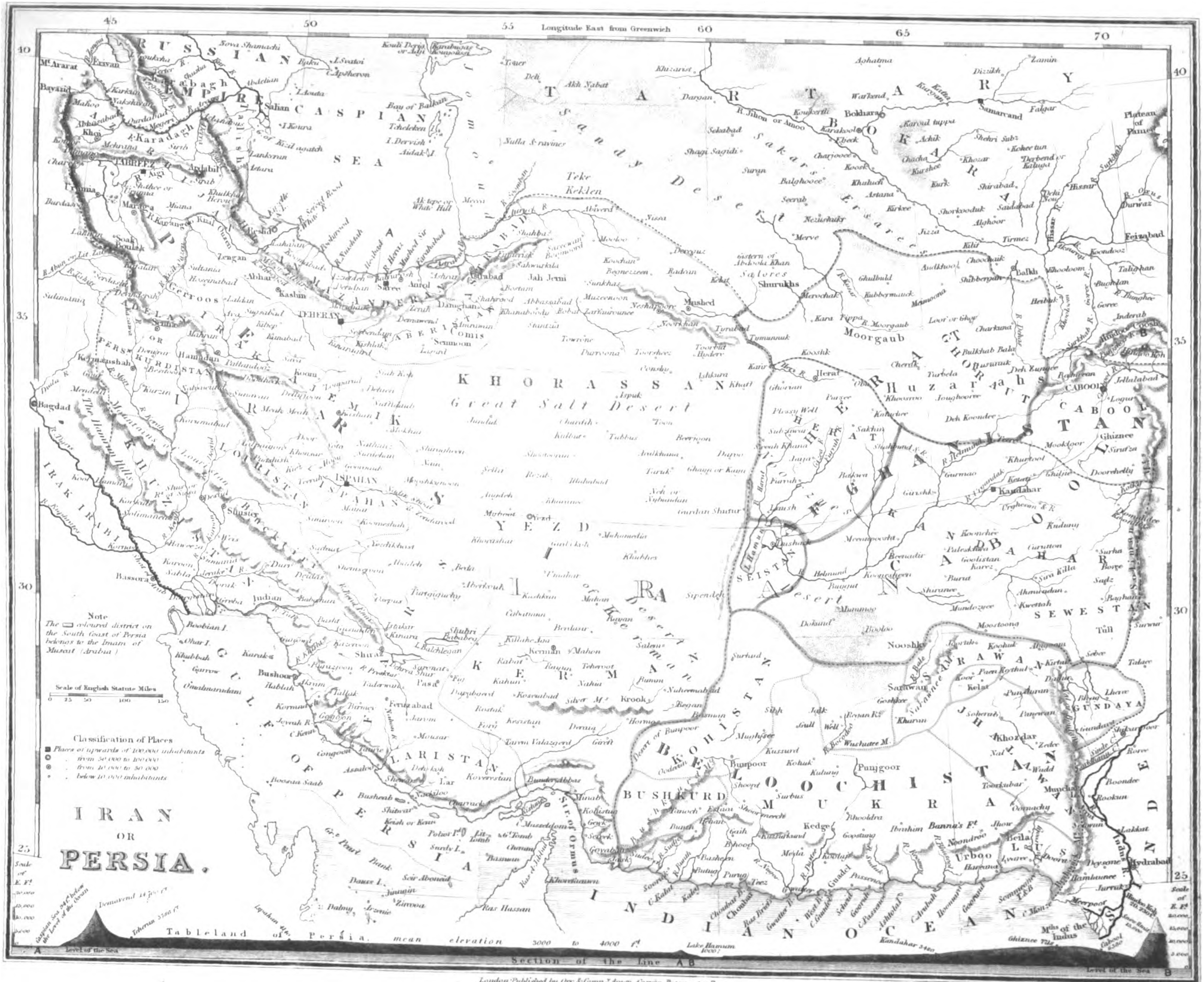
Tobolsk, the capital of the government of that name, and of the province of Western Siberia, situated on the River Irtish at its junction with the Tobol, contains about 20,000 inhabitants. Though 550 miles in a direct line from the Gulf of Obi, the upper part of the town is only 357 feet above the level of the Arctic Ocean, and the lower part but 128 feet. Almost all the houses, the public buildings excepted, are of wood, Europeans of German descent forming a large portion of the population. Irkutsk, the capital of Eastern Siberia, on the Angara, at a short distance from Lake Baikal, contains about 15,000 inhabitants. It is the depôt of the Russian trade with China, the small town of Kiakta, on the border of the two empires, being about 200 miles to the south-east.

The population of Siberia is supposed to amount to 2,000,000, which includes half a million of Europeans or their descendants, mostly belonging to the dominant Russian race, located in the towns. The aboriginal Siberians consist of a great variety of nomadic tribes, subsisting by hunting and fishing, among whom the most important are the Samoiedes, ranging along the coast of the Arctic Ocean; the Ostiaks, on the Obi; the Yakuts, in the lower basin of the Lena; the Tungusians, in the upper basin of the Lena; the Yenisseans, on both banks of the Upper Yenessei; the Tschukchi, Koriats, and Kamschatkans, occupying the extreme north-eastern districts. Some of these tribes, as the ichthyophagi (or fish-eaters) of the north, are in the lowest state of barbarism.

Kamschatkan.

VI. The second section of Asiatic Russia, consisting of the Caucasian provinces, includes a portion of territory north of the Caucasus, belonging to Europe, and extends from that celebrated mountain-chain southward to the frontiers of Asiatic Turkey and Persia. Masses of bold highlands largely occupy the surface, rising in Mount Elburz, the culminating point of the great Caucasian range, to the height of 18,493 feet. The country also comprises rich and well-watered mountain valleys, embellished with cypresses, palms, and plantains, with low and barren plains extending along the Caspian, sandy, saline, or bituminous. Georgia, the principal province, has Tiflis for its capital, seated on the River Kur. It was nearly destroyed by the Persians under Aga Mohammed Khan, at the close of the last century, but has made rapid advances in prosperity and wealth since its occupation by the Russians.

RUSSIA IN ASIA
Longitude East from Greenwich
Classification of Places
Places from 10,000 inhabitants & upwards
10,000 to 5,000 inhabitants
below 5000 inhabitants
ARCTIC OCEAN
EUROPE
TARTARY
CHINESE EMPIRE
AMERICA
Bherings Strait
G. of Anadir
White Sea
Karskoe Sea
Gulf of Obi
New Siberia
Arctic Circle
TCHUKTCHI
KAMTCHATKA
SEA OF OKHOTSK
OKHOTSK
IAKUTSK
IRKUTSK
TOMSK
OMSK
Lake Baikal
Sagalin
Jesso
Sea of Japan
JAPAN ISLANDS
Kurile Is.
Scale of English Statute Miles
Siberian Plain
Altai Mts
Sajan Mts
Nertchinsk Mts 4000 ft
Iablonnoi and Stannovoi Mts 3000 to 3500 ft
Level of the Sea
Section of the Line A B
Drawn & Engraved by J. Dower, Pentonville, London



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XXIX. PERSIA.

I. Under the general name of Persia, the great geographical region is included extending from the basin of the Tigris on the west, to that of the Indus on the east, and from the Indian Ocean on the south, to the Caspian Sea and Turkestan, or Independent Tartary, on the north. This region comprehends Persia Proper, known to its inhabitants as the kingdom of Iran, with Afghanistan and Beloochistan.

II. Persia Proper has for its natural limits, on the south, the Persian Gulf and Indian Ocean; on the west, the Shat-el-Arab, Tigris, and mountains of Kourdistan, forming the frontier towards the Turkish empire; and on the north, the river Araxes, marking the boundary from the Caucasian provinces of Russia, with the Caspian Sea. On the north-east and east, the frontier is a very indefinite line in the deserts extending into Bokhara, Herat, and other states.

Latitudinal limits.—25° 40′ N., coast of the Indian Ocean, and 39° 40° N., the Araxes near Ararat.

Longitudinal limits.—44° E., west border of Azerbijan, and 62° E., east border of Khorassan.

Extent.—About 1250 miles from N.W., Ararat, to S.E., Cape Jask, near the entrance of the strait of Ormus; and 870 miles from S.W., Shat-el-Arab at Bassorah, to N.E., desert beyond Mushed. The area is estimated at 500,000 square miles.

By the treaty of Turkomanshee, Feb. 21, 1828, between Persia and Russia, the boundary-line of their respective territories was drawn from Asiatic Turkey, over the summit of the Little Ararat; from thence to the Araxes, and along the whole middle course of that river, descending southward from it along the Elburz Mountains to the little river Ashtara, which flows into the Caspian at its south-west extremity.

III. A narrow tract of low land lies along the shores of the Persian Gulf, called the Dushistan, or the level country, which the heat and drought of the climate convert into a series of sandy and almost uninhabitable wastes; a few plantations of date trees and patches of cultivation appearing where a scanty rivulet or abundant spring occurs. Approaching the banks of the Shat-el-Arab and the Tigris, this tract becomes more fertile, and was formerly celebrated for its rich productions when a more vigorous race occupied the soil. Similar low grounds mark the borders of the Caspian, on the north, but of a totally different character from those in the south. The atmosphere here is excessively humid, the combined influence of heat and moisture producing the greatest vegetable luxuriance, but rendering the district damp, swampy, and insalubrious. Between the northern and southern lowlands lies a vast extent of country, a plateau region, comprehending nine-tenths of the area of Persia, with a general elevation of from 3,000 to 4,000 feet, ranges of mountains intersecting and bounding the tablelands. Few parts of the globe are more uninviting than these highlands, consisting of extensive salt wastes, and immense seas of sand, heated by the rays of a fervid sun, and blasted with utter barrenness, the monotony of the landscape being only broken by masses of bare rock, enclosing valleys without trees or streams. Almost the whole of Persia answers to this description, the districts where wood, verdure, and streamlets appear still yielding the rich fruits, flowers, roses, and wine, renowned in oriental poetry, constituting only a very small proportion of the country.

Salt lakes form a prominent feature in the physical geography of Persia, which, together with masses of rock-salt, deserts covered with efflorescent salt, and streams impregnated with that substance, evince a remarkable preponderance of the mineral. The great salt lake of Urumiah in Azerbijan, has, according to Colonel Kinneir, a circumference of 300 miles. The country is probably rich in other minerals not developed, owing to the distracted state of society. Iron is known to be abundant; copper has been discovered; lead is by no means scarce; and antimony has been found.

The rivers, apart from the Shat-el-Arab, Tigris, and Araxes, which are frontier streams, are rare and unimportant, losing themselves in the deserts, or entering lakes without outlets, or descending as unnavigable mountain torrents to the Caspian.

The mountains form several noble ranges, of which the great chain of Elburz, branching off from the Caucasus, and sweeping round the southern shores of the Caspian, rises to the height of 14,700 feet in the volcanic Peak of Demavend, the culminating point of Iran.

IV. Persia is distributed into eleven provinces, but their limits are so frequently changing under a despotic and unsettled government as to render a graphical delineation of them very uncertain. Ispahan, the ancient capital, on the banks of the Zendarood, in the province of Irak Ajemi, was formerly one of the most splendid cities of the east, containing nearly a million of inhabitants, proverbially reckoned, according to Persian ideas, as forming "half the world." Though for the most part now in ruins, there are imposing vestiges of its ancient greatness, and a population estimated at 150,000. Teheran, the modern capital, in the northern part of the same province, is much smaller, and situated in a far less attractive locality, with a climate oppressively hot and unhealthy in summer, obliging the people largely to migrate for the season; but has been chosen for the metropolis, owing to its vicinity to the native possessions of the reigning dynasty.

Tabreez, near the lake Urumiah, in Azerbijan; Khoi, to the north-west; Reshd, in Ghilan, near the Caspian; Saree, in Mazanderan; Mushed, in Khorassan; Hamadan, and Casbin, in Irak Ajemi; Shiraz, in Fars; Kerman, in the province of that name; and Bushire, on the Persian Gulf, are the other important cities and towns, comprising from 10,000 to 60,000 inhabitants.

The celebrated ruins of Persepolis are in Fars, thirty-five miles N.E. of Shiraz; the site of Ecbatana, the capital of ancient Media, is near Hamadan; of Susa, one of the ordinary residences of the Medo-Persian kings, the Shushan of Scripture, is identified by Major Rawlinson with the town of Susan, upon the banks of the Kuran, in Khuzistan.

V. The Persians may be considered as forming two great classes, one fixed, and another erratic; the former comprising about 7,000,000 individuals, the latter 2,500,000,—making a total population of 9,500,000. But very little dependence, however, can be placed upon the estimate. The fixed class embraces the inhabitants of the cities, towns, and villages, engaged in various mechanical arts and in agriculture. They are a very mixed race of Turks, Tartars, Armenians, Georgians, and Arabs, grafted on the old Persic stock, cheerful, hospitable, and polite, hence styled the French of the east, but insincere, cunning, and intolerably vain. The erratic class, partially or wholly wandering, dispersed over the greater part of the country, consists of bold and free tribes of various origin,—Arabs, Turks, Kurds, Afghans, and old Persians, whose habits are pastoral, military, and predatory. The existence of these nomadic tribes, separate from the rest of the people, yet moving to and fro among them, rude, quarrelsome, and plundering, strikingly evinces the incapacity of the government, and an insecure social state. The form of government is an unmitigated military despotism; and perhaps in no country are public functionaries more servile, rapacious, and unjust. In religion, the majority of the people are Mohammedans of the Sheah sect; most of the wandering hordes, and some others, belong to the Sonnee division; and Suffees, a kind of Mohammedan freethinkers, are numerous. There are Nestorian and Armenian Christians, many Jews, and a few Guebres, descendants of the ancient fire-worshippers.

The Persians have great aptitude for several industrial occupations. The sword-blades of Mushed are highly esteemed, as well as other works in steel imported from India; and in iron of Russian manufacture, conveyed by mules from the ports on the Caspian. The stone and seal-cutters of Ispahan are famed for their workmanship. Casbin is known for its manufacture of ornamental tiles; Shiraz for its otto of roses; Kerman for its shawls; Khorassan for its carpets. Gold and silver brocade, silks of considerable beauty, camel and goat's hair stuffs, are produced in many parts of the country.

VI. Afghanistan and Beloochistan, to the east of Persia Proper, comprise the governments of Cabool, Herat, and Kelat, each including a number of tribes whose chiefs are more or less independent, often at war with one another, but uniting as policy may dictate. A small portion of Persia, stretching along the shores of the Gulf, belongs to the sultan of Oman, in Arabia, commonly called the Imam of Muscat, who claims the sovereignty of the whole coast of the Indian Ocean from Africa to the Indus.

XXX. PALESTINE, ANCIENT AND MODERN.

I. This country, a portion of the Turkish empire in Asia, is made the subject of a special Map, on account of the deep interest attached to it. It extends from the Mediterranean on the west to the Syrian Desert on the east, and from the Anti-Lebanon on the north to an indefinite line in the desert on the south, nearly coinciding with the parallel of the southern shores of the Dead Sea.

Latitudinal limits.—31° 10′ N., and 33° 28′ N.
Longitudinal limits.—34° 32′ E., and about 36° 35′ E.
Extent.—Greatest length from north to south, about 160 miles; greatest breadth from east to west, about 120 miles.
The ancient distribution of the country at different periods may be stated:

Canaanitish Division.	Israelitish Division.	Roman Division.
Sidonians	Tribe of Ashur (in Libanus)	Upper Galilee.
Unknown	Naphtali (north-west of the Lake of Gennesareth,	
Perizites	Zebulun (west of that lake)	Lower Galilee.
The same	Issachar (Plain of Esdraelon, Mount Tabor)	
Hivites	Half-tribe of Manasseh (Dora and Cesarea)	Samaria.
The same	Ephraim (Shechem, Samaria)	
Jebusites	Benjamin (Jericho, Jerusalem)	Judea.
Amorites, Hittites	Judah (Hebron, Judea Proper)	
Philistines	Simeon (south-west of Judah)—Dan (Joppa)	
Moabites	Reuben (Peræa, Heshbon)	Peræa.
Ammonites, Gilead	Gad (Decapolis, Ammonites)	
Kingdom of Bashan	Half-tribe of Manasseh (Gaulonitis, Batanea)	

II. The physical character of this region is determined by the southern prolongations of the mountains of Lebanon, which extend through it from north to south, and have numerous offsets, inclosing many elevated plains and deep valleys. The eastern branch of the great Syrian chain or Anti-Lebanon, culminates on the northern frontier at the height of 10,000 feet, near the sources of the Jordan. The main trunk here separates into two ranges, which traverse Palestine, bounding between them the valley and lakes of the river through its whole course, the country on both sides being largely occupied with ridges running parallel or transverse. These uplands have a very varying character, being verdant and covered with woods in the north, and consisting only of bare and desolate rocks, full of caverns and frightful precipices, in the south. The Jordan, the principal river, remarkable for its depression below the level of the Mediterranean, forms Lake Merom and the well-known Lake of Tiberias in its flow, discharging into the singular expanse of the Dead Sea. The only other river of any importance is the ancient Kishon, which drains Lower Galilee, and enters the Mediterranean at the base of Carmel.

Mountains.	Height. Feet.	Mountains.	Height. Feet.
Mount Hermon	10,000	Mount of Olives	2,398
„ Carmel	700?	Mountains of Ephraim	2,500
„ Tabor	1,800	„ Judah	3,000
„ Ebal	2,500?	„ Gilead	4,000?
„ Gerizim	2,500	„ Gilboa	1,300

The Jordan has a very tortuous course. Though fordable at many points during the drought of summer, it shows great depth at other seasons, and has a rapid dangerous current, owing to the inclination of its bed. From the Lake of Tiberias to the Dead Sea, it falls 582 feet, in a distance of about 65 miles. Its entire course may be stated at 120 miles, excluding the windings.

The Dead Sea, or Bahr Lut, (the Sea of Lot, as the natives call it,) is the most singular body of water on the face of the globe; occupying a great cavity, its own surface being depressed 1312 feet below the level of the Mediterranean, while its depth amounts in places to near 1000 feet. It holds in solution the greatest proportionate quantity of saline matter of any sheet of water known. Owing to this, its waters have an indescribably nauseous taste, and such specific gravity as not to be readily put in motion by the wind. No fish can live in the lake. Its dimensions are about 45 miles in length by 10 in breadth.

The Lake of Tiberias is 730 feet below the level of the Mediterranean. Its greatest length runs nearly north and south from 12 to 15 miles, and its breadth in general is from 6 to 9 miles.

III. Palestine is distributed between the pashalics of Damascus and Acre, cities without the proper limits of the Holy Land; the principal part of the country belonging to the former province.

Eyalets.	Cities and Towns.
Damascus	El Kuds or Jerusalem, Bethlehem, El Khulil or Hebron, Rayah or Jericho, Nablous or Sichem, Gaza, Ramlah or Rama, Ludd or Lydda, Yafa or Joppa.
Acre	Nazra or Nazareth, Tabaria or Tiberias, Safed.

Jerusalem, in lat. 31° 48′ N., long. 35° 14′ E., occupies a hilly site, 2705 feet above the level of the sea, deep ravines nearly surrounding the city, which has a circumference of upwards of 2¼ miles, and a population estimated at about 30,000. Though intensely interesting to the traveller on account of its historic associations, it is one of the most melancholy places upon the face of the earth, the country in its neighbourhood being little better than a desert; while mean, dirty, ruined buildings characterise the interior, an air of complete desolation investing the whole spot. Turks, Jews, Arabs, Greeks, Armenians, Latins, compose the population, and that of the country at large, the descendants of the ancient race occurring in the greatest numbers at Jerusalem.

Nablous, the next place of importance, has about 10,000 inhabitants; Hebron, Yafa, and Ramlah from 4000 to 5000. Bethlehem ranks as a large village; Nazareth, a poverty-stricken hamlet; and Jericho is represented by a collection of miserable huts.

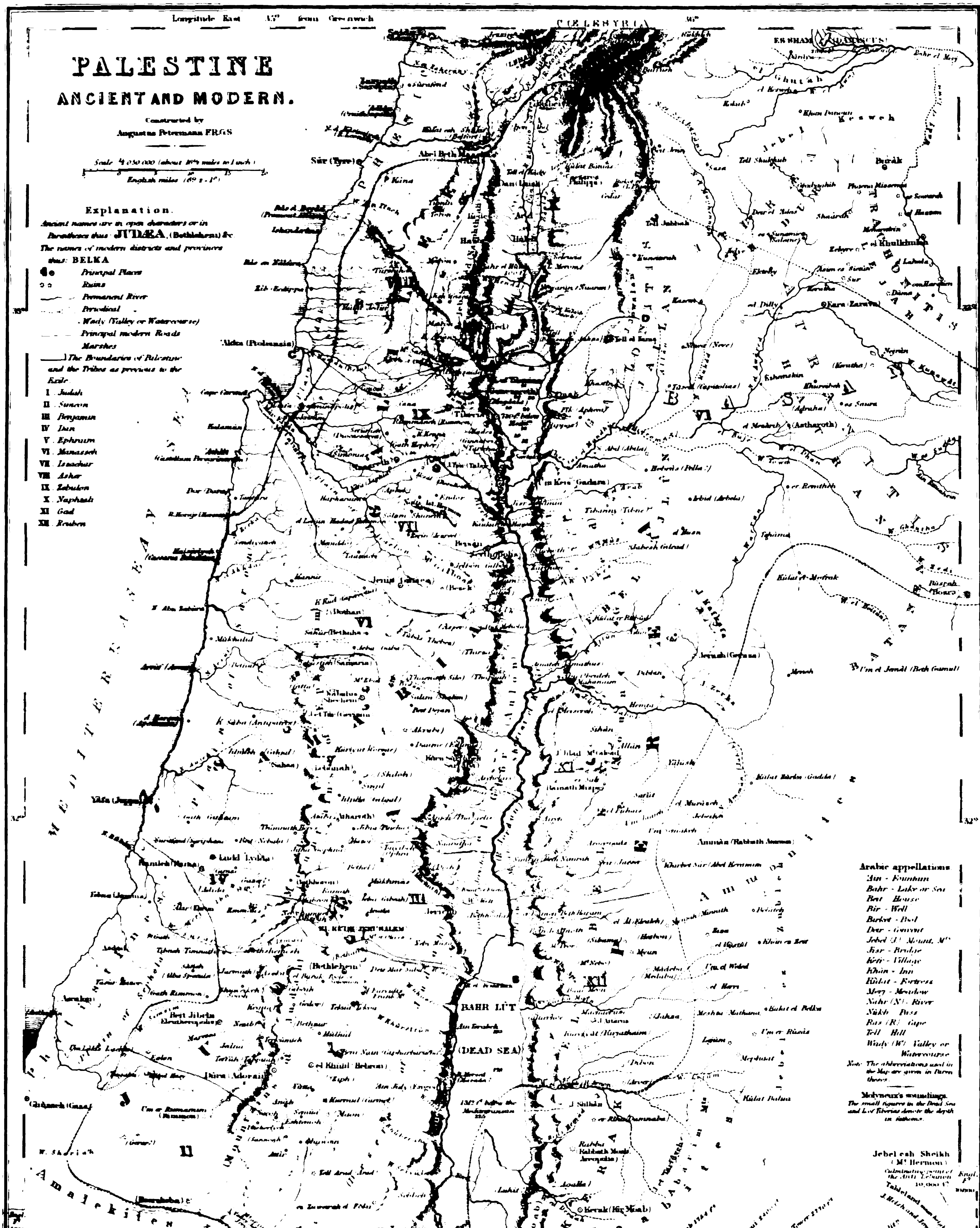
IV. The vine, fig, pomegranate, olive, orange, citron, palm, and terebinth, with various other fruit and forest trees, appear in the vegetation of Palestine; but the palm is no longer a characteristic, surviving only in a few places; and the check which cultivation has long encountered from a wretched government, becoming oppressive to individuals in proportion as the fruits of industry are accumulated, will sufficiently account for any discrepancy that may appear between the present aspect of the country and the historic testimony to its vegetable luxuriance in former times.

XXXI. INDIA.

I. Continental India, the central of the three southern peninsulas of Asia, including the Trans-Gangetic territories of Assam and Aracan, is inclosed by Thibet on the north, part of the Burman empire on the north-east, Afghanistan and Beloochistan on the north-west, the Indian Ocean, with its great arms, the Bay of Bengal and the Arabian Sea, surrounding it in other directions. Separated from the peninsula by a channel about 60 miles wide on the south-south-east, lies the large island of Ceylon, its only extensive insular dependency.

Latitudinal limits.—8° N., Cape Comorin, and 35° N., passage of the Himalayas by the Indus.
Longitudinal limits.—67° E., Soliman Mountains west of the Indus, and 96° E., eastern limits of Assam.
Extent.—Extreme length from the north of Cashmere to Cape Comorin about 1900 miles; extreme breadth from the western border of Sinde to the east extremity of Assam about 1800 miles; area, probably not less than 1,300,000 square miles. The coast line may be roughly estimated at about 3280 miles, of which 1830 miles belong to the Arabian Sea, 1290 to the Bay of Bengal, and about 160 to the Gulf of Manaar and Palk Strait, between the continent and Ceylon. This island has an extreme length of 270 miles from north to south, by an extreme breadth of 145 miles, and a circuit of about 750 miles.

II. India has a well-defined natural boundary on the north, consisting of the Himalaya Mountains and the western prolongation of the Hindoo Koosh, which separate the peninsula from the great mass of Asia. These mountains, the loftiest on the face of the globe, present a succession of immense snow-clad peaks,



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separated by narrow valleys, some of which form passes through which intercourse is maintained between India and Thibet, the routes rising to heights of from 15,000 to 18,000 feet. The greatest elevation above the level of the sea ever attained by human beings on the declivity of this stupendous range is 19,409 feet, or 3600 feet higher than the summit of Mont Blanc, reached by Captain Gerard, with seven barometers, on the mountain of Tarhigang. Secondary highlands traverse the east and west sides of the peninsula, respectively called the Eastern and Western *Ghauts*, a Sanscrit term referring to the narrow passes by which they are crossed, strikingly analogous in its form and meaning to our word "gate." The Eastern Ghauts are the lowest, least continuous, and rise at the greatest distance from the sea, bounding the maritime region of the Lower Carnatic and the northern Circars. The Western Ghauts inclose a very narrow maritime tract extending from the north of Bombay to the south of Calicut, the range culminating near its southern termination at the height of 6055 feet. The two chains converge in the south of the peninsula, and form in the angle between them the table-land of the Upper Mysore and that of Mysore or the Deccan. India comprises an immense extent of lowland, but of a very varying character. East of the lower course of the Indus, and south of the Sutlege, lies the Great Desert, a region of sand assuming in the dry season the aspect of the Sahara, cultivable spots occurring only as oases in the neighbourhood of streams and springs, or where artificial irrigation is supplied. South of the lower terraces of the Himalayas, the vast Gangetic plain exhibits widely different features, the alluvial soil displaying a vigorous vegetation, forming the most fertile, best cultivated, and most thickly inhabited portion of the country.

India is rich in the forms of vegetable and animal life. The luxuriance of vegetation on the Gangetic plain is scarcely equalled in any other part of the globe. Magnificent forests are general, producing teak, extensively used in ship-building, and other species of trees. Gigantic bamboos and palms abound. The cultivated productions include rice, (chiefly, in Bengal, the common food of the people,) cotton, (the common wear), the ordinary cereals, the banana, sugar-cane, and poppy, pepper, indigo, coffee, and tobacco plants, and the tea-plant in Assam.

The more important larger animals are the elephant, wild in the forests and jungles, but generally in a state of domestication; the rhinoceros, principally in Bengal; the tiger, general; the lion, in the northern provinces; the camel, in the north-west desert region; the buffalo, wild and tame, everywhere; the yak, in the higher ranges of the Himalayas; goats and sheep, in Cashmere, celebrated for the fineness of their wool.

Among mineral products, coal occurs in various localities; rock-salt in the north-west; and iron in the Carnatic. Gold, silver, tin, and copper have also been found. Diamonds, rubies, chrysolites, amethysts, and other precious stones, are likewise found in many places. The largest diamond of which we have any knowledge, the famous Koh-ee-Noor, once the property of the Great Mogul, afterwards obtained by Runjeet Singh, and recently acquired by Great Britain through the conquest of the Punjaub, has the form and size of half a hen's egg. It was found in 1550, in the mine of Koloor, on the banks of the Godavery, and weighs 861 grains.

III. The greater part of India is under the immediate or indirect control of the crown of Great Britain. That portion which forms an integral part of the British empire, consists of the three Presidencies of Bengal, Madras, and Bombay, and the island of Ceylon. The Bengal Presidency in the north, embraces nearly the whole basin of the Ganges, that of the lower Brahmapootra, and since the acquisition of the Punjaub, great part of the basin of the middle Indus. It includes the provinces of Bengal Proper, Bahar, Orissa, Assam, Aracan, Agra, Delhi, the Punjaub, and other districts. Calcutta, the capital, and that of all India, in lat. 22° 33′ N., long. 88° 28′ E., is seated on the left bank of the Hoogly River, about a hundred miles from the sea, and probably contains with its suburbs not less than 500,000 inhabitants. The Madras Presidency extends along the east coast, comprising the Carnatic and northern Circars, and embraces on the west coast Malabar and Canara. Madras, the capital on the Coromandel coast in the Lower Carnatic, has upwards of 400,000 inhabitants, including the suburbs. The Bombay Presidency, stretching along the west coast northwards from near Goa, consists of portions of the old provinces of Aurungabad, Beejapoor, Khandeish, and Gujerat, and has now incorporated with it the newly-acquired district of Sinde, on the Lower Indus. Bombay, the capital, on a small rocky island, separated from the main land by a narrow strait, and strongly fortified, has a population approaching to 250,000. The large island of Ceylon, of an oval form, traversed by finely wooded mountains, and watered by numerous streams, abounds in useful minerals and valuable gems, and is the principal district for the growth of cinnamon. Columbo, the capital, on the south-west coast, contains about 60,000 inhabitants.

	Estimated area. Square miles.	Population.
Presidency of Bengal, including Assam, Aracan, and the Punjaub	411,894	51,571,000
Presidency of Madras	121,982	15,090,000
„ Bombay, including Sinde	102,542	10,940,000
Ceylon	24,664	1,250,000
	661,082	88,851,000

The three Presidencies are the possessions of the East India Company. The executive government in each is administered by a Governor appointed by the Court of Directors, subject to the approval of the Crown, the Governor of Bengal being also the Governor-General of India. The Directors are checked in the exercise of their powers by the Board of Control, the members of which are appointed by the Government and responsible to the British Parliament. In fact, the President of the Board of Control is a Secretary of State for the affairs of India, governing by means of the Court of Directors.

Ceylon is not a possession of the East India Company, but directly subject to the home government of Great Britain.

TRAVELLING DISTANCES FROM CALCUTTA:

	Miles.		Miles.		Miles.
To Agra	839	To Cabool	1761	To Monghir	275
Allahabad	544	Candahar	1781	Mooltan	1450
Ahmedabad	1234	Cheitore	1063	Moorshedabad	118
Ahmednuggar	1119	Cape Comorin	1470	Mysore	1178
Aracan	475	Dacca	177	Nagpore	722
Arcot	1070	Delhi	956	Nagpore (Little)	280
Ava	1150	Ganjam	369	Oude	562
Bahar	297	Gwalior	805	Patna	340
Balasore	141	Hydrabad	902	Pondicherry	1130
Baroach	1220	Juggernauth	311	Poonah	1208
Bareilly	805	Lahore	1342	Seringapatam	1170
Bednore	1290	Lucknow	649	Surat	1238
Benares	460	Madras	1030	Tanjore	1235
Bombay	1301	Mirzapore	493	Trichinopoly	1238
Buxar	408				

IV. The remainder of the peninsula is divided between states left to the rule of native princes, but completely under British influence, either directly controlled in their internal affairs as vassals, or subsidiary in their general policy, as the price of British protection; and a few native governments, which may still be considered as independent, or nearly so; with the small territories of the French, Danes, and Portuguese.

The principal vassal and protected states are the kingdom of Hydrabad, occupying the middle portion of the table-land of the Deccan, capital Hydrabad, a densely inhabited, but notoriously vile city; the kingdom of Nagpoor, north of Hydrabad, capital Nagpoor, on an affluent of the Godavery; the kingdom of Oude, in northern India, on the left of the Ganges, capital Lucknow, on one of its tributaries; the kingdom of Baroda, in Gujerat, capital Baroda, near the head of the Gulf of Cambay; the Mahratta states, on the western side of the peninsula, chief towns, Sattara and Bejapoor; the district of Travancore, north of Cape Comorin, on the coast of Malabar, capital Trivandrum; and Holkar's Territory, intersected by the Nerbudda river, on its passage to the Gulf of Cambay, capital Indore.

The independent states are the kingdom of Nepaul, on the central Sub-Himalayas, extending from the main chain to the Bengal Presidency and Oude, capital Khatmandu; Bhotan, on the eastern Sub-Himalayas, governed by a rajah, tributary to the Grand Lama of Thibet, summer capital, Tassisudon; and Scindia, in central India, capital Gwalior, remarkable for its strong fortress.

In India, the French possess a few small detached districts forming the single government of Pondicherry, a city on the Coromandel coast; the Danes have a settlement at Tranquebar, a seaport town to the south of Pondicherry; and the Portuguese retain Goa on the west coast, and a settlement in Gujerat, with the small adjacent island of Diu.

V. The total population of India probably amounts to 130,000,000, the vast majority being the aborigines, or Hindoos, who are divided into an immense number of tribes, differing in complexion and manners, and speaking not less than thirty distinct languages, of which twenty-four are derived from the Sanscrit, and six belong to an entirely different family. Besides the aborigines, the Asiatic foreign settlers form a considerable body, consisting of Arabs, Jews, Syrian Christians, and Parsees in the west, with many Afghans in the north, who came in the train of the conquerors of northern India from beyond the Indus. The Europeans include the descendants of the Portuguese, a somewhat numerous class on the west coast, a few French and Danes, the politically dominant British race, very unimportant in point of numbers, and the Anglo-Indians, of mixed British and Hindoo descent.

XXXII. BURMAN EMPIRE.

I. **The** south-eastern peninsula of Asia, containing the southern extremity of the continent, extends from the eastern Himalayas on the north, between the Bay of Bengal on the west, and the Chinese Sea on the east, terminating in the long and narrow peninsular projection of Malacca on the south, within a short distance of the equator.

Latitudinal limits.—1° 20′ N., Cape Romania near Singapore, and 27° 20′ N., Burman border towards Thibet.

Longitudinal limits.—91° E., Burman border towards the lower Brahmapootra, and 109° 20′, Cape Pagoda, east Coast of Anam.

Extent.—About 1800 miles, extreme length from north to south, by an extreme breadth of 800 miles, following the parallel of 20°, the breadth of the Malayan peninsula contracting to 60 miles in the narrowest part. The area comprises between 500,000 and 600,000 square miles.

II. The interior of the country is very little known. It appears to be traversed longitudinally by chains of mountains, which divide the surface into several great valleys, each drained and watered by a grand river-system, that of the Cambodia eastward, flowing into the Chinese Sea, the Meinam central, entering the Gulf of Siam, and the Irawaddy westward, discharging into the Bay of Bengal. The animal, vegetable, and mineral productions correspond in general to those of India; but the people are physically and mentally inferior to the Hindoos, and addicted to habits calculated to keep them low in the scale of civilization. The territory is politically distributed as follows:

States.	Population.	Capitals.
Burman Empire	8,000,000	Ava.
Kingdom of Siam	2,700,000	Bankok.
Empire of Anam	10,000,000	Hue.
Country of the Laos	Unknown.	Saynymal.
British Possessions, continental and insular:		
Provinces of Yep, Tavoy, Mergui, and Tenasserim	112,400	Moulmeyn.
Penang (Betelnut Island); or, Prince of Wales' Island, with Wellesley Province, on the adjoining mainland	90,000	Georgetown.
Territory of Malacca	34,000	Malacca.
Island of Singapore	28,000	Singapore.
Malaya	300,000	
	21,264,400	

Of the British possessions, the provinces above-mentioned were ceded to Great Britain, by the Burmese, in the year 1826. They extend along the west coast upwards of 400 miles, but are very narrow, the area being about equal to that of Ireland. Penang, or the Prince of Wales's Island, and the district on the opposite main shore, are possessions of the East India Company, for which an annual acknowledgment is paid to one of the Malay rajahs. The territory of Malacca, about the size of Leicestershire, was obtained from the Dutch, in 1825, in exchange for Bencoolen, in Sumatra; and the island of Singapore was taken possession of by Sir Stamford Raffles, in 1818. Penang, Malacca, and Singapore, are highly important stations, completely commanding, in the centre and at either entrance, the great northern route between India and China, through the strait between Sumatra and the continent.

XXXIII. CHINA AND JAPAN.

I. **China Proper**, the principal part of the Chinese empire, is situated on the borders of the Pacific Ocean in the east of Asia, bounded inland by the countries which are dependant upon it, except on the south-west, where it meets the territories of Burmah and Anam.

Latitudinal limits.—18° N., including the island of Hainan, and 41° N., frontier towards Mongolia.

Longitudinal limits.—98° E., border towards the Burman empire, and 123° E., coast of the Pacific, near the island of Chusan.

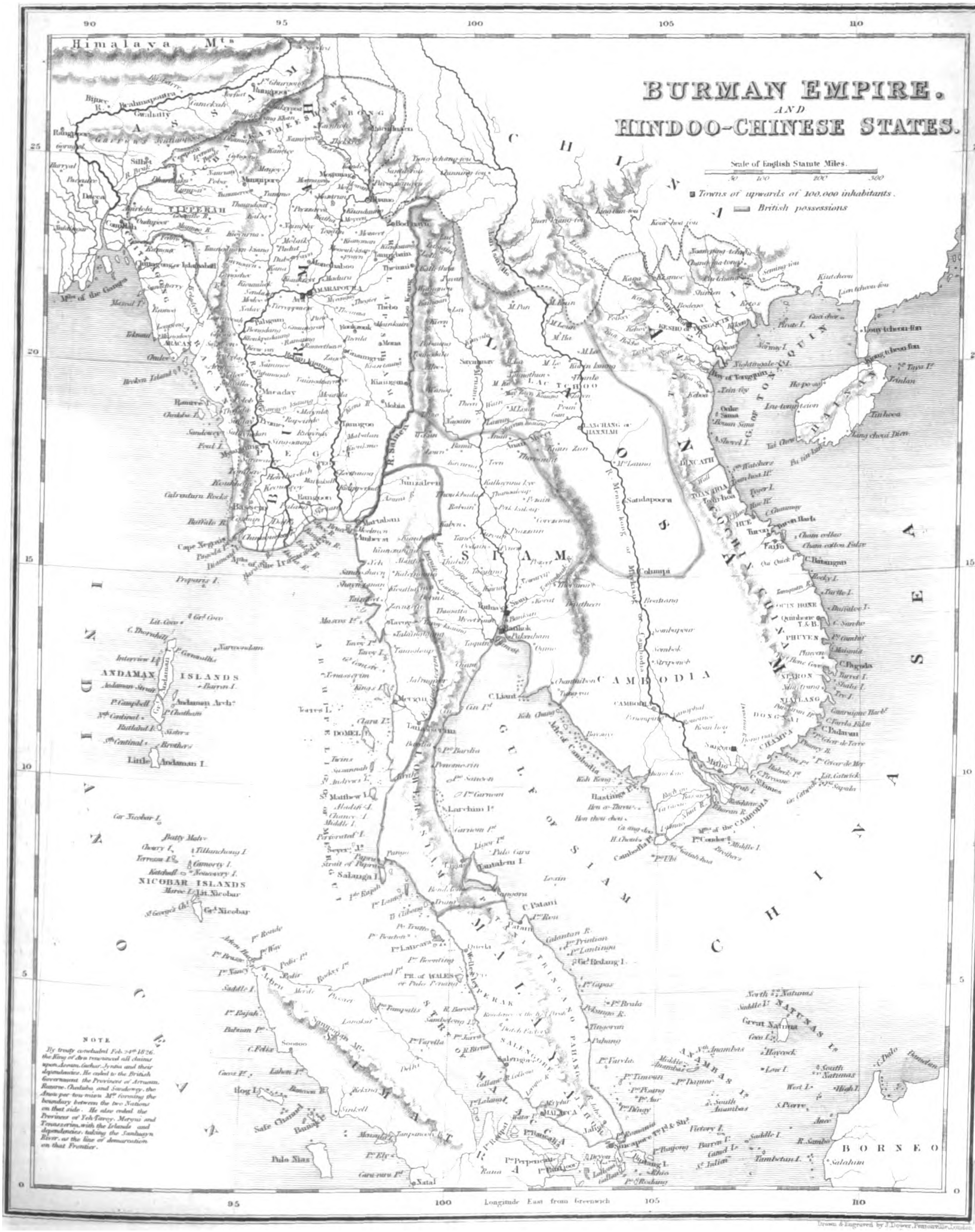
Extent.—Greatest length from north to south, about 1450 miles; greatest breadth from east to west, 1200 miles; area probably not less than 1,298,000 square miles, nearly equal to one-third the area of Europe.

II. The country on the north-east, extending along the coast from Pekin to below Nankin, and stretching far inland, is an immense alluvial plain, equal to the whole extent of France. It is traversed by two of the greatest rivers of the globe, possesses an extensive system of canals, exhibits the most active internal navigation, enjoys a temperate climate, and presents an advanced state of agriculture, forming, perhaps, the richest and most populous granary in the whole world. The western and south-western districts are mountainous, occupied by ranges running generally from west to east, apparently oriental prolongations of the highlands of central Asia, variously extending towards the Pacific. The two great rivers are the Yang-tse-kiang (River of the Son of the Ocean), and the Hoang-ho, or Yellow River, remarkable for taking their rise not far remote from each other in Thibet, separating to a distance of near 1000 miles, and approximating again in the lower part of their course, entering the ocean very little more than 100 miles apart. These rivers are connected by the Imperial or Grand Canal.

The Grand Canal extends from north to south through the great Chinese lowland, facilitating communication between the northern and southern provinces, besides answering the purposes of drainage and irrigation in swampy and dry districts. Cut through a generally level surface of light alluvial soil, its construction required little mechanical ingenuity, but involved vast labour, as it is sufficiently broad and deep to accommodate a vast traffic by vessels of considerable burden. It is, however, carried in places across rising grounds by excavations, and over depressions by artificial mounds and locks. From Hang-Tchou, where the canal commences on the south, to the town of Lintchin, where it terminates on the north, falling into the river-system connected with Pekin, the distance in a straight line exceeds 500 miles, and probably its whole length amounts to 700. The southern portion of this great work was executed in the seventh or eighth century, but the northern part was made in the thirteenth, by Kublai Khan and his successors, when the Tartar dynasty removed the imperial residence from Nankin to Pekin.

Another remarkable industrial work of the Chinese is the Great Wall, which incloses the country on the north, and was constructed about two centuries before the Christian era, in order to protect the frontier from the incursions of the Tartars. It extends through nearly 19° of longitude from the shore of the Yellow Sea westward, over mountains and rivers, through a distance of nearly 1,500 miles, ending amid nearly impassable rocks and extensive deserts. The wall consists of an embankment of earth, raised upon a basis of stone, and cased with stones or bricks, with towers and gates at intervals, strongly fortified and garrisoned. The height varies; but may average 20 feet, the thickness at the base amounting to 25 feet. Many parts of it are now in ruins.

III. China is distributed into eighteen provinces, the eastern and north-eastern being the most densely inhabited. The population, according to the native census, exceeds 350,000,000,—or more than a third of the whole human race, taking the highest estimate made of the population of the globe; and Europeans, who have had the best opportunities of forming a judgment upon the subject, do not consider the return to involve any important exaggeration. The government is a pure form of despotism, but not oppressively administered. No people are more remarkable for industry and ingenuity in all that relates to the sustenance of life, and its conveniences; and in no country is so large a proportion of the surface made available for the production of food, rice-fields characterising the southern provinces, and ordinary corn-fields the northern. The



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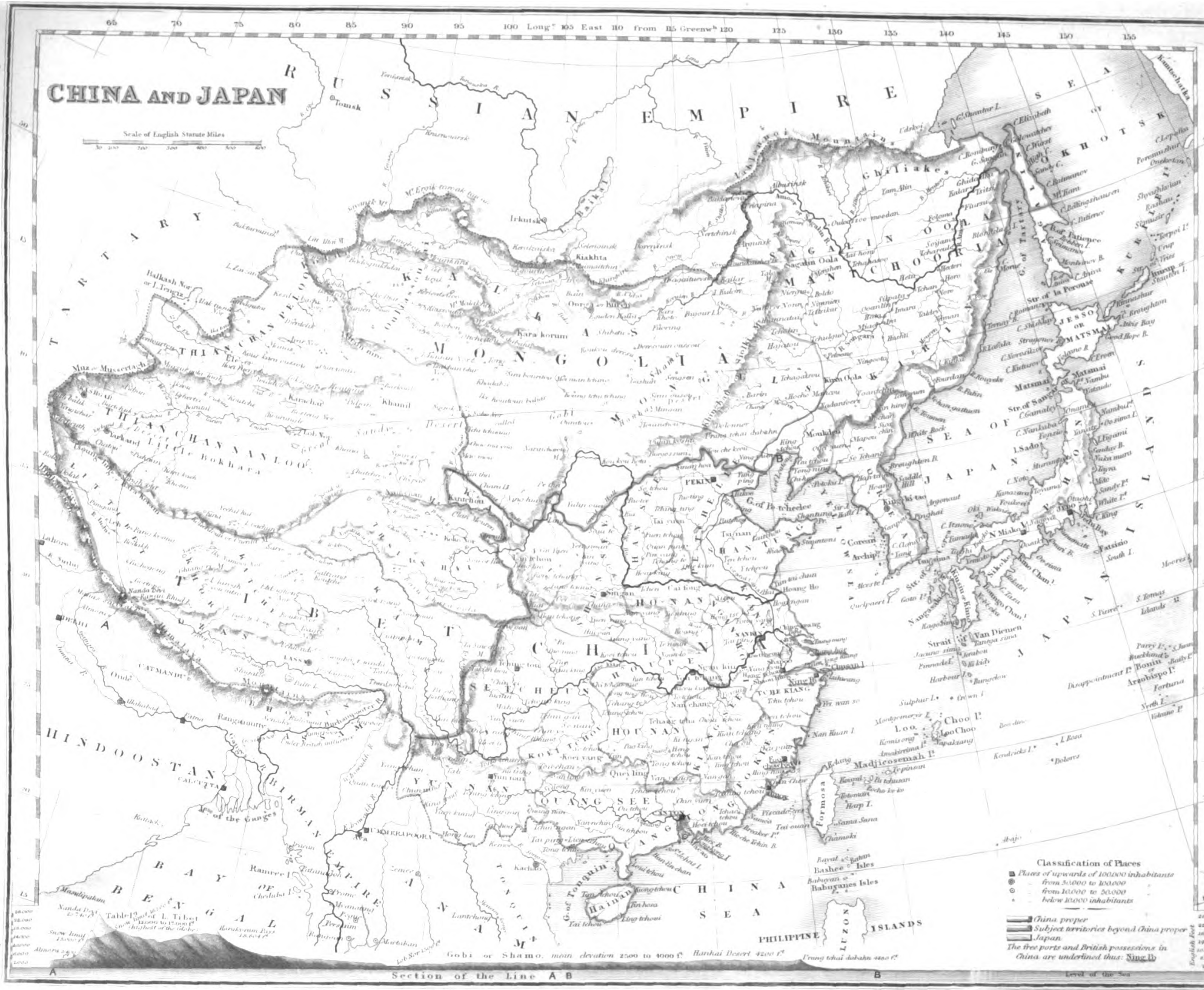
CHINA AND JAPAN
Scale of English Statute Miles
Long.e 105 East 110 from 115 Greenw.h
RUSSIAN EMPIRE
TARTARY
MONGOLIA
MANTCHOORIA
SEA OF OKHOTSK
SEA OF JAPAN
JAPAN ISLANDS
CHINA
CHINA SEA
TIBET
HINDOOSTAN
BIRMAN EMPIRE
BAY OF BENGAL
PEKIN
CANTON
CALCUTTA
Formosa
LUZON
PHILIPPINE ISLANDS
Classification of Places
Places of upwards of 100,000 inhabitants
from 50,000 to 100,000
from 10,000 to 50,000
below 10,000 inhabitants
China proper
Subject territories beyond China proper
Japan
The free ports and British possessions in China are underlined thus: Ning Po
Gobi or Shamo, mean elevation 2500 to 4000 f.t
Section of the Line A B
Level of the Sea
Drawn & Engraved by J. Dower Pentonville, London

Chinese are admirable cultivators. They excel in the execution of almost all ornamental works, embroidery, dyeing, and varnishing, carving in wood and ivory, the lapidary art, and the manufacture of paper, porcelains, silks, and cloths. An extensive commerce is carried on by land with Anam, Burmah, Thibet, and Asiatic Russia; by sea with Japan and the neighbouring islands; and with Europe and America through the vessels of maritime nations, chiefly those of Great Britain and the United States. The chief imports are opium, raw cotton, cotton and woollen goods, and furs; the most important exports are teas, raw and spun silk, and porcelain. Pekin, the capital, in lat. 39° 42′ N., long. 116° 30′ E., about twenty-six miles from the great wall, occupies an immense area, and is supposed to comprise within its walls a population not far short of 2,000,000.

The tea-plant is the most important vegetable production of China. It grows about five feet high, is characterised by narrow leaves indented at the edges, and blossoms from October to January. Specimens from the black and green tea districts differ slightly in the form and colour of the leaf, though either black or green tea may be prepared from any tea-plant. The cultivation is chiefly conducted on elevated grounds. It prevails in various parts of the country; but the principal green tea district, according to Dr. Abel, is in Kiang-nan, between 29° and 31° N. lat., at the north-west base of a ridge of mountains dividing the province from that of Tche-kiang; the black tea district being in Fokien, between 27° and 28° N. lat., on the slopes of a range separating the province from that of Kiang-see. Russia takes annually about 6,000,000lbs. of tea, transported by caravans across the deserts of Mongolia; Holland 3,000,000lbs.; America, 10,000,000lbs.; more than twice the whole quantity being shipped to Great Britain. The amount in 1847 was 55,626,765lbs., of which 46,324,298lbs., were entered for home consumption.

By treaty with China, in 1842, the island of Hong-Kong was ceded to Great Britain, and five ports, Canton, Amoy, Foo-chow-foo, Ning-po, and Shang-hae, were opened to British trade. Hong-Kong, off the mouth of the Canton river, has a circuit of about 15 miles.

IV. The subject territories of the empire far exceed in extent the area of China Proper, inclosing it on the north, and nearly so on the west. They stretch northwards to the Altai chain, which forms the boundary from Asiatic Russia, and westward to the great mountain nucleus of Central or High Asia, comprising a vast extent of desert country, sandy, stony, dreary, and desolate, only occasionally crossed by trading caravans, or visited by wandering Mongol and Tartar hordes. European acquaintance with these regions is very imperfect; but the principal districts may be indicated.

1. Corea, a peninsula projecting between the Yellow and Japanese seas, the seat of a separate kingdom, acknowledging dependance upon the Court of Pekin by an annual tribute; capital, King-ki-tao.

2. Mantchooria, north of Corea, the country of the Mantchews, the original seat of the imperial family of China; capital, Kirin Oola, residence of a Chinese viceroy.

3. Mongolia, north of China Proper, occupied by the great desert of Gobi, or Shamo, an elevated table-land, thinly inhabited by nomadic tribes of Mongols, Kalmucks, and Khalkas; chief town, Oorga.

4. Thian-chan-pe-lou, and Thian-chan-nan-loo, or the country north and south of the Thian-chan (Celestial Mountains), the latter sometimes called Little Bokhara, both westward of Mongolia; chief towns, Kashgar and Yarkand, residence of the Chinese military governor at Aksou.

5. The Thibets, high plateau regions, separated from India by the Himalayas, under a spiritual sovereign, the Grand or Dalai lama, who resides at Lassa.

V. Japan, an independent empire of insular Asia, consists of four large islands, and many minor islets on the north-east of China Proper. Niphon, the largest island, more extensive than Great Britain, contains the capital, Jeddo, on the south-east coast. In no part of the globe is intercourse with foreigners more rigorously restricted, the Chinese and Dutch alone being permitted to trade in the harbour of Nangasaki, while the laws limit the number of vessels, and define the kind and quantity of their cargoes. The islands are supposed to be thickly inhabited, and the people are known to excel in agriculture, horticulture, and various mechanical arts. The process of japanning received its name from Japan, from whence articles highly varnished and ornamented with figured work were first brought to Europe.

XXXIV. AFRICA.

I. Africa, nearly separated from the mass of the Old World by the projection of the Red Sea towards the Mediterranean, forms an enormous peninsula of the eastern continent, attached to it by the narrow Isthmus of Suez, very closely approaching Europe at the Strait of Gibraltar, and Asia at the Strait of Bab-el-Mandeb.

Latitudinal limits.—37° 20′ N., Cape near Bizerta, Tunis, and 34° 50′ S., Cape Lagullas.

Longitudinal limits.—17° 32′ W., Cape Verd, and 51° 22′ E., Cape Guardafui.

Extent.—Greatest length from north to south, about 5,000 miles; greatest breadth, 4,600; area, estimated at 11,870,000 square miles; coast line, 16,048 miles.

II. This great division of the globe is remarkable for its compact mass, not a single opening of any importance occurring on the coast, a conformation which has contributed to keep the interior comparatively unknown. It is the hottest and driest region of the earth, an immense proportion of the surface being within the limits of the torrid zone, and all the remainder immediately tropical. It presents, therefore, the greatest extent of desert country, though its vegetable luxuriance can scarcely be surpassed where sufficient moisture combines its influence with that of heat, and its zoology is eminently rich in the higher forms of animal life. Africa, as at present known, has its culminating point in Abba Jared, at the height of 15,200 feet, one of the summits that rise from the plateau of Abyssinia. The Atlas range traversing the Barbary States, the mountains of Kong, bounding on the north the countries of the Guinea coast, and those of the Cape colony, are the other principal elevations of the surface correctly ascertained; though it seems almost certain that central Africa, from the equator southwards, consists of elevated table-lands rising by terraces from the shores on either hand. Besides the Nile, no stream of any magnitude flows northward to the Mediterranean; and on the western side, connected with the Atlantic, the Senegal, Gambia, Quorra (Niger of the ancients, Joliba of Park), Zaire, and Gariep, are mostly inferior to the great northern river, and all except the Gariep are very little known in the upper parts of their course. A considerable number of streams occur on the eastern side, but none of sufficient consequence to require remark. The broad belt of desert, or the Sahara, extending from the neighbourhood of the Atlantic, to the basin of the Nile, interrupted by a few oases around wells and springs, is the most prominent feature in the physiognomy of the African continent. It has either a surface of bare rock, stones, and hard clay, or a soil of gravel and fine sand, every breath of wind shifting the position of the sandy particles, and really changing the outline of the superficies without altering its desert aspect.

The principal islands in the African seas are as follows:

In the North Atlantic Ocean,—The Madeiras, consisting of Madeira, Porto Santo, and the rocky islets of the Dezertas; and the Cape Verd Group, both belonging to Portugal. The Archipelago of the Canaries, in the possession of Spain, Fernando Po, Pinces Island, and St. Thomas, in the Gulf of Guinea.

In the South Atlantic Ocean—St. Helena, Ascension, and the three small islands of Tristran d'Acunha, belonging to Great Britain, St. Matthew and Annabon.

In the Indian Ocean—Bourbon and Rodriguez, belonging to France; the Mauritius, the Seychelles, Amirante Isles, and Socotra, belonging to Great Britain; Madagascar, one of the largest islands of the globe, exceeding the area of France, under native government; the Comoro Group, in the Mozambique Channel.

III. The vegetation of northern Africa corresponds to that of the extreme south of Europe. The date-palm is characteristic of the Sahara, growing in the oases, and along the margin of the desert, a portion of which has received the name of Biledulgerid, the land of dates. The coffee-plant grows wild in Abyssinia, its native site. Coppices of mimosas, thickets of the prickly pear, and numerous kinds of cassias, the leaves of some of which form senna, abound in Upper Egypt. A magnificent vegetation appears in Senegambia and the adjoining districts. Forests of acacia yielding gum arabic, masses of the unwieldy boabab, huge cotton-trees, and tall gramineous plants, distinguish the landscape. In the south, towards the Cape, there is a very peculiar botany, consisting of endless species of heaths and geraniums. The zoology of Africa is remarkable for the number of its ruminants,—principally antelopes, ferocious and large quadrupeds, and the extraordinary animal which makes the nearest approach to the organization of man, the chimpanzee.

The mammalia peculiar to Africa comprise the following number of species:

Quadrumana	48
Cheiroptera	26
Carnivora	52
Rodentia	38
Edentata	3
Pachydermata	12
Ruminantia	63
Cetacea	8
	250

IV. Sixty millions of people, at the lowest estimate, are supposed to inhabit Africa, divided into an immense number of tribes, largely out of the pale of the most ordinary civilization, and comprising, in the Bushmen of the south, some of the most degraded specimens of the human family. The north Africans, generally above the parallel of 20°, Moors, Berbers, Arabs, Copts, and Abyssinians, belong to the Syro-Arabic or Semitic branch of the Iranian (Caucasian) nations. South of the parallel to the borders of the Cape colony, the negro races, distinctive of the continent, appear, the variety being most conspicuous in the tribes of Senegambia, Soudan, and the Guinea Coast. In the extreme south, the Hottentots and Bushmen exhibit a different physical conformation, and are classed as a distinct variety of mankind, most resembling the type of the North Asiatics.

Malte Brun estimates the Africans at 70,000,000, and other authorities raise the number very considerably higher still.

V. The more important districts of the continent, not included in the special maps, are the Barbary States, Senegambia, Guinea, and Soudan. The Barbary States extend from the borders of Egypt along the north coast to the Atlantic, having very indefinite inland limits. They consist of Morocco, at the north-west corner, an empire under despotic sway, stretching from Cape Nun on the Atlantic to the Mediterranean river Moolonia; Algeria, a province of France, extending eastward from the preceding territory to the river Zaine; Tunis, the smallest of the states, occupying the territory of Ancient Carthage, between the Zaine and the Gulf of Cabes, subject to an independent hereditary bey; and Tripoli, with Barca, extending from the Tunisian territory to the frontier of Egypt, a province of the Turkish empire. Senegambia, consisting principally of the basins of the Senegal and the Gambia, and Guinea, extending along the coast eastward to the Bight of Biafra, are held by a great number of petty negro tribes with the powerful Ashantee State, several of the European nations having maritime stations and settlements. Soudan, or Nigritia, the Negroland of the Arabs, is the great inland region stretching from Senegambia on the west to the east of Lake Tchad, the sultans of Sackatoo and Bornou being the predominating powers. Wars are almost constant in this district, not for the purpose of acquiring territory, but making prisoners, to be disposed of as slaves to Trans-Atlantic masters.

XXXV. SOUTH AFRICA.

I. South Africa, strictly speaking, is the proper designation of that portion of the continent which lies south of the Equator; or, in a less restricted sense, it denotes the country below the southern tropic. With the northern part of this region we are only very imperfectly acquainted; and as the phrase is commonly used with a still more confined meaning, in relation to the extreme south under European government, attention will be limited to the Cape Colony and Port Natal possessions of Great Britain.

The Cape of Good Hope, the south-western point of Africa, was discovered by the Portuguese. The colony was founded by the Dutch in 1650, and continued in their possession until 1795, when it was taken by the English. At the peace of Amiens, in 1802, it was restored to the Dutch; but retaken by the English in 1806, and confirmed to them at the peace in 1814.

II. The limits of the Cape Colony, variously extended from time to time, now include the country stretching from the south extremity of the continent, Cape Lagullas, northwards to the Gariep or Orange River, through about 6° of latitude; and from the Atlantic in the west, to the Key River on the east, the boundary between British Kaffraria and Kafferland, through 10° of longitude. The space thus indicated comprises nearly twice the extent of surface in the mother country; but a very large proportion of it, lying along the Gariep, is only nominally included in the colonial territory. The interior exhibits a succession of terraces or elevated plains, rising one above another, divided by chains of mountains. In the district of Graffreynet, the most inland and highest range, which takes the names of Roggeveld Bergen, Winter Bergen, and Sneew Bergen, in different parts of its course, attains the height of 7500 feet, but has its culminating point in Kafferland. Sandy tracks, altogether sterile or thinly clothed with tufted grass and low brushwood, are numerous and extensive, inhabited by herds of buffaloes, antelopes, zebras, quaggas, gnus, and other wild animals; but many parts of the territory are finely watered, fertile in pasturage, and, under cultivation, produce excellent corn and fruits, which, with wool, are the staple products of the colony, exported to a considerable amount. Cape Town, the capital, in lat. 33° 55′ S., long. 18° 21′ E., on the shore of Table Bay, and at the foot of Table Mountain, conveniently situated for vessels sailing to and from the East Indies to obtain supplies, contains about 20,000 inhabitants. Table Mountain, a granitic mass, surmounted with red sandstone, rises 3672 feet, and forms a very remarkable object, resembling a gigantic altar, occasionally covered with white fleecy clouds, called the Tablecloth.

The colony is divided into two provinces, the western and eastern, each being subdivided into districts. The executive government is administered by a governor, who resides at Capetown; subordinate to whom is a Lieutenant-governor, who has charge of the eastern province, and resides at Grahamstown, in the district of Albany, 650 miles east of Capetown. The districts have each a civil commissioner, or superior resident magistrate, and are distributed into smaller divisions superintended by veld-cornets, or petty magistrates. The population, under 200,000, consists of the aborigines, various tribes of Hottentots and Caffers; the Dutch, descended from the original settlers, commonly termed boors; the Africanders, their descendants by native or other foreign women, formerly slaves; the British; and the other emancipated slaves, negroes, and Malays.

III. The settlement of Port Natal or Victoria, a detached district on the east coast separated from the Cape Colony by a portion of Kafferland, was commenced by a number of Dutch boors, at a comparatively recent period, and is now a regularly constituted colonial possession of the British crown, under the charge of a Lieutenant-Governor. It contains an area of 18,000 square miles, with capabilities for agricultural and grazing-purposes of the highest class, wanting only an intelligent white population to develope its resources. Water abounds in every part, and flowing streams cross the path at intervals of only a few miles. The soil is fertile, and on the alluvial lands near the rivers much larger crops are yielded than are produced in the Cape Colony. Coal occurs; and iron ore is found in great abundance. A considerable emigration is now in process to this district. Natal received its name from Vasco di Gama, who discovered the coast on Christmas day, 1497, the day of the Nativity.

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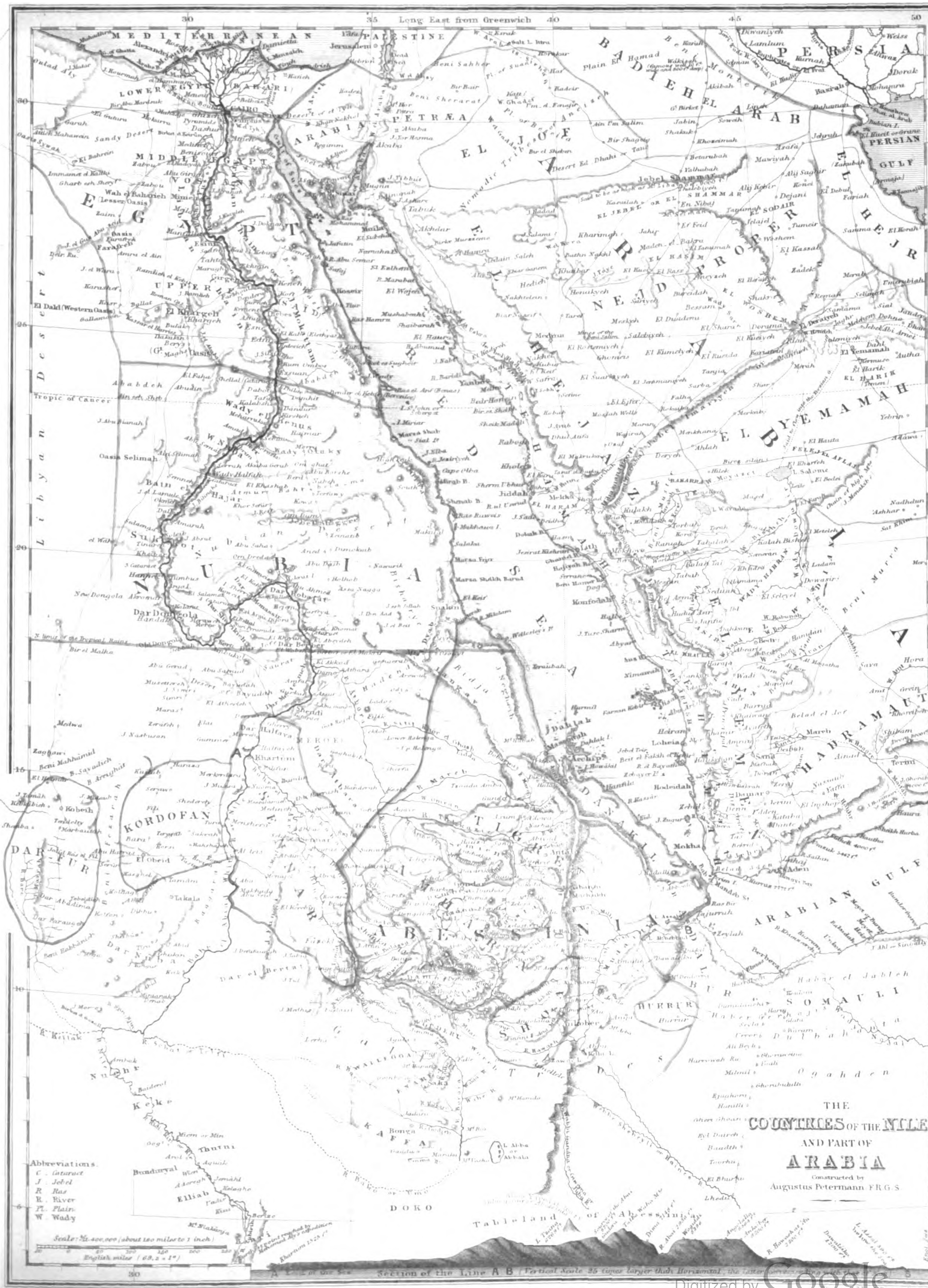

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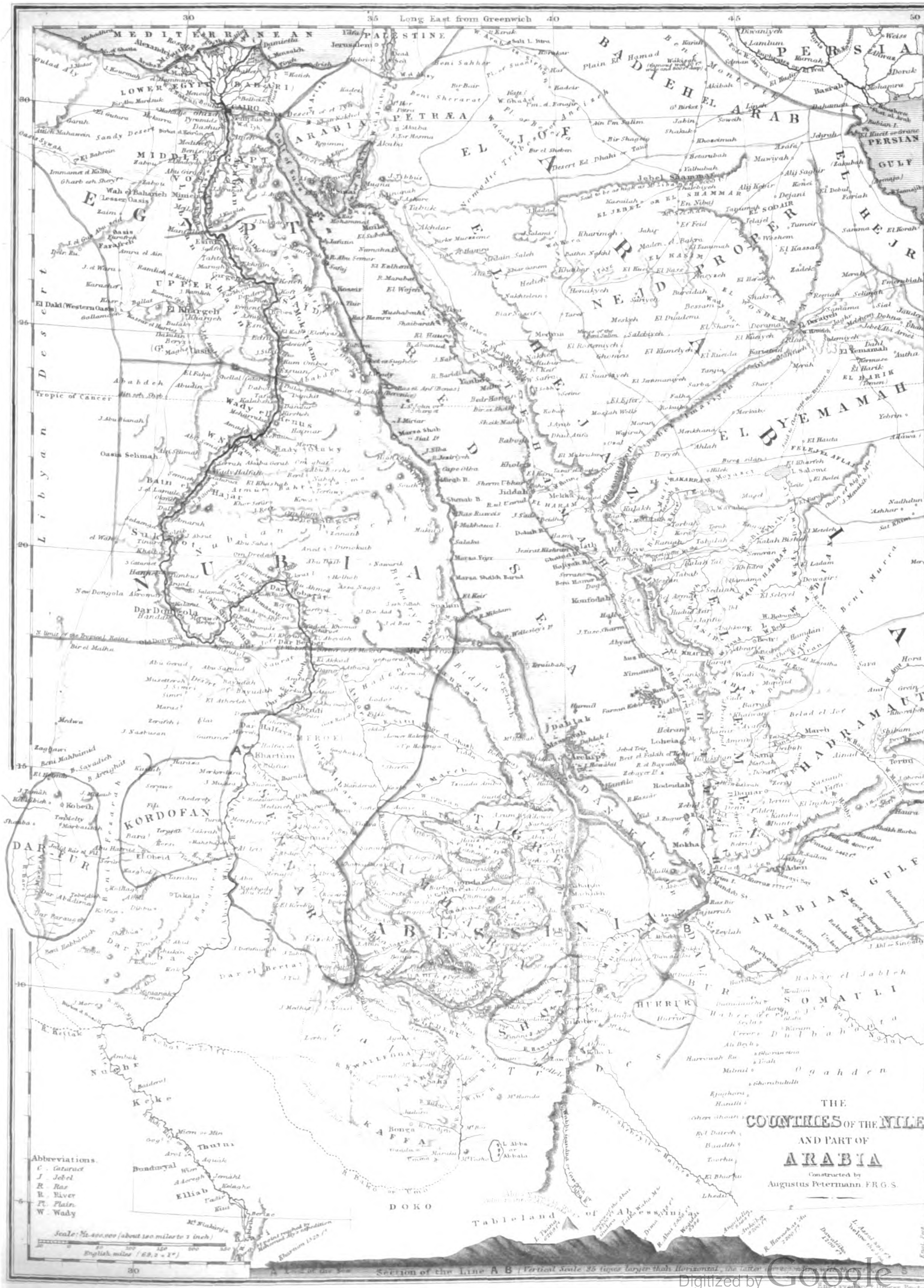

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XXXVI. EGYPT, NUBIA, AND ABYSSINIA.

I. Egypt, Nubia, and Abyssinia, the countries of the Nile, occupy the north-east corner of Africa, bounded by the Mediterranean on the north, the Isthmus of Suez and Red Sea on the east, the Lybian desert, Darfur, and the largely unexplored regions of Central Africa on the west and south.

Latitudinal limits.—Between 7° and 32° N.

Longitudinal limits.—Between 28° and 42° E.

Extent.—About 1750 miles from north to south, by a breadth varying from little more than 150 miles in the north, to near 1000 miles in the south.

II. Egypt has for its prominent physical features a triangular alluvial plain, forming the delta of the Nile; the long narrow valley of the river; the country apart from the delta and the valley consisting of sandy levels, barren mountains, and salt marshes, with a few oases of cultivable soil. The delta, almost a dead level, extending inland from the Mediterranean to the neighbourhood of Cairo, is intersected on the east by the Damietta branch of the Nile, and on the West by the Rosetta branch, the two principal channels into which the river diverges towards its termination. The soil between these branches, a deposit of the river, going back to anti-historic times, is rich and fertile; and, together with plains of the same character on either side, is either periodically inundated or readily irrigated by canals during the annual rise of the great stream, rendering the whole district singularly productive—an important granary to Europe. The valley, which extends from near Cairo southwards into Nubia, is inclosed by ranges of hills closely advancing to the river at some points, and presenting considerable expansions in other places. Its mean breadth is stated to be about seven miles; but the space susceptible of irrigation, or the width of the cultivable portion, is estimated at five miles and a half. The remaining productive part of the country consists of wadys or narrow ravines in the district east of the Nile, and oases in the desert westward, which are fertilized by springs, and have the date-palm prominent in their vegetation.

As rain is only very occasional in Lower Egypt, falling in the winter season, and amounts to only four or five annual showers at Cairo, a still less quantity descending upon Upper Egypt, the fertility of the whole country depends upon the periodical rise and overflow of the Nile. The cultivated districts embrace those which are inundated by the river, and those which are irrigated by means of artificial canals filled by the inundation, in which the water is retained by locks, and let off upon the adjoining lands.

The annual rise of the river is owing to the heavy rains which annually descend within the tropics. It commences about the time of the summer solstice, attains its maximum at the autumnal equinox, and gradually diminishes to the time of the winter solstice. But to benefit the country the rise must observe certain limits. The lowest inundation compatible with being of service is reckoned at eighteen cubits of $21\frac{7}{8}$ inches each, when the canals are cut; nineteen is tolerable; twenty good; twenty-one sufficient; twenty-two fills every canal, and is termed perfect; but twenty-four would overwhelm everything, and involve whole villages in destruction. Hence a perpendicular rise of about 38 feet is required fully to fertilize Egypt.

III. Lower Egypt, or Bahari, which signifies the maritime province, extends from the sea to Cairo; Vostani, or Central Egypt, from Cairo to Manfalout; and Said, or Upper Egypt, from Manfalout to Essouan, on the border of Nubia. Cairo, the capital, and the largest city of Africa, in lat. 30° N., long. 31° 18′ E., situated on the east bank of the Nile, at a short distance from the river, is supposed to contain nearly 300,000 inhabitants. The overland route between Great Britain and India extends from Cairo to Suez at the head of the Red Sea, a distance of 80 miles. The road is nearly a perfect level, and the greater part of it is well gravelled. There are seven stations for the accommodation of travellers; a good inn at the fourth; refreshment-rooms at the second and sixth; and mere stabling at the rest. Camels perform the journey in from two to three days, but the British mail is conveyed in little more than twelve hours. The government of Egypt is a military despotism administered by an hereditary pasha, nominally subject to the Turkish sultan, but practically independent. The total population, excluding the nomadic Bedouin tribes of the desert, who claim a wild independence, is estimated at upwards of 2,000,000. Arab Moslems form the great majority; Christian Copts are the next considerable class, a mixed race descended from the old Egyptians; Turks, Jews, Armenians, and settlers belonging to various European nations composing the remainder. Rice, wheat, sugar, cotton, flax, indigo, and dates are the principal vegetable products. Ivory, ostrich-feathers, and slaves, brought from the more inland countries, are exchanged in the markets for European produce. The cotton manufacture has been introduced, but owing to the habits of the people and the monopolising spirit of the government, it has not prospered.

Alexandria, on the Mediterranean, the principal commercial port, and the station of the Egyptian fleet, occupies a neck of land joining the island of Pharos to the continent. A small miserable town at the commencement of the present century, it rapidly rose to importance under the government of Mehemet Ali, and now contains about 60,000 inhabitants.

Thebes, the original capital of the Pharaohs, is now represented by magnificent ruins, about latitude 25° 40′ N., at Luxor, Karnac, and Medamon, on the right bank of the Nile; and at Medinet Abou, and Gournah, on the left bank. Wretched villages occupy the site of Memphis, not far from the great pyramids. Some remains of Heliopolis exist at Mataria, a village a few miles north-east of Cairo. Denderah represents the ancient Tentyris, and Essouan Syene.

The principal wild animals of Egypt are the jerboa, hyena, ichneumon, and crocodile. The latter has been banished from the Delta, and is now confined to the latitude south of Manfalout. The hippopotamus has disappeared totally, though common in Upper Nubia.

Among the plants for which the country was anciently celebrated, the nymphæ lotus, a species of water-lily, still grows in the small canals and ponds after the inundation of the Nile, but not in the river itself; the byblus or papyrus is also found in the same localities; the rose-lily of the Nile, or Egyptian bean, has disappeared; the acacia Nilotica forms large groves and coppices.

IV. Nubia, the ancient Ethiopia, extends southward along the course of the Nile from Egypt to Abyssinia. The country in the north is an immense desert of deep sand or shingle, with a burning climate; but, in the south, or below the confluence of the Tecazze with the Nile, about lat. 18°, the district now known as Upper Nubia, the Meroe of antiquity, with Sennaar, lying within the range of the tropical rains, is as remarkable for vegetable luxuriance, gigantic grasses, mimosa forests, and parasitical plants abounding in every direction. The whole territory was conquered by the late Pasha of Egypt, and largely depopulated by the conquest, numbers being carried off into slavery, or perishing by the sword, or seeking safety by retiring into interior Africa. The people consist of various tribes of distinct origin, physiognomy, and language,—Arabic, negro, and mixed races. Kordofan, a mere assemblage of oases in the desert, west of the White Nile, is likewise subject to Egyptian rule. Darfur, further west, is occupied by an independent negro state under a sultan.

Nubia abounds in ancient monuments and cave temples. The most remarkable are the temples of Ipsambul, and the ruins of Meroe.

The Nile Proper is formed in Nubia, about latitude 15° 35′, by the junction of the Bahr-el-Azrek, or Blue River, a branch from the Abyssinian highlands, and the Bahr-el-Abiad, or White River, the main stream, which probably has its source in snow mountains south of the equator.

V. Abyssinia, to the south-east of Nubia, has no definite natural boundaries, and its political limits have been very fluctuating through constant wars. Its rulers have no command of the sea-coast, which is in the hands of petty savage tribes. The country has for the most part a grandly alpine character, consisting of lofty table-lands rising from 6,200 to 8,500 feet, intersected by mountains which attain the height of 15,400 feet. The climate of the elevated interior is comparatively temperate, approaching to that of Southern Europe; but the heat of the low grounds is almost insupportable, Massowa, on the shore of the Red Sea, having the highest mean annual temperature hitherto observed in any part of the globe, amounting to 87°. Rain in perfect deluges descends incessantly upon the highlands from June to September, originating a prodigious number of streams and some extensive lakes, the structure of the country giving rise to many imposing cataracts. Abyssinia formerly constituted a single empire, with Axum for the capital, but it has long been dissolved, and now comprises the three principal states of Amhara, Tigre, and Shoa, whose chief towns are respectively Gondar, Antalow, and Ankobar, various Galla tribes occupying its southern districts.

The Abyssinians raise very fine wheat, with other kinds of corn, and cultivate the vine. Lemon and orange-trees grow wild in the woods, and the coffee-bush occurs. The country is remarkably rich in flowers,—roses, jessamines, lilies, primroses, and other fragrant plants abounding in most parts.

The wild animals include the rhinoceros, elephants, lions, hyænas, buffaloes, panthers, gazelles, and monkeys. Crocodiles and hippopotami haunt the rivers and lakes. Among the cattle, the Galla ox is remarkable for its enormous horns.

VI. The most southern countries of the Nile have not yet been explored, nor the true source of the river ascertained; but it will probably be found to take its rise from a chain of snowy mountains near the equator, known to the old geographers as the Mountains of the Moon, and generally traced in our maps, the existence of which has very recently been determined in about 4° south latitude.

XXXVII. NORTH AMERICA.

I. North America includes all that portion of the New World or western continent which lies north of the Isthmus of Panama, washed by the Atlantic Ocean on the east, by the Pacific on the west, and by the Icy Ocean at its northern extremity. Greenland, a great detachment from the main land, forming either an island or the peninsula of an arctic continent, belongs to this division of the globe, with the North Georgian Isles, and other polar districts.

Latitudinal limits.—8° N., Isthmus of Panama, and 71° N., Point Barrow.

Longitudinal limits.—55° W., east extremity of Labrador, and 168° W., east shore of Behring's Strait.

Extent.—Length from N.W. to S.E., upwards of 6000 miles; breadth along the parallel of 51°, about 3250 miles; area estimated, at 7,400,000 square miles.

II. The general form of this part of the American continent is triangular, the base extending along the shore of the Arctic Ocean, the vertex lying in the Panama Isthmus, which at the narrowest point is not more than thirty miles wide. It has an immense extent of sea-coast, the eastern side being deeply indented by arms of the Atlantic. A great central valley drained by the Mississippi-Missouri, with its boundaries, the Alleghany Mountains and the Canadian lakes on the east, and the Rocky Mountains on the west, are the prominent physical features of the interior. The Alleghanies, also called the Appalachian Chain, consist of several ranges of moderate elevation, mostly clothed with forests, which commence about the latitude of 34° in the United States, and extend from south-west to north-east about 1200 miles, terminating on the banks of the Gulf of St. Lawrence. The Rocky Mountains constitute the great highland system of North America, traversing its whole extent from north-west to south-east. They comprise several parallel chains, which form and inclose lofty table-lands, thickly studded with volcanic cones in Mexico and Guatimala; and though the continuity of the range is interrupted by two depressions or breaks in the Isthmus of Panama, it may be considered as prolonged by the Andes of South America, the two forming the grandest longitudinal chain on the face of the globe. The central valley, between the two mountain systems named, stretches from the level of the northern lakes to the Gulf of Mexico, having regions of almost perpetual cold at its north point, and the tropical warmth of Louisiana at its south extremity. It is one of the largest and most interesting valleys in the world, comprising leagues of uninterrupted forests on the banks of the rivers, vast treeless prairies, adorned in spring with myriads of wild flowers, intermingled with the long grass, and extensive wastes, occasionally exhibiting a salt efflorescence where the country is more elevated, sandy, and dry.

The Rocky Mountains properly designate that part of the chain which lies within the territory of the United States. It has several elevated peaks always covered with snow, and the mean temperature of the whole district is very low. The Big Horn, or Long's Peak, about lat. 42°, rises 13,575 feet. Southwards, the chain takes the name of the Sierra Madre; and northwards, it is sometimes called the Chippewayan Range. Mount Brown, in British America, about lat. 53°, near the source of the Saskatchawan River, rises 16,000 feet. But the highest point is apart from the main trunk, in the most western branch, which runs close by the shore of the Pacific Ocean, Mount St. Elias, near lat. 60°, in Russian America, 18,760 feet, being the culminating point of North America.

About lat. 31°, the branch of the Ozark Mountains diverges from the main chain, running to the north-east towards the confluence of the Mississippi and Missouri, through which the Arkansas and Red Rivers have forced a passage.

III. The drainage of the central valley, or great plain, forms the Mississippi, the "Father of Waters;" and its principal affluent, or rather master-flood, the Missouri, the grandest river-system of North America, and the second in point of magnitude among the flowing waters of the globe. The Mississippi rises from a small lake on the table-land west of Lake Superior, and, following the windings, has a course computed at about 3000 miles to the Gulf of Mexico; but the course of the Missouri, from its sources in the Rocky Mountains to the same point, is estimated at 4,100 miles. The junction of these noble rivers takes place above St. Louis, upwards of 1200 miles from the sea, the Missouri bringing down the largest mass of water, and giving its turbid character to the united stream, which may more properly be designated from thence the Mississippi-Missouri, than singly entitled by the name of the smaller branch. On the side of the Pacific the great rivers are the Columbia or Oregon, and the Colorado, draining the country west of the main trunk of the Rocky Mountains. On the side of the Atlantic, the St. Lawrence carries off the surplus waters of the Canadian Lakes, communicating with the ocean by a broad and deep channel. The more northern parts of the continent are drained by the Mackenzie and Coppermine rivers flowing north to the Arctic Ocean, and by the Saskatchawan flowing east to Hudson's Bay. The rivers of the United States east of the Appalachian Chain, falling into the Atlantic, though of great local importance, are comparatively inconsiderable; a remark which applies to the Rio del Norte, descending to the Gulf of Mexico from the interior table-land of the Sierra Verde. North America is pre-eminently lacustrine, exhibiting in the great chain of lakes which characterises the river system of the St. Lawrence masses of fresh water unequalled in any other part of the world, forming vast inland seas. An immense number occupy the surface from Upper Canada to the Arctic Ocean, some of which are of great extent, but are ice-bound through the greater portion of the year. The Lake of Nicaragua, with volcanic shores and islands, is the largest example in central America.

RIVER SYSTEM OF THE MISSISSIPPI-MISSOURI.

	Length in Miles.		Length in Miles.
Mississippi Proper, or from source to confluence with the Missouri	1800	Missouri Proper, or from source to confluence with the Mississippi	2900
St. Peter's	500	Yellowstone	1000
Penaca, or Turkey	200	Little Missouri	300
Iowa	350	Shienne	300
Chacaguar	200	Quicourt	500
Des Moines	600	Platte	1200
St. Croix	300	Kansas	800
Chippewa	300	Osage	500
Wisconsin	600	Gasconade	300
Rock River	450	Jacques	600
Illinois	500	Sioux	500
Salt	250	Grand	500
Mississippi-Missouri, from confluence to New Orleans			1200
Affluents from the West—		Affluents from the East—	
White River	600	Kaskaskia	300
Arkansas	2500	Ohio	1250
Canadian	1000	Tennessee	1500
Neosho	800	Cumberland	600
Red River	2000	Wabash	550
Washita	800	Yazoo	300

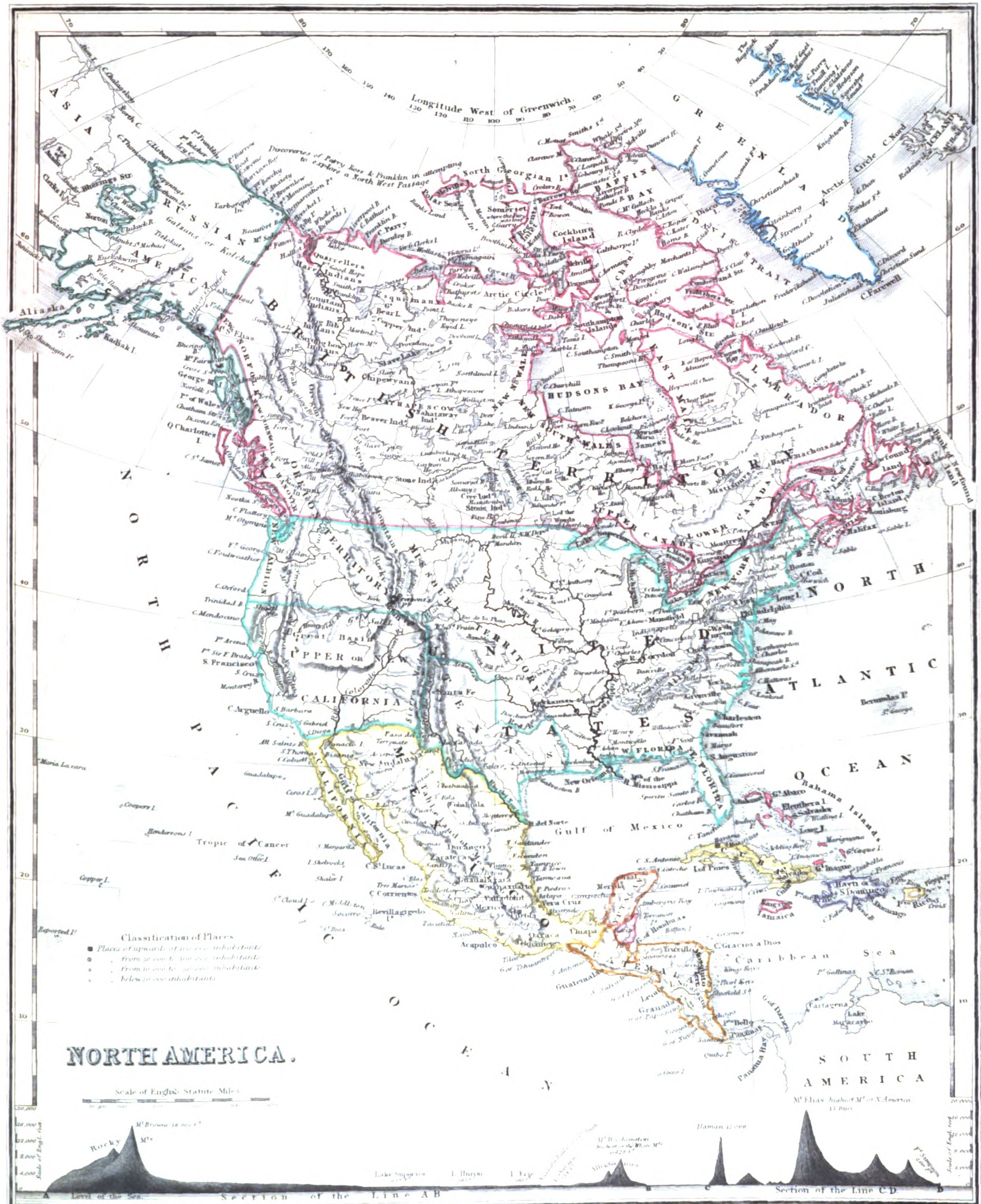
One of the striking peculiarities of the river, and of all its lower tributaries, is the uniformity of its meanders, called, in the phrase of the country, its points and bends. In many instances, the curves are described with a precision as if they had been marked out by the sweep of a compass. After performing one semicircular route, the stream is precipitated diagonally across its own channel, to another curve of the same regularity bending in an opposite direction. In the bend is the deepest channel, the heaviest movement of the water, and what is termed the thread of the current. Between this thread and the shore, on the one side, there are generally counter-currents, or eddies; while the rush of the river being directed against the shore opposite, makes frequent havoc with the tender alluvial soil of the banks.

The "bluffs" form another striking feature, generally near the river between St. Louis and the mouth of the Ohio, and seldom diverging more than two miles from it. They are mostly perpendicular masses of limestone, shooting up into walls, domes, and pinnacles, resembling the battlements and towers of an ancient city.

The river begins to rise upon the melting of the winter's snow, early in March, and gradually increases till about July, when a vast extent of country towards its month is inundated, the flood sometimes threatening New Orleans with destruction, as in the present year, 1849.

Steam navigation, now so extensive on the river, commenced in the year 1810.

IV. The mean temperature of that great portion of North America which lies east of the Rocky Mountains, is many degrees lower than that of Western Europe in corresponding latitudes. Among the causes of this difference may be mentioned, the small part of the continent lying in the torrid zone, and the general elevation of that part; the high mountain-range traversing the western side, which prevents the warm winds from the Pacific visiting the interior; the great expansion of the land northwards, and the absence of mountains in that direction, to ward off the piercing Arctic blasts; the narrowness of the transatlantic part of the Gulf stream, and the prevailing south-west winds, which carry away from the continent the hot circumambient air, a source of warmth to Western Europe; and the cold polar oceanic current which brings down the icebergs of



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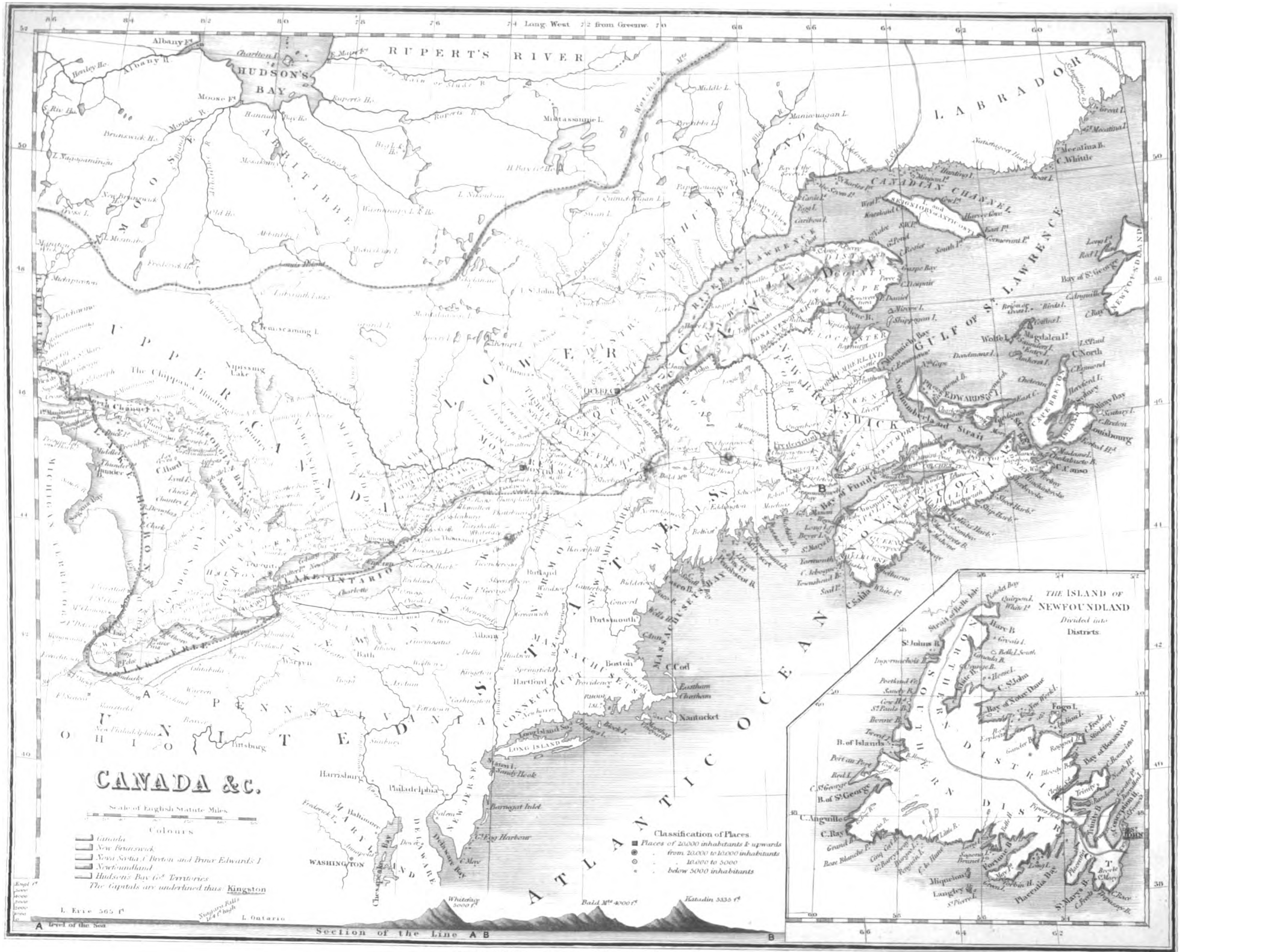

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Spitzbergen and Greenland to the shores of Labrador and Newfoundland. The same circumstances will explain the well ascertained fact of the average temperature on the coast of the Pacific being higher than under corresponding parallels on the side of the Atlantic.

In the temperate regions, the climate is generally distinguished by its excessive contrasts between the heat of summer and the cold of winter, and the suddenness of the seasonal transitions.

At Quebec the mean temperature of the year is 40°, while at Paris, in nearly the same latitude, it is somewhat more than 51°. But while at Quebec the temperature of the hottest month differs from that of the coldest by about 60°, the difference amounts to 31° at Paris, and is less than 28° at London.

It marks the difference between the climate of the east and west coasts to state, that while at Quebec snow lies for five months, and the mean temperature of the three coldest months is 18° below the freezing point; that of the coldest month at the mouth of the Columbia River, in the same latitude, is 4° above the freezing point.

V. In the tropical lowlands of the continent, the usual vegetation of such latitudes occurs, with peculiar forms. Palms, bananas, plantains, yams, indigo, cotton, coffee, tobacco, the sugar-cane, maize, and rice, are cultivated products; enormous mahogany and logwood trees clothe the low grounds of Honduras; the chocolate and vanilla plants inhabit the most burning districts; pine-apples grow wild in the woods; cacti flourish in the most arid situations; and the deciduous cypress acquires gigantic dimensions, constituting, with the Spanish moss pendent from its boughs, the pride of the forests of the south United States. Forms characteristic of the tropics have here their extreme northern limit. Noble tulip and locust trees, various kinds of oaks, pines, and larches, the sugar-maple, mountain laurel, and arborescent azaleas, combine in the magnificent woods of the northern states, ranging into Canada, where majestic poplars, spruce firs and birches are prominent. Stunted forms of the two latter occur in patches in the far north, with various berry-bearing plants, and the little Arctic willow, reindeer moss, and other lichens overspreading the land to the shores of the Arctic Sea. It is impossible to notice in circumscribed limits the botany of this vast region otherwise than in this general way, and equally so the zoology, which comprises among the land mammalia twenty-seven species not found south of the Isthmus of Panama, but common to Europe and Northern Asia.

The Table of American mammalia is given in connection with South America.

Among the land mammals exclusively confined to North America, the more remarkable are the Rocky Mountain goat and sheep, the musk ox, and the true grisly bear; the latter the most formidable quadruped of the New World.

VI. The aboriginal inhabitants consist of various Indian tribes in Mexico and Guatimala, the western territory of the United States, and in the vast region extending from thence towards the Arctic Ocean, with a few Esquimaux, a distinct stock, in the far north, all without political influence, and numerically unimportant when compared with the occupants of European and African descent, constantly becoming still more so by the tide of immigration from the eastern to the western world. Besides the natives and the foreign settlers of pure blood, there is a considerable number of Indo-European, and of European-Negro origin.

All the aboriginal inhabitants of both North and South America, excepting the polar tribes of Esquimaux, are identified as one race by certain physical correspondencies, and form a distinct variety in the human family; while their verbally discordant languages have a common bond of union in their grammatical structure. In relation to the whole western continent, the aborigines are far outnumbered by the settlers from the eastern. M. Balbi, whose estimate of the gross population is very low, makes the following distribution of the indigenous and foreign races:

Native Americans, or Indians, of the copper-coloured race . . .	10,000,000
Europeans, and their descendants of pure blood	14,600,000
Africans, and their descendants of pure blood	7,400,000
Races of mixed blood	7,000,000
Total	39,000,000

The total is raised much higher by other authorities, or to 50,000,000, consisting of 28,000,000 of European origin, 6,000,000 of negroes, 9,000,000 of Indians, and 7,000,000 of mixed races.

VII. Those parts of North America which have not been introduced into special maps consist of countries very partially occupied by the respective governments claiming possession of them, and which are, to some extent, in the hands of native tribes, or altogether desolate. They comprise the western territory of the United States, with Texas, noticed in connection with the organised parts of the republic, the territory of the Hudson's Bay Company, and the Arctic islands, claimed by Great Britain, of which a notice is given in connection with the North American British colonies; Russian and Danish America. The sovereignty of Russia extends over the north-western portion of the continent from Behring's Strait to the meridian of Mount St. Elias, or 140° W., and from the Arctic Ocean to the parallel of 54° on the coast of the Pacific, including the adjacent islands. There are a few fur and fishing establishments of Russian merchants on the coast, the whole interior forming only a nominal portion of the empire. New Archangel, the capital, on Sitka Island, has about a thousand inhabitants. Danish America consists of Greenland, a vast unexplored district, occupied by a scanty Esquimaux population, and some Danish commercial settlements on the west coast, with Moravian missionary establishments. Whale oil, seal, bear, and reindeer skins, with eider-down, are the principal articles of export. Uppernavik, in lat. 72° 30′ N., is perhaps the most northerly permanent station of civilised man on the globe.

XXXVIII. BRITISH POSSESSIONS IN NORTH AMERICA.

I. The British North American Possessions, excluding the territory of the Hudson's Bay Company, Honduras, and the West Indies, comprise a north-eastern portion of the continent and its adjacent islands, consisting of Canada, New Brunswick, Nova Scotia and Cape Breton, Prince Edward's Island, and Newfoundland, districts under the immediate government of the British Crown, and largely occupied by a European population.

II. Canada extends along both sides of the St. Lawrence from its mouth to the point where the parallel of 45° N. strikes the river, at St. Regis, about sixty miles above Montreal, and from thence along its north bank to Lake Ontario, which, with the great chain of lakes, forms the chief part of the boundary from the United States, and constitutes the grand hydrographical feature of the region. On the north it is separated from the territory of the Hudson's Bay Company by a range of hills. The western limit is very vague, but usage does not extend it farther than Lake Superior.

Latitudinal limits.—Between 41° 30′, and 52° N.
Longitudinal limits.—Between 63° 30′, and 90° W.
Extent.—About 1300 miles from east to west, and 700 from north to south. The area is estimated at 355,000 square miles.

III. The physical geography of Canada is peculiarly distinguished by vast collections of fresh water in the basin of the St. Lawrence, Lakes Superior, Huron, Michigan, Erie, and Ontario, which may be properly styled inland seas in respect to depth and extent of surface, the smallest being tossed with tempests like the ocean, and capable of navigation by the largest vessels. Other considerable expanses occur, and some important streams, the largest of which, the Ottawa, falls into the St. Lawrence above Montreal, and strikingly resembles that river in its great breadth and lake-like expansions. The country comprises an immense extent of unoccupied and uncleared land, trees of the pine family predominating in the forests. Its winters are intensely cold, especially in the eastern districts, where their severity endures through half the year, diminishing to four months in the western parts. Yet, though the thermometer may be as low as zero, the season is far from being distressing or disagreeable. The air is in general perfectly calm and dry, the sky clear and bright, while the pure exhilarating atmosphere, by generating great animal heat, causes the sense of cold to be very much less than what might be expected from its degree. On the other hand, the summers are remarkably hot, and sudden changes of temperature, sometimes amounting to 40°, render the climate trying to the constitution of a

European settler till he has become inured to them. But on the whole, where proper caution is exercised, and habits of moderation are observed, the climate is as favourable to the duration of life and freedom from disease as in any other country of the globe.

The St. Lawrence first receives that name after passing the Lake of the Thousand Islands; but the great lakes and their connecting water-courses are parts of its river system, and the St. Louis, falling into the western extremity of Lake Superior, may be deemed its head spring.

Lake Superior is the largest freshwater formation on the globe, computed to have an area of 40,000 square miles; length 420 miles; extreme breadth, 165; circuit, 1700; height above the level of the Atlantic, 627 feet; greatest depth about 1200 feet. Its surplus waters are discharged by the River St. Mary, after a course of between thirty and forty miles, into Lake Huron.

Lake Huron, remarkable for its brilliant transparency, has an area of about 25,000 square miles, 595 feet above the sea; and Lake Michigan, connected with it by a broad strait, has nearly the same extent. The Huron pours its surplus waters into the river St. Clair, which, after passing through the small lake of that name, are conducted by the Detroit into Lake Erie, after a course of about seventy miles.

Lake Erie has a surface estimated at 11,000 square miles, 565 feet above the Atlantic. Its outlet is the Niagara river, which runs about thirty-three miles to Lake Ontario, forming on its course those stupendous falls which have no equal in the world.

Lake Ontario, the smallest expanse, has a computed area of 10,000 square miles, 234 feet above the sea-level. Its outlet is a spacious channel studded with islands, called the Lake of the Thousand Islands, but the number actually counted by the Commissioners employed in fixing the boundary with the United States, amounted to 1692. From hence, the St. Lawrence, under that name, flows to the ocean, rapids at various points obstructing the navigation, which are avoided by lateral cuts. Its channel contains numerous islands, opens into wide expansions, and contracts, being only 1314 yards broad at Quebec, but from thence the breadth gradually increases to 25 miles at Cape des Monts Pelées, at the head of the gulf. Vessels of large burden ascend to Montreal, about 500 miles from the mouth of the river.

IV. Canada was divided in the year 1791 into two provinces, Lower and Upper, or East and West, with distinct executives and separate legislative assemblies, the Ottawa River forming the general boundary between them. Lower or East Canada, the largest division, comprehends an area of about 200,000 square miles, of which not less than 3200 miles are supposed to consist of lakes and rivers. The latest account assigns to the province a population of 623,649, chiefly of French origin, the remainder consisting of British and other foreign settlers, with a few native Indians along the north boundary. Though considerable tracts occur either unoccupied or unfit for settlement, there is abundance of excellent land on the banks of the rivers to be obtained on easy terms, while the provision for intercommunication, education, and religion, is more matured and ample, and the conveniences of civilized life are more readily attainable than in the other province. Quebec, the capital, in lat. 46° 48′ N., long. 71° 10′ W., the Gibraltar of British America, very finely situated on the right bank of the St. Lawrence, is accessible to the largest ships. Its citadel, crowning the summit of Cape Diamond, the most elevated point of the city; batteries overhanging a range of formidable steeps; and the panorama of the river, crowded with vessels from the largest merchantmen to the light bark canoe, combine to form a landscape scarcely to be rivalled in the most favoured parts of the earth. It contains about 30,000 inhabitants. Upper or West Canada, for the most part a region of plains covered with dense forests, comprises an area of about 150,000 square miles, the greater portion of which is unoccupied though in process of clearance and settlement. The population, composed principally of emigrants from Britain or the United States, amounts to about 507,000. Toronto, the capital, on the shore of Lake Ontario, contains upwards of 12,000 inhabitants. In 1841 the Canadas were united by an Act of the British Parliament, and now form a single province for legislative purposes, with one representative assembly, meeting at Montreal, but about to be removed to Toronto. The Governor is captain-general of all British America. Raw produce, consisting of timber, fur-skins, wheat, flour, and potash, are the chief exports; manufactured goods the imports.

Montreal, seated on an island of that name in the St. Lawrence, off the mouth of the Ottawa, is the largest city and principal commercial emporium of Canada. It is the highest point of the river to which vessels of the first class can ascend. It contains the most splendid edifice of British America, the Roman Catholic Cathedral, capable of accommodating 12,000 persons.

Internal communication is maintained with little difficulty throughout the country by means of the rivers and lakes, and by the *postages*, narrow and low water-partings, across which light vessels are readily carried. Transit is further facilitated by canals constructed to avoid the falls and rapids which obstruct the river navigation. The Rideau Canal extends from the Ottawa River at Bytown to Kingston on Lake Ontario, a distance of 135 miles, consisting principally of natural channels connected by artificial cuts. It forms the regular passage from Montreal into Upper Canada by the Ottawa, and was executed at the cost of nearly 1,000,000*l.* sterling. The Welland canal, 53 miles long, connects Lakes Erie and Ontario, avoiding the falls of Niagara, and opening communication into the interior of the continent.

Canada was first colonised by the French in 1608. It remained in their possession till 1759, when Quebec was taken by the British, and the whole country conquered in 1760.

The trade of Canada, important with the mother country, is most extensive with the United States.

COMMERCE OF THE UNITED STATES AND CANADA.

The navigation or the tonnage between the United States and the British possessions in America, is one-third of the whole tonnage of the United States. Of this more than two-thirds, or nearly one-fourth of the whole tonnage of the United States, is with Canada. The results are thus:

Whole tonnage entering the Ports of the United States	2,289,309	Entering from British America	761,096
		From Canada . . .	535,464

Great as is the commerce of the United States with England, the tonnage required to carry it on is less than that engaged in the lake commerce with Canada.

Entered from England . . .	496,773	Entered from Canada . . .	593,464

Treasury Report presented to Congress, 1841.

V. New Brunswick, possessing an independent legislature under a lieutenant-governor, is a compact portion of the main land, lying between Canada and Chaleur Bay on the north; the Gulf of St. Lawrence on the east; the state of Maine on the west; Nova Scotia and the Bay of Fundy on the south. It forms an irregular square, containing about 27,000 square miles, or 16,500,000 acres, of which 11,000,000 are arable, and is said to be capable of supporting 3,000,000 inhabitants. The quality of the soil is indicated by magnificent forests of gigantic trees, by which it is more richly clothed than any other part of British America. It abounds in river, lake, and sea-fish of all kinds, carries on fish-curing and whaling to a large extent, with a vast timber trade, and possesses important mineral wealth, especially very fine seams of coal, and excellent salt springs. The colony is highly recommended to emigrants, as amply furnishing the means of employment and commerce, hitherto very imperfectly developed. The climate in the north resembles that of Canada; that of the south is rather milder; and extremes of temperature are said to be diminishing, owing to the gradual thinning of the woods. The population, not far short of 200,000, consists of Anglo-Americans descended from the loyalists who left the United States at the revolution, of emigrants from Great Britain, a few Indians and Acadians, the latter the descendants of the early French colonists.

New Brunswick was formerly called New France, and formed part of the French province of Acadia. Its existence as a separate colonial state dates from the year 1783. Frederickton, on the river St. John, is the capital and seat of government; but the most important place is St. John, on the bay of Fundy, a town of 12,000 inhabitants.

VI. Nova Scotia, a peninsula south-east of New Brunswick, connected with it by a narrow isthmus, and Cape Breton, an island immediately adjacent to it, form another colonial dependency of Great Britain. The peninsula extends in an oblique line from north-east to south-west upwards of 300 miles, with a general breadth of from 30 to 60 miles. The island, called by the French L'Isle Royale, consists of two narrow peninsulas formed by the deep gulf of the Bras d'Or, which leaves only an isthmus about a mile wide to connect them. The whole province has an area estimated at 17,500 square miles, of which somewhat more than one-fifth belongs to the island. Both sections of the colony abound in coal, iron, gypsum, salt, and other minerals, are well supplied with salt and fresh water fish, and capable of yielding a large amount of agricultural produce. The population is upwards of 170,000, consisting of Anglo-Americans, Acadians, and British immigrants.

Halifax, the capital, on the Atlantic coast of the main land, is the third town of British America, containing upwards of 20,000 inhabitants; and is said to be more exclusively English than any other American town. Its fine harbour is one of the principal transatlantic stations of the British navy. Halifax may be reached in ten days from Liverpool, by fine and safe steam-vessels, the Cunard mail-packets.

Nova Scotia was permanently annexed to the British crown in 1710, and Cape Breton in 1758, by conquest from the French.

VII. Prince Edward's Island, on the south side of the Gulf of St. Lawrence, and north of Nova Scotia, extends in the form of an irregular crescent about 135 miles, but is nowhere broader than 34 miles, and is so deeply indented with bays and inlets, that the north and south coasts are, at various points, not more than seven or eight miles apart, and in one place the breadth contracts to a single mile. It comprises 2,130 square miles, and contains an exclusively British population of nearly 50,000. The island has a more temperate climate than the adjoining main land, is well wooded, and claims the attention of emigrants as admirably adapted for successful and even luxuriant cultivation.

Charlottetown, the capital, is a small pleasant town of about 4,000 inhabitants, on the north coast.

Prince Edward's Island surrendered to Great Britain immediately after the reduction of Cape Breton. It was then called St. John, and received its present name in 1799, in honour of Prince Edward, the late Duke of Kent, and father of the present Queen.

VIII. Newfoundland, on the east side of the Gulf of St. Lawrence, is one of the largest and most important islands of the American continent, separated from Cape Breton by a channel about fifty miles wide, and from the coast of Labrador by the strait of Belle-Isle, not exceeding ten miles in width. It is supposed to comprise 36,000 square miles, a very considerable portion of which is occupied with rivers, lakes, and swamps. Owing to the internal resources of the island being very scanty, while the adjacent seas are singularly productive, the entire population, amounting to 80,000, is confined to the shores, excepting a few aborigines. Newfoundland belongs to Great Britain, subject to French and American rights of fishery, and of curing their produce on certain unoccupied parts of the coasts.

St. John, the capital, situated on the most easterly part of the coast, opposite the great bank, and the expanse of the Atlantic, has about 11,000 inhabitants. The colony has had a representative assembly since the year 1832.

The fishing-ground, or great bank, east and south of the island, is estimated to extend 600 miles in length, and 200 in breadth, composed chiefly of rocky masses. Its sides descend precipitously, and the increase of depth is great and sudden. It forms a vast submarine mountain, and not the slightest diminution in the productiveness of its waters has been observed, though maritime nations have laboured indefatigably for two or three centuries in the capture of its cod-fish.

IX. The territory of the Hudson's Bay Company consists of the triangular peninsula of Labrador, and the whole of that vast portion of the continent extending from the boundary-line towards the United States on the south, the parallel of 49°, to the Arctic Ocean on the north, and from Hudson's Bay on the east, to the Russian frontier and Pacific Ocean on the west. It is largely overspread with lakes, swamps, and forests, the stately pines in the south being represented by stunted trees in the north; but extensive tracts of beautiful prairie country occur westward of Lake Superior, covered with luxuriant herbage, affording pasturage to immense herds of buffaloes. There is a thin population, consisting of various tribes of Indians, employed in hunting and fishing, a few hordes of Esquimaux towards the northern boundary, and the officers and servants of the Company engaged in the fur trade. In the higher latitudes, the region is one whose desolation and rigorous climate find a parallel alone in the arctic districts of Siberia.

The territory of the Hudson's Bay Company is divided into four departments, which are subdivided into districts. At the head of each department and district a chief factor or trader generally presides, to whom all the officers within their respective jurisdiction are amenable, a governor superintending the whole, whose decisions are referred for final adjustment to the governor and directors of the Company in London.

The head-quarters and chief depôts of the four departments are La Chine, near Montreal; Moose Factory, at the mouth of the Moose river, James's Bay; York Factory, near the west shore of Hudson's Bay; and Fort Vancouver, on the Columbia river, west of the Rocky Mountains. York Factory is considered the grand emporium. The beaver is the main staple of the fur-trade, owing to its abundance, and the large and sure demand for it in the hat-manufacture. The martin ranks next in importance, and has the finest fur of any land animal on the new continent, usually sold as sable. Animals of the weasel kind, foxes, the musquash or musk-rat, wolves, and bears, supply valuable skins, and the sea-otter, taken on the shores of the Pacific, but now of rare occurrence. The capture of the fur animals has been largely conducted without any regard to keeping up the breed; but greater attention being now paid to this point, it is believed that the races are at present rather recruiting than otherwise.

The Hudson's Bay Company, established about the year 1670, is now the only survivor of the many bodies which once enjoyed a monopoly in various branches of British trade. The Company possess the entire jurisdiction of their extensive territories, except in criminal cases, in which the judicial courts of Canada have concurrent control. Their officers and servants are perhaps the most hardy and enterprising class of men in existence; and four-fifths of them are said to be from the north of Scotland.

X. The islands in the Arctic seas of the New World belong to Great Britain by right of discovery, but present no features requiring notice in this place. Altogether, the British possessions in North America embrace an area of not less than 2,500,000 square miles.

XXXIX. UNITED STATES.

I. The territory of the United States stretches from the Atlantic Ocean on the east to the Pacific on the west, and from British America on the north to Mexico on the south. But the states proper, or those which are under an organised government, and politically form part of the confederation, are included in the district bounded northward by the great lakes, south by the Gulf of Mexico, east by the Atlantic, and west by the country adjacent to the right bank of the Mississippi-Missouri.

Latitudinal limits.—24° 30′ N., south extremity of Florida; and 47° N., north frontier of Maine.

Longitudinal limits.—67° W., east point of Maine; and 95° 30′ W., western limit of the State of Missouri.

Extent.—Upwards of 1200 miles, following the meridian of 90°, from the south of Louisiana to the shores of Lake Superior; 1100 miles, following the parallel of 40°, from the east of New Jersey to Missouri River: area, 900,000 square miles.

II. The country along the coast of the Atlantic is a generally level region, but slightly elevated above the ocean, called the Atlantic Plain, extending only a few miles inland in the north, but gradually expanding southward to 150 miles or more in the Carolinas, and in the extreme south occupying the whole territory on the borders of the Gulf of Mexico. Northwards from the State of Alabama, the western limits of the plain are formed by the Appalachian Mountains, a system consisting of numerous parallel ridges, which have a general direction from south-west to north-east, gradually approach the Atlantic coast, and may be traced into British America, extending to the shores of the Gulf of St. Lawrence. The component parts of the chain take a variety of names, as the Cumberland Mountains in the east of Tennessee and Kentucky, the Alleghany range in Virginia and Pennsylvania, the Catskill highlands in the State of New York, the Green Mountains in Vermont, so called from the moss upon their summits and the forests on their slopes, and the White Mountains in New Hampshire, the bare rock being of a whitish hue. Mount Washington, one of the latter, has an elevation of 6428 feet; but the culminating point of the United States is the Black Mountain, one of the Alleghanies, on the borders of North Carolina and Tennessee, rising to the height of 6476 feet. West of the Appalachian system, the country falls by a gentle but broken descent to the Mississippi, and consists of a moderately undulating region of savannahs and forests, rivers tributary to the grand stream deeply and extensively furrowing the surface.

The Appalachian mountains exhibit very fine scenery, and some remarkable natural curiosities, as the natural bridge which passes over Cedar Creek in Virginia, and Weyer's Cave, in the same State, an immense chambered cavern abounding with stalactical formations.

III. The Mississippi-Missouri, the great river of the United States, belonging to the basin of the Gulf of Mexico, is noticed in connection with North America. Its principal tributary from the east, the Ohio, *La Belle Rivière* of the early French colonists, so called from its beauty, descends from the south-west of the state of New York, and has a course of upwards of 1200 miles to its confluence, at the junction of the three states of Illinois, Kentucky, and Missouri. It forms an important channel of intercommunication, though the navigation is impeded or suspended for a time by the ice in winter, and by low water in summer. The Alabama, chiefly draining that state, called in the lower part of its course the Mobile, and the Appalachichola, from which the Appalachian Mountains derive their name, forming the boundary for some distance between the states of Georgia and Alabama, are also connected with the Mexican Gulf. Of the rivers flowing into the Atlantic, the principal are the Penobscot and Kennebec in Maine: the Merrimac in New Hampshire; the Connecticut, dividing the latter state from Vermont, and intersecting Massachusets; the Hudson in New York; the Delaware on the frontier of New Jersey and Pennsylvania; the Susquehanna, chiefly in Pennsylvania; and the Potomac in Virginia and Maryland. Of these, the Hudson forms the most important line of navigation, and is renowned for the picturesque scenes along its banks where it forces the passage of the Catskill highlands. Lakes are numerous in the northern states; swamps and morasses in the southern; and vast sheets of water, formed by the overflowing of the Mississippi, are permanent in Louisiana. The small Wenham Lake, known in London by its ice, is in the south-east of Massachusets.

The lakes and navigable rivers afford important natural facilities for communication, aided by numerous canals and an extensive system of railroads.

CANALS IN THE UNITED STATES.

	No.	Miles.		No.	Miles.
Maine	1	50·50	Virginia	4	216·25
New Hampshire	5	11·13	North Carolina	2	13·50
Vermont	3	1·06	South Carolina	8	52·45
Massachussetts	6	103·50	Georgia	2	28·
Connecticut	2	61·50	Alabama	2	51.95
New York	14	985·94	Louisiana	4	99·25
New Jersey	3	147·75	Illinois	1	105·30
Pennsylvania	16	973·81	Indiana	2	217·
Delaware	1	13·63	Ohio	10	764·
Maryland	1	136·			
				87	4,032·92

The splendid canal which connects the Hudson River with Lake Erie, surpasses by far in extent any similar work in Europe. It measures 363 miles, and is as remarkable for the rapidity with which it was completed as for its extent. The difference of level to be overcome was 689 feet, and required 84 locks. It was projected by the legislature of the State of New York in 1808, but not commenced until July, 1817, being completed in October, 1825, at an expense of more than 7,000,000 dollars. The Ohio canal, which connects Lake Erie, and consequently the city of New York with the Ohio River, is 324 miles long, and was completed in October, 1832, in little more than seven years. By these works an uninterrupted line of inland navigation has been secured from the bay of New York to the Gulf of Mexico.

IV. The country is distributed into twenty-nine states, and one district, independent of Texas and the great region extending westward to the Pacific Ocean. The states form a federal union for general purposes; but each state regulates its internal affairs by means of a governor, senate, and representatives. The legislature of the Union consists of two chambers, a senate, and house of representatives, unitedly called the Congress, meeting annually on the 1st of December; the executive being vested in a president, who must have the concurrence of two-thirds of the senate in important affairs. Senators are elected by the local state legislatures, for six years; representatives, by the people, for two years; and the president, for four years, by the electoral colleges of the several states. Washington, the capital of the Union, in the district of Columbia, lat. 38° 53′ N., long. 77° W., finely situated on the Potomac river, is only important as the seat of government, the ordinary residence of the president and the foreign ambassadors, and the site of the annual session of Congress. New York, the commercial capital, situated on the south extremity of Manhattan island, at the mouth of the Hudson, is the largest and most flourishing city of the States and of the whole western continent, containing upwards of 350,000 inhabitants. The entire population of the United States at present exceeds 18,000,000, the vast majority being of British descent, with a considerable number of German extraction in Pennsylvania, Dutch in New York, French in Lousiana, and nearly two millions and a half of slaves, whose bondage and general treatment darkly blot the fame of the republic.

States.	Population.	Slaves, 1840.	Capitals.
Eastern States, or New England.			
Maine	501,793 in 1840	0	Augusta.
*New Hampshire.	284,574 ,,	1	Concord.
Vermont	291,948 ,,	0	Montpelier.
*Massachussets	737,699 ,,	0	Boston.
*Rhode-Island	108,830 ,,	0	Providence and Newport.
*Connecticut	309,978 ,,	17	Hartford and Newhaven.
Middle States.			
*New York	2,604,495 in 1845	4	Albany.
*Pennsylvania	1,724,033 in 1840	64	Harrisburg.
*New Jersey	373,306 ,,	674	Trenton.
*Delaware	78,085 ,,	2,605	Dover.
*Maryland	470,019 ,,	89,737	Annapolis.
District of Columbia	43,712 ,,	4,694	Washington.
Southern States.			
*Virginia	1,239,797 ,,	448,987	Richmond.
*North Carolina	753,419 ,,	245,817	Raleigh.
*South Carolina	594,398 ,,	327,038	Columbia.
*Georgia	774,325 in 1845	280,944	Milledgeville.
Alabama	624,827 ,,	253,532	Tuscaloosa.
Florida	54,477 in 1840	25,717	Tallahasse.
Western States.			
Mississippi	375,651 ,,	195,211	Jackson.
Louisiana	352,411 ,,	168,452	New Orleans.
Arkansas	145,000 in 1845	19,935	Little Rock.
Tennessee	829,210 in 1840	183,059	Nashville.
Kentucky	779,828 ,,	188,258	Frankfort.
Ohio	1,519,467 ,,	3	Columbus.
Michigan	304,278 in 1845	0	Detroit.
Indiana	685,866 in 1840	3	Indianopolis.
Illinois	643,482 in 1845	331	Springfield.
Missouri	511,937 ,,	58,240	Jefferson.
Wisconsin	155,277 ,,	11	Madison.
Iowa	81,920 in 1844	16	Burlington.
	17,994,042	2,487,355	

The States marked with an asterisk are the thirteen provinces which united in the famous Declaration of Independence in 1776, acknowledged by Great Britain in 1783.

Foreigners and their descendants in the United States are supposed to amount to 1,500,000; meaning by foreigners those who have been adopted by the nation since it achieved its independence. Subtracting this number, with that of the slaves, from the population, will leave about 14,000,000 of a purely native stock descended from the founders of the national independence.

V. The United States have the more useful minerals in great abundance, and to some extent gold is found in Virginia, North Carolina, and Georgia; but the metallic wealth of the country has only been imperfectly developed, and its mining operations are altogether of very recent date. The lead region in Missouri, Illinois, Wisconsin, and Iowa, is probably equal to the richest European localities in that product. Iron ore is widely distributed, and the iron manufacture is in course of rapid extension. Salt from brine springs is largely obtained in the Mississippi valley; and along the whole western slope of the Appalachian Chain, from the state of New York to Louisiana, salt-works are established at intervals. Enormous deposits of coal occur, in nearly all its known varieties, from the driest and most compact anthracites to the most fusible and bituminous common kind. The coal regions consist of a great central tract, the Alleghany field, extending from the state of Alabama to the west of Pennsylvania, apparently resumed in New Brunswick and Nova Scotia; a second district, striking north-westward from Kentucky, across the Ohio, through Illinois to the Mississippi; a third, smaller but important district, lying between the three great lakes Eric, Huron, and Michigan; and several minor basins, comprising the detached troughs of anthracite in eastern Pennsylvania.

It is supposed that these contiguous basins are no more than detached parts of a once continuous deposit, measuring at a reasonable calculation 900 miles in length, and in some places more than 200 miles in breadth, the included area amounting to 63,000 square miles. The resources of the region have scarcely been touched, for it was not till the year 1828 that the first cargoes from the Alleghany coal-fields reached Baltimore and Philadelphia. By the treaty of 1768, the whole area of the bituminous coal land of Pennsylvania passed away from the native Indians for the sum of 10,000 dollars. Immense changes have resulted from attention being paid to the coal-deposits. "In the year 1753, there were probably no white men living within the limits of the present city of Pittsburgh (present population perhaps 25,000), where, even in 1775, only a few cabins were standing; but in our day, three-fourths of a million of tons of coal are annually received there; and the iron manufacture is so great as to confer upon the place the title of the Birmingham of America."

VI. The northern states are the chief scenes of manufacturing industry, where the production of cotton, woollen, and linen fabrics has acquired importance. In 1840, there were 1240 cotton-mills, with 2,284,631 spindles, employing 72,119 operatives, the value of the produce amounting to upwards of £10,000,000. The factory town of Lowell, in Massachussets, about twenty miles from Boston, with its lyceums, reading-rooms, and literary magazine conducted by artizans, has become familiar to most English readers through the publication of the Lowell Offering in this country, a collection of papers from the production referred to. In (1820) the town now with its thirty cotton mills and 20,000 inhabitants, was represented by a few dwellings. But agriculture is the staple pursuit in the United States; and probably no country can be found exhibiting a more desirable variety of products of the soil, contributing to the sustenance and comfort of its inhabitants, and supplying articles of export. There is little skill exemplified or required in ordinary tillage, owing to the abundance of fertile land, which renders it superfluous to connect science with labour. Besides wheat and the common species of grain, flax and hemp, maize, rice, cotton, tobacco, and sugar, are the principal products.

Tennessee, Kentucky, Ohio, Virginia, and Indiana, are in their order the greatest producers of maize.

Kentucky is the chief district of flax and hemp.


UNITED STATES.
Long. W. from Greenwich
Classification of Places
Places of upwards of 100.000 inhabitants
from 50.000 to 100.000
from 10.000 to 50.000
below 10.000 inhabitants
Capitals of the States
Railways
Statistical divisions
Eastern States or New England
Middle States
Southern States
Western States
Unorganized States: Minnesota, Nebraska, Western Terr.
Texas
Scale of English Statute Miles
Section of the Allegheny Mountains from A to B
Level of the Sea
GULF OF MEXICO
ATLANTIC OCEAN
CANADA
WESTERN TERRITORY
NEBRASKA
MINNESOTA
IOWA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
MISSOURI
KENTUCKY
TENNESSEE
ARKANSAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
PENNSYLVANIA
NEW YORK
NEW HAMPSHIRE
TEXAS
L. SUPERIOR
L. MICHIGAN
L. HURON
L. ERIE
L. ONTARIO
QUEBEC
Montreal
Toronto
Boston
WASHINGTON
C. Hatteras

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Virginia, Kentucky, Tennessee, North Carolina, and Maryland, are the great tobacco-growing states.

Louisiana is the principal sugar district.

Mississippi, Georgia, Louisiana, Alabama, South and North Carolina, are the great cotton-growing states.

Cotton, the great article of export, was first sown in the United States about the year 1787. The crop is now more than one-half of the crop of the whole world. It averages 500,000,000 lbs., the principal half of which finds its way to England.

VII. Texas, formerly a part of the Mexican confederation, having declared itself independent in 1836, was annexed to the United States in 1845. The great western territory, extending to the coast of the Pacific, comprises the celebrated gold region of California, likewise obtained from Mexico, occupied by desperate and lawless adventurers from various countries, but chiefly Anglo-Americans. The entire possessions of the United States include an area estimated at 2,300,000 square miles.

XL. MEXICO AND GUATIMALA.

I. Mexico extends from the gulf of that name on the east to the Pacific Ocean on the west, and from the territory of the United States on the north, gradually narrowing to the contracted district of Central America on the south, which connects the two main masses of the western world.

Latitudinal limits.—Between 16° and 33° N.
Longitudinal limits.—Between 91° 30′ and 117° W.
Extent.—Length, about 1500 miles from north to south; breadth, varies from 700 miles in the north to 140 in the south; area, upwards of 1,000,000 square miles.

II. The great longitudinal mountain chain of North America traverses and largely occupies the country, forming a lofty central plateau region bounded by maritime lowlands, extending along the shore of the Mexican Gulf and the coast of the Pacific. The plateau has a mean height of from 6000 to nearly 8000 feet, and is the platform of volcanoes crowned with perpetual snow; one of which, Popocatepetl, near the city of Mexico, rising 17,720 feet, is the culminating point, and after Mount St. Elias, the highest eminence of North America. Earthquakes and volcanic eruptions have repeatedly altered the physical outlines of various districts. Owing to the extremely varied altitude of the surface, there is great diversity in the climate within comparatively narrow bounds. Passing from Vera Cruz on the Gulf to Acapulco on the Pacific, the traveller leaves the hot regions, *tierras calientes*, which include low grounds along the coasts, and ascending the plateau, the temperate regions, *tierras templadas*, are entered at the height of about 2000 feet, a further ascent bringing him to the cold regions, *tierras frias*, at the altitude of about 5000 feet. In the hot regions, the vegetation is tropical, and the summer heat excessive, marked with a periodic outbreak of the yellow fever; but in the temperate districts, the ordinary cereals flourish, with vegetable products analagous to those of Europe, and the pestilence is unknown. One of the chief physical disadvantages of the country is the want of navigable rivers; but no part of the world is richer in the precious metals, especially silver, besides possessing copper, lead, tin, and iron in great abundance.

Long before the Spanish conquest of the country, the native Mexicans were acquainted with the uses of several metals, and had made considerable advance in the art of obtaining them in a pure state, as well as in applying them to useful or decorative purposes. Cortes, in the account of his expedition, states that gold, silver, copper, lead, and tin, were publicly sold in the great market of Tenochtitlan. In all the large towns of Anahuac, gold and silver vessels were manufactured, and the Spaniards particularly admired the ingenuity of the goldsmiths. The Aztec tribes extracted lead and tin from the veins of Tlachco, and obtained cinnabar from the mines of Chilapan. Their arms, axes, chisels, and other implements, were made of copper, intermixed with tin, to give them the requisite hardness.

At the time of the revolution, when Mexico became independent of Spain, it contained nearly 500 places celebrated for their metallic treasures, comprehending nearly 3000 mines. The richest silver mine was discovered in 1558 in Guanaxuato, in a ravine, which alone yielded more than a fourth of the whole silver of Mexico, and a sixth of the produce of all America. The annual produce of the mines at the beginning of the present century, amounted in gold to 4289 lb. troy; in silver, to 1,439,832 lb.; in all, to 23,000,000 of piastres, equal to £5,031,250. The mint of Mexico furnished, from 1690 to 1803, more than 1,353,000,000 piastres, or £295,968,750; and from the Spanish conquest to the commencement of the century, Humboldt estimates the produce at probably 2,028,000,000 piastres, equivalent to £443,625,000.

The most important mines are situated in temperate regions, where the climate is favourable to agriculture; an advantage which does not belong to the lofty mining regions of the Bolivian Andes.

III. Mexico, formerly called New Spain, after a long and sanguinary struggle was acknowledged as an independent state by the mother country in 1822. It became for a short time an empire; but in 1824, the constitution was changed to a federal republic, analogous to that of the United States. But owing to internal dissensions, frequent civil wars, and repeated revolutions, its condition has in all respects sensibly declined since the era of independence; and this fine country, possessing inexhaustible mineral wealth, and commanding the greatest facilities for foreign commerce with the nations across the Atlantic and Pacific, is now remarkable for its political impotence, impoverishment, insecurity, and crime. Manufactures of any kind scarcely exist; agriculture has decayed through the neglect of the artificial irrigation promoted by the old Spaniards; mining operations have been largely suspended; and productive industry, to a considerable extent, has given place to subsistence by robbery. The total population is unknown, but is commonly stated at about 7,000,000. Mexico, the capital, in lat. 19° 25′ N., long. 99° W., one of the finest cities in the New World, surrounded with scenes of unsurpassed natural magnificence, is supposed to have nearly 150,000 inhabitants.

The Mexican population consists of several races:—1. *Gachupines*, or persons born in Europe, comparatively few; 2. Spanish *Creoles*, or whites of European extraction born in America, the dominant class; 3. *Indians* of the indigenous race, or native Mexicans, numerous and partially independent, but in a state of great moral degradation; 4. African *Negroes*; 5. *Mestizoes*, the descendants of whites and Indians; 6. *Mulattoes*, the descendants of whites and negroes; 7. *Zamboes*, the descendants of negroes and Indians.

The city of Mexico is situated in an oval-shaped valley 63 miles long by 43 broad, enclosed by a wall of porphyritic mountains, most elevated on the southern side, where the grand volcanoes of Popocatapetl and Iztaccihuate occur. But the valley is a basin of the plateau region; and the site of the capital, on the border of the lake of Tezenco, which marks the least elevated point, is 7483 feet above the sea level.

IV. The narrow tract of country extending from Mexico to the Isthmus of Panama, formerly for the most part under the dominion of Spain, comprises the republic of Yucatan, occupying the large peninsula of that name; the district of Belize, on the Gulf of Honduras, a settlement valuable for its supply of mahogany and other woods, of which Great Britain has had undisturbed possession since the year 1798, under the charge of a superintendent nominated by the Crown, aided by a local council; the Musquito territory extending along the coast of the Caribbean Sea, with an independent Indian population; and the United States of Guatimala, San Salvador, Nicaragua, Costa Rica, and Honduras, forming a federal republic in possession of the greater part of the region. Attention has long been directed to the project of opening a channel through this contracted portion of the continent, facilitating thereby the communication between the ports on the Atlantic and Pacific side, and between Western Europe and Eastern Asia. One plan proposed for this purpose is that of rendering the river San Juan navigable to the Lake of Nicaragua, and constructing a canal from that lake to the Pacific Ocean. Such a work, benefiting the commerce of the world, would be appropriately executed by combined effort on the part of the great maritime nations.

XLI. SOUTH AMERICA.

I. THE southern peninsula of the western world, or South America, has the Pacific Ocean on the west, the Antarctic on the south, the Atlantic on the east, and its arm the Caribbean Sea on the north, an oceanic boundary thus inclosing it in all directions, except at the north-west extremity, where a narrow neck of land connects it with North America.

Latitudinal limits.—12° 10′ N., Point Gallinas, and 54° S., Cape Froward, Strait of Magellan.

Longitudinal limits.—35° W., Cape St. Augustin, and 82° W., Isthmus of Panama.

Extent.—4700 miles from north to south; 3200 miles from east to west, where the greatest expansion occurs; area, estimated at 6,500,000 square miles.

The celebrated headland of Cape Horn, in lat. 56° 30′ S., part of a small rocky island, is the most southern prolongation of the continent.

II. The southern portion of the American continent, like the northern, has its great mountain system on the western side; but the Andes of South America run much closer to the Pacific Ocean than the Rocky Mountains, leaving only a narrow belt of country between them and the sea, and pressing so close to the shore in parts of their course as to form the coast line. The chain extends without a break on the mainland from north to south, and, including the insular continuations, has its southern termination at Cape Horn, the entire length being upwards of 4000 miles. It does not consist of a single ridge, but divides at intervals into double or triple ranges, more or less parallel to each other, which inclose elevated table lands, and form at the points of reunion a confused aggregation of masses, or mountain knots. North of the equator, the range becomes triple, and the three branches do not again unite, the western or coast branch continuing to the Isthmus of Darien. The Andes are narrowed in the extreme south to a width of not more than twenty miles; the general width is from sixty to seventy miles; but the greatest lateral extension amounts to nearly 400 miles in Bolivia. The loftiest and most powerful active volcanoes of the globe are comprised in the chain; that of Pichincha rising to the height of 15,920 feet; Cotopaxi, 18,890; Antisana, 19,140; all in Quito: and that of Aconcagua, in Chili, attaining the vast elevation of 23,200 feet, which appears to be the culminating point of the Andes, and of the whole western continent. The highest inhabited spot in the New World is the farm of Antisana, 13,470 feet. Three other systems of highlands break the surface of South America, the mountains of Venezuela running nearly at right angles to the Andes, and parallel with the Caribbean Sea; the mountains of Parime, or Guiana, between the Orinoco and the Amazon; and the mountains of Brazil, between the basin of the Amazon, the east coast, and the Rio de la Plata. But plains vastly predominate in the physical geography of the country, the llanos of the Orinoco, the selvas of the Amazon, and the pampas of Buenos Ayres, comprehending an area in the proportion of four to one to that occupied by the mountains.

The Chimboraço, in Quito, 21,423 feet, was formerly supposed to be the loftiest summit of the Andes. But relying upon the accuracy of Mr. Pentland's trigonometrical measurements in 1827 and 1838, the Nevado de Sorata, in the eastern cordillera of Bolivia, 25,250 feet passed for the culminating point down to June, 1848, when his map of the basin of the Lake of Titicaca was published. It now appears from a more exact calculation of the trigonometrical operations, that the elevation ascribed to this mountain is far too great; and that the Peak of Sahama, 22,350 feet, is the loftiest of the Bolivian Andes. This height, though superior to that of the Andes of Quito, is inferior to that of the volcano of Aconcagua, one of the Chilian Andes, measured by the expedition of the "Beagle," under Captain Fitzroy, 23,200 feet, which, as far as at present known, is the highest point of the New World.

The name *Andes*, or *Antis*, in the language of the Incas, is supposed to have been applied to these mountains owing to their metallic wealth, being probably derived from a Peruvian word *anta*, which signifies copper and metal in general. By the Spaniards they were styled Cordilleras de los Andes, or the Chains of the Andes, and hence the word Cordillera singly is sometimes used to denote them.

HEIGHT OF THE PRINCIPAL PASSES OF THE ANDES.

	Feet.
Tocracruz, Bolivia	15,790
Portachuato di Tucto, Peru	15,750
Alto de Toledo, Bolivia	15,590
Ladera di Caalud, Ecuador	15,527
Portillo, Chili	14,365

III. The maritime position of the Andes forbids the formation of any considerable stream on the slope towards the Pacific, but the chain contains the sources of the most extensive water-system of the globe, that of the Amazon, developed in the vast tract of country on the opposite side, with other rivers of the first class as to magnitude, the Orinoco and La Plata. The Amazon has a course of 3550 miles. Though of inferior length to the Mississippi-Missouri, it drains a greater extent of surface in a region remarkable for excessive humidity, and discharges a far larger volume of water. Its most remote source is in the Bolivian Andes, where the Apurimac takes its rise, north-west of Lake Titicaca. The tide ascends the river to Obidos, 400 miles from its mouth, and upon its recession liberating the imprisoned current, it rushes out with prodigious force, the influence of the stream being perceptible far out in the Atlantic. To the distance of 2000 miles in a direct line from the ocean, there is depth of water for vessels of almost every description. In the upper parts of its course, the Amazon averages from one to two miles in width, but acquires considerable expansion lower down, the opposite banks being seen with difficulty towards the estuary, the breadth of the estuary at its mouth amounting to 180 miles. In the rainy season an immense extent of country along its banks is deluged by the overflowing of the river. Many of its tributaries exceed the largest streams of Western Europe, and some are equal to the Volga. The basin of the Orinoco lies to the north of that of the Amazon, but both mingle their waters through the natural channel of the Cassiaquaire, forming a unique example of navigable communication subsisting between two independent river-systems unaided by artificial means. The La Plata designates the great confluent streams of the Parana and Paraguay, draining the country south of the Amazon, and the extensive estuary through which they reach the Atlantic. South America is as deficient in lakes of important magnitude as the northern peninsula is distinguished by them; but the lake Titicaca on the Bolivian table-land is, next to the Sir-i-kol in Central Asia, the most elevated expanse of which we have any knowledge, being 12,795 feet above the level of the sea.

The Amazon has been so named from the early discoverers observing armed women on its banks—a supposed race of amazons. It is frequently styled the Maranon, probably from some nation of that name on its course; and the Orellana by the Spanish geographers, from Francesco Orellana, a Spaniard, who first accomplished the descent of the river from Peru in 1539. The Amazon, Mississippi-Missouri, and Yang-si-Kiang, the three largest rivers of the globe, strikingly display the contrast between rude tribes and civilized communities. Commanding important navigable channels, more vessels probably pass along the Chinese river in a single day, and along its North American rival in a week, than are to be found on the mighty Amazon during the whole year.

IV. Stretching from 12° north of the equator to 56° south, the South American peninsula exhibits very different climatic conditions, its northern regions being exposed to the heat of the tropics, while its southern extremities are cold and comfortless districts. But independent of varying latitude, the vast wall of the Andes, with its colossal summits, lofty plateaus, and deep valleys, induces striking variations of temperature within circumscribed spaces; heights clad with permanent snow being discernible from low burning plains, while an intermediate table-land, as that of Quito, though under the equator, enjoys a temperate climate. That mural ridge also, by intercepting the moisture drifted from the Atlantic by the trade winds, remarkably influences the distribution of rain, little or none falling on the Peruvian coast, while perfect deluges descend upon the plains of the Amazon. Hence the unexampled exuberance of the vegetation in that region, clothed with forests, the growth of thousands of years, formed into impenetrable fastnesses by the interlacing of enormous parasitical plants, the combined effect of great heat and moisture. Animal life is not less prolific, the insect tribes being intensely developed, with reptiles, birds, and various orders of mammalia. Alligators haunt the rivers, pools, and swamps; countless numbers of birds of gorgeous plumage, and monkeys of various families, throng the woods; the panther-like jaguar, the most formidable of the South American carnivora, lurks in the dense vegetation; while the condors, lamas, vicunas, alpacas, and guanacos have their habitat marked out by the line of the Andes, ranging from the Strait of Magellan to the north of the equator, but not passing the Isthmus of Darien, which is also the north limit of the jaguar.

North and South America possess about 537 species of mammals, of which 57 belong likewise to the other continents, leaving 480 species peculiar to the western world:—

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Drawn & Engraved by J. Dower Pentonville

Drawn & Engraved by J. Dower, Pentonville, London

	No. of American Species.	No. of Species peculiar to America.	No. of Species common to America and other parts of the globe.
Quadrumana	82	82	0
Cheiroptera	82	82	0
Carnivora	140	106	34
Marsupialia	18	18	0
Rodentia	133	126	7
Edentata	20	20	0
Pachydermata	6	6	0
Ruminantia	30	28	2
Cetacea	26	12	14
	537	480	57

All the quadrumana, edentata, and pachydermata, belong exclusively to South America.

V. The chief insular dependencies of this great region consist of a number of islands in the Caribbean Sea belonging to the West India group; the Falkland Isles, off the south-east coast of Patagonia, a large but desolate and monotonous cluster in the possession of Great Britain, with scarcely fifty residents besides the slender garrison; the Patagonian Archipelago, close in shore on the south and west of that country, the southern group forming the Tierra del Fuego, occupied by a scanty population of wretched Fuegians, and terminating with Cape Horn; and the Galapagos Archipelago, a volcanic formation upwards of 500 miles west of the continent, intersected by the equinoctial, and belonging to the republic of the Equator.

XLII. COLOMBIA.

NEW GRENADA. VENEZUELA. EQUADOR.

I. Upon the revolt of the Spanish colonies in South America from the despotic control of the mother country in 1810, and the triumph of the patriots in the ensuing long and sanguinary struggle, the northern provinces formerly included in the viceroyalty of New Grenada and the Caraccas, were constituted in 1819 a republican state, under the name of Colombia, which was finally cleared of the royalist forces in 1822. It embraced the territory extending from the Caribbean Sea, on the north, to the Amazon, on the south; and from British Guiana, on the east, to the coast of the Pacific, on the west. But, in 1831, this region was divided into the three republics of New Grenada, Venezuela, and Equador.

Latitudinal limits.—Between 12° 20′ N., and 5° 20′ S.
Longitudinal limits.—Between 60° and 82° W.
Extent.—About 1120 miles from north to south along the meridian of 74°; 1300 miles from east to west, following the parallel of 8° N.; area estimated at 1,160,000 square miles.

II. New Grenada includes the north-western section of South America, between the coast of the Pacific Ocean and the Caribbean Sea, and the Panama isthmus, and comprehends an area of 380,000 square miles; Venezuela forming the continental boundary on the east, and the Equador on the south; a portion of Brazil interposing between them. The country comprehends an area of 380,000 square miles, consisting generally of a maritime mountainous region, and great inland plains. The Andes enter it from the south, clustered into a single group, or mountain knot; but immediately dividing, three chains run nearly parallel northwards, walling in great longitudinal valleys; that of the Magdalena, the principal river, lying between the central and eastern chains; and that of the Cauca, its leading affluent, between the central and western. The central chain is the most elevated, and contains the culminating point of South America north of the equator. This is the truncated cone of Tolima, rising 18,320 feet, covered with perpetual snow, one of the ordinary passes of the range lying at its foot, over the mountain of Quindiu, the highest part of the road ascending to 14,500 feet. Eastward from the mountain region to the Orinoco are the plains, which correspond in the south to the selvas of the Amazon, being covered with vast forests; but form part of the llanos in the north, running into Venezuela—treeless steppes, with the exception of a few palms and bushes, alternately changed into pastures and deserts in the rainy and dry seasons. The population is probably upwards of 1,500,000, composed of the descendants of Spanish settlers, of native Indian tribes, and a few negroes. The latter formed the best soldiers during the war of independence, and were largely cut off in the course of that terrible conflict. Santa Fe de Bogota, the capital, in lat. 4° 40′ N., long. 74° 10′ W., containing about 30,000 inhabitants, is seated on elevated table-land, 8,650 feet above the sea, on the west side of the eastern cordillera.

Bogota has in its neighbourhood the natural bridges of Iconozo, consisting of masses of rock lying across a ravine of immense depth; and the magnificent cataract at Tequendama, a fall of 650 feet, formed by the descent of the river Bogota from the table-land of the capital towards the bed of the Magdalena.

Carthagena, near the north-east point of the Gulf of Darien; Panama, on the south-east of the Isthmus; Popayan and Socorro, on the Andean table-lands, are the principal places after the capital.

New Grenada possesses considerable mineral wealth. The forests furnish various kinds of dye-woods, with the well-known medicinal Peruvian bark of commerce. Herds of horses, mules, and horned cattle are reared on the plains. Cacao, cotton, sugar, tobacco, coffee, indigo, and rice are cultivated. There are manufactures of coarse cottons, woollens, and straw hats at Socorro and Tunja.

The country was discovered by the Spaniards in 1499. Their first settlement was made on the Gulf of Darien in 1510.

III. Venezuela extends along the Caribbean Sea and Atlantic Ocean, from the west of the Gulf of Maracaybo to the principal mouth of the Orinoco, the coast line amounting to nearly 1600 miles; British Guyana on the east, Brazil on the south, and New Grenada on the west, forming the continental boundaries. The area included is estimated at 450,000 square miles. Though occupied in the south-east with mountains, and in the north-west and north with continuations of the Andes, which run along the coast in an unbroken rampart, from the Gulf of Triste to the promontory of Paria, the plains, or llanos, whose general character is indicated above, vastly predominate. They compose more than three-fourths of the country; extend between the two mountain regions named; are traversed by the Orinoco and its tributaries; and are in some instances so perfectly level, that the current of the stream is scarcely perceptible, and may be inversed by a contrary wind. The remote sources of the great river have never been visited by any European; but at the distance of 560 miles from its mouth, Humboldt found its breadth when full to be upwards of three miles. Venezuela contains a population supposed to amount to nearly 1,000,000, composed of whites of Spanish descent, a considerable number of native Indians, and negroes, mixed races forming a majority. Its industrial products are similar to those of New Grenada, but are raised upon a much more extensive scale, and largely exported. Caraccas, the capital, near the north coast, in lat. 10° 30′ N., long. 66° 45′ W., has upwards of 20,000 inhabitants; but had more than double that number previous to the earthquake, which nearly destroyed it in 1812, and the political catastrophes of the revolution.

Coffee, cotton, sugar, and tobacco, are the important objects of culture, but the number of useful plants cultivated is said to exceed 180, the forests containing 240 species of valuable woods, besides 36 plants yielding gums and resins, and 45 which produce medicinal drugs.

The aggregate of domestic animals in the llanos is immense, and constitutes the chief wealth of the State, a considerable number of horses and horned cattle being annually exported to the West Indies.

Coarse cotton and woollen fabrics are made in various places; hammocks at Coro; carpets at Merida, scarcely inferior to those of Europe; and tanning is extensively conducted.

Venezuela was first discovered by Columbus in 1498, who reached the mouth of the Orinoco, and sagaciously inferred that the land supplying such an immense body of fresh water must be a continent, not an island.

IV. Equador, inclosed by the Pacific on the west, New Grenada on the north, Brazil on the East, and Peru on the south, contains an area estimated at upwards of 320,000 square miles. It derives its name from the circumstance of lying under the equator. The Andes traverse the western side, grandly developed in the towering heights of Chimborazo, Cotopaxi, and Antisana; the country eastward, comprising the principal portion of the territory, consisting of forests and savannahs, intersected by the tributaries of the Amazon. The population is vaguely rated at 600,000, the aboriginal Indians outnumbering those of Spanish origin. Quito, the capital, in lat. 15′ S., long. 78° 45′ W., occupies an elevated site in the Andes, 9540 feet above the level of the sea, and has upwards of 50,000 inhabitants. Guayaquil, on the coast, the seat of all the maritime commerce, and Cuença, are the other chief towns. Near Cuença is the Paramo de Assuay, where the great road connecting New Grenada and Peru attains the height of 15,536 feet, the passage of which is annually attended with many fatal casualties. The medicinal fever-bark forms an important article of export, the most efficacious of all the species being obtained from the Quina woods, growing on the eastern declivities of the Andes, towards the Peruvian border.

XLIII. BRAZIL.

GUYANA. PARAGUAY. URAGUAY.

I. Brazil, the most extensive territory of South America, comprehends its eastern and central districts, and borders all its other countries with the exception of Chili and Patagonia, having a coast line on the Atlantic extending from Cape Orange in the north to the mouth of the Rio Grande de S. Pedro in the south, measuring upwards of 3500 miles.

Latitudinal limits.—5° N., frontier towards Venezuela, and 32° 30′ S., lake of Mirim, on the border of Uraguay.

Longitudinal limits.—35° W., Cape St. Augustin, the most easterly projection of South America, and 72° W., frontier towards Equador.

Extent.—About 2600 miles from north to south; 2400 miles from east to west; area, 2,500,000 square miles.

II. The country comprises a highland and a lowland region, dividing it into two nearly equal parts. The highlands in the east and south consist of several chains of moderate elevation, the highest point of the surface, Pico dos Orgaos, 7,500 feet, lying near the coast immediately behind Rio de Janeiro. The lowlands in the north and west embrace nearly the whole basin of the Amazon, a forest-clad undulating plain intersected by the majestic flood from west to east, the country along its banks being traversed by its great affluents the Madeira, Topayos, Xingu, and Rio Negro, and their tributaries. This district is almost entirely in a state of nature, and must remain for ages to a considerable extent untouched by the hand of man. Though accessible by means of the rivers, their banks are lined with gigantic trees and underwood, so closely matted together by creeping plants as to form a scarcely penetrable wall of vegetation, the front rank of a dense mass of foliage extending for leagues behind it. The aspect of the surface is altogether different in the highland region, which, with rich woodland tracts, comprises treeless salt steppes, and extensive pasture grounds, the latter sustaining vast droves of domestic cattle. The population, including all classes, independent Indian tribes, Portuguese and their descendants, negroes and mixed races, is probably not less than 6,000,000, half of whom are negro slaves. Rio Janeiro, the capital, on the south-east coast, in lat. 22° 53′ S., long. 43° W., is the largest city of South America. It contains upwards of 200,000 inhabitants, and possesses one of the finest harbours in the world.

Brazil, formerly a possession of Portugal, was declared an independent state, October, 1822, under a prince of the House of Braganza, who adopted the title of Emperor. The constitution is an hereditary monarchy, limited in its powers by a representative assembly.

The principal towns are on the coast,—Bahia, or St. Salvador, Pernambuco, Maranhao, and Para ranking after the capital as commercial ports. The only important place far inland is Villa-Bella, in a mining neighbourhood. In Brazil generally the occupied and cultivated spots are in the maritime provinces, farms becoming fewer, and occurring at greater distances on receding from the coast. Cotton, coffee, sugar, and tobacco, are important articles of export, with woods from the forests for ornamental furniture and dyeing; cacao, vanilla, cloves, cinnamon, caoutchouc, sarsaparilla, balms, and resins. The country has long been celebrated for its precious stones, especially diamonds and topazes. Gold is also obtained from mines in the mountains, but principally from the alluvial deposits of the rivers. Iron is also very abundant, almost the entire masses of some mountains consisting of the ore. The district where the greatest number of diamonds have been found occupies both sides of the Sierra Espinhaco, about lat. 18° S., almost due north of Rio Janeiro. They are obtained chiefly from the beds of the rivers.

III. Guyana properly designates the whole country between the Orinoco on the north, the Rio Negro on the west, the Amazon on the south, and the Atlantic on the east, but the principal part of this region is included in the Brazilian and Venezuelan territories, a maritime portion belonging to Great Britain, Holland, and France. British Guyana, the western district, extends along the coast between the Orinoco and the Corentyn river, and comprehends the country inland to the sources of the Essequibo, the area amounting to upwards of 60,000 square miles. But its inland range has never yet been settled; and the interior was almost entirely unknown till visited in 1835 by Sir Robert Schomburgh under the auspices of the Royal Geographical Society. The tracts adjacent to the coast are low, flat, and unhealthy; but behind these the surface undulates, rises into eminences and highland ranges, clothed with great luxuriance of vegetation. Dutch Guyana, a central smaller district, of a similar character, extends along the coast from the Corentyn river to the Marony; and French Guyana, the smallest and most easterly territory, stretches from Marony to the Oyapok river, the boundary from Brazil. The products are those common to tropical America.

British Guyana is divided into the three districts of Demerara, Essequibo, and Berbice, the names of rivers. It contains a population of about 100,000, exclusive of the Aborigines, consisting mostly of emancipated negroes, the few whites being English, but chiefly descended from the old Dutch occupiers. Georgetown, the capital, on the Demerara river, contains about 20,000 inhabitants. The colony is under a lieutenant-governor.

Dutch Guyana has a population of about 70,000, chiefly negro slaves, with Paramaribo, a considerable town on the Surinam river, for the capital.

French Guyana contains a population of about 30,000, with Cayenne, a miserable place on an island, for the capital.

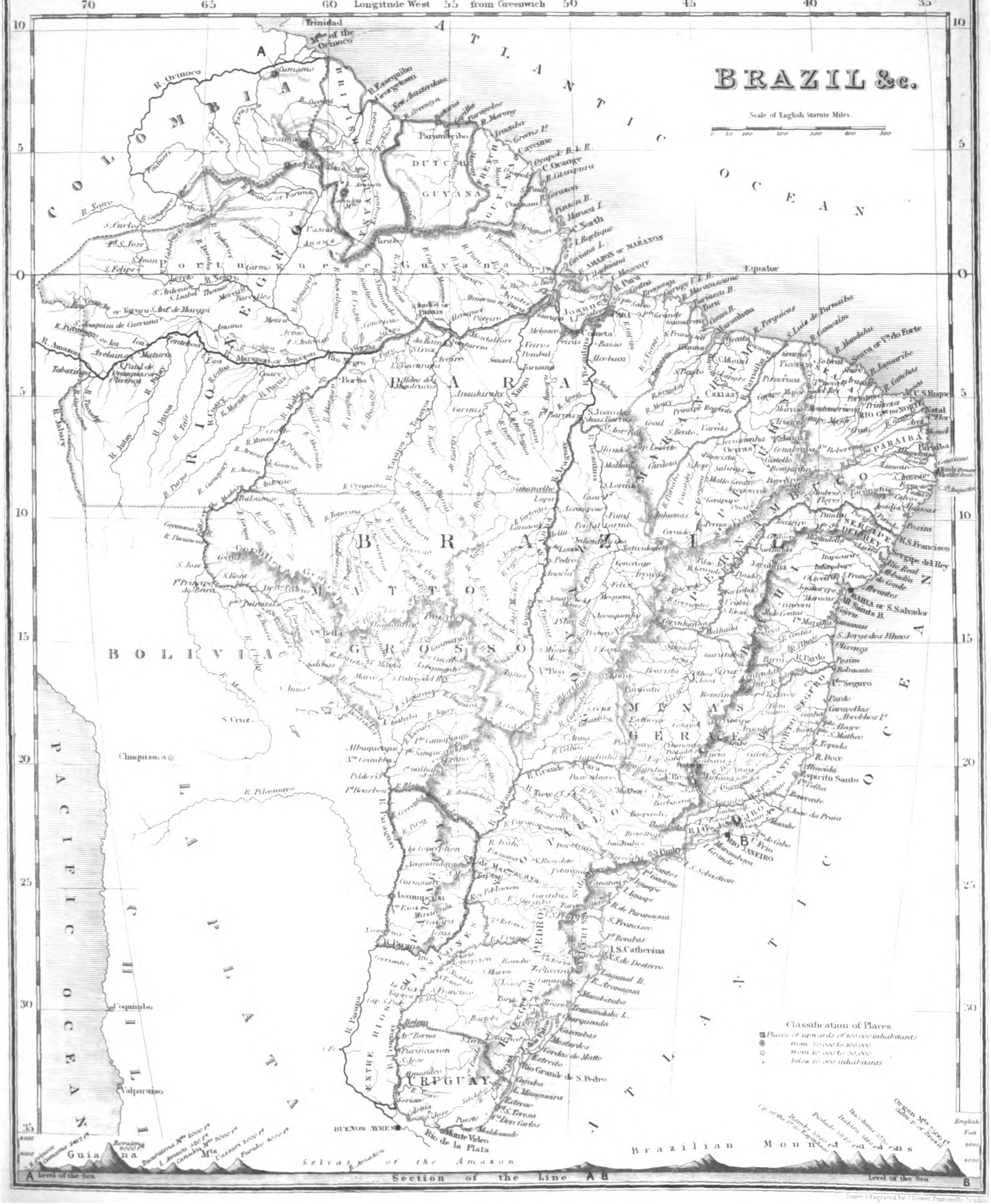
The British took possession of the whole of Guyana during the last European war, but restored the present Dutch and French portions at the peace of 1814.

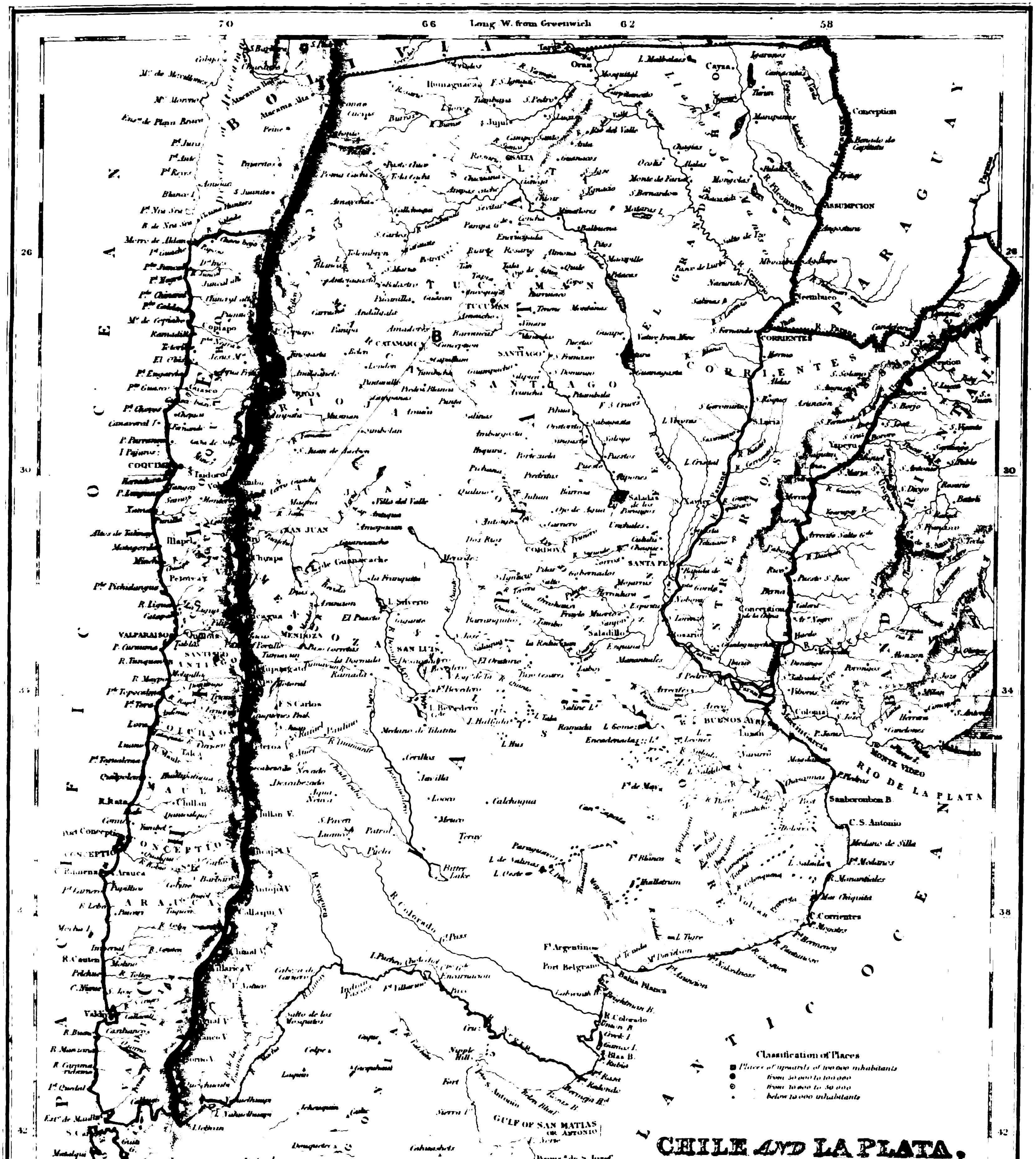
IV. Paraguay, an inland territory inclosed by Brazil and the united states of the La Plata, consists of the country between the Parana and Paraguay rivers, extending northwards from their confluence upwards of 400 miles, with Assumption for the capital, a small mean city finely situated on the left bank of the latter river. The area of this state is estimated at 80,000 square miles, and the population at 250,000.

This district is very imperfectly known, owing to the long reign of terror to which it was subject upon the declaration of independence, under the dictatorship of the infamous Francia, who sustained his own tyranny by forbidding intercourse with foreigners.

The indigo plant and Indian rubber tree grow wild, with the evergreen in great abundance, the leaves of which furnish the Paraguay tea, *yerba-mate*, used as commonly as the teas of China in Europe.

V. Uruguay, or the Banda Oriental, is a territory of about 75,000 square miles, and 120,000 inhabitants, between Brazil, the Atlantic, the La Plata estuary, and the Uruguay river. After a contest for its possession between the republic of La Plata and the Brazilians, both parties agreed to recognise it as an independent state in the year 1828. Monte Video, the capital, styled after a hill of that name in its neighbourhood, is only of consequence for possessing the best harbour on the Plata.


BRAZIL &c.
Scale of English Statute Miles.
Longitude West 55 from Greenwich
ATLANTIC OCEAN
PACIFIC OCEAN
COLOMBIA
BRITISH GUYANA
DUTCH GUYANA
Portuguese Guyana
RIO NEGRO
PARA
MATTO GROSSO
BRAZIL
BOLIVIA
MINAS GERAES
LA PLATA
CHILI
URUGUAY
ENTRE RIOS
Equator
Trinidad
Cayenne
R. AMAZON or MARANON
Chuquisaca
Coquimbo
Valparaiso
BUENOS AYRES
Monte Video
Rio de la Plata
BAHIA or S. Salvador
RIO JANEIRO
Classification of Places
Places of upwards of 100,000 inhabitants
from 50,000 to 100,000
from 10,000 to 50,000
below 10,000 inhabitants
Guiana
Brazilian Mountains
Selvas of the Amazon
Section of the Line A B
Level of the Sea
English Feet



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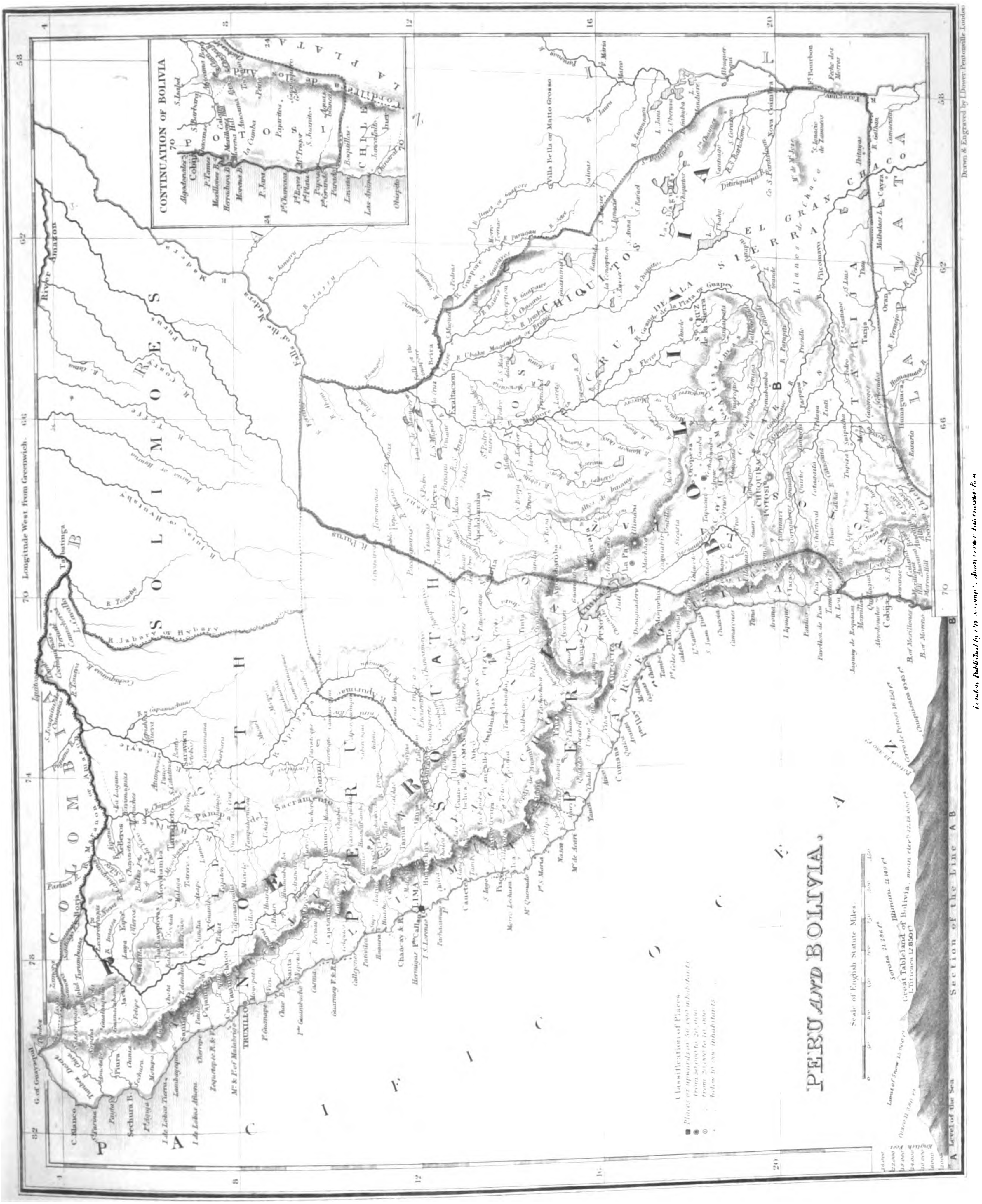

PERU AND BOLIVIA
Longitude West from Greenwich
CONTINUATION OF BOLIVIA
Classification of Places
Scale of English Statute Miles
Section of the Line A B
Level of the Sea
Drawn & Engraved by J. Dower, Pentonville, London

XLIV. CHILE AND LA PLATA.

I. **Chile** consists of the strip of country between the Pacific and the crests of the Andes, extending from the border of Bolivia, in lat. 25° 30′ to nearly 42° S.; but the republic claims the territory along the coast to the Strait of Magellan, though there has been no actual occupation of it. The large island of Chiloe, and its archipelago, close to the mainland, stretching about 2° beyond its southern limit, and the small insulated group of Juan Fernandez, westward of Valparaiso, belong to the state.

The entire extent is about 1,170 miles from north to south, by 150 miles at a mean from east to west, including an area of 170,000 square miles.

II. The eastern mountain boundary contains some of the highest points of the Andes, if not the most elevated summit; and fine glimpses of its rugged outline and conical masses may be caught from most parts of the country. There are upwards of twenty active volcanoes; and perhaps in no region of the globe are earthquakes more frequent, slight shocks being ordinary events, and great catastrophies occurring at intervals. In the northern and central districts the vegetation is very scanty, owing to the dryness of the climate, no rain falling through the greater part of the year. Trees appear only in the deep valleys; but proceeding southwards, where rain is more abundant and the dews are heavier, the country becomes largely clothed with verdure, until the surface is completely hidden by one impenetrable forest, the fine timber-trees forming one of the important articles of export. Agriculture and mining are the principal occupations. The minerals include gold, obtained in small quantities from the sands of the Andean streams, silver more abundantly, and copper in great profusion, the copper ores being shipped to Swansea, in Wales, to be smelted. Chile contains a white population of Spanish descent, a few negroes and mulattoes, and Indian tribes, chiefly in the south; the total number of all classes not falling far short of 1,500,000. Santiago, the capital, in lat. 33° 20′ S., long. 70° 45′ W., delightfully situated on an extensive plain abutting against the base of the Andes, studded with acacia woods, contains upwards of 60,000 inhabitants. Valparaiso, Conception, and Coquimbo, are the important sea-ports, in which the foreign trade of the republic centres; now one of the most flourishing of the South American states.

The Spaniards never conquered the whole of Chile, and the Indian tribes in the south are still independent. The liberation of the country from the dominion of Spain was effected by the battle of Maypu, April 5, 1818.

III. The provinces of La Plata, often styled the Argentine Republic, occupy the vast region extending eastward from Chile to Paraguay, the Banda Oriental, and the Atlantic; bounded on the north by Bolivia, and on the south by Patagonia, where there is no determinate limit. A small colony, established half a century ago, under the old Spanish government, near the mouth of the Rio Negro, lat. 41°, about three hundred miles south of the estuary of the Plata, is still the most southernly position occupied by civilized man on the east coast of America.

The extent is upwards of 1,300 miles from north to south, by a medium breadth of 500 miles, comprehending not less than 900,000 square miles.

IV. Excepting the country at the base of the Andes, diversified by its roots and isolated hilly ridges, few and far between, the surface consists of nearly level plains, or pampas, covered with an immense depth of alluvial soil, and clad with a luxuriant growth of coarse grass, or other kinds of herbaceous vegetation, but presenting no tree through vast spaces to relieve the monotony of the landscape. Other districts have a different aspect, being swampy, thickly set with canes and reeds, and interspersed with shallow small lakes and ponds; and a great tract, where the soil consists of loose sand impregnated with saline matter, bears the name of Las Salinas, or Salt Desert, corresponding in its character to the Salt Steppes of Asia. Millions of horned cattle, horses, and sheep, are reared on the pampas, whose hides and horns are exported in enormous quantities. The population is very scanty, chiefly of Spanish descent, amounting probably to not more than 700,000, excluding the native Indians. Buenos Ayres, the capital, in lat. 34° 36′ S., long. 58° 10′ W., is on the south bank of the La Plata estuary, opposite Colonia, distant about 36 miles, on the northern shore. The city, very regularly built, is one of the most important in South America, containing 60,000 inhabitants. The Argentine Republic, a confederation of thirteen provinces, nearly independent in internal affairs, but uniting for common purposes under a general congress and president, was formed in 1819, under the style of the United States of the Rio de la Plata. But the constitution had only a nominal existence, and, after a series of revolutions, the chief authority on the Plata is now an irresponsible military dictatorship.

XLV. PERU AND BOLIVIA.

I. **Peru** extends on the coast of the Pacific from the Gulf of Guayaquil in the north, to the mouth of the Loa River in the south, between lat. 3° 20 and 20° 21′ S., inclosed inland by the territories of Equador, Brazil, and Bolivia. The Amazon forms for a considerable space the boundary from Equador, and its affluents, the Gabary from Brazil, and the Purus from Bolivia.

The extent is given at 1500 miles from north to south; the greatest breadth is not far short of 600 miles.; the area is upwards of 500,000 square miles.

II. Peru consists of three distinct natural regions, formed by the central mountains and the districts on the west and east. The Andes intersect the country parallel to the coast in two grand chains; the western or maritime chain running at the average distance of from sixty to seventy miles from the sea, and forming the point of partition between the rivers flowing to the Pacific and Atlantic Oceans. They inclose between them vast tracts of monotonous and dreary table-lands, at the height of 12,000 feet, to which the Spaniards applied the name of *Despoblado*, the uninhabited, scantily covered with grasses, the sterile soil and cold climate admitting only of very limited agriculture. Both chains are rich in metallic produce, the principal wealth of Peru. The western region between the mountains and the ocean, or the coast country, though supplied with streams fed from the Andean snows, has no navigable rivers, and contains many desert tracts, owing to rain never falling; but has great fertility in places where heavy dews or artificial irrigation is supplied. The eastern inland region, stretching out towards Brazil, consists of generally well wooded plains, watered by the tributaries of the Amazon. North Peru is divided into three provinces; South Peru into four; the total population perhaps exceeding 1,500,000, including the aborigines. Lima, the capital, in lat. 12° S., long. 77° W., about six miles inland from the port of Callao, contained, in 1842, 53,000 inhabitants; the whites consisting chiefly of the descendants of Spaniards, but people of colour, mixed races, predominating. Owing to the earthquakes, most of the houses are only one story high, and some have only the ground-floor. Cuzco, the ancient capital of the Incas, situated on a plateau, 11,380 feet above the sea, is nearly as populous as Lima.

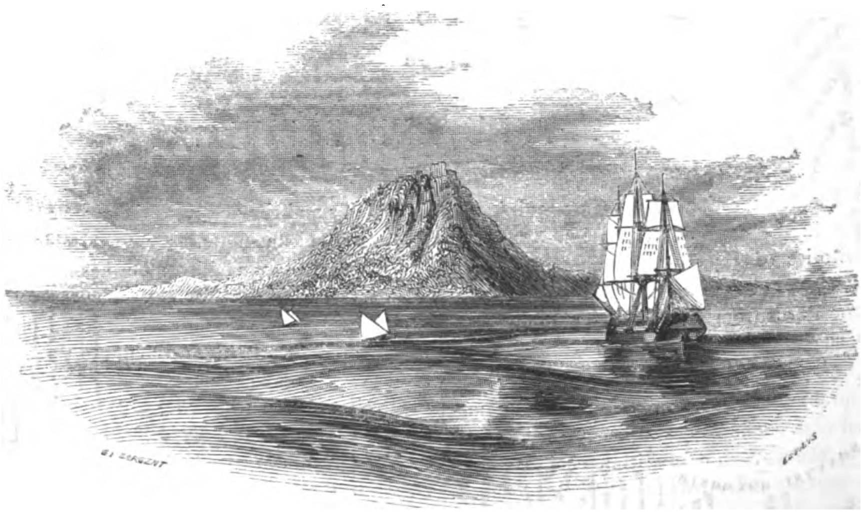
The mineral wealth of Peru is proverbial. Gold is rare in mines, but is collected from the sands of several rivers. Silver, the principal product, occurs in great abundance in the mountains, presenting itself in all forms and combinations, from the pure metal to the argentiferous lead-ore. At the highest elevations, in parts scarcely trodden by human footsteps, rich veins of silver have been discovered, and new streaks are frequently encountered. Cerro de Pasco, a town in the province of Junin, at the height of 13,673 feet above the sea level, is famed for its stores of wealth, which have drawn to that elevated region, on the confines of the perpetual snows, a population of 18,000. There are two remarkable veins of silver, respectively 380 and 412 feet in breadth, which have been traced 6,400 and 9,500 feet in length, and are supposed from their direction to intersect one another under the market-place of the town. There are other districts equally rich in silver; quicksilver is likewise found; and copper, lead, and iron ores in abundance.

The battle of Ayacucho, in 1824, finally delivered Peru from the yoke of Spain. The republican constitution adopted was modeled after that of the United States. But successive revolutions distracted the country, till the four southern provinces separated from North Peru, in 1836, and formed themselves into a distinct state.

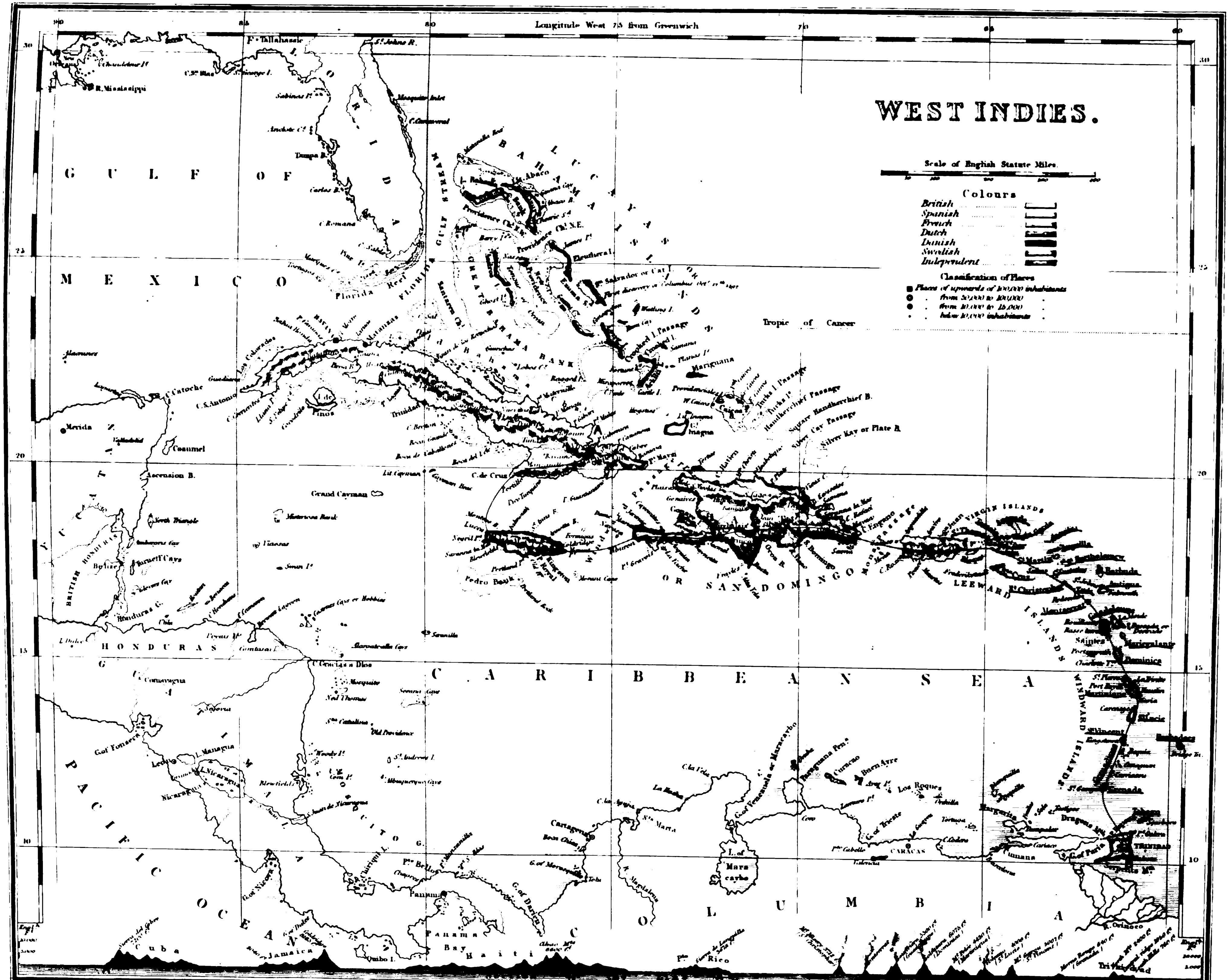
III. Bolivia,—an extensive territory of 350,000 square miles, inclosed by Peru, Brazil, Paraguay, the La Plata states, and Chili,—is only to a very small extent a maritime region, having a coast line of little more than 250 miles on the Pacific between the Peruvian and Chilian states. An enormous plateau formed by the main mass of the Andes, and inclosed by two longitudinal ridges, which tower above it, is the great physical feature of the country. It extends 240 miles in mean width, 400 miles in length, and covers an area of 100,000 square miles, the general elevation of the surface being from 12,000 to 13,000 feet. The plateau contains the largest Alpine lake of the globe, that of Titicaca, and the basin of its outlet the Desaguadero River, which, after a course of 180 miles, is lost in sands and swamps. It sustains no trees, and the ordinary cereals will not ripen, but produces abundance of coarse grass, and some beautifully green turf in the lowest districts. The principal portion of the country lies east and north of the plateau, consisting towards Brazil of primeval forests, in the hands of wild Indian tribes. Its coast region is for the most part a sandy desert. Bolivia, formerly called Upper Peru, upon becoming an independent state, took its present name in honour of General Bolivar; but it has been one of the least fortunate, and is one of the least known of the so-called South American Republics. Chuquisaca, the capital, is on the south-east slope of the great table-land. Potosi, celebrated for its silver mines, on the table-land itself, is at the foot of the Cerro de Potosi, which is pierced with mines in every direction, now neglected or exhausted. The great square of the city is 13,350 feet above the sea level, about 9000 inhabitants at present representing a population said to have amounted to 160,000 in the days of its mining industry.

XLVI. WEST INDIES.

I. THE archipelago of the West Indies consists of a chain of islands, extending in a curving line from north-west to south-east, or from the mouth of the Gulf of Mexico and the south-eastern seas of the United States to the delta of the Orinoco, continuing westward along the coast of Venezuela. The chain comprises five large and about fifty smaller islands, with a multitude of rocky islets, coral reefs, and sandbanks, forming a kind of division between the basins of the Atlantic Ocean, the Caribbeean Sea, and the Mexican Gulf. The archipelago lies between the parallels of 10° and 27° N., and between the meridians of 59° and 55° W. It is distributed into the three groups of the Bahamas, the Greater Antilles, and the Lesser Antilles, which are mostly in the possession of different European powers.



Island of St. Eustatia, West Indies.



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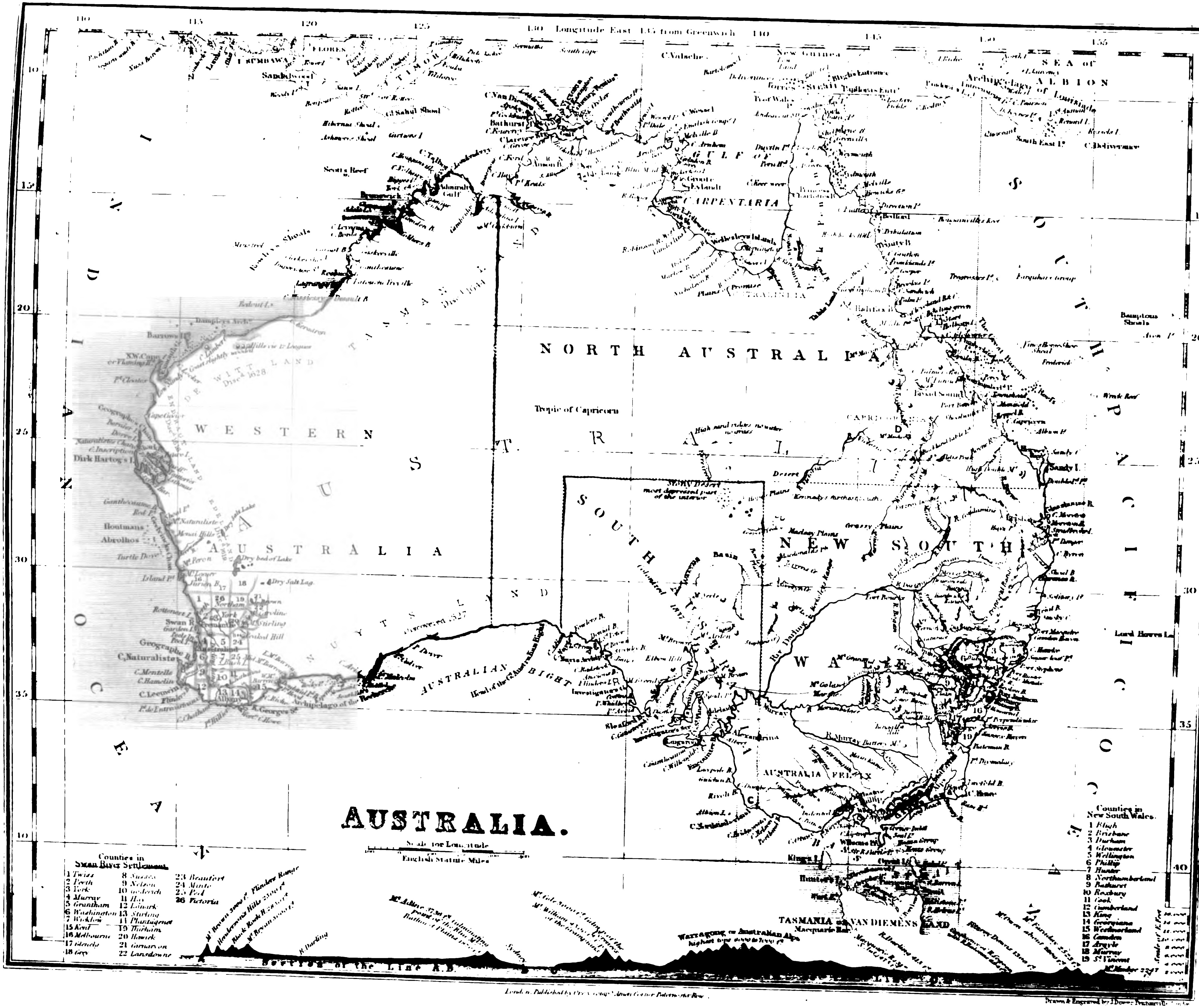
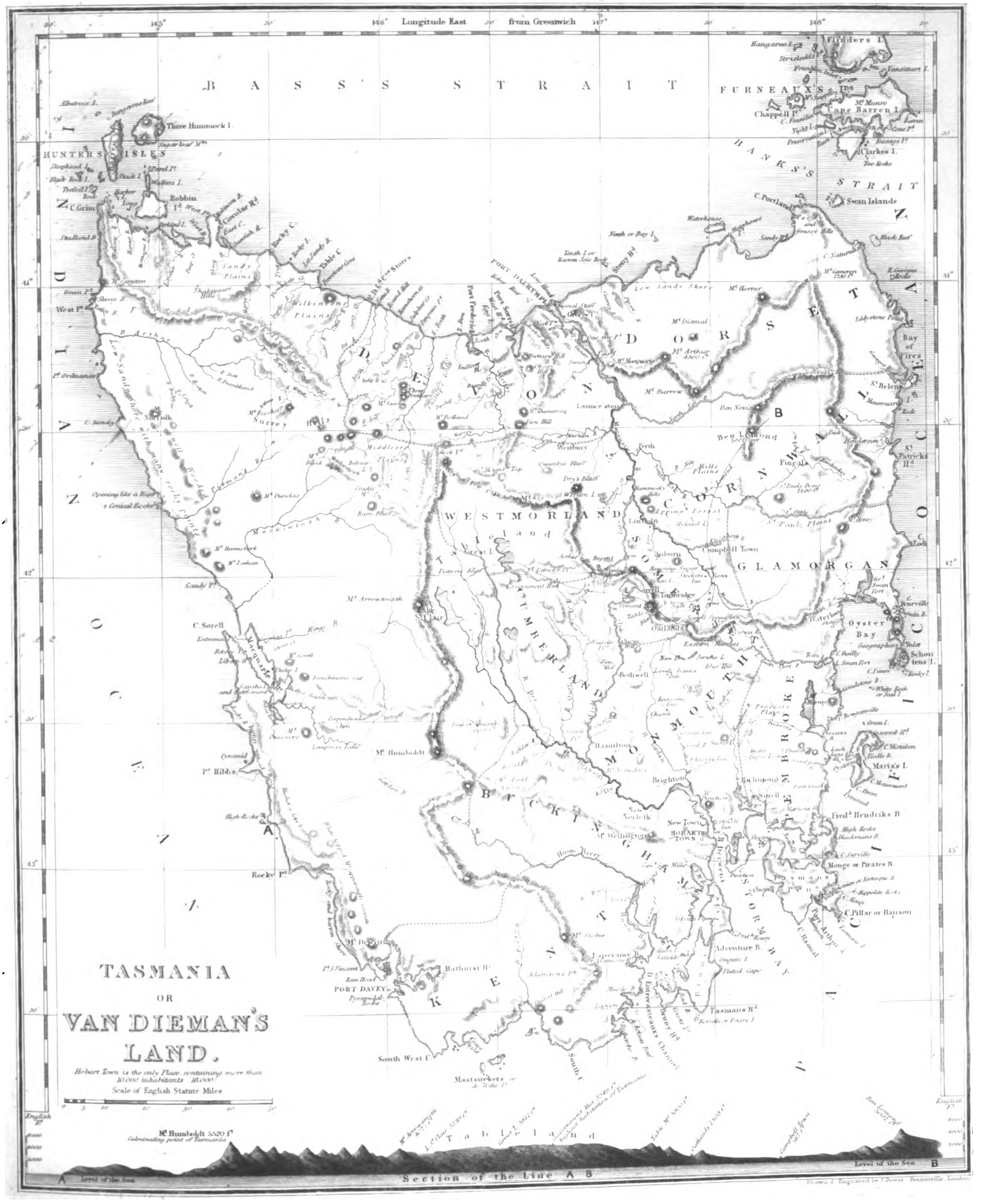


AUSTRALIA.
Scale for Longitude
English Statute Miles
NORTH AUSTRALIA
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
AUSTRALIA FELIX
TASMANIA or VAN DIEMENS LAND
GULF OF CARPENTARIA
AUSTRALIAN BIGHT
Tropic of Capricorn
Longitude East 135 from Greenwich
Counties in Swan River Settlement
1 Twiss
2 Perth
3 York
4 Murray
5 Grantham
6 Washington
7 Wicklow
8 Sussex
9 Nelson
10 Goderich
11 Hay
12 Lanark
13 Stirling
14 Plantagenet
15 Kent
16 Melbourne
17 Glenelg
18 Grey
19 Durham
20 Howick
21 Carnarvon
22 Lansdowne
23 Beaufort
24 Minto
25 Peel
26 Victoria
Counties in New South Wales.
1 Bligh
2 Brisbane
3 Durham
4 Gloucester
5 Wellington
6 Phillip
7 Hunter
8 Northumberland
9 Bathurst
10 Roxburg
11 Cook
12 Cumberland
13 King
14 Georgiana
15 Westmoreland
16 Camden
17 Argyle
18 Murray
19 St Vincent
Section of the Line A.B.



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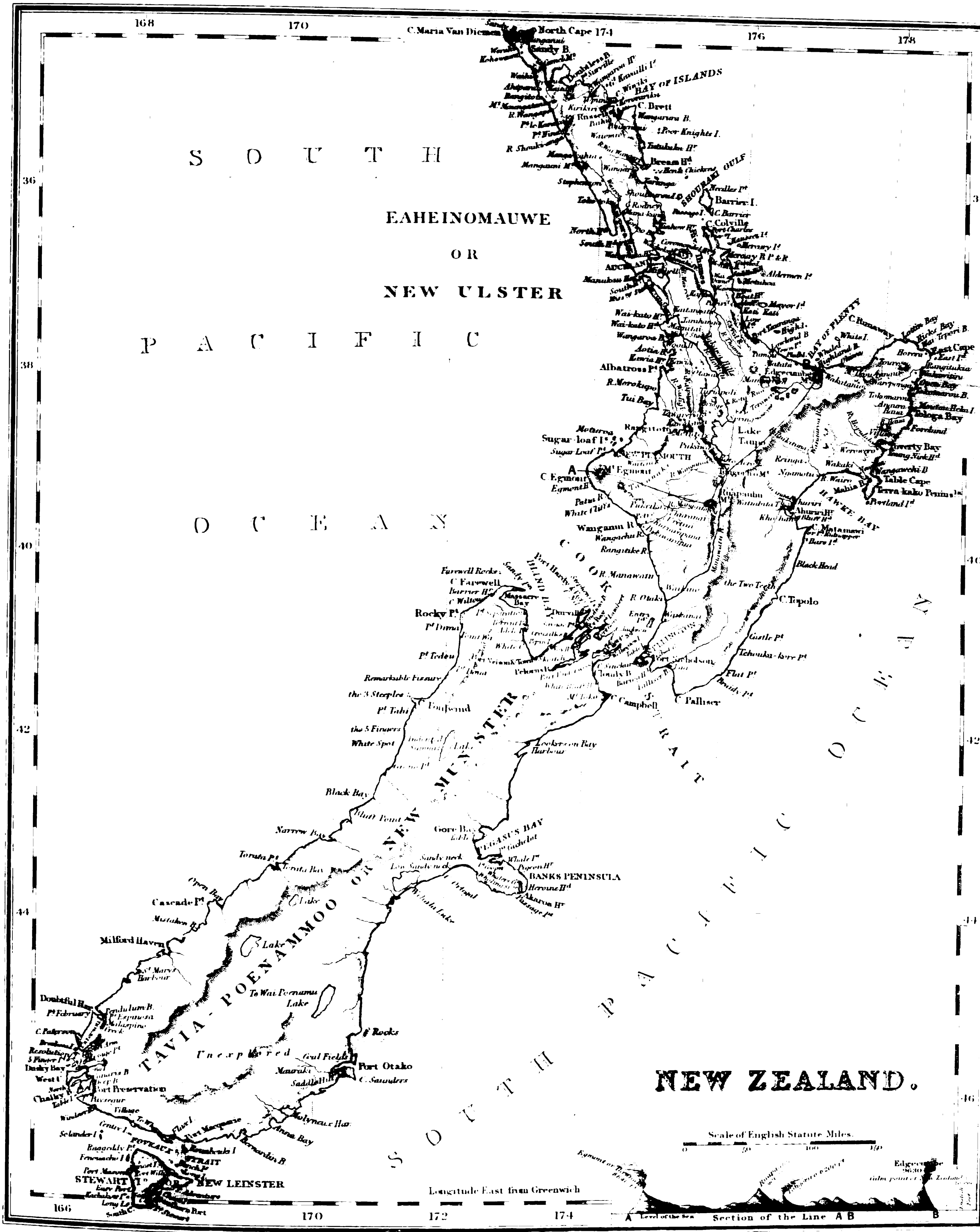

NEW ZEALAND.
EAHEINOMAUWE
OR
NEW ULSTER
TAVIA - POENAMMOO OR NEW MUNSTER
STEWART I.
NEW LEINSTER
SOUTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
COOK STRAIT
FOVEAUX STRAIT
North Cape 174
C. Maria Van Diemen
BAY OF ISLANDS
C. Brett
Poor Knights I.
Bream Hd
SHOURAKI GULF
Barrier I.
C. Colville
BAY OF PLENTY
C. Runaway
East Cape
Poverty Bay
Table Cape
HAWKE BAY
Lake Taupo
NEW PLYMOUTH
Sugar-loaf Is.
C. Egmont
Mt Egmont
Wanganui R.
Albatross Pt
Black Head
C. Turnagain
C. Palliser
C. Campbell
C. Farewell
Rocky Pt
Cloudy B.
Black Bay
Gore Bay
PEGASUS BAY
BANKS PENINSULA
Cascade Pt
Milford Haven
Doubtful Har.
Pt Preservation
Port Otako
C. Saunders
Molyneux Har.
Unexplored
To Wai Poenamu Lake
Scale of English Statute Miles.
0 50 100 150
Longitude East from Greenwich
168
170
172
174
176
178
166
36
38
40
42
44
46
Section of the Line A B
A
B
Level of the Sea
Mt Egmont
Edgecumbe
Ruapahu

BRITISH WEST INDIES.

	Area Sq. Miles.	Population.	Capitals and Chief Towns.
Anagada	50	—	
Anguilla	90	3,666	
Antigua	108	35,412	St. John's, Falmouth.
Bahamas	4,440	23,048	Nassau.
Barbadoes	164	102,912	Bridgetown.
Barbuda	72	1,500	
Bieque	40	—	
Cayman	60	—	
Culebra	12	—	
Dominica	275	18,830	Charlottetown.
Grenada	120	28,123	St. George.
Grenadines	30		
Jamaica	5,520	348,844	Spanish-town, Kingston, Port Royal.
Montserrat	47	7,659	Plymouth.
Nevis	20	11,422	Charlestown.
Roatan	28	—	
St. Kitts	68	25,272	Basseterre.
St. Lucia	275	18,148	Carenage.
St. Vincent	121	27,122	Kingston.
Tobago	120	14,901	Scarborough.
Tortola	20	7,731	Tortola.
Trinidad	1,970	45,284	Puerto de Espana.
Virgin-gorda	15	—	
SPANISH.			
Cuba	43,380	704,487	Havanna, Puerto Principe, Santiago.
Porto Rico	3,865	57,086	San Juan.
FRENCH.			
Desirade	16	127,668	Basseterre, Point-a-Pitre.
Guadaloupe	534		
Mariegalante	60		
Saintes	5		
St. Martin's N. part	18		
Martinique	290	116,031	Fort Royal, St. Pierre.
SWEDISH.			
St. Bartholomew.	25	15,000	Gustavia.
DUTCH.			
Curacoa	375	12,000	Williamstadt.
St. Eustathius	10	18,000	St. Eustathius.
Saba	20		
St. Martin's S. part	10	—	
DANISH.			
Santa Cruz	80	34,000	Christianstadt.
St. John	70	3,000	
St. Thomas	50	7,000	
INDEPENDANT.			
Haiti	29,400	600,000	Port-au-Prince, San Domingo.

	Area of Square Miles.	Population.
British Islands	13,665	719,874
Spanish ditto	47,245	761,573
French ditto	920	243,699
Swedish ditto	25	15,000
Dutch ditto	415	30,000
Danish ditto	200	44,000
Independent	29,400	600,000
Total	91,870	2,414,146

II. The Bahamas extend from the coast of East Florida to the north of Haiti, forming a chain upwards of 700 miles in length. There are about fourteen principal islands, all low, with many smaller, and innumerable rocks and reefs. They are mostly situated on and inclosed by remarkable banks formed of coral, shells, and calcareous sand, which occupy a vast submarine area, and rise almost perpendicularly from an unfathomable depth of water. Nassau, the capital and seat of government, is in the island of New Providence.

The government of the Bahamas, like that of the other British West India islands, except Trinidad and St. Lucia, is administered by a Governor and Council appointed by the Crown, and a House of Assembly consisting of Representatives of the people.

St. Salvador, one of this group, is remarkable for being the first land reached by Columbus in 1492. The island then bore the name of Guanahain.

III. The Greater Antilles comprehend the islands of Cuba, Haiti, Porto Rico, and Jamaica, all mountainous, and containing evidence of volcanic origin, though no volcanoes have been in active operation since their possession by Europeans. Earthquakes have, however, been frequent, and on several occasions terribly destructive.

Cuba, the largest island of the archipelago, is divided into three intendancies or provinces. Santiago de Cuba is the capital of the eastern; Puerto Principe of the central; and Havanna of the western province, which is also the seat of the Captain-General. Havanna, on the north-west coast, one of the most important cities of the New World, has upwards of 100,000 inhabitants.

Haiti, Hispaniola, or St. Domingo, formerly divided between France and Spain, acquired independence early in the present century by a successful revolt of the Negroes, and became nominally a republic, but in reality a military despotism with a few republican forms. Recently hereditary monarchy has been established, of doubtful permanence, the black sovereign assuming the title of Emperor. Port-au-Prince, the capital, at the head of an inlet of the west coast, chiefly of wood, is said to have a population of 30,000. The decayed city of San Domingo, on the south-east coast, is the oldest existing European establishment in the New World, founded by Columbus in 1504.

Jamaica, the principal British possession in the West Indies, is divided into three counties, Surrey in the east, Middlesex central, and Cornwall western, containing twenty-one parishes. San Jago de la Vega, or Spanish-town, on the plain of St. Catherine, the political capital, is only of consequence as the seat of the government, the superior courts, and public offices. Kingston, on the south-east coast, containing upwards of 33,000 inhabitants, is the largest town of the island, and the chief site of commerce.

Porto Rico, the smallest of the Greater Antilles, has its principal town, San Juan, with a population of about 30,000 on the north coast.

IV. The Lesser Antilles include the remainder of the archipelago, extending in a curve from the east of Porto Rico to the mainland of South America. They are commonly distributed into the three groups of the Leeward Islands, in the north, from St. Thomas to Dominica, inclusive; the Windward Islands, in the south, from Martinique to Trinidad, inclusive; and the Venezuelan coast chain westward. But this distinction is not true to nature, both the first and second groups being, in relation to the trade wind, properly the Windward Islands, and those only along the coast of Venezuela the Leeward Islands. Their general aspect is mountainous or rocky; many are volcanic formations; and some have active volcanic sites.

The Lesser Antilles, except the most southern islands, are subject to hurricanes of inconceivable violence, which visit the Greater Antilles and Bahamas, but more occasionally. They are nowhere, however, of frequent occurrence, or the insecurity of life and property would lead the inhabitants of such dangerous sites to abandon them. They are never experienced but during a short period of the year, principally August and September, and the scene of their greatest fury is the ocean.

V. Lying within the Tropics, except a portion of the Bahamas, the summer heat in the West Indies is excessively oppressive, but happily moderated by flying clouds, and the daily sea-breeze. The high temperature and copious rains combine with a fertile soil to produce a surprising luxuriance of vegetation; but the low districts are rendered insalubrious by the moisture, heat, and decayed vegetable matter, and are periodically ravaged by the yellow fever. The products include some of the most delicious fruits, largely exported, especially pine-apples, with spices, sugar, coffee, cotton, cocoa, tobacco, turtles, mahogany, and logwood. None of the ancient races encountered by Columbus linger, except a small remnant in the southern islands, the great bulk of the population consisting of negroes, and the mixed races sprung from their crossing with the whites and the Indians. Separated by a distance of 640 miles from Atwood's Keys, one of the Bahamas, and 580 miles from Cape Hatteras, in North Carolina, lie the Bermudas, consisting of hundreds of rocks, with five small islands, belonging to Great Britain. St. George, the capital, is on the island of that name. The colony has a population of rather more than 9,000; but is only serviceable as a naval station and penal settlement.

OCEANIA.

THE large islands and numerous archipelagoes in the basin of the vast Ocean between the south-eastern shores of Asia, and the western coasts of America, are conveniently classed together as forming a distinct division of the Globe under the general title of Oceania, adopted from the French geographers. This region is commonly distributed into the three great districts of Australasia, Malaysia, and Polynesia.

AUSTRALASIA.

XLVII. AUSTRALIA. XLVIII. VAN DIEMAN'S LAND. LI. NEW ZEALAND.

I. AUSTRALASIA has its limits defined by an irregular curve line encircling Australia on the west, passing between that island and Timor, around the Papuan Archipelago on the north, including Solomon's Archipelago, Queen Charlotte's Islands, New Hebrides, New Zealand, and other groups on the east and south-east, and proceeding from thence north-westward to the commencing point.

Such an imaginary line will touch the Equator, and extend to lat. 55° S. The meridians of 112° and 180° E. will be the longitudinal limits.

II. AUSTRALIA, the largest island in the world, approaching to the character of a continent in its dimensions, extends between lat. 11° and 39° S., from Cape York on the north, to Wilson's Promontory on the south; and between long. 113° and 153° 30′ E., from Steep Point, south of Dirk Hartog's island on the west, to Cape Byron on the east. It comprehends an area estimated at 3,000,000 square miles, and possesses a coast line of nearly 8,000 miles. The general direction of its main mass follows that of the parallels of latitude. The greatest extent amounts to about 2,400 miles east and west, by 1,900 miles north and south, the southern tropic intersecting the country nearly in the centre. Enterprise has not yet pushed its way through the interior to the opposite coasts; and nowhere has exploration made any considerable advance, except in the south-eastern districts, and in a smaller degree at the south-west and north-east angles. But as far as inland researches have been extended, the general aspect of the surface seems to be that of an immense level, varied only by occasional sandy or rocky undulations, perfectly bare arid wastes alternating with vast tracts densely covered with bushes, but everywhere deficient of timber, and with many basins of dried-up salt lakes, or such as contain only shallow salt water and mud. There are, however, millions of acres sufficiently rich and fertile amply to reward industry, and sustain a numerous population; but it is highly probable, whenever the veil shall be removed from the central regions, only a dreary inhospitable desert will be discovered. Australia contains no river of important magnitude yet known besides the Murray, which, in common with the other streams, spreads out in inundations, and dwindles to a thread, owing to alternating seasons of excessive rains and drought. Lake Torrens, scantily supplied with water, but exhibiting a vast basin coated with an unbroken sheet of pure white salt, is unique in its horse-shoe configuration. The most mountainous portions of the country appear to be near the south-east coast, where the Warragong Mountains or Australian Alps have peaks covered with permanent snow.

The general climate, though tropical, is salubrious, but has marked disadvantages. The summer temperature is very high, the thermometer sometimes rising to 146° in the sun and 95° in the shade. In South Australia, the winds blowing from the north, or from the interior, are terrifically hot, and can only be compared to the fiery and withering blasts of the simoon. The greatest drawback, however, is the long terrible droughts, fatal to animal and vegetable life, followed by extraordinary rains, which seem to occur periodically, after intervals of ten or twelve years.

No region is more remarkable for its animal and vegetable productions, exhibiting few varieties, but almost all entirely unknown in the other great divisions of the globe.

III. The Australian population consists of scattered and wandering hordes of aborigines, in extreme barbarism, forming a numerical aggregate wholly unimportant, and gradually diminishing, with foreign settlers, almost entirely British, in the colonies of New South Wales, Southern, Western, and North Australia. New South Wales, the oldest colony, founded in 1788 as a penal settlement, comprises the territory extending along the whole of the east and south-east coasts; but the occupied parts are entirely in the south-east, between Moreton Bay and Port Phillip—about 860 miles of sea-board intervening between the two points. Sustained by large annual grants from the mother country to meet the expenses of the penal administration, the settlement has attained considerable prosperity. Sydney, the capital, on the splendid harbour of Port Jackson, is a convenient, well built city, containing about 40,000 inhabitants. The country in its neighbourhood is divided into nineteen counties, with a gross population of 200,000. The south portion of the colonial territory, or Australia Felix, commonly called the Port Philip district, consists of three counties, with Melbourne for the capital, and a total population of nearly 40,000. Situated most remote from the tropic, its more moderate temperature, together with its superior fertility, and greater command of surface water, render this part of the country peculiarly eligible for settlement.

PROGRESS OF THE COLONY OF NEW SOUTH WALES.

In 1788, it possessed—

Horned cattle	5
Sheep	29
Pigs, no return.	
Horses	5
Population of convicts and official persons in the first fleet	1,030

In 1848, or seventy years afterwards, it possessed—

Horned cattle	1,596,914
Sheep	10,053,641
Pigs	62,646
Horses	103,915
Population	205,009
Total value of exports for the four years from 1844 to 1847 inclusive	£6,035,686
Total value of imports, &c.	5,777,659
Excess of value of the exports	£258,027

The number of convicts merging in the general mass of society upon the expiration of their sentences—of escaped convicts becoming bushrangers and harassing the distant solitary settlements, and the disproportion of the sexes, are signal disadvantages; the latter evil, though diminishing, is still great.

Progress of the population in the ten years from 1838 to 1847 inclusive:

	Adult Males.	Adult Females.	Children.	Total.
1838	57,485	18,000	22,427	97,912
1847	83,572	41,809	79,628	205,009

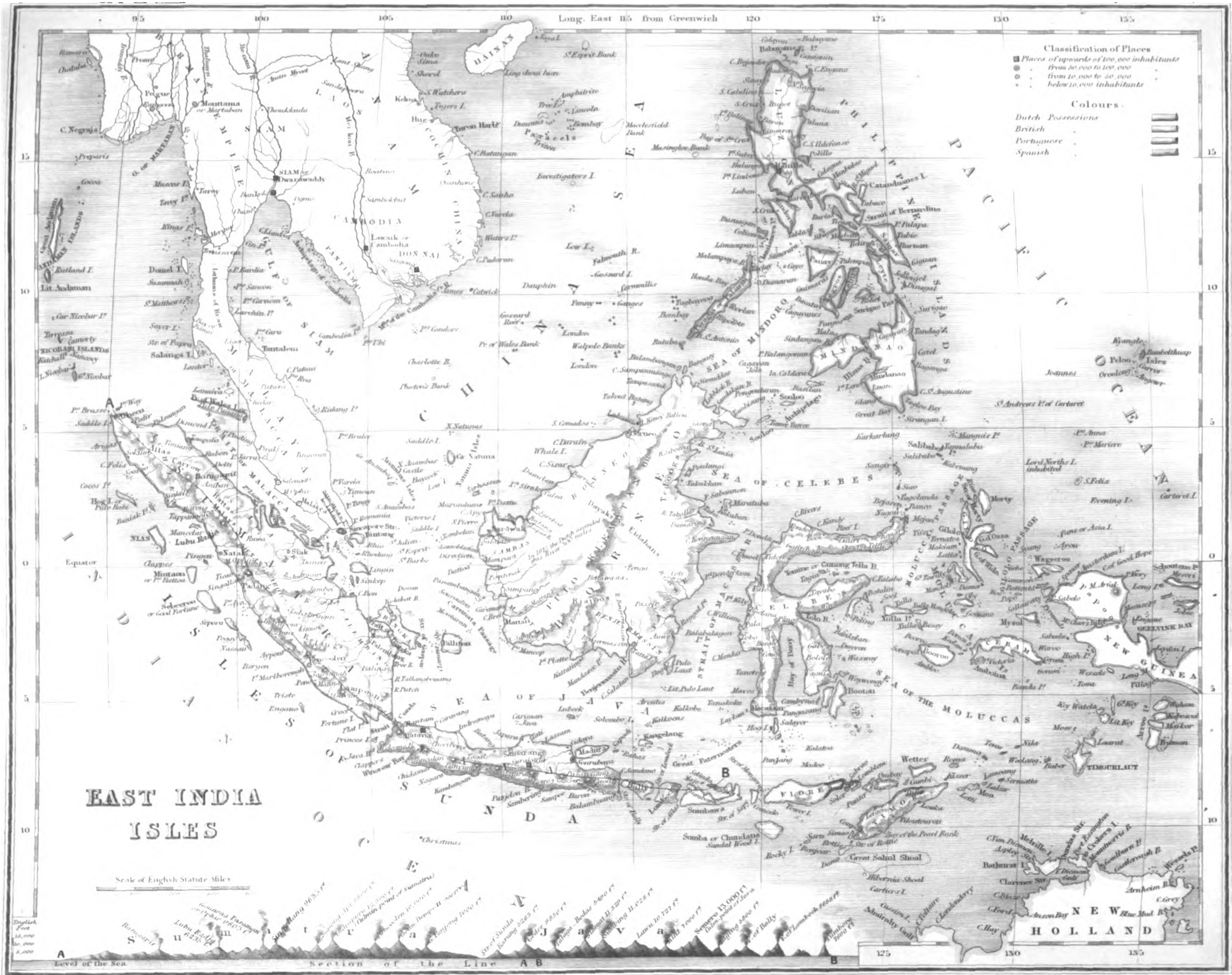
The population was thus more than doubled, while the disproportion of the sexes has diminished from one female to three males, to one female to two males.

Transportation to New South Wales ceased in 1840, at which time there were 26,977 convicts undergoing their sentences, now largely reduced by the terms having expired.

The other Australian Colonies are of very recent establishment:

	Date.	Population.	Capitals.
Western Australia	1829	4,622	Perth.
South Australia	1837	33,587	Adelaide.
North Australia	1838	——	Victoria.

IV. VAN DIEMAN'S LAND or Tasmania, lies to the south of Australia, separated from it by Bass's Strait, a channel about 140 miles in average width. The island extends 210 miles from north to south, and 150 miles from west to east, comprising an area of 24,000 square miles, being one-fourth less than the area of Ireland. The surface is agreeably diversified with plains and valleys clothed with the finest timber, interspersed among bold mountains, and occasionally stern highlands. Ben Lomond rises in the north-east 5002 feet, and Mount Humboldt in the south-west 5520 feet. The coast abounds with commodious harbours,



Drawn and Engraved by J. Dower, Pentonville, London.

while the interior is everywhere well watered. Rain is regular and abundant; the climate temperate; and large tracts of country possess a soil of the richest alluvial mould. The population amounted in 1847 to 57,420,—all of foreign origin, with the exception of a mere handful of Aborigines, and almost exclusively British. The settled districts, divided into the counties of Dorset, Devon, Cornwall, Glamorgan, Somerset, Westmoreland, Cumberland, Monmouth, Pembroke, Buckingham, and Kent, occupy the eastern half of the island, several portions of the western being comparatively unknown. Hobart Town, the capital, on the right bank of the estuary of the Derwent, about twenty miles from its mouth, founded in the year 1804, contains about 16,000 inhabitants. An excellent road connects it with Launceston on the Tamar, the next place of importance, distant about 120 miles.

The colony is a penal settlement, the greater number of the convicts being located on Tasman's peninsula, E.S.E. of Hobart Town. The beautiful Norfolk Island, included in the same government, 900 miles E.N.E. of Sydney, is inhabited solely by convicts, and the officials in charge of them.

Tasmania is a more appropriate name for the island than Van Dieman's Land, owing to Tasman being the actual discoverer, and Van Dieman simply his patron.

V. New Zealand consists of three principal islands extending in a line generally from north to south, through a distance of 1100 miles, reckoning the intervening straits; the breadth sometimes amounting to 200 miles and dwindling to five, owing to a deeply-indented coast. The central island, New Munster, is the largest; the north island, New Ulster, separated from the former by Cook's Strait, is very little inferior; the south island, New Leinster, divided from the central by Foveaux Strait, is very small. The group has a coast-line of not less than 3000 miles, and an area of about 80,000 square miles. A coast serrated with harbours securely insulated; a climate milder than that of the southern counties of England, and at the same time healthy and invigorating; a surface traversed by high mountains and intersected with numerous rivers, streams, and rills; magnificent forests mantling the flanks of the highlands; extensive tracts of fertile soil; and considerable mineral wealth, characterize the country. The north island is of volcanic origin, and contains some active vents and extinct craters, with many warm, hot, and boiling springs. Slight shocks of earthquakes are common in various localities, and several violent concussions were experienced towards the close of the year 1848, but no tradition has been traced among the natives of any prior convulsions of serious moment. New Zealand, constituted a British colony in 1841, but occupied by settlers a few years previous, has Auckland for the capital, in the north island, on the Firth of Thames. The Aborigines are supposed to number 150,000, with probably 20,000 colonists.

The present nearest route from Great Britain to her Australian Colonies is eastward, by the overland passage to India; and it is proposed to extend the line of steam navigation from Singapore to Sydney, and from thence to Port Nicholson. But probably the time is not far distant when the route will be westward, across the Isthmus of Panama, and by the Society Islands to Port Nicholson, and from thence to Sydney. A comparison of the two routes stands as follows:

	Miles.
Southampton to Sydney, *viâ* Gibraltar, Malta, Alexandria, Suez, Aden, Ceylon, Singapore, Batavia, and Torres Strait	13,288
Sydney to Port Nicholson	1,200
	14,488
Southampton to Port Nicholson, *viâ* St. Thomas, Panama, and Tahiti	11,500
Port Nicholson to Sydney	1,200
	12,700

Difference in favour of the western route, by Panama to Port Nicholson, 2,988 miles; and to Sydney 588 miles.

VI. The remaining portion of Australasia may be very briefly dismissed. Antipodes Island,—an uninhabited spot to the south-east of New Zealand, discovered in the year 1800,—is only remarkable for being the nearest land to the antipodes of Greenwich, an oceanic site, after which circumstance it has been named. It is situated in lat. 49° 40′ S., and long. 177° 20′ E., the true Antipodes being of course in lat. 51¼° S., and long. 180°. South of New Zealand lie the Auckland Isles, of importance as a station in the prosecution of the southern whale fishery, for which purpose the group has been granted by the British Government to a Company, and is now in process of settlement. The great chain of islands, comprising New Guinea on the north of Australia, and an immense number on the north-east, are altogether without European colonists, in the hands of independent barbarian tribes, and but very imperfectly known apart from the coasts.

MALAYSIA.

XLIX. EAST INDIA ISLES.

I. Malaysia, denominated from the population consisting principally of Malay races, but commonly styled the Indian Archipelago, comprehends the islands immediately adjacent to the south-eastern shores of Asia, consisting of some low coraline formations, but chiefly of high mountainous volcanic tracts fringed with coral, occasionally the scenes of tremendous convulsions. They are remarkable for an intense development of animal and vegetable life, and are specially important to the civilized nations as the chief region of the plants producing aromatic substances. Trees of gigantic dimensions and exuberant foliage descend in dense masses from the inland heights to the water's edge; harmless snakes hang pendant from their branches, while dangerous serpents lie coiled at their roots; birds of gorgeous plumage and varied notes flit from bough to bough; elephants, tigers, rhinoceroses, and other quadrupeds, inhabit the jungles; alligators haunt the creeks and rivers; richly-coloured shells lie on the sandy beaches; and beautifully-symmetric corallines line the shores. These are some of the common phases of animal and vegetable life in Malaysia.

Of the groups composing the Indian Archipelago, the principal are the Isles of Sunda, the Banda Isles, the Moluccas, Celebes, Borneo, and the Philippine Islands.

II. The Isles of Sunda form a long curving chain, stretching from the south-eastern entrance of the Bay of Bengal to the north-western seas of Australasia. Sumatra, Java, Sumbawa, Flores, and Timor, are the largest. They are, to some extent, possessed by native tribes, but principally held by the Dutch, with the exception of parts of Flores and Timor, which belong to the Portuguese. The Banda Isles, an irregularly-distributed group east and north-east of Timor, are likewise Dutch possessions, along with the Moluccas, the far-famed Spice Islands, further north. The singularly-formed tract of Celebes, on the west, is also in part occupied by the same power. Borneo, the most extensive portion of the Archipelago, comprehending an area of 260,000 square miles, is nominally governed by a sultan, but really ruled by a number of independent chieftains,—excepting the territory of Sarawak, on the east coast, recently ceded to the British, together with the small islet of Labuan. The Philippine Islands, (a cluster of nearly a thousand, including those of minor dimensions,) are divided between petty native chiefs and the Spanish.

The Dutch, among European powers, have the greatest territorial possessions in the Indian Archipelago. Batavia, on the north-west coast of Java, is the capital of the Dutch East Indies.

III. A few of the sites most remarkable for their natural productions may be indicated. Banca Island, north of Sumatra, has long been renowned for the quantity and quality of its tin, found in alluvial deposits, and exported largely to India and China, as well as to more distant countries. Banda, which gives its name to an islet group, furnishes annually a large amount of nutmegs and mace, the latter consisting of the internal cover of the shell inclosing the nutmeg kernel. Amboyna, one of the Moluccas, is peculiarly distinguished for its crop of cloves, the flower-buds of the *Caryophyllus aromaticus*. Borneo is rich in diamonds and gold; where also the ouran-outang is found, the quadrumanous animal which,—next to the chimpanzee, makes the nearest approach to the organization of man. The gorgeous birds of Paradise, and the beautiful lories, occur in the eastern islands.

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POLYNESIA.

L. PACIFIC OCEAN.

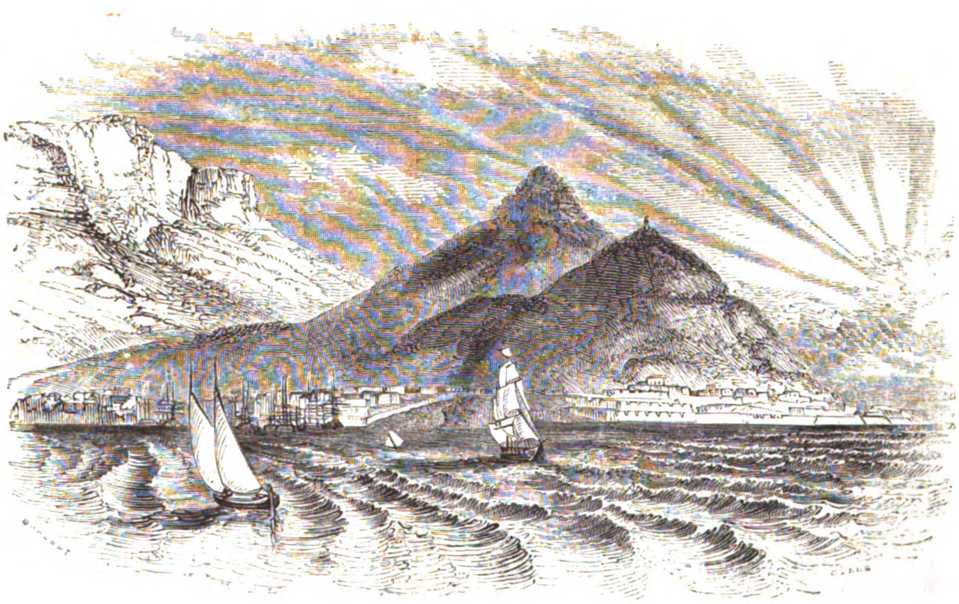
I. Polynesia consists of the insular groups and detached islets eastward of Australasia and Malaysia, largely occupying the central regions of the Pacific Ocean, between the parallels of 30° north and south of the equator. These islands are sometimes divided into three classes according to their physical aspect,—low, median, and high. The low islands are coral formations, very slightly elevated above the surface of the waves, or only left dry at ebb-tide, and are not discernible at a very small distance, unless vegetation has established itself upon them, commonly that of the cocoa-nut tree. They are generally narrow, circular, or elliptical belts inclosing lagoons, and are supposed to be the crests of submarine volcanoes, the central lagoons occupying the craters, the belts being their rims, with a coral superstructure. The median, or hilly islands, are limestone masses, varying in height from 100 to 500 feet, probably of coral origin, crystallised and elevated by volcanic action. The high islands rise from 2000 to 13,000 feet, and generally present a conical form, exhibiting indubitable marks of volcanic eruption, either in the rocks of which they are composed, or in volcanoes at present in a state of activity.

The principal clusters are the Ladrone Islands; the Carolines; the Friendly, Fidjee, Navigator's, and Hervey Groups; the Society Islands; the Marquesas; the Low and Dangerous Archipelago; and the Sandwich Islands.

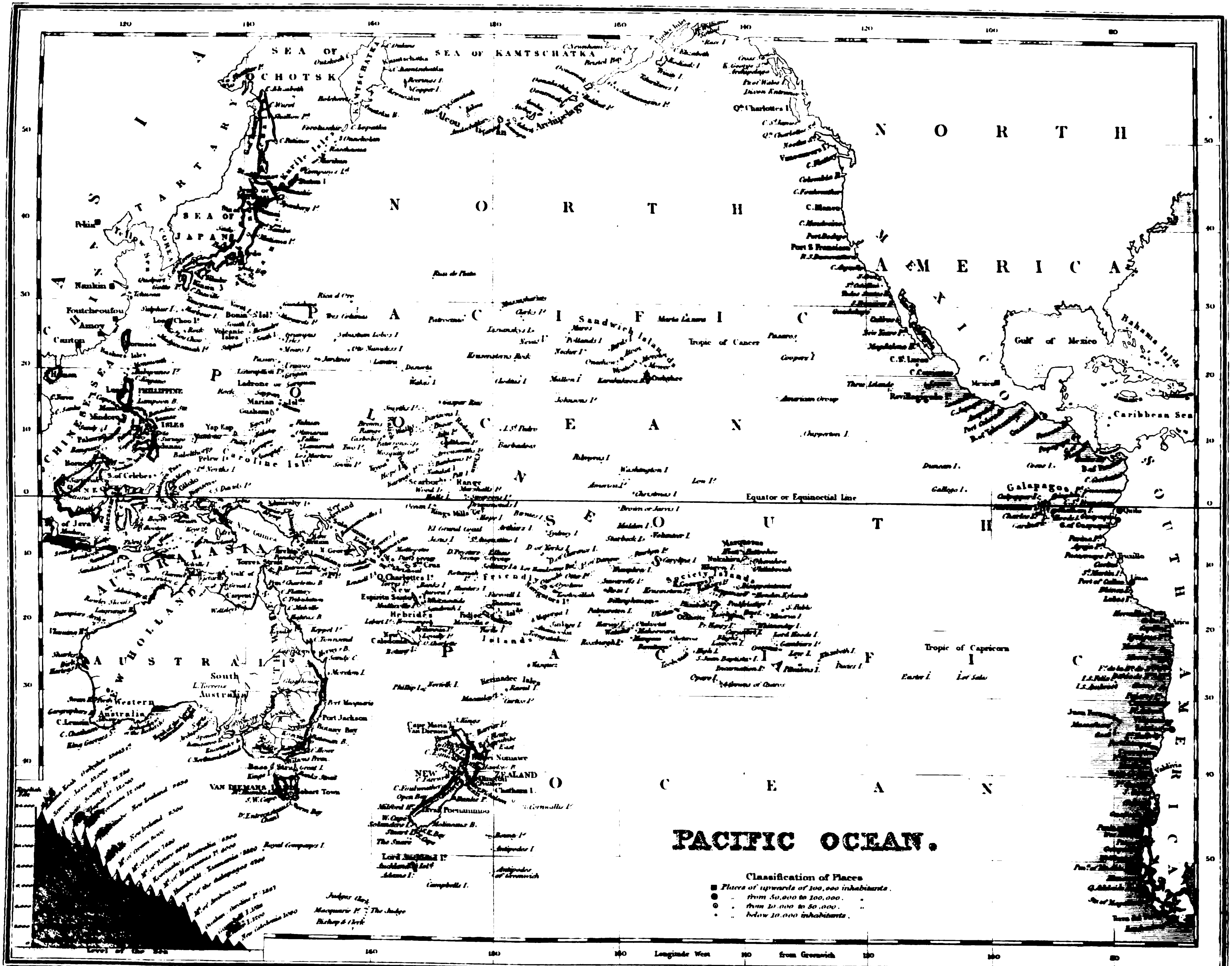
II. The Ladrone or Marian Isles, east of the Philippines, are a volcanic cluster, under the control of Spain, and have been largely deserted by the native population owing to oppressive government. The Carolines, to the south, with several other groups, form an enormous chain of mostly low isles, extending east and west through a space of nearly 3000 miles, between the meridians of 133° and 173° E. The Friendly, Fidjee, Navigator's, and Hervey Islands, are four groups east of Australasia,—the latter containing Raratonga, the chief scene of the beneficial labours of the missionary Williams. Further east, between lat. 8° and 20° S., are the Society Islands and the Marquesas, now under the protectorate of France, with the Low Isles and Dangerous Archipelago. Otaheite or Tahiti, the principal island of the whole, has a circuit of nearly 150 miles, and consists of two peninsular volcanic masses, one of which rises to the height of 12,250 feet. The Sandwich Islands are an insulated cluster in the North Pacific, the largest, Hawaii or Owhyhee, the scene of Captain Cook's death, containing in Mowna Keah, at the elevation of 13,645 feet, the culminating point of Polynesia.

Pitcairn's Island, belonging to the Low Archipelago, immediately south of the southern tropic, is remarkable for containing the descendants of the mutinous crew of the "Bounty," by Tahitian women, its only population. In July, 1849, they numbered 75 males and 74 females, forming a very orderly community, under the government of a magistrate, elected annually,—all persons, male and female, above sixteen years of age, being voters. Though not recognised by Great Britain, they consider themselves British subjects.

III. Polynesia contains unrivaled scenes of natural beauty, and enjoys largely the advantages of a prolific soil and genial climate, while the surrounding waters offer an inexhaustible supply of fish. Tahiti, replenished with luxuriant woods of valuable timber, and possessing numerous streams from its mountain summits, produces readily abundance of food for its inhabitants, and is capable of yielding the materials of an extensive traffic, being adapted to the growth of the vine, cotton, coffee, and sugar. Palm-oil and arrow-root are its principal exports. The Sandwich Islands have an important commerce in provisions and sandal-wood. Honororu, the capital of this group, with about 7000 inhabitants, is the largest town of Polynesia. The capitals of the Dutch and Spanish colonies in the east, Batavia and Manilla, are the largest towns of Oceania.



Cape of Good Hope.



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NOTE.—For convenience of reference the Columns of the Pages have been distinguished in this Index; i. indicating the First Column, and ii. the Second Column.

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GENERAL INDEX.

In consulting this Index, it is necessary to observe, that it does not give the latitude and longitude of places with scientific exactitude, but indicates their position as laid down on these Maps.

There are several of the Maps which contain smaller maps, as continuations or additions; so that if a place quoted from one of these in this Index is not found in the larger one, it will be found in the smaller; for instance—White Bay may appear not to be in No. 38, for it is not comprised within the Map of Canada itself, but is found in the smaller map inserted in it.

The Latitude and Longitude of Countries, Islands, Seas, Bays, and Gulfs, are given at their respective centres; that of Rivers at their mouths or confluences.

* Denotes a locality to be found in the section at the foot of a map. ‡ Denotes a District, Province, or Country. § Denotes a Tribe or People.

Contractions are used, such as N. for North; O. for Old; M. for Mountain; L. for Lake; R. for River; P. for Point; Devonsh. for Devonshire; and U. States for United States.

NAME	LAT.	LONG.	MAP
Campofrio....	37 50 N	6 30 W	20
Campomanes..	43 9 N	5 57 W	20
Camporobres..	39 45 N	1 30 W	20
Campos	39 23 N	3 2 E	20
Camprodon ..	42 18 N	2 21 E	20
Campsut......	46 31 N	9 29 E	17
Çamraigne Harbour........	11 50 N	109 10 E	32
Camucheros ..	3 52 S	70 20 W	45
Camucross....	57 10 N	5 42 W	7
Camurana	43 33 N	13 30 E	18
Camus	52 34 N	7 56 W	8
Cana	7 47 N	77 25 W	42
Canaare	45 0 N	71 40 W	39
Canach, River	57 25 N	4 40 W	7
Canada	48 0 N	80 0 W	37
Canada Bay ..	50 43 N	56 10 W	38
Canadian Channel	50 0 N	63 0 W	38
Canadian River	35 18 N	95 0 W	40
Canaguan Isles	12 35 N	61 15 W	46
Canamares....	40 20 N	2 12 W	20
Cananea.. ...	25 0 S	48 0 W	43
Cananova, P...	20 40 N	74 50 W	46
Canara	42 59 N	12 33 E	18
Canaro	39 2 N	8 4 W	20
Canary Island	28 0 N	16 10 W	34
Canary Isles ..	28 40 N	17 0 W	34
Canaveis......	41 15 N	8 3 W	20
Canaveral	38 2 N	6 20 W	20
Canaveral Isle	29 5 S	71 35 W	44
Canaveral, Cape	28 25 N	80 35 W	39
Canaviche, R..	7 30 N	67 37 W	42
Canchas, River	4 52 S	37 30 W	43
Cande	47 32 N	1 2 W	9
Candelaria....	10 28 N	74 56 W	42
Candelario....	27 24 S	55 55 W	44
Candelaro	41 34 N	15 50 E	19
Candern	47 43 N	7 39 E	14
Candes	47 6 N	0 6 E	9
Candia, West (Piedmont)..	45 20 N	7 51 E	18
Candia, East (Piedmont)..	45 10 N	8 32 E	18
Candia(Turkey)	35 18 N	25 7 E	25
Candia Island	35 10 N	25 0 E	25
Candnunore ..	11 52 N	75 30 E	31
Candra	49 57 N	12 17 E	14
Candu Isles ..	5 0 S	72 30 E	1
Canduela	42 47 N	4 4 W	20
Canea	35 25 N	24 0 E	25
Canello	43 20 N	10 45 E	18
Canelones	34 36 S	55 58 W	44
Canelos..	1 30 S	77 50 W	42
Canercolly	24 45 N	89 25 E	31
Canero, Cape..	2 22 S	80 45 W	42
Canete........	12 58 S	76 23 W	45
Canfranc. M...	42 55 N	0 30 W	20
*Canfranc, Pass of..........			20
Cangallo......	13 30 S	73 55 W	45
Cangas	42 32 N	7 47 W	20
Cangregos	22 0 S	59 50 W	45
Camapuscow, Lake	54 30 N	67 40 W	37
Canie Isles....	49 50 N	66 33 W	38
Caniles	37 25 N	2 54 W	20
Canino	42 29 N	11 46 E	18
Canio	44 44 N	8 16 E	18
Canna Isle....	57 4 N	6 30 W	7
Cannadoona, P.	51 43 N	10 0 W	8
Cannano......	40 17 N	16 30 E	19
Canning Isle..	72 10 N	21 30 W	37
Cannisbay	58 40 N	3 8 W	7
Cannon, River	44 38 N	92 40 W	39
Canoa	0 27 S	80 20 W	42
Canoa, Point..	1 12 S	80 43 W	42
Canoas, Cape..	10 35 N	75 33 W	42
Canolton......	39 20 N	90 0 W	39
Canoma, River	4 0 S	58 30 W	43
Canosa........	41 12 N	16 8 E	19
Canosio	44 24 N	7 9 E	18
Canouge......	26 52 N	80 7 E	31
Canso, Cape ..	45 13 N	60 57 W	38
Canstadt......	48 50 N	9 14 E	14
Canta	11 10 S	76 18 W	45
Cantagallo	21 52 S	42 30 W	43
Cantal, Mount	45 2 N	2 43 E	9
Cantalejo	41 20 N	3 58 W	20
Cantario, River	12 25 S	63 45 W	45
Canterbury....	51 15 N	0 58 E	6
Cantiano......	43 29 N	12 36 E	18
Cantillana	37 40 N	5 20 W	20
Canton, (China)	24 20 N	113 20 E	33
Canton, (Ohio)	40 46 N	81 22 W	39
Canucu Mountains........	2 52 N	59 0 W	42
*Canuku Mtns.			43
Canvey Isle ..	51 30 N	0 40 E	6
Canyketoke ..	55 30 N	59 0 W	37
Canzig	51 18 N	13 9 E	13
Cao	7 50 S	79 13 W	45
Capa Antigua..	30 36 S	67 27 W	44
Capaci........	38 9 N	13 10 E	19
Capallum	27 54 S	65 50 W	44
Capamachuas, River	5 30 S	73 10 W	45
Capanna......	42 43 N	11 11 E	18
Capar, Lake ..	48 50 S	72 35 W	41
Capas, Pulo...	5 10 N	103 10 E	32
Cape Colony ..	32 0 S	23 0 E	35
‡Cape Colony Proper......	33 30 S	18 20 E	35
Cape, River ..	20 33 S	146 20 E	47
Cape, River ..	15 0 N	83 8 W	40
Cape Barren I.	40 23 S	148 15 E	48
Cape Breton I.	46 0 N	61 0 W	38
Cape Coast Castle	5 35 N	1 0 W	34
Cape o Good Hope	34 25 S	18 26 E	35
Cape Town ..	33 50 S	18 20 E	35
*Cape Town ..			34
Cape Verd Isles	16 0 N	24 0 W	34
Capelinha	19 44 S	49 58 W	43

NAME	LAT.	LONG.	MAP
Capell	60 52 N	16 40 E	22
Capelletti	37 57 N	21 20 E	24
Capenara	53 1 N	7 32 W	8
Capercotia	32 28 N	35 14 E	30
Capernaum....	32 55 N	35 32 E	30
Capetown, (New Brunswick)	45 50 N	66 15 W	56
Capet	46 20 N	6 10 E	17
Capharbarucha	31 33 N	35 25 E	30
Capilla........	6 0 N	54 40 W	43
Capim, River..	1 22 S	48 30 W	43
Capira........	10 0 N	65 45 W	42
Capira, River..	10 8 N	65 50 W	42
Capistrelle....	41 57 N	13 24 E	19
Capitolias	32 52 N	35 57 E	30
Capo d'Istria..	45 32 N	13 50 E	16
Cappamore....	52 36 N	8 17 W	8
Cappard	53 6 N	7 25 W	8
Cappel........	61 58 N	15 20 E	22
Cappelen......	46 57 N	7 20 E	17
Cappino	45 39 N	10 50 E	16
Cappoquin....	52 9 N	7 51 W	8
Capraja	43 2 N	9 45 E	18
Capraja Isle ..	43 2 N	9 45 E	18
Caprera Isle ..	41 12 N	9 29 E	19
Capri, (Sicily)	38 3 N	14 40 E	19
Capri Isle, (Naples)....	40 35 N	14 13 E	19
Capri Isle, (Dalmatia)..	43 40 N	15 43 E	16
Capri, Cape ..	38 7 N	20 50 E	24
Capricorn, C...	23 30 S	151 15 E	47
Capricornia ..	23 0 S	146 0 E	47
Caprik........	51 14 N	3 35 E	10
Capritz	44 5 N	17 10 E	25
Caprone	43 31 N	13 7 E	18
Capu	37 15 S	175 32 E	51
Capua........	41 7 N	14 13 E	19
Capucui	1 7 S	76 0 W	42
Caputerra	39 10 N	9 0 E	19
Caqueta, River	3 0 S	65 0 W	42
Caquiabiri	17 25 S	69 17 W	45
Cara-bagh	33 12 N	71 50 E	31
Carabeli	15 30 S	73 30 W	45
Carabobo	10 0 N	68 5 W	42
‡Carabobo....	9 30 N	68 30 W	42
Caracas	10 25 N	66 53 W	42
‡Caracas......	9 0 N	67 0 W	42
Caracoles, Point	7 50 N	78 7 W	42
Cara-eili	38 55 N	29 25 E	27
Carah	34 0 N	37 6 E	27
Caragnone	40 53 N	16 10 E	19
Caralia........	37 48 N	31 45 E	27
Caramaridamo, River	40 48 S	73 50 W	44
Caramoussal ..	40 40 N	29 37 E	27
Caranaguinha, River	10 30 S	59 0 W	43
Carancovays ..	29 57 N	96 10 W	40
Cara, Pulo.....	8 30 N	101 0 E	32
Carasseu, River	1 18 S	69 22 W	42
Caratasca, Lake	15 20 N	84 0 W	40
Caratirimani, River	0 40 N	61 20 W	43
Caravaca......	38 6 N	2 0 W	20
Caravang, Point	6 0 S	107 15 E	49
Caravellas	17 45 S	39 17 W	43
Carberg	63 10 N	9 30 E	22
Carbonano, R.	37 41 N	21 50 E	24
Carbonara	41 4 N	16 52 E	19
Carbonara, C.	39 5 N	9 32 E	19
Carbonera	36 59 N	6 30 W	20
Carboneras, (Andalusia)	36 58 N	2 0 W	20
Carboneras, (New Castile)	39 55 N	1 55 W	20
Carbouthi	35 11 N	32 40 E	27
Carcassonne ..	43 10 N	2 21 E	9
Carcastillo....	42 20 N	1 29 W	20
Cardaki	39 1 N	22 41 E	24
Cardamula....	36 52 N	22 16 E	24
Cardiff........	51 32 N	3 12 W	6
Cardigan......	52 4 N	4 40 W	6
Cardigan Bay, (Nova Scotia)	46 0 N	62 18 W	38
Cardigan Bay, (Wales)	52 30 N	4 30 W	6
‡Cardiganshire	52 10 N	4 10 W	6
Cardigos......	39 40 N	8 0 W	20
Cardona	41 55 N	1 39 E	20
Cardoza	7 37 S	46 27 W	43
Cardross......	55 58 N	4 38 W	7
Cardyana	40 18 N	3 7 W	20
Caremata	1 45 S	109 20 E	49
Caremata Passage	2 30 S	109 30 E	49
Carenage	14 0 N	61 0 W	46
Carentan	49 16 N	1 13 W	9
Careteque	9 55 S	73 30 W	45
Cargill........	56 32 N	3 21 W	7
Cariary, River	7 0 S	53 50 W	43
Cariati........	39 30 N	17 0 E	19
Caribou Isle ..	49 30 N	66 42 W	38
Caricall	10 55 N	79 52 E	31
Carigaholt	52 36 N	9 35 W	8
Carigbarron ..	52 10 N	7 27 W	8
Carignano	44 55 N	7 42 E	18
Carikebrachy	55 15 N	7 22 W	8
Cariman Javas Isles........	5 55 S	110 44 E	49
Carinis	5 45 S	53 50 W	43
Carlanstown ..	53 46 N	6 45 W	8
Carlaverock ..	54 58 N	3 30 W	7
Carlby, Great	64 0 N	23 20 E	23
Carlby, Little	63 50 N	22 40 E	23
Carlet	39 18 N	0 32 W	20
Carleton	45 15 N	66 6 W	38
‡Carleton (Canada)	45 15 N	76 10 W	38
Carlingford ..	54 2 N	6 10 W	8
Carlingford Bay	54 0 N	6 3 W	8
Carlisle (England)	54 55 N	2 55 W	6
Carlisle (U. States)......	40 5 N	77 8 W	39

NAME	LAT.	LONG.	MAP
Carlisle Fort ..	51 49 N	8 13 W	8
Carlo Forte....	39 10 N	8 18 E	19
Carlota	37 40 N	5 0 W	20
Carlow	52 50 N	6 57 W	8
*Carlow			8
‡Carlow, County	52 42 N	6 50 W	8
Carioway	58 15 N	6 40 W	7
Carluke	55 45 N	3 53 W	7
Carlsbad......	50 11 N	12 52 E	16
Carlsburg	46 2 N	23 31 E	16
Carlscrona	56 10 N	15 20 E	22
Carlsruhe	49 1 N	8 25 E	14
Carlstad (Sweden)........	59 24 N	13 40 E	22
‡Carlstadt (Sweden) ..	60 0 N	13 0 E	22
Carlstadt (Croatia)....	45 30 N	15 34 E	16
*Carlton House	53 0 N	117 0 W	37
Carmagnola ..	44 48 N	7 45 E	18
Carmel, Cape..	32 51 N	34 58 E	30
Carmel, Mount	32 47 N	35 5 E	30
Carmen, Fort	40 45 S	63 20 W	41
Carmen Isle ..	26 15 N	111 37 W	40
Carmo	10 28 S	48 22 W	43
Carmony	54 40 N	5 50 W	8
Carn..........	55 14 N	7 17 W	8
Carn Tual	52 0 N	9 50 W	8
*Carn Tual			8
‡Carnatic	12 0 N	79 0 E	31
Carneceria	2 35 N	75 40 W	42
Carnero	30 58 S	63 30 W	44
Carnero, Point	37 30 S	73 22 W	44
Carnero, River	31 0 S	63 12 W	14
*Carnethy			7
Carnew	52 43 N	6 31 W	8
Carnom, Pulo	9 50 N	100 0 E	32
Carnom Point	9 0 N	100 0 E	32
Carnot Bay....	17 10 S	122 25 E	47
Carnsore Point	52 13 N	6 20 W	8
Carntogher Mountains..	54 48 N	7 0 W	8
Carnwath	55 43 N	3 35 W	7
Carolath	51 47 N	15 48 E	15
Carolina (Spain)	38 18 N	3 40 W	20
‡Carolina, North	36 0 N	80 0 W	39
‡Carolina, South	34 0 N	81 0 W	39
Caroline Islands	9 0 N	144 0 E	50
Caroline Isle..	10 0 S	150 10 W	50
Caroline, Mount	31 50 S	118 5 E	47
Carony, River	8 5 N	62 50 W	42
Carouge	46 9 N	6 8 E	17
Carpathian Mountains..	47 40 N	24 0 E	16
*Carpathian Mountains..			4 25
Carpena	43 12 N	4 50 W	20
Carpentaria, Gulf of	12 0 S	140 0 E	47
Carpentaria, R.	32 50 S	56 0 W	44
Carpentras....	44 2 N	5 3 E	9
Carpi	44 47 N	11 53 E	18
Carpineto	42 26 N	13 59 E	18
Carpino	41 53 N	15 48 E	19
Carpitancito ..	22 54 S	62 20 W	44
Carra, Lough	53 41 N	9 10 W	8
Carracha......	26 52 S	67 38 W	44
Carradell......	55 35 N	5 28 W	7
Carragh, Lough	52 3 N	9 47 W	8
Carral	43 0 N	8 23 W	20
Carrapateria ..	37 18 N	8 55 W	20
Carrara	44 5 N	10 7 E	18
Carrascocilla ..	40 11 N	2 40 W	20
Carreto (Venezuela)	7 4 N	68 14 W	42
Carreto (N. Grenada)	8 47 N	77 37 W	42
Carriacou	12 20 N	61 30 W	46
Carrick on Shannon	53 57 N	8 2 W	8
Carrick on Suir	52 21 N	7 23 W	8
Carrickbeg....	54 43 N	7 12 W	8
Carrickfergus..	54 42 N	5 40 W	8
Carrickmacross	53 57 N	6 37 W	8
Carrigallen....	54 2 N	7 28 W	8
Carrigboy	51 36 N	9 30 W	8
Carril	42 28 N	8 45 W	20
Carrington....	32 12 S	152 35 E	47
Carrion	42 20 N	4 37 W	20
Carriso........	24 0 N	102 30 W	40
Carrizal	11 52 N	72 6 W	42
Carrolton	33 36 N	90 0 W	39
Carron........	54 18 N	8 0 W	8
Carron, Loch	57 20 N	5 40 W	7
Carron Water	56 4 N	3 40 W	7
Carron Works	56 4 N	3 48 W	7
Carror........	7 25 N	134 25 E	49
Carrouge......	46 35 N	6 46 E	17
‡Carrow (Sumatra)......	3 45 N	98 0 E	49
Carrow (England)	55 0 N	2 20 W	6
Carrylough....	52 25 N	6 25 W	8
Carsoli	42 7 N	13 7 E	18
Carsphairn....	55 13 N	4 15 W	7
Carstairs......	55 43 N	3 38 W	7
‡Cartagena, (Colombia)	9 30 N	75 10 W	42
Cartagena, (Colombia	10 23 N	75 31 W	42
Cartagena, (Spain)	37 36 N	1 3 W	20
Cartago, (Colombia)	4 45 N	76 5 W	42
Cartago, (Guatimala......	10 0 N	83 59 W	40
*Cartago, (Colombia)			42
Carteret Isle ..	2 35 N	135 35 E	49
Carterogli	37 12 N	22 5 E	24
Carthage......	36 14 N	85 50 W	39
Carthaus......	54 20 N	18 10 E	15
Cartier's Isle..	12 15 S	125 30 E	47
Cartosco	44 35 N	8 30 E	18
Caruachi......	7 40 N	62 56 W	42

NAME	LAT.	LONG.	MAP
Carugni	37 53 N	24 3 E	24
Carvalhos	41 2 N	8 35 W	20
Carvoeiro, Cape	39 17 N	9 25 W	20
Carwitz	53 15 N	13 15 E	12
Carynhanha ..	14 28 S	44 50 W	43
Carysfort Isle..	21 0 S	138 0 W	50
Cas Kisternes	36 23 N	22 27 E	24
Casa del Rey..	39 18 N	0 20 W	20
Casa de Sal ..	29 18 S	70 0 W	44
Casa, Fort	9 4 S	49 0 W	43
Casal Maggiore	44 59 N	10 26 E	20
Casale, (Naples)	42 20 N	14 6 E	18
Casale, (Piedmont)	45 8 N	8 24 E	18
Casaletto......	45 18 N	9 38 E	18
‡Casanare	5 30 N	71 0 W	42
Casanare......	5 57 N	71 52 W	42
Casanna Ridge	46 37 N	10 5 E	17
Casasbuenas ..	39 50 N	4 10 W	20
Casavieja	36 20 N	5 47 W	20
Casbobos Isle	10 0 N	162 0 E	50
Casca	20 17 S	43 0 W	43
Cascade Point	43 54 S	168 30 E	51
Cascaes	38 42 N	9 26 W	20
Cascana	41 15 N	14 0 E	19
Cascar, El	39 30 N	6 12 W	20
Casembas	30 40 S	50 38 W	43
Caserras	42 0 N	1 46 E	20
Cashel........	52 32 N	7 52 W	8
‡Cashmere....	34 0 N	76 0 E	31
Cashmere	34 15 N	75 20 E	31
*Castillian Mts.	40 40 N	4 0 W	20
Castine	44 22 N	68 25 W	39
Castro Vetrano	37 40 N	12 40 E	19
Casiana, River	4 30 N	73 40 W	42
Casigua	10 55 N	70 55 W	42
Casilianco	40 5 S	72 30 W	44
Casiquiare, R.	3 10 N	66 20 W	42
Casita	35 30 N	107 20 W	40
Caslie Water..	57 55 N	4 20 W	7
Caslin	52 34 N	16 55 E	15
Casma........	9 40 S	78 20 W	45
Casoliti	39 20 N	16 40 E	19
Casoyo........	42 21 N	7 5 W	20
Caspian Sea ..	42 0 N	51 0 E	4
*Caspian Sea..			23 29
Cassa Ogla....	39 50 N	53 6 E	27
Cassabili......	36 59 N	15 12 E	19
Cassagnes	44 10 N	2 32 E	9
Cassandra, G. of	39 55 N	23 45 E	25
Cassano	41 19 N	16 9 E	19
Cassaro	37 5 N	14 54 E	19
Cassel, (France)	50 48 N	2 26 E	9
Cassel, (Germany)	51 20 N	9 30 E	13
*Cassel, (Germany			15
Cassipura, R...	3 45 N	51 14 W	43
Cassville......	42 32 N	90 55 W	39
Castalla	38 39 N	0 41 W	20
Castanav-de-Ibor	39 36 N	5 20 W	20
Castaneyra....	42 9 N	6 59 W	20
Castanuela	26 12 N	101 50 W	40
Castasegna....	46 23 N	9 31 E	17
Castel a Mare	40 43 N	14 30 E	19
Castel a Mare, Gulf of	38 10 N	12 50 E	19
Castel Doria ..	40 52 N	8 57 E	19
Castel Franco	44 37 N	11 5 E	18
Castel Rodrigo	40 56 N	7 0 W	20
Casteldalco....	43 50 N	12 10 E	18
Castella	38 58 N	17 3 E	19
Castellacio	42 18 N	11 38 E	18
Castellana	42 16 N	12 23 E	18
Castellane	43 48 N	6 32 E	9
Castellaneta ..	40 38 N	16 56 E	19
Castellarano ..	44 30 N	10 43 E	18
Castelletta	43 21 N	12 57 E	18
Castello (Brazil)	7 35 S	42 12 W	43
Castello (Italy)	43 29 N	12 12 E	18
Castellon......	39 59 N	0 2 W	20
Castelluccia ..	40 0 N	16 0 E	19
Castellucio....	41 15 N	15 23 E	19
Castellum Peregrinorum ..	32 44 N	34 57 E	30
Castelnovo....	44 28 N	10 23 E	18
Castelo Branco	39 50 N	7 25 W	20
Castels	43 51 N	1 6 W	9
Castelvecchio..	44 27 N	10 41 E	18
Castiel........	46 50 N	9 40 E	17
Castiglioncella	43 25 N	11 9 E	18
Castiglione, North (Sardinia) ..	44 53 N	8 9 E	18
Castigliole, South (Sardinia) ..	44 32 N	7 32 E	18
Castiglione (Lombardy)......	45 23 N	10 30 E	18
Castiglione (Tuscany........	44 9 N	10 24 E	18
Castilblanco ..	37 39 N	5 54 W	20
Castillejo......	39 32 N	1 50 W	20
Castle Blakeney	53 24 N	8 24 W	8
Castle Blaney	54 5 N	6 36 W	8
Castle Cadwgan	52 14 N	4 14 W	6
Castle, C. Coast	32 43 S	17 50 E	35*
Castle Comer..	52 50 N	7 14 W	8
Castle Dawson	54 46 N	6 25 W	8
Castle Derg ..	54 41 N	7 30 W	8
Castle Dermot	52 54 N	6 50 W	8
Castle Island..	52 14 N	9 25 W	8
Castle Isle (West Indies)	22 0 N	74 0 W	46
Castle Isle (N. Zealand)....	36 52 S	175 51 E	51
Castle Jordan..	53 24 N	7 2 W	8
Castle Lyons..	52 5 N	8 15 W	8
Castle, Point ..	40 58 S	176 20 E	51
Castle Pollard	53 40 N	7 12 W	3
Castle Shane..	54 14 N	6 43 W	8
Castlebar	53 51 N	9 11 W	8
Castlehaven Harbour........	51 32 N	9 7 W	8
Castlehill	54 3 N	9 15 W	8
Castlemain....	52 11 N	9 40 W	8

NAME	LAT.	LONG.	MAP
Castlemain Harbour........	52 10 N	9 45 W	8
Castlemartyr..	51 55 N	8 4 W	8
Castlenau	45 0 N	0 47 W	9
Castlenaudary	43 18 N	1 55 E	9
Castleplunket	53 45 N	8 15 W	8
Castlereagh ..	53 46 N	8 26 W	8
Castlereagh, R.	30 0 S	147 30 E	47
Castletown (Ireland)....	52 43 N	7 47 W	8
Castletown (Ireland)....	52 44 N	6 10 W	8
Castletown (Man)	54 5 N	4 45 W	6
Castletown (Scotland) ..	55 11 N	2 50 W	7
Castletown (Scotland) ..	58 36 N	3 28 W	7
Castletown Roche......	52 10 N	8 28 W	8
Castletownsend	51 32 N	9 10 W	8
Castlewellan ..	54 14 N	5 56 W	8
Castre........	50 44 N	4 5 E	10
Castres (Tarn)	43 36 N	2 18 E	9
Castres (Gironde)	44 40 N	0 23 W	9
Castril........	37 50 N	2 55 W	20
Castritza (Greece)	38 54 N	22 22 E	24
Castritza, (Turkey)........	39 36 N	21 18 E	25
Castro, (Greece)	37 38 N	22 58 E	24
Castro, (Spain)	37 41 N	4 33 W	20
Castro, (Italy)	40 2 N	18 27 E	19
Castro Galli ..	39 45 N	16 15 E	19
Castro Novo, (Candia)	35 3 N	24 48 E	25
Castro Novo, (Sicily)	37 40 N	13 31 E	19
Castro, Point..	43 20 S	65 5 W	44
Castro Vetere..	38 30 N	16 26 E	19
Castromaio....	42 12 N	7 5 W	20
Castromarigo..	42 19 N	7 5 W	20
Castromarin ..	37 15 N	7 18 W	20
Castropol	43 32 N	7 0 W	20
Castroverde ..	41 51 N	4 17 W	20
Castrovireina..	13 35 S	74 47 W	45
Castrovite	42 41 N	8 20 W	20
Castrup	55 39 N	12 36 E	21
Castua	45 23 N	14 20 E	16
Castuera......	38 40 N	5 33 W	20
Casza Isle	42 43 N	16 30 E	16
Cat Island	24 20 N	75 30 W	46
Cat, Lake	52 28 N	92 30 W	37
Cat Lake House	52 12 N	92 30 W	37
Catagaita, River	20 47 S	66 30 W	45
Catagerry	13 35 N	77 15 E	31
Catalano.......	37 1 N	15 12 E	19
‡Catalonia	42 0 N	1 20 E	20
‡Catamarca ..	27 0 S	68 0 W	44
Catamarca	27 42 S	66 3 W	44
*Catamarca ..			44
Catanduane's Isle	13 40 N	124 10 E	49
Catania	37 27 N	15 0 E	19
Catania, Gulf of	37 25 N	15 10 E	19
Catanzaro	38 58 N	16 38 E	19
Catapalco	32 28 S	71 18 W	44
Catapuliche, R.	40 22 S	70 12 W	44
Cataract, Second (Nile)	21 52 N	31 17 E	36
Cataract, Third (Nile)	19 45 N	30 20 E	36
Cataract, Fourth (Nile)	18 52 N	32 0 E	36
Cataract, Fifth (Nile)	18 22 N	33 44 E	36
Cataract, Sixth (Nile)	16 38 N	33 30 E	36
Catarroja	39 24 N	0 23 W	20
Catastari, Bay of	37 51 N	20 47 E	24
Catastrophy, Cape	35 0 S	136 0 E	47
Catel	7 45 N	125 53 E	49
Catherina, S...	38 37 N	16 34 E	19
Catlenburg....	51 40 N	10 6 E	13
Cato Divris....	37 49 N	21 56 E	24
Cato Leo......	38 5 N	20 42 E	24
Catoche, Cape	21 23 N	87 0 W	40
Catouchi......	38 26 N	21 15 E	24
Catskill	42 5 N	74 20 W	39
Catskill Mountains	42 20 N	75 0 W	39
*Catskill Mountains			39
Cattaro	42 30 N	18 46 E	16
‡Cattaro District	42 20 N	18 40 E	16
Cattegat	56 40 N	11 40 E	21
Catterick......	54 20 N	1 35 W	6
Cattolica (Sicily)	37 25 N	13 21 E	19
Cattolica (Italy)	43 57 N	12 40 E	18
Catua, River ..	3 40 S	64 45 W	45
Catuna........	38 45 N	21 10 E	24
Catwick Isle, Great	10 0 N	108 4 E	32
Catwick Isle, Little	10 0 N	109 0 E	32
Cauca, River..	9 22 N	74 45 W	42
‡Caucasia	45 0 N	43 0 E	23
*Caucasus, M.			14
Caucasus Mountains........	43 0 N	43 0 E	23
Cauinari, River	1 20 S	70 56 W	42
Cauquenes Peak	34 18 S	70 0 W	44
Caura	7 37 N	65 21 W	42
Caura, River..	7 37 N	65 22 W	42
Cauten, River	38 50 S	73 30 W	44
Cauvary, River	10 50 N	79 50 E	31
Cava..........	40 44 N	14 42 E	19
Cavada, River	41 30 N	8 40 W	20
Cavaiva, River	9 35 S	58 0 W	43
Cavalar	44 44 N	7 44 E	18
Cavaliere, Cape	36 5 N	33 40 E	27
Cavallo, Cape..	40 38 N	18 0 E	19
Cavallo Isle ..	41 24 N	9 16 E	18
Cavan	54 2 N	7 16 W	8

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NAME	LAT.	LONG.	MAP
Fort Stewart..	55 3 N	7 38 W	8
Fort William (India)	22 35 N	88 36 E	31
Fort William (Scotland) ..	56 52 N	5 7 W	7
Fortesque Bay	43 7 S	148 3 E	48
Forteventura Island......	28 20 N	14 15 W	34
Forteviot	56 23 N	3 30 W	7
Fortfergus....	52 44 N	8 57 W	8
Forth, Frith of, (Scotland) ..	56 10 N	2 40 W	7
Forth, River, (Scotland) ..	56 2 N	3 10 W	7
Forth, River, (Tasmania)	41 11 S	146 14 E	48
Fortingall	56 38 N	4 2 W	7
Fortino	43 40 N	10 15 E	18
Fortore, River	41 55 N	15 19 E	19
Fortrose......	57 37 N	4 5 W	7
Fortune Bay ..	47 20 N	55 40 W	38
Fortune Isle, (W. Indies)	22 30 N	74 10 W	46
Fortune Isle, (Sumatra) ..	5 45 S	104 30 E	49
Fosen	64 0 N	10 20 E	22
Fossalta	45 37 N	12 30 E	18
Fossano	44 35 N	7 47 E	18
Fosses........	50 24 N	4 40 E	10
Fossombrone..	43 41 N	12 45 E	18
Fotoma	50 40 N	136 10 E	33
Foukoci	36 20 N	136 20 E	33
Foul Isle	18 0 N	94 0 E	32
Foul Sound ..	53 5 N	9 30 W	8
Foula Isle	60 2 N	0 48 W	5
Foulez........	50 40 N	4 54 E	10
Foulsham	52 48 N	1 0 E	6
Foulstrup	56 4 N	9 33 E	21
Foulweather,C.	45 40 N	123 40 W	37
Foulwind,Cape	41 44 S	171 30 E	51
Fouly	46 8 N	7 5 E	17
Fountstown ..	53 5 N	6 55 W	8
Four Crowns, The, (of Quiros)	28 5 S	144 0 W	50
Fourcroy, Cape	11 50 S	130 0 E	47
Fourdan......	43 10 N	132 0 E	33
Fourna	39 0 N	21 50 E	24
Foveaux Strait	46 35 S	167 40 E	51
Fowler's Bay..	32 0 S	132 30 E	47
Fox Channel ..	66 0 N	80 0 W	37
Fox River	41 12 N	88 35 W	39
Foxborough ..	53 35 N	7 11 W	8
Foxford	53 59 N	9 0 W	8
Foyle, Lough..	55 5 N	7 0 W	8
Fraadge	55 23 N	10 29 E	21
Frabersheim ..	48 1 N	12 21 E	14
Fradelo	42 12 N	7 10 W	20
Fraqua, River	0 50 N	74 8 W	42
Fraiture	50 15 N	5 47 E	10
Franca, La....	43 25 N	4 32 W	20
Francavilla (Sicily)	37 50 N	15 8 E	19
Francavilla (Italy)......	40 8 N	16 18 E	19
‡France	46 0 N	2 0 E	4
‡France, Mountains of			4
‡FrancheComte	47 10 N	6 10 E	9
Francis, Cape	49 0 S	70 10 E	1
Francis, Port..	33 35 S	26 43 E	35
Francis, River	45 54 N	72 10 W	39
Francisca, Cape	49 50 S	67 15 W	41
Franckenthal..	49 34 N	8 20 E	14
Frank, Mount	31 40 N	35 15 E	30
Franke, Cape..	55 12 N	10 56 E	21
Franken	52 50 N	7 16 E	12
Frankenburg..	53 12 N	8 55 E	12
Frankenhausen	51 21 N	11 5 E	13
Frankenheim..	50 34 N	10 8 E	13
*Frankenheim			13
Frankenstein (Bavaria) ..	49 27 N	7 56 E	14
Frankenstein (Prussia)....	50 38 N	16 52 E	15
Frankford	53 12 N	7 37 W	8
Frankfort (Indiana)......	40 12 N	86 16 W	39
Frankfort (Kentucky)......	38 7 N	84 42 W	39
Frankfort on the Mayn ..	50 9 N	8 35 E	13
Frankfort on the Oder....	52 17 N	14 35 E	15
Frankland, R.	41 16 S	145 11 E	48
Frankland's Isles........	16 55 S	146 15 E	47
Franklin (Georgia) ..	31 10 N	83 23 W	39
Franklin (Missouri)	38 53 N	92 35 W	39
Franklin (Pennsylvania) ..	41 8 N	79 56 W	39
Franklin (Arkansas)	35 4 N	90 55 W	39
Franklin Bay..	70 18 N	124 0 W	37
Franklin, Cape	40 25 S	147 58 E	48
Franklin, Cape	74 10 N	83 30 W	37
Franklin, Fort	65 22 N	122 10 W	37
Franklin, Point	70 45 N	158 55 W	37
Franklinton ..	30 59 N	90 16 W	39
Franquistais ..	38 56 N	21 36 E	24
Franquita, La	31 54 S	67 10 W	44
Franville......	50 16 N	5 23 E	10
Frasca, Cape..	39 46 N	8 27 E	18
Frascati	41 50 N	12 43 E	19
Frascinetto ..	40 21 N	16 13 E	19
Fraserburgh ..	57 43 N	2 0 W	7
Frasne, Easter	50 32 N	4 27 E	10
Frasne, Wester	50 39 N	3 36 E	10
Frat, River ..	31 5 N	47 10 E	27
Fratta........	43 18 N	12 18 E	18
Frauenstein ..	50 48 N	13 31 E	13
Fraustadt	51 46 N	16 19 E	15
Frayle Muerto	32 33 S	61 59 W	44

NAME	LAT.	LONG.	MAP
Frayles	17 40 N	71 30 W	46
Freckenham ..	52 20 N	0 30 E	6
Fredensborg ..	55 58 N	12 23 E	21
Fredericia	55 34 N	9 46 E	21
Frederick, Fort	33 58 S	25 32 E	35
FrederickHouse	48 27 N	81 40 W	38
Frederick Shoal	20 50 S	154 30 E	47
Frederick Hendrick's Bay..	42 50 S	148 0 E	48
Frederick Henry, Cape	43 15 S	147 35 E	48
Fredericksborg	55 55 N	12 15 E	21
Fredericksburg (Denmark)..	55 41 N	12 30 E	21
Fredericksburg (CapeColony)	33 18 S	27 0 E	35
Frederickadal	54 55 N	11 2 E	21
Frederickshorst	54 27 N	10 5 E	21
Frederickstadt	54 24 N	9 10 E	21
Fredericksund	55 50 N	12 4 E	21
Frederikshaab	62 20 N	50 0 W	37
Frederikstadt Island	17 40 N	64 50 W	46
Freehold......	40 15 N	74 20 W	39
Freels, Cape, South	46 45 N	53 20 W	38
Freels, Cape, North	49 21 N	53 28 W	38
Freemantle ..	32 7 S	116 0 E	47
Fregenal......	38 10 N	6 41 W	20
Freinsheim....	49 31 N	8 13 E	14
Freisack	52 45 N	12 30 E	15
Freising	48 25 N	11 44 E	14
Frek..........	45 45 N	24 20 E	16
Fremont's Peak	43 3 N	110 13 W	40
‡FrenchFlanders	50 30 N	3 10 E	9
French Isle....	38 20 S	145 25 E	47
FrenchRiver,The	45 55 N	80 48 W	38
Frenchman'sCap Mountain ..	42 20 S	145 38 E	48
Frenchpark ..	53 53 N	8 20 W	8
Frendenstadt..	48 28 N	8 24 E	14
Freren........	52 28 N	7 31 E	12
Fresco, River..	7 50 S	53 18 W	43
Freshford	52 45 N	7 22 W	8
Fresno........	41 40 N	5 37 W	20
Fresskill......	58 35 N	4 30 W	7
Freswick......	58 36 N	3 8 W	7
Freudenburg..	52 51 N	8 41 E	12
Freuenfield....	47 33 N	8 52 E	17
Freyberg (Bavaria)	48 45 N	13 29 E	14
Freyberg (Saxony)	50 55 N	13 20 E	13
Freyberg (Saxony)	51 11 N	12 52 E	13
Freyburg (Pr. Saxony)	51 15 N	11 44 E	15
Freyburg (Silesia)	50 48 N	16 20 E	15
Freycinet's Harbour........	26 30 S	114 0 E	47
Freystadt (Prussia)	53 38 N	19 10 E	15
Freystadt (Austria)	48 32 N	14 32 E	16
Friar's Island..	43 33 S	147 25 E	48
Frias	42 46 N	3 14 W	20
Fribach	57 18 N	15 25 E	22
Friburg (Switzerland)	46 48 N	7 10 E	17
‡Friburg (Switzerland)	46 40 N	7 5 E	17
Friburg(Baden)	48 0 N	7 50 E	14
*Friburg (Baden)			14
Friderichshausen	47 39 N	9 28 E	14
Fridericksgade	55 40 N	9 3 E	21
Friderikstad ..	59 10 N	11 3 E	22
Friedberg	50 23 N	8 38 E	13
Friedburg	48 23 N	10 59 E	14
Friedeburg....	52 58 N	15 36 E	15
Friedenfels....	49 51 N	12 5 E	14
Friedewald....	50 52 N	9 49 E	13
Friedland (East Prussia)	54 28 N	21 0 E	15
Friedland (West Prussia) ..	53 35 N	17 10 E	15
Friedland (Silesia)	50 55 N	15 0 E	15
Friedland(Mecklenburg)	53 37 N	13 26 E	12
Friedling	49 12 N	12 25 E	14
Friedlos	50 55 N	9 44 E	13
Friedrichshof..	53 30 N	21 16 E	15
Friedrichsroda	50 55 N	10 35 E	13
‡FriendlyIslands	18 0 S	178 0 W	50
Friesach	46 55 N	14 26 E	16
‡Friesland....	53 5 N	5 50 E	11
‡Friesland,East	53 25 N	7 30 E	12
Frimley	51 23 N	0 45 W	6
Frio, Cape (S. Africa)........	18 0 S	12 0 E	34
Frio, Cape (Brazil)	22 56 S	42 3 W	43
Frische Haff ..	54 30 N	19 40 E	15
FrischeNehrung	54 30 N	19 40 E	15
Fritlingen	48 8 N	8 43 E	14
Fritzlar	51 9 N	9 14 E	13
Fritzow	54 0 N	14 52 E	15
Frobisher's Strait	64 0 N	66 0 W	37
Froblinge	50 49 N	11 45 E	13
Frodlingham..	53 55 N	0 20 W	6
Frodsham	53 17 N	2 45 W	6
Frome........	51 16 N	2 20 W	6
Fronau	49 14 N	12 17 E	14
Fronteira	39 8 N	7 27 W	20
‡Frontenac (L. Ontario)......	44 25 N	76 30 W	38
Frontenhausen	48 31 N	12 27 E	14
Froom, River	50 42 N	2 7 W	6
‡Frooerne Isles	64 0 N	9 20 E	22
Frorup........	55 24 N	10 19 E	21
Frosinono	41 41 N	13 20 E	19

NAME	LAT.	LONG.	MAP
Frostrupgaard	55 42 N	8 29 E	21
Froyeen	63 45 N	8 40 E	22
Frozen Strait..	65 10 N	84 0 W	19
Fruermark....	54 55 N	9 23 E	21
Frutigen......	46 35 N	7 38 E	17
Frystrup......	56 55 N	9 25 E	21
Fucecchio	43 44 N	10 45 E	18
Fucecchio,Lake	43 50 N	10 45 E	18
Fuegos Isle ..	9 2 N	123 25 E	49
Fuencaliente..	38 30 N	4 3 W	20
Fuenfkirchen..	46 2 N	18 17 E	16
Fuen-tchou ..	37 15 N	111 40 E	33
Fuente-del-Fresno........	39 17 N	3 52 W	20
Fuentelapena	41 20 N	5 27 W	20
Fuentelsauco..	41 20 N	5 38 W	20
Fuentepinel ..	41 26 N	4 0 W	20
Fuenterrabia..	43 21 N	1 48 W	20
Fuentes	41 32 N	0 38 W	20
Fuentes de la Campana ..	37 25 N	5 22 W	20
Fuentesauco ..	41 44 N	2 20 W	20
Fuerte Isle....	9 20 N	76 14 W	42
Fugelsang	56 24 N	10 53 E	21
Fugloe	62 35 N	6 18 W	21
Fuhais, El....	32 3 N	35 50 E	30
Fuhrberg	52 33 N	9 49 E	12
Fuir, Loch....	57 46 N	5 20 W	7
Fulbeck	52 56 N	0 29 E	12
Fulda	50 34 N	9 42 E	13
*Fulda			13
Fulda, River ..	51 26 N	9 40 E	13
Fulesd........	47 57 N	22 40 E	16
Fulston	53 30 N	0 5 E	6
Fumal........	50 35 N	5 7 E	10
Funado	40 10 N	7 23 W	20
Funchal	32 0 N	17 15 W	34
Fundah	8 5 N	8 50 E	34
FundicodelFico	38 50 N	16 16 E	19
‡Funen	55 20 N	10 20 E	21
Fungi, Jebel..	12 0 N	33 15 E	36
Funia........	36 38 N	22 52 E	24
Funil	9 56 S	48 46 W	43
Funnel, Mount	21 40 S	149 20 E	47
Fuoring	47 15 N	113 0 E	33
Furako, Mount	1 15 N	57 30 W	43
*Furako, Mt..			43
Fureidis, Jebel	31 40 N	35 15 E	30
FurneauIslands	40 20 S	148 0 E	48
Furnera	38 3 N	15 9 E	19
Furnes........	51 4 N	2 40 E	10
Furo, River ..	2 35 S	56 50 W	43
Furrah	33 0 N	62 0 E	29
Furrah, River	32 16 N	61 15 E	29
Furruckabad..	27 30 N	79 40 E	31
Furstenau	52 30 N	7 39 E	12
Furstenberg (Brunswick)	51 44 N	9 21 E	12
Furstenberg (Prussia)....	52 5 N	14 40 E	15
Furstenberg (Mecklenburg)	53 9 N	13 0 E	12
Furstenfeld ..	48 13 N	11 16 E	14
Furstenow	53 10 N	15 50 E	15
Furstenried ..	48 5 N	11 27 E	14
Furstensee....	53 15 N	12 59 E	12
Furth (Switzerland)	46 43 N	9 14 E	17
Furth (Bavaria)	49 26 N	11 2 E	14
Furth (Bavaria)	49 18 N	12 40 E	14
Furtwangen ..	48 3 N	8 11 E	14
Fusau	53 2 N	10 54 E	13
*Fusi			50
Fussen........	47 35 N	10 41 E	14
Fusso	41 6 N	14 48 E	19
Fustinana	42 4 N	1 26 W	20
Futheli, Jebel	13 38 N	46 0 E	36
Fuur Island...	56 50 N	9 3 E	21
Fyvie	57 26 N	2 22 W	7
Fyzabad	26 50 N	82 45 E	31
Gaba	32 21 N	35 13 E	30
Gabally	52 24 N	8 15 W	8
Gabas, River..	43 43 N	0 40 W	9
Gabbiano	45 10 N	8 12 E	18
Gabe	3 10 S	122 35 E	49
Gabello	43 9 N	17 40 E	25
Gablem	50 52 N	13 12 E	13
§Galzans, The	66 0 N	150 0 W	37
Gachingen	48 28 N	9 21 E	14
Gachun, Lake	35 30 N	86 0 E	33
Gad	32 7 N	35 45 E	30
Gadamis......	29 30 N	10 55 E	34
Gadara	32 41 N	35 43 E	30
Gadda (Palestine)........	32 5 N	36 8 E	30
Gadda (Abessinia)	6 36 N	36 30 E	36
Gadda, Wady El	29 40 N	38 40 E	36
Gaddedet	64 28 N	14 16 E	22
Gadmen	46 46 N	8 21 E	17
Gador	36 59 N	2 32 W	20
Gadouriari....	38 8 N	21 50 E	24
Gadow........	53 9 N	12 30 E	15
Gael Hamke's Bay	74 10 N	18 0 W	37
Gaeta	41 12 N	13 34 E	19
Gaeta, Gulf of	41 8 N	13 40 E	19
Gaghabib	15 30 N	35 15 E	36
Gagnef	60 32 N	15 10 E	22
Gahyba, Lake	17 50 S	58 15 W	45
Gaidarn Isle ..	38 41 N	24 15 E	24
Gaidaronisi Isle	37 40 N	23 58 E	24
Gaiduro Isle ..	39 5 N	24 1 E	24
Gaih..........	26 20 N	60 18 E	29
Gaildorf	49 0 N	9 45 E	14
Gaillac........	43 53 N	1 53 E	9
Gaillego, River	41 44 N	0 52 W	20
Gainsborough	53 25 N	0 55 W	6
Gainsville	34 15 N	83 45 W	39
Gair, Loch....	57 44 N	5 40 W	7
Gairloch	57 43 N	5 35 W	7
Gaishofen	48 35 N	13 14 E	14
Gaishorn......	47 25 N	10 16 E	12
Gal	40 55 N	42 15 E	27
Gala, River ..	55 38 N	2 48 W	7

NAME	LAT.	LONG.	MAP
*Galapagos, Peak of			50
Galcota	10 10 N	61 0 W	46
Galeata	43 59 N	12 0 E	18
Galego Isle....	2 10 N	104 5 W	50
Galena	42 20 N	90 20 W	39
Galera, Point..	10 50 N	60 55 W	46
Galera, Port ..	10 46 N	75 22 W	42
Galatino......	40 10 N	18 10 E	19
Galatz........	45 22 N	27 57 E	25
Galaxidi......	38 22 N	22 24 E	24
Galhan, River	22 0 S	58 0 W	44, 45
‡Galicia	42 40 N	8 0 W	20
‡Galicia and Lodomir......	49 0 N	23 0 E	16
Galiera	44 45 N	11 25 E	18
‡Galilee	32 55 N	35 20 E	30
Galinaza, River	7 14 N	73 55 W	42
Galisteo	39 59 N	6 0 W	20
Galitch	58 15 N	44 40 E	23
Galivan's Bay	25 50 N	81 35 W	39
‡Galla Country	8 0 N	40 0 E	34
Gallamoon....	25 25 N	28 55 E	36
Gallan Head..	58 8 N	7 0 W	7
Gallarate	45 39 N	8 45 E	18
Gallashiels....	55 38 N	2 50 W	7
§Gallat Tribes	9 0 N	38 0 E	36
Galle	6 5 N	80 20 E	31
Galle, Pointe de	6 0 N	80 30 E	31
Gallega, La ..	41 54 N	3 16 W	20
Gallegos, River	52 0 S	68 50 W	41
Gallinas, Point	12 26 N	71 34 W	42
Gallinas, River	6 40 N	11 40 W	34
Gallipoli, (Dardanelles)....	40 25 N	26 45 E	25
Gallipoli, (Naples)	40 4 N	18 0 E	19
Gallipolis	38 50 N	82 10 W	39
Gallo, Cape, (Greece)	36 41 N	21 55 E	24
Gallo, Cape di	38 2 N	13 15 E	19
Gallo, Cape, (Naples)......	40 43 N	17 57 E	19
Galloway, New	55 5 N	4 7 W	7
Gally Head ..	51 33 N	8 56 W	8
Galstrom	68 30 N	13 40 E	22
Galtee Mountains	52 20 N	8 10 W	8
*Galtee Ms...			8
Galtzang Koutche......	33 30 N	92 0 E	33
Galway	53 17 N	9 0 W	8
Galway Bay ..	53 10 N	9 25 W	8
‡Galway,County	53 20 N	9 0 W	8
Galvaes	19 16 S	40 30 W	43
Galveston Bay	29 15 N	95 37 W	40
Gamagna	42 14 N	13 15 E	18
Gamako,Mount	37 14 N	22 40 E	24
Gamaley, Cape	40 40 N	140 0 E	33
Gamarini-aguas	9 20 S	72 20 W	45
Gamas Isle....	40 24 S	62 7 W	44
Gambia, River	13 0 N	17 0 W	34
Gambier's Isles	22 0 S	134 30 W	50
Gambote......	10 2 N	75 22 W	42
Gambrod	55 33 N	12 0 E	21
§Gamboushees	31 0 S	29 0 E	35
Gamerdingen	48 16 N	9 13 E	14
Gamka, River	33 18 S	22 7 E	35
Gammel Skagen	57 33 N	10 34 E	21
Gammon	0 35 S	130 30 E	49
Gampelen	47 1 N	7 3 E	17
Gamtoo's River	33 36 S	25 10 E	35
Gan	18 55 N	102 40 E	32
Gananoqui,Lake	44 30 N	76 0 W	38
Gander Bay ..	49 27 N	54 38 W	38
Gandi	8 30 N	77 22 W	42
Gandia	39 0 N	0 14 W	20
Gandix	37 20 N	3 20 W	20
Gandowa,River	13 17 N	35 45 E	36
Gandria	46 3 N	9 3 E	17
Ganges Isle ..	9 40 N	114 30 E	49
Ganges, River	22 0 N	90 0 E	31
Gangoutri, Mt.	30 42 N	78 45 E	31
*Gangoutri,Mt.			31
Gangpoor	22 8 N	84 50 E	31
Ganjam	19 22 N	85 15 E	31
Gannat	46 5 N	3 11 E	9
Ganos	40 42 N	27 18 E	25
Ganterisch....	46 42 N	7 28 E	17
GantheaumeBay	27 40 S	114 10 E	47
Gantheaume, Cape	36 5 S	137 40 E	47
Gantheaume P.	17 50 S	122 20 E	47
Gantinga	0 15 N	122 17 E	49
Ganton	52 30 N	1 45 E	6
Ganya........	48 5 N	23 48 E	16
Ganz	53 32 N	9 44 E	12
Gap..........	44 32 N	6 5 E	9
Gara..........	46 1 N	19 6 E	16
Gara, Lough ..	53 56 N	8 25 W	8
Garah	29 37 N	26 50 E	36
Garate's Point	48 20 N	52 38 W	38
Garchina......	48 17 N	11 39 E	14
Garcia	38 8 N	8 15 W	20
Garcia Reus ..	41 11 N	0 40 E	20
Garcias	39 16 N	5 27 W	20
‡Gard Depart.	44 3 N	4 0 E	9
Garda........	45 35 N	10 45 E	18
Garda, Lake of	45 40 N	10 40 E	18
Gardal Nœs ..	60 35 N	9 20 E	22
Garden Isle ..	32 10 S	115 40 E	47
Garden, Lake	54 37 N	17 5 E	15
Garderen	52 14 N	5 42 E	11
Garditz	51 11 N	13 6 E	13
Gare, Loch....	56 0 N	4 40 W	7
Gareloch (village)	56 3 N	4 47 W	7
Garessio	44 13 N	7 59 E	18
Gargagliano ..	37 2 N	21 38 E	24
*Gargano,Monte			19
Gargano,Mount	41 49 N	16 8 E	19
*Gargano, Plateau of			19
Gargano Promontory	41 50 N	16 12 E	19

NAME	LAT.	LONG.	MAP
Gargnas	65 20 N	18 30 E	22
Garia Bay	47 37 N	58 30 W	38
Garibick......	30 5 N	81 0 E	31
Gariep, River..	28 40 S	16 30 E	35
Garigliano, R.	41 14 N	13 45 E	19
Garioch	57 17 N	2 23 W	7
Garlasco	45 9 N	8 55 E	18
Garlieston	54 46 N	4 19 W	7
Garmouth	57 40 N	3 5 W	7
Garnet Bay ..	24 40 N	15 0 W	34
Garnoe	55 14 N	11 35 E	21
GaromnaIsland	53 15 N	9 40 W	8
Garonne, River	45 35 N	1 0 W	9
Garotta	38 55 N	16 35 E	19
*Garon, Mount			46
Garrie Goreum	58 15 N	6 15 W	7
Garrison......	54 24 N	8 0 W	8
Garrough	55 18 N	4 45 W	7
Garroway	4 25 N	7 55 W	34
Garry, Cape ..	71 50 N	95 30 W	37
Garry, Loch ..	56 48 N	4 10 W	7
Garryhill......	52 41 N	6 50 W	8
Garstang	53 50 N	2 45 W	6
Gartmore	56 10 N	4 20 W	7
Gartree Point	54 35 N	6 9 W	8
Gartz	54 4 N	11 43 E	12
Garvagh	54 58 N	6 32 W	8
Garvald	55 55 N	2 35 W	7
Garve Water..	57 34 N	4 30 W	7
Garviemore ..	57 2 N	4 25 W	7
Garvilan Isles	55 24 N	7 18 W	8
Gasco	43 1 N	18 50 E	25
Gasconade,River	38 31 N	91 25 W	39
‡Gascony	43 40 N	0 10 W	9
Gaschunden ..	52 43 N	9 15 E	12
Gashun	45 0 N	110 50 E	33
Gask	56 23 N	3 37 W	7
Gasmalla	14 17 N	33 52 E	36
Gaspar Rico ..	15 12 N	171 0 E	50
Gaspar, Strait of	3 0 S	107 30 E	49
Gaspe Bay....	48 40 N	64 15 W	38
‡Gaspe District	48 40 N	65 0 W	38
Gasselt	52 56 N	6 43 E	11
Gassen	46 10 N	7 55 E	17
Gassum	56 34 N	10 2 E	21
Gastein	47 10 N	13 8 E	16
*Gastein......			16
Gastouni......	37 52 N	21 16 E	24
Gasturi	39 32 N	19 54 E	24
Gata, Cape....	36 43 N	2 10 W	20
Gatehouse	54 54 N	4 10 W	7
*Gatesgarth House......			6
Gath	32 0 N	34 50 E	30
Gath	31 47 N	34 45 E	30
Gath Hepher..	32 45 N	35 20 E	30
Gath Rimmon	31 40 N	34 54 E	30
Gatinara......	45 37 N	8 21 E	18
Gatineau, River	45 22 N	75 32 W	38
Gaub	50 6 N	7 44 E	13
Gaude, Lake..	70 20 N	30 0 E	22
Gaudy, River..	57 18 N	2 30 W	7
Gauerslund ..	55 39 N	9 40 E	21
Gaueta, La....	41 25 N	15 36 E	19
‡Gaulonitis ..	32 57 N	35 50 E	30
*Gaulonitis, Tableland of			30
Gauri	10 58 N	7 40 E	34
Gaurit's River	34 20 S	21 55 E	35
Gavandin	42 58 N	24 26 E	25
Gave de Pau, R.	43 30 N	1 10 W	9
Gavi..........	44 40 N	8 50 E	18
Gaviano	39 29 N	7 50 W	20
Gavilanes	40 17 N	4 50 W	20
Gavind, River	0 15 S	42 25 E	34
Gavo	38 39 N	23 30 E	24
Gavrilovsk	47 20 N	34 0 E	23
Gavrios, River	38 31 N	23 7 E	24
Gawulgur	21 30 N	77 8 E	31
Gaza	31 27 N	34 27 E	30
Gazal, Birket El	9 15 N	29 15 E	36
Gazer	31 54 N	35 0 E	30
Gdov	58 40 N	28 5 E	23
*Geant, Col de			17
Gebaa, River..	13 37 N	38 40 E	36
Gebba........	19 40 N	42 0 E	36
Gebe	0 17 S	130 15 E	49
Gebel	32 10 N	45 40 E	27
Gebizeh	40 43 N	29 26 E	25
Gebsattel	49 21 N	10 14 E	14
Gedd,Loch....	57 26 N	5 7 W	7
*Gedee Volcano			49
Gedern	50 27 N	9 2 E	13
Gedinne	49 59 N	4 55 E	10
Gedor	31 39 N	35 5 E	30
Geel..........	51 10 N	4 48 E	10
Geelvink Bay..	2 0 S	136 0 E	49
Geelvinck's Channel	29 0 S	114 0 E	47
Geerden	52 19 N	9 35 E	12
Geertruideburg	51 43 N	4 50 E	11
Gefle	60 42 N	17 10 E	22
‡Gefle(Common)	61 0 N	16 40 E	22
‡Gefle (Proper)	60 40 N	16 40 E	22
*Gehatsch,Mt.			16
Gehren	50 40 N	11 1 E	13
Geifenheim ..	50 0 N	7 56 E	13
Geisclwind....	49 46 N	10 31 E	14
Geisingen	47 55 N	8 38 E	14
Geislingen (Wirtemburg)	48 37 N	9 50 E	14
Geislingen (Bavaria) ..	49 37 N	10 10 E	14
Geisselbach ..	50 11 N	9 12 E	13
‡Gelderland ..	52 5 N	5 50 E	11
Geldorp	51 25 N	5 32 E	11
Gelert........	53 0 N	7 49 E	12
Gellivar	67 20 N	20 45 E	22
Gelly Hill	56 57 N	3 43 W	7
Gelnhausen ..	50 17 N	9 13 E	13
Gembloux	50 34 N	4 40 E	10
Gemishkhana	40 18 N	39 20 E	27
Gemmersdorf	54 23 N	10 59 E	12
Gemona	46 14 N	13 8 E	18
Gemunden....	50 5 N	9 44 E	13

NAME	LAT.	LONG.	MAP
Naragume	27 24 N	105 7 W	40
Naraiow	49 31 N	24 50 E	16
Narba	13 58 N	39 1 E	36
Narbeth	51 47 N	4 45 W	6
Narbonne	43 10 N	3 0 E	9
Narcoondam Isle	13 10 N	94 0 E	32
Nardo	40 10 N	18 3 E	19
Nareenpoot ...	17 45 N	80 40 E	31
Naren	54 49 N	8 20 W	8
Narenta, River.	43 4 N	17 27 E	16
Naria	26 45 N	100 58 W	40
Narim........	59 0 N	81 0 E	28
Narincharou, Mount......	41 0 N	106 0 E	33
Narnhoh......	25 53 N	96 0 E	32
Narni	42 31 N	12 29 E	18
Narnol........	28 5 N	76 18 E	31
Naro	37 13 N	13 45 E	19
Narol	50 25 N	23 30 E	16
Naroonda	15 0 S	47 30 E	34
Narop, River..	24 12 S	16 55 E	35
Naros	28 50 S	19 30 E	35
Narovtchat....	54 6 N	43 30 E	23
Narrow Bay ..	43 15 S	170 17 E	51
Narset........	64 6 N	17 0 E	22
Narsingur	22 35 N	86 45 E	31
Narva	59 25 N	28 10 E	23
Nasa Field....	66 22 N	16 5 E	22
Nasbusan, Jebel	15 56 N	30 45 E	36
Nasby	57 30 N	15 0 E	22
Nasca	15 2 S	75 35 W	45
Nasebye	70 10 N	28 58 E	22
Nashville	35 56 N	86 45 W	39
Naskov	54 51 N	11 7 E	21
Naspukolsk ..	62 20 N	67 10 E	28
Nass	57 28 N	18 20 E	22
Nassach	50 12 N	10 28 E	13
Nassadel......	51 3 N	17 43 E	15
Nassau	50 20 N	7 47 E	13
‡Nassau	50 25 N	8 0 E	13
Nassau Bay ..	55 50 S	68 0 W	41
Nassau Island	25 0 N	77 20 W	46
Nassau Isle ..	2 56 S	100 22 E	49
Nassau, River	50 40 S	141 30 E	47
Nassaub	14 30 N	45 50 E	36
Nassif, Biar ..	25 37 N	39 30 E	36
Nassogue	50 5 N	5 17 E	10
Nassuck	19 58 N	73 50 E	31
Nastetten	50 13 N	7 50 E	13
Nata	8 35 N	80 0 W	42
Natal (Brazil)	5 35 S	35 44 W	43
Natal (S. Africa)	30 20 S	30 47 E	35
Natal (Sumatra)	0 30 N	99 28 E	49
Natal, Port....	29 55 S	30 53 E	35
Natal, First Port of	32 3 S	28 50 E	35
Natal, Mid Port of	30 40 S	30 30 E	35
Natal, Third Port of	30 20 S	30 46 E	35
§Natchitoches, The	31 40 N	93 0 W	39
Naters........	46 22 N	7 57 E	17
Nathunz Surdehan	33 12 N	51 50 E	29
Natistagoet Harbour	50 5 N	60 40 W	38
Natividade	11 22 S	47 44 W	43
Natle, Lake ..	70 32 N	28 40 E	22
Nato	8 55 N	64 7 W	42
‡Natolia. See Anadolia.			
Natrun, Wady El..........	30 2 N	31 9 E	36
Natuna, Great	4 0 N	108 15 E	49
Natunas, North	4 52 N	108 15 E	49
Naturalist, Cape	40 52 S	148 10 E	48
Naturaliste, Cape	33 20 S	115 0 E	47
Naturaliste's Channel	25 25 S	113 0 E	47
Naturaliste, M.	28 15 S	114 30 E	47
Nauders	46 52 N	10 51 E	16
Naudoway, R.	40 27 N	94 45 W	39
Naumburg (Hesse)	51 16 N	9 10 E	13
Naumburg (Prussia)....	51 10 N	11 45 E	15
Naundfeld	51 14 N	13 42 E	13
Naundorf	50 56 N	13 25 E	13
Naungthun ..	19 56 N	102 5 E	32
Naurzumska..	51 40 N	65 40 E	28
Naustedal	61 35 N	5 40 E	22
Nava (Spain)..	41 20 N	5 0 W	20
Nava (Sweden)	67 10 N	22 40 E	22
Navacerada ..	40 45 N	4 0 W	20
§Navahoes, The	36 0 N	109 0 W	40
Navalcarnero..	40 20 N	4 3 W	20
Navalmoral ..	39 47 N	4 40 W	20
Navalosa	40 29 N	5 0 W	20
Navamorquende	40 8 N	4 51 W	20
Navan........	53 38 N	6 38 W	8
Navarin Isle..	55 15 S	67 30 W	41
Navarino	36 52 N	21 41 E	24
‡Navarre	42 40 N	1 40 W	20
Navarro	35 2 S	59 10 W	44
Navas	41 15 N	3 42 W	20
Navasa	18 20 N	74 50 W	46
Navel	67 32 N	14 20 E	22
Navelli	42 14 N	13 45 E	18
Navenby......	53 5 N	0 35 W	6
Naver, Loch ..	58 18 N	4 25 W	7
Navia	43 34 N	6 46 W	20
Navidad, Porto de..........	19 18 N	104 58 W	40
Navigator's Islands	13 0 S	170 0 W	50
Navolok, Cape	69 40 N	33 0 E	23
Navur	43 40 N	45 40 E	23
*Navur			23
Nawarik	19 55 N	35 17 E	36
Nawayn-kiaung	18 56 N	96 55 E	32
Nayd	13 55 N	80 15 E	31
Nayon........	3 22 S	79 12 W	42

NAME	LAT.	LONG.	MAP
Nazaret	33 40 N	45 20 E	27
Nazareth (Belgium)	50 58 N	3 36 E	10
Nazareth (Palestine)	32 43 N	35 19 E	30
Nazareth, R...	0 45 S	8 40 E	34
Naze, The	51 53 N	1 12 E	6
Naziltza, R. ..	40 32 N	22 35 E	25
Nazimovska ..	59 55 N	86 55 E	28
Neagh, Lough	54 35 N	6 15 W	8
Neath	51 38 N	3 50 W	6
Neb Sheri	38 35 N	34 38 E	27
Nebala	31 58 N	34 57 E	30
Nebo, Mount..	31 43 N	35 47 E	30
Nebreda	41 56 N	3 35 W	20
Neby Musa ..	31 46 N	35 27 E	30
Neby Samuel..	31 49 N	35 10 E	30
*Neby Samuel			30
Nechi, River..	8 30 N	74 58 W	42
‡Neckar (Baden)	49 20 N	8 40 E	14
‡Neckar, Low (Wirtemberg)	49 10 N	9 20 E	14
‡Neckar, Mid (Wirtemberg)	48 30 N	8 50 E	14
‡Neckar, Upper (Wirtemberg)	48 10 N	8 40 E	14
Neckar, River	49 31 N	8 27 E	14
Neckarreins ..	48 54 N	9 16 E	14
‡Necker Isle ..	23 15 N	165 0 W	50
Ned Thomas Isle	14 17 N	82 30 W	40
Neday	21 25 N	94 53 E	32
Neddemin	53 36 N	13 11 E	12
‡Nedenæ	59 0 N	8 0 E	22
Nederbrakel ..	50 46 N	3 55 E	10
Nedlitz	52 7 N	12 22 E	13
Needham	52 10 N	1 3 E	6
Needles, The..	50 42 N	1 35 W	6
Needle's Point	36 3 S	175 26 E	51
Neeguddir....	18 35 N	81 35 E	31
Neembuco	26 58 S	58 25 W	43
Neemuch	24 30 N	75 0 E	31
Neepigon Bay	48 58 N	88 20 W	39
Neermull	19 15 N	78 25 E	31
Neers	53 47 N	10 20 E	21
Nees	56 25 N	8 14 E	21
Negapatam ..	10 45 N	79 50 E	31
Negheib, Jebel	17 0 N	38 30 E	36
Negombo	7 17 N	79 50 E	31
Negra, Point..	26 24 S	70 55 W	44
Negrais, Cape	15 50 N	94 10 E	32
Negrete, Cape	37 36 N	0 48 W	20
Negril, Point..	18 10 N	78 25 W	46
Negro, Cape ..	38 20 E	24 3 E	24
Negro, Rio (Banda Oriental)	33 18 S	58 12 W	44
Negro, Rio (La Plata)	41 0 S	62 33 W	44
Negro, Rio (Para)	5 30 S	55 50 W	43
Negrokop	41 30 N	24 5 E	25
‡Negroland: see ‡Nigritia....			
Negropont....	38 32 N	23 43 E	24
‡Negropont ..	38 30 N	24 0 E	24
Negropont Channel	38 20 N	24 0 E	24
Negros Island	10 0 N	123 0 E	49
Neh..........	32 54 N	58 55 E	29
Nehi Abel	33 40 N	36 15 E	27
Neidenburg ..	53 22 N	20 25 E	15
Neidenfels	49 13 N	10 3 E	14
Neimphy	23 25 N	95 10 E	32
Neisse........	50 28 N	17 24 E	15
‡Nejd Proper..	26 30 N	44 0 E	36
Nejin	51 5 N	31 55 E	23
Nejran	32 55 N	35 28 E	30
Nejran, Wady	18 0 N	46 45 E	36
Neleiska......	60 10 N	118 50 E	28
Nellore	14 15 N	80 5 E	31
‡Nelson	33 50 S	116 0 E	47
Nelson, Cape..	38 25 S	141 30 E	47
Nelson, Port..	41 18 S	173 18 E	51
Nelson, Port, Harbour....	41 18 S	173 18 E	51
Nemeran	20 0 N	44 25 E	36
Nemerow	53 26 N	13 8 E	12
Nemethi......	47 48 N	22 52 E	16
Nemeti	48 18 N	18 59 E	16
Nemitz	54 17 N	16 27 E	15
Nemours......	48 15 N	2 41 E	9
Nen, River....	52 45 N	0 10 E	6
Nenagh	52 53 N	8 6 W	8
Nenda........	46 10 N	7 19 E	17
Nendorf	52 19 N	9 24 E	13
Nenguen, River	38 54 S	68 0 W	44
Neochorio (Greece)	38 21 N	23 8 E	24
Neochorio (Greece)	38 50 N	22 58 E	24
Neochorio (Turkey)....	41 14 N	24 37 E	25
Neopoli	41 20 N	31 48 E	27
Nepakiang....	26 0 N	127 50 E	33
Nepena	9 15 S	78 30 W	45
Nera, River ..	42 26 N	12 21 E	18
Nerac	44 7 N	0 20 E	9
Nerbudda, River	21 30 N	72 45 E	31
Nerenstetten ..	48 31 N	10 5 E	14
Nerja	36 43 N	3 56 W	20
Nero	41 45 N	8 41 E	18
Nerpio........	38 10 N	2 25 W	20
Nerpitchie, Lake	65 0 N	177 0 E	28
Nertchinsk....	52 0 N	117 10 E	28
Nervesa	45 47 N	12 10 E	18
Nervion, River	43 20 N	3 3 W	20
Nes	53 26 N	5 45 E	11
Neshapoore ..	36 9 N	58 45 E	29
Neshlot	62 0 N	29 0 E	23
Nesle	49 45 N	2 55 E	9
Ness, Loch....	57 20 N	4 25 W	7
*Ness, Loch ..			7
Nesse	53 42 N	7 25 E	12
Nesse, River ..	51 2 N	10 15 E	13
Nessourak	39 30 N	26 6 E	27
Nest, Lake....	62 0 N	24 0 E	23
Neston	53 17 N	3 5 W	6

NAME	LAT.	LONG.	MAP
*Nethou, Pic..			20
Netley Bay....	41 4 S	144 42 E	48
Netoczi	44 5 N	25 26 E	25
Netphen	50 57 N	8 0 E	15
Netschkau	50 40 N	12 13 E	13
Nettlecamp ..	52 51 N	10 32 E	12
Netuino	41 27 N	12 40 E	19
Netz, River....	52 38 N	15 25 E	15
Netze	53 21 N	10 43 E	17
Neuboerger ...	52 57 N	7 30 E	12
Neubruck	52 42 N	16 13 E	15
Neuburg......	48 44 N	11 10 E	14
Neuchatel	47 0 N	6 55 E	17
‡Neuchatel....	47 0 N	6 50 E	17
Neuchatel, Lake	46 55 N	6 50 E	17
Neudorf (Bavaria)	49 11 N	8 30 E	14
Neudorf (Bavaria)	48 58 N	11 1 E	14
*Neudorf, (Prussia)	51 19 N	15 39 E	15
Neuenburg....	48 52 N	8 35 E	14
Neuenburg (Baden)	47 48 N	7 33 E	14
Neuenburg (Prussia)....	53 40 N	18 42 E	15
Neuenhaus....	52 29 N	6 55 E	12
Neuenkirchen (Oldenburg).	54 14 N	10 33 E	12
Neuenkirchen (Strelitz)....	53 34 N	13 15 E	12
Neuenrode....	51 17 N	7 50 E	15
Neuenstadt....	49 15 N	9 20 E	14
Neuenstein....	49 15 N	9 20 E	14
Neuerberg	50 0 N	6 23 E	15
Neufchateau (Belgium) ..	49 50 N	5 23 E	10
Neufchateau (France)	48 21 N	5 40 E	9
Neufchatel....	49 46 N	1 28 E	9
Neufof........	53 51 N	9 5 E	12
Neugedeyn....	49 22 N	13 5 E	16
Neuhaus (Bavaria)	49 46 N	12 8 E	14
Neuhaus (Hanover)........	53 49 N	9 3 E	12
Neuhaus (Mecklenburg)	53 21 N	10 55 E	12
Neuhausen....	48 33 N	9 19 E	14
Neukahlden .	53 46 N	12 47 E	12
Neukirchen (Bavaria)....	49 34 N	11 32 E	14
Neukirchen (Bavaria)....	48 30 N	12 45 E	14
Neukirchen (Bavaria)....	49 14 N	12 45 E	14
Neukirchen (Hesse)	50 53 N	9 20 E	13
Neuland	53 47 N	9 20 E	12
Neumark (Pomerania)....	53 18 N	14 45 E	15
Neumark (Silesia)	51 9 N	16 37 E	15
Neumark (West Prussia)	53 25 N	19 30 E	15
Neumarkt (Bavaria)	49 16 N	11 21 E	14
Neumarkt (Galicia)	49 26 N	20 2 E	16
Neumarkt (Tyrol)	46 18 N	11 20 E	16
Neumartl	46 20 N	14 20 E	16
Neumunster ..	54 7 N	9 56 E	21
Neunkirch (Prussia)....	50 55 N	7 18 E	15
Neunkirch (Switzerland)	47 40 N	8 30 E	17
Neuofen	48 44 N	12 19 E	14
Neuse, River..	35 5 N	77 4 W	39
Neusiedler, L.	47 47 N	16 45 E	16
Neusohl	48 40 N	19 3 E	16
Neustadt (Austria)........	47 48 N	16 13 E	16
Neustadt (Austria)........	49 50 N	17 8 E	16
Neustadt (Bavaria)	50 19 N	10 18 E	14
Neustadt (Bavaria)	49 43 N	12 6 E	14
Neustadt, Little (Bavaria) ..	49 49 N	11 44 E	14
Neustadt (Bavaria)	49 35 N	10 41 E	14
Neustadt (Brunswick)	51 52 N	10 33 E	12
Neustadt (Coburg)	50 25 N	11 4 E	13
Neustadt (Hanover) ..	52 30 N	9 26 E	12
Neustadt (Hanover) ..	51 43 N	10 48 E	12
Neustadt (Hesse)	49 50 N	9 1 E	13
Neustadt (Mecklenburg)	53 26 N	11 33 E	12
Neustadt (Prussia)....	52 49 N	13 38 E	15
Neustadt (Prussia)....	50 20 N	17 46 E	15
Neustadt (Prussia)....	52 5 N	17 25 E	15
Neustadt (Prussia)....	54 38 N	18 12 E	15
Neustadt (Rhine)	49 21 N	8 9 E	14
Neustadt (Weimar)........	50 45 N	11 45 E	13
Neustadt (Weimar)........	51 2 N	10 8 E	13
Neustadtel (Illyria)	45 48 N	15 13 E	16
Neustadtel (Prussia)....	51 39 N	15 45 E	15
Neustadtel (Saxony)....	50 38 N	12 39 E	13
Neustatt......	47 6 N	7 5 E	17

NAME	LAT.	LONG.	MAP
Neustats	45 17 N	20 0 E	16
Neutra	48 20 N	18 6 E	16
Neuvic	45 20 N	2 15 E	9
Neuville......	48 3 N	2 2 E	9
Neuvillers	49 54 N	5 18 E	10
Neuwedel	53 15 N	15 42 E	15
Neuwerk Isle..	53 56 N	8 30 E	12
Neuwied	50 27 N	7 26 E	15
Nevada, Sierra	39 0 N	120 0 W	40
*Nevada, S. ..			40
Nevado, Collo	35 20 S	69 0 W	44
Neva's Isle....	25 22 N	171 30 W	50
Nevda, River..	57 40 N	66 40 E	28
Neve	32 56 N	35 59 E	30
Nevel	56 10 N	29 50 E	23
Nevele........	51 2 N	3 33 E	10
Nevers........	47 0 N	3 10 E	9
Nevesigno	43 24 N	18 17 E	25
Nevin	52 56 N	4 32 W	6
*Nevis, Ben ..			5
Nevis Island ..	17 5 N	62 35 W	46
Nevish, Loch..	57 2 N	5 40 W	7
New Abbey ..	55 0 N	3 40 W	7
‡New Albion ..	40 30 N	122 0 W	37
New Amsterdam	6 15 N	57 16 W	43
‡New Biscay ..	29 0 N	106 0 W	40
New Bridge ..	56 45 N	2 25 W	7
New Brisack ..	48 1 N	7 34 W	9
‡New Britain..	5 30 S	151 0 E	50
‡New Brunswick	46 30 N	66 0 W	38
New Byth	57 35 N	2 18 W	7
‡New Caledonia	21 40 S	166 0 E	50
*New Caledonia, Mt.			50
‡New Castile ..	39 40 N	3 40 W	20
New Castle....	52 26 N	9 0 W	8
‡New Cornwall	55 0 N	128 0 W	37
New Deer	57 32 N	2 18 W	7
New Edinburgh	8 52 N	77 50 W	42
‡New England	44 0 N	71 0 W	39
‡New Georgia	8 30 S	157 20 E	50
New Guatimala	13 50 N	90 33 W	40
‡New Hampshire State	44 0 N	72 0 W	39
‡New Hanover	51 0 N	124 0 W	37
‡New Hantam	31 0 S	26 20 E	35
‡New Hebrides	18 0 S	165 0 E	50
New Inn......	42 17 S	147 20 E	48
‡New Ireland..	4 0 S	151 30 E	50
‡New Jersey State	40 0 N	75 0 W	39
‡New Leinster	46 56 S	167 30 E	51
New Luce	54 56 N	4 45 W	7
New Mexico ..	32 54 N	90 58 W	39
‡New Munster	43 0 S	171 0 E	51
‡New Norfolk	59 0 N	134 0 W	37
‡New N. Wales	60 0 N	97 0 W	37
New Orkneys..	60 30 S	46 0 W	2
New Orleans..	30 0 N	90 0 W	39
New Plymouth	39 0 S	174 20 E	51
New Quay Bay	52 13 N	4 25 W	6
New Reede....	53 4 N	7 15 E	12
New Ross	52 23 N	6 59 W	8
New Russia ..	48 0 N	35 0 E	23
New Santander	23 43 N	99 0 W	40
‡New Santander	27 0 N	99 0 W	40
‡New Siberia	75 0 N	148 0 E	28
‡New Somerset	73 0 N	96 0 W	37
New South Shetland........	65 0 S	60 0 W	2
‡New South Wales	27 0 S	144 0 E	47
‡New South Wales (Hudson's B.)	56 0 N	92 0 W	37
New Town	42 53 S	147 26 E	48
‡New Ulster ..	38 0 S	176 0 E	51
New Work Isle	49 42 N	54 50 W	38
New York	40 40 N	74 0 W	39
‡New York State	42 40 N	77 0 W	39
‡New Zealand	41 0 S	173 0 E	51
Newaka	39 4 S	177 47 E	51
Newark	53 5 N	0 50 W	6
Newark Isle ..	57 0 N	61 0 W	37
Newberne	35 5 N	77 4 W	39
Newberry	34 13 N	81 25 W	39
Newborough (Ireland)....	52 44 N	6 16 W	8
Newborough (Wales)	53 10 N	4 15 W	6
Newburgh (Scotland) ..	56 23 N	3 12 W	7
Newburgh (U. States)......	41 25 N	74 10 W	39
Newbury	51 24 N	1 20 W	6
Newbyre......	55 35 N	4 25 W	7
Newcastle (Australia)	32 55 S	151 35 E	47
Newcastle (Canada)	44 0 N	77 45 W	38
‡Newcastle (Canada)	45 0 N	78 20 W	38
Newcastle (England) ..	55 0 N	1 38 W	6
Newcastle (Ireland)	54 26 N	5 24 W	8
Newcastle (Ireland)	53 6 N	6 3 W	8
Newcastle (N. Brunswick)	46 57 N	65 21 W	38
Newcastle Emlyn	52 2 N	4 35 W	6
Newcastle-under-Line........	52 55 N	2 10 W	6
*Newcastle-u.-Line........			6
Newdown	53 32 N	7 10 W	8
‡Newfoundland	49 0 N	56 0 W	38
Neufreisten ..	48 40 N	7 59 E	14
Neufville......	50 32 N	5 23 E	10
Newham......	51 48 N	2 30 W	6
Newhaven	41 10 N	73 0 W	39
Newlands	55 44 N	3 20 W	7
Newman	33 25 N	84 50 W	39
Newmarket (Canada)....	43 58 N	79 17 W	38
Newmarket (England) ..	52 16 N	0 25 E	6

NAME	LAT.	LONG.	MAP
Newmarket (Ireland) ..	52 13 N	8 56 W	8
Newmill	57 35 N	2 55 W	7
Newport (England)	51 38 N	3 0 W	6
Newport (England)	50 42 N	1 20 W	6
Newport (England)	52 47 N	2 23 W	6
Newport (Ireland)	52 40 N	8 20 W	8
Newport (U. States)......	41 0 N	71 8 W	39
Newport (Wales)	52 2 N	4 52 W	6
Newport Pagnell	52 8 N	0 42 W	6
Newportpratt	53 53 N	9 28 W	8
Newry........	54 10 N	6 10 W	8
Newstadt	54 8 N	10 54 E	21
Newstadtl	49 32 N	16 14 E	16
Newstone	52 46 N	6 42 W	8
Newton (England)	52 42 N	1 15 W	6
Newton (England)	50 55 N	2 12 W	6
Newton (Scotland)	55 25 N	3 39 W	7
Newton Bushel	50 32 N	3 40 W	6
Newton Congham	54 58 N	7 28 W	8
Newton Forbes	53 46 N	7 45 W	8
Newtonglens..	55 4 N	5 55 W	8
Newtonstewart	54 57 N	4 26 W	7
Newtown (England)	52 30 N	3 20 W	6
Newtown (Ireland)	52 2 N	8 5 W	8
Newtown (Ireland)	52 14 N	7 24 W	8
Newtown (Ireland)	53 7 N	6 5 W	8
Newtown Ardes	54 35 N	5 32 W	8
Newtown Barry	52 40 N	6 40 W	8
Newtown Bellew	53 26 N	8 27 W	8
Newtown Butler..........	54 10 N	7 12 W	8
Newtown Fortescue......	53 46 N	6 30 W	8
Newtown Hamilton......	54 11 N	6 25 W	8
Newtown Limavaddy..	55 3 N	6 49 W	8
Newtown Point	55 45 N	5 12 W	7
Newtown Stewart	54 40 N	7 17 W	8
Newtyle......	56 35 N	3 10 W	7
Nexoe........	55 3 N	15 8 E	21
Neyland......	51 58 N	0 50 E	6
Neyva........	3 10 N	75 30 W	42
‡Neyva	3 20 N	75 30 W	42
Nezib	31 36 N	35 0 E	30
Ngamotu	39 7 S	177 10 E	51
‡Ngan-hoei ..	32 0 N	117 0 E	33
Ngan-kin	30 30 N	116 35 E	33
Ngan-lo	31 35 N	112 30 E	33
Ngan-ping-tcheou......	22 57 N	107 4 E	32
Ngansi	40 5 N	96 0 E	33
Nhamunda, R.	2 8 S	56 16 W	43
Nha-tzang....	12 20 N	109 3 E	32
Nhut, River ..	9 0 N	106 20 E	32
Niagara	43 10 N	79 0 W	39
‡Niagara	42 50 N	79 40 W	38
*Niagara Falls			38
Niakanja, Mt.	4 30 N	32 25 E	36
Niakra	15 45 N	16 30 W	34
‡Niaron	12 30 N	108 30 E	32
Nias Island ..	1 0 N	97 0 E	49
Niata	36 57 N	22 50 E	24
‡Niatlang	12 0 N	108 30 E	32
Nibaj, En	28 2 N	43 2 E	36
Nibe	56 58 N	9 40 E	21
Nibiola	45 21 N	8 39 E	18
Nicaragua	11 30 N	85 50 W	40
Nicaragua, Lake	12 0 N	85 30 W	40
Nicaria Island	37 40 N	26 10 E	27
Nice..........	44 43 N	7 18 E	18
‡Nice	44 0 N	7 10 E	18
Nicholson, Port	41 20 S	174 56 E	51
Nicholson, R.	17 5 S	139 20 E	47
Nicici	42 51 N	19 7 E	25
Nicobar Island, Great	7 0 N	93 50 E	32
Nicobar Islands	7 30 N	93 50 E	32
Nicolaev......	47 0 N	32 0 E	23
Nicolai	50 10 N	16 52 E	15
Nicollet, Lake	39 30 N	113 30 W	40
Nicollet, River	39 30 N	113 20 W	40
Nicon	50 38 N	1 17 W	6
Nicosia (Sicily)	37 42 N	14 23 E	19
Nicosia (Turkey)	35 10 N	33 25 E	27
Nicoubau, Lake	50 0 N	74 40 W	38
Nicoya, Gulf of	9 0 N	84 30 W	40
Nicsar........	40 2 N	37 33 E	27
Nicup	43 20 N	25 25 E	25
Nidd, River ..	54 5 N	1 15 W	6
Nidda	50 24 N	8 57 E	13
Nidda, River..	50 7 N	8 26 E	13
Nidder, River	50 15 N	8 40 E	13
Nider Kerschen	49 33 N	5 52 E	10
Niebla........	37 21 N	6 30 W	20
Niedenstein ..	51 15 N	9 20 E	13
Niederwald ..	46 29 N	8 9 E	17
Niegleve......	53 46 N	12 21 E	12
Nielston	55 48 N	4 27 W	7
Nienborg	52 8 N	7 7 E	15
Nienburg	52 38 N	9 10 E	17
Nienhaagen ..	51 42 N	9 46 E	12
Niepean, Point	38 25 S	144 45 E	47
Niergui	48 15 N	124 10 E	33
Niesa, Mount..	11 40 S	35 0 E	34
Nieuport (Belgium)	51 7 N	2 46 E	10

NAME	LAT.	LONG.	MAP
Nieuport (Holland)	51 56 N	5 51 E	11
Nieuwe Schans	53 10 N	7 6 E	11
Nieuwerslai	52 12 N	4 58 E	11
‡Nieuwveld Bergen	32 20 S	22 30 E	35
Nieva, River	4 40 S	77 12 W	45
‡Nievre Depart.	47 13 N	3 30 E	9
Niewe Kraal	30 50 S	24 55 E	35
Nigdeh	37 56 N	34 54 E	27
Niger, River	4 20 N	6 0 E	34
Night Island	40 28 S	148 0 E	48
Nightingale Isle	20 0 N	108 0 E	32
‡Nigritia	10 0 N	10 0 E	24
Nigue, Cape	39 12 S	73 30 W	44
Nij Mama, R.	57 20 N	113 10 E	28
Nijar	36 56 N	2 17 W	20
Nijenui Koluimsk	69 7 N	159 0 E	28
Nijnia Tunguska, River	65 35 N	90 40 E	28
Nikolaevsk	50 40 N	44 40 E	23
Nikolsk (Astracan)	47 40 N	46 25 E	23
Nikolsk (Orenburg)	51 25 N	56 30 E	23
Nikolsk (Vologda)	60 20 N	46 10 E	23
Nikolsk (Vologda)	59 25 N	45 30 E	23
Nikolsko, Lake	54 0 N	77 0 E	28
Nikopol	43 45 N	24 57 E	25
Nikovo	45 19 N	26 30 E	25
Nila Isle	7 0 S	129 50 E	49
Nile, Cape	40 46 S	173 55 E	51
Nile, River (Egypt)	31 30 N	31 0 E	36
Nile, River (Tasmania)	41 40 S	147 17 E	48
Nilly, Lough	54 15 N	7 45 W	8
Niman	46 0 N	133 45 E	33
Nimawah	17 30 N	42 20 E	36
Nimbheera	24 40 N	74 37 E	31
Nimburg	50 12 N	15 2 E	16
Nimeguen	51 52 N	5 48 E	11
Nimmen	47 45 N	124 0 E	33
Nimrin	31 55 N	35 35 E	30
Nina, Point	35 34 S	173 28 E	51
Nine-Degree Channel	9 0 N	74 0 E	31
Ninfas, Point	42 54 S	64 22 W	44
Ning Po	29 50 N	121 40 E	33
Ning-hia-oei	38 35 N	105 40 E	33
Ningkoui	30 25 N	119 0 E	33
Ningoota	44 30 N	129 0 E	33
Ning-yuen	28 5 N	102 30 E	33
Ning-yuen, East	40 40 N	120 20 E	33
Ninove	50 47 N	4 0 E	10
Ninth Island	40 50 S	147 15 E	48
Nions	44 20 N	5 10 E	9
Niort	46 18 N	0 28 W	9
Nipisiguil Bay	47 40 N	65 20 W	38
Nipissing, Lake	46 30 N	80 20 W	39
Nipple Hills	40 35 S	64 40 W	44
Nisi	37 1 N	22 3 E	24
Nisibin	37 0 N	41 5 E	27
Nisibost	57 47 N	6 59 W	7
Nismes	43 50 N	4 22 E	9
Nismow	49 59 N	25 15 E	16
Nisoye	46 13 N	7 34 E	17
Nissa	43 20 N	22 3 E	25
Nissa, River	56 40 N	12 50 E	22
Nisse	59 10 N	8 38 E	22
Nissila	64 0 N	26 50 E	23
Nissum	56 20 N	8 12 E	21
Nissum Fiord	56 23 N	8 6 E	21
Nitchegoun, L.	53 5 N	69 0 W	37
Nith, River	54 56 N	3 35 W	7
Nittenau	49 11 N	12 9 E	14
Niuia, River	60 25 N	116 10 E	28
Niuiska	60 25 N	116 10 E	28
Nive, River	25 3 S	146 50 E	47
Nivelles	50 36 N	4 20 E	10
‡Nivernois	47 5 N	3 30 E	9
Nizampatam	15 58 N	80 40 E	31
Nizioi	37 8 N	14 43 E	19
‡Nizneigorod	56 0 N	44 0 E	23
Nizsra	49 52 N	23 17 E	16
Njurunda	65 15 N	17 20 E	22
Nlastia	64 3 N	53 50 E	23
Noale	45 32 N	12 3 E	18
Nobambee	28 19 S	31 20 E	35
Nobillo	10 33 N	72 50 W	43
Nobi-oka	32 40 N	131 35 E	33
Noboya	32 24 S	60 10 W	44
Nocella	42 15 N	9 12 E	18
Nocera	43 7 N	12 45 E	18
Nodadores	28 0 N	101 25 W	40
Nœrim	58 39 N	5 45 E	22
Nœs (Denmark)	62 7 N	6 43 W	21
Nœs (Norway)	68 10 N	15 10 E	22
Nœs (Norway)	61 28 N	7 17 E	22
Nœs (Norway)	59 23 N	9 27 E	22
Nœs (Norway)	63 50 N	9 45 E	22
Nofes, Cape	42 15 N	3 20 E	20
Nogaibalz	55 10 N	53 15 E	23
Nogal, Wady	9 0 N	47 0 E	36
Nogath, River	54 15 N	19 25 E	15
Nogent	48 17 N	0 50 E	9
Nogent, East	48 28 N	3 30 E	9
Nogoa, River	23 15 S	148 25 E	47
Nogueruelas	40 16 N	0 40 W	20
Noia	41 0 N	16 59 E	19
Noirmoutier Island	46 55 N	2 14 W	9
Nokuneen Kraal	27 3 S	25 0 E	35
Noli	44 12 N	8 24 E	18
Nolinsk	57 30 N	50 0 E	23
Nollers	52 21 N	8 53 E	12
Nomao	41 10 N	7 26 W	20
Nombre de Jesus	1 37 S	74 58 W	42
Nomeny	48 53 N	6 12 E	9
Nonas	58 54 N	17 57 E	22
Noncovery Isle	7 55 N	93 40 E	32
‡Nonda Country	17 0 S	142 0 E	47
Noniglio	46 1 N	8 38 E	18
Nonke	20 35 N	105 25 E	32
Nonn	47 45 N	123 40 E	33
Nonni, River	50 40 N	124 20 E	33
Noon	52 35 N	7 47 W	8
Noord Hoek	34 20 S	18 18 E	35
Noordbroek	53 12 N	6 48 E	11
Noorkhan	35 50 N	58 45 E	29
Noorpoor	32 15 N	76 8 E	31
§Noorzyes, The	33 0 N	62 0 E	29
Nooshky	29 52 N	64 45 E	29
Nooska	45 20 N	17 2 E	16
Nootka Sound	49 30 N	126 0 W	37
Noping	48 19 N	12 54 E	14
Nora	62 55 N	17 50 E	22
Norboved	55 59 N	9 23 E	21
Norcia	42 49 N	13 3 E	18
‡Nord Depart.	50 20 N	3 20 E	9
Nord, Riviere du	45 30 N	76 47 W	38
Nordborg	55 5 N	9 44 E	21
Nordbye	55 25 N	8 23 E	21
Nordbye, East	55 57 N	10 37 E	21
Norden	53 35 N	7 14 E	12
Nordenbroe	54 46 N	10 44 E	21
Nordergiov	62 38 N	6 55 W	21
Norderney	53 44 N	7 12 E	12
Nordfolden	67 40 N	14 40 E	22
Nordhausen	51 30 N	10 44 E	15
*Nordhausen			15
Nordheim (Hanover)	51 41 N	9 58 E	12
Nordheim (Weimar)	50 37 N	10 14 E	13
Nordhorn	52 25 N	7 3 E	12
Nordingra	62 58 N	18 10 E	22
‡Nordland (Norway)	67 30 N	16 0 E	22
‡Nordland (Sweden)	63 30 N	16 0 E	22
Nordlingen	48 51 N	10 29 E	14
Nordlingen, N.	49 18 N	10 14 E	14
Nordmaling	63 32 N	19 42 E	22
Nordstetten	48 27 W	8 41 E	14
Nordstrand Island	54 32 N	8 53 E	21
Nordtorf	54 13 N	9 50 E	21
Nore, River	52 25 N	6 59 W	8
Norenburg	53 28 N	15 33 E	15
‡Norfolk (England)	52 40 N	1 0 E	6
‡Norfolk (U. States)	36 50 N	76 20 W	39
Norfolk Bay	42 55 S	147 50 E	48
Norfolk Isle	29 15 S	168 30 W	50
Norfolk Mountain	41 26 S	144 58 E	48
Norfolk, New	42 50 S	147 12 E	48
Norfolk Sound	56 30 N	136 0 W	37
Norgh	53 3 N	6 25 E	11
Norhaa	56 55 N	8 28 E	21
Norham	55 41 N	2 5 W	6
Norie, Point	41 3 S	63 47 W	44
Norin	43 6 N	17 30 E	16
Norken	50 43 N	7 45 E	13
‡Normandy	49 0 N	0 0	9
Normanton	50 10 N	1 25 W	6
Noro	46 26 N	133 40 E	33
Noromme	56 7 N	8 35 E	21
Norotal	25 47 N	106 25 W	40
Norr Bay	62 6 N	17 22 E	22
Norrbarke	60 10 N	15 30 E	22
Norridgewock	44 32 N	69 45 W	39
Norrkoping	58 40 N	16 33 E	22
Norrmark	61 40 N	22 0 E	23
Norrtege	59 46 N	18 50 E	22
Norsaa	65 15 N	19 40 E	22
Norsunda	59 18 N	18 50 E	22
Norte, Point del	9 2 N	60 30 W	42
Norte, Rio del	26 0 N	97 37 W	40
North Bay	63 0 N	70 0 W	37
North Branch, R. (Canada)	48 22 N	71 11 W	38
North Canadian River	35 15 N	95 22 W	40
North, Cape (Brazil)	1 40 N	50 7 W	43
North Cape (Iceland)	66 30 N	22 40 W	21
*North Cape (Iceland)			21
North Cape (N. Zealand)	34 24 S	173 5 E	51
North Cape (Norway)	71 15 N	25 40 E	22
North, Cape (N. Scotia)	46 57 N	60 18 W	38
North Cape (N. Scotia)	47 0 N	63 57 W	38
North Cape (Russia)	69 10 N	180 30 E	28
‡North Carolina State	36 0 N	80 0 W	39
North Centinal Isle	11 30 N	92 20 E	32
‡North Depart.	50 20 N	3 30 E	9
North Ferry	56 2 N	3 24 W	7
North Foreland	51 22 N	1 23 E	6
North Head (N. Zealand)	36 38 S	174 10 E	51
North Head (N. America)	48 40 N	52 50 W	38
†North Holland	52 30 N	4 45 E	11
North Isle (Australia)	15 30 S	137 10 E	47
North Isle (Japan)	25 5 N	141 0 E	33
North Isle (N. Zealand)	45 51 S	166 19 E	51
‡North Peru	8 0 S	74 30 W	45
Northallerton	54 20 N	1 30 W	6
Northampton (Australia)	31 30 S	116 40 E	47
Northampton (England)	52 17 N	0 55 W	6
‡Northamptonshire	52 20 N	0 50 W	6
North-east Cape	73 0 N	77 0 E	28
‡Northern District (Newfoundland)	49 0 N	55 0 W	38
Northleach	51 50 N	1 50 W	6
‡Northumberland (Australia)	33 0 S	151 20 E	47
‡Northumberland (England)	55 10 N	2 0 W	6
‡Northumberland (L. Ontario)	44 0 N	78 0 W	38
‡Northumberland (N. Brunswick)	47 0 N	66 0 W	38
‡Northumberland (St. Laurence)	50 0 N	69 0 W	38
Northumberland, Cape	38 10 S	140 30 E	47
Northumberland Isle	21 50 S	150 0 E	47
Northumberland Strait	46 20 N	64 20 W	38
North-west, Cape	21 50 S	114 17 E	47
North-west Depot	48 40 N	94 14 W	37
Northwich	53 17 N	2 30 W	6
Nortmohr	53 16 N	7 39 E	12
Norton Sound	63 45 N	166 0 W	37
Nortoog Isle	54 33 N	8 35 E	21
Norwall	41 6 N	82 44 W	39
‡Norway	64 0 N	10 0 E	4
Norway Isle	20 40 N	107 30 E	32
Norwich (England)	52 35 N	1 18 E	6
Norwich (U. St.)	43 40 N	72 25 W	39
Nosberg	55 35 N	8 39 E	21
Noss Head	58 28 N	3 3 W	7
Noss Isle	60 6 N	0 39 W	5
Nossen	51 5 N	13 18 E	13
Nostimo	38 39 N	21 53 E	24
Nostra Senora Bay	25 24 S	70 48 W	44
Nostra Senora, Point	25 12 S	70 52 W	44
Nostril, River	31 52 S	29 7 E	35
Notawaska Bay	44 40 N	80 0 W	38
Noto	36 53 N	15 0 E	19
Noto, Cape	37 30 N	137 0 E	33
Notre Dame Bay	49 50 N	55 40 W	38
Notre Dame de Monts	46 46 N	2 8 W	9
Nottingham	52 55 N	1 10 W	6
‡Nottinghamshire	53 10 N	1 0 W	6
Notuco Volcano	39 14 S	70 37 W	44
Nova Coimbra	19 53 S	57 45 W	45
‡Nova Scotia	45 0 N	64 0 W	38
‡Novaia Zemlia	70 40 N	55 0 E	28
Novara	45 28 N	8 38 E	18
Novelda	38 22 N	0 50 W	20
Noventa	45 17 N	11 33 E	18
Novgorod	58 35 N	31 20 E	23
‡Novgorod	59 0 N	35 0 E	23
Novgorod, Niznei	56 20 N	44 20 E	23
Novi (Italy)	44 46 N	8 46 E	18
Novi (Turkey)	45 0 N	16 30 E	25
Novi Bazar	42 55 N	20 30 E	25
Noville	50 3 N	5 40 E	10
Novisheer	44 27 N	18 3 E	25
Novita	4 54 N	76 46 W	42
Novo Tzurukaievska	5 10 N	118 40 E	28
Novo Tzurukaihevsk	50 30 N	118 45 E	33
Novogorod, Sieversk	52 2 N	33 30 E	23
Novokhapersk	51 0 N	41 30 E	23
Novomalorossisk	45 35 N	40 0 E	23
Novopostavlek	59 30 N	47 30 E	23
Novosil	53 5 N	37 0 E	23
Novosiltzov, Cape	43 20 N	140 10 E	33
Novrad Volinsk	50 40 N	27 30 E	23
Nowa	32 56 N	35 59 E	30
Nowancip	14 50 N	101 30 E	32
Nowanuggur	22 30 N	70 15 E	31
Nowaran	33 3 N	35 42 E	30
Noy Head	41 8 S	173 28 E	51
Noya	42 48 N	8 54 W	20
Nozeroy	46 43 N	6 4 E	9
Nuaran	33 3 N	35 49 E	30
Nuba, Wady	22 45 N	31 45 E	36
‡Nubia	19 0 N	34 0 E	34
Nuces, Rio de los	27 32 N	98 0 W	40
Nuchel	54 15 N	10 41 E	21
Nuddingah	24 17 N	89 30 E	31
†Nuehr	8 15 N	29 30 E	36
Nues, Isle aux	45 5 N	75 3 W	38
Nueva Helvetia	38 35 N	121 20 W	40
Nueva, River	34 18 S	67 5 W	44
Nuevitas	21 30 N	77 10 W	46
Nuevo, Gulf of	42 54 S	64 20 W	44
Nuevo, River	20 12 N	87 31 W	40
Nufi	9 35 N	7 58 E	34
Nugeena	29 30 N	78 30 E	31
Nugor, River	25 9 N	61 30 E	29
Nuheemabad	29 3 N	58 55 E	29
Nuimaka	68 48 N	21 24 E	23
Nuishtah	36 45 N	51 0 E	29
Nukahiva Island	9 0 S	140 0 W	50
Nuland	51 44 E	5 24 E	11
Nules	39 51 N	0 10 W	20
Numansdorp	51 44 N	4 25 E	11
Numanya	32 30 N	45 30 E	27
Nummedal	64 40 N	12 20 E	22
Nun	23 15 N	10 50 W	34
Nun, Cape	28 25 N	11 30 W	34
Nundoorbar	21 17 N	74 20 E	31
Nunivack Island	60 15 N	166 0 W	37
Nunspeet	52 23 N	5 47 E	11
Nuoma	14 55 N	32 32 E	36
Nuoro	40 17 N	9 25 E	19
Nura, River	45 4 N	9 50 E	18
Nura, Great, R.	51 30 N	71 50 E	28
Nuremburg	49 25 N	11 4 E	14
Nuri Pyramids	18 30 N	32 0 E	36
Nurki, Cape	56 59 N	139 20 E	28
Nurmo	63 0 N	23 0 E	23
Nurralleo	39 45 N	9 6 E	19
Nurrholm	65 55 N	17 25 E	22
Nurtingen	48 39 N	9 20 E	14
Nurva Steffhest Ridge	45 33 N	24 0 E	16
Nusco	40 58 N	15 7 E	19
Nusterup	55 18 N	9 9 E	21
Nutatlgal	63 10 N	142 30 W	37
Nutrias	7 35 N	69 22 W	42
Nuttam	10 20 N	78 30 E	31
Nuttoosir	28 32 N	73 50 E	31
Nutzfeld	53 19 N	10 38 E	12
Nuyt's Archipelago	32 30 S	133 0 E	47
Nuyt's Cape	32 7 S	132 30 E	47
‡Nuyt's Land	32 0 S	125 0 E	47
Nyakona	61 0 N	156 30 E	28
Nyamtz	47 10 N	26 16 E	25
Nyassi, Lake	10 0 S	32 0 E	34
*Nyassi, Lake			34
Nybundan	32 54 N	58 55 E	29
Nyby	64 4 N	19 40 E	22
Nydau	47 8 N	7 15 E	17
‡Nyeborg	55 10 N	10 30 E	21
Nyega	53 9 N	5 57 E	11
Nyegard	56 17 N	8 55 E	21
Nyekiobing	54 46 N	11 52 E	21
Nyekiobing, N.	55 55 N	11 40 E	21
Nyested	54 40 N	11 44 E	21
Nyeuwolde	53 15 N	6 52 E	11
Nygojestic	44 15 N	26 35 E	25
Nykerk	52 15 N	5 29 E	11
Nykiobing	56 47 N	8 52 E	21
Nykoping	58 48 N	17 0 E	22
‡Nykoping	59 0 N	16 40 E	22
Nyland	61 2 N	18 40 E	22
Nymbico, Port	36 27 N	23 10 E	24
Nyon	46 22 N	6 13 E	17
Oa, River	3 37 N	70 0 W	42
Oadby	52 35 N	1 3 W	6
Oakfield	53 24 N	9 11 W	8
Oakham	52 45 N	0 48 W	6
Oakhampton	50 44 N	3 58 W	6
Oakingham	51 27 N	0 50 W	6
Oancharry, River	55 13 N	7 48 W	8
Oarupano	10 38 N	63 23 W	42
Oasis, Great	24 45 N	30 30 E	36
Oasis, Lesser	28 0 N	29 0 E	36
Oatlands	42 11 S	147 20 E	48
*Oatlands			48
Oaxaca	16 34 N	97 1 W	40
‡Oaxaca	17 0 N	96 30 W	40
Ob Kirchen	52 16 N	9 5 E	12
Ob Stacken	52 26 N	9 38 E	12
Oba	34 48 N	63 20 E	29
Oba Cave	56 56 N	5 20 W	7
Oban	56 27 N	5 30 W	7
Obdorsk	66 40 N	67 0 E	28
Obeid, El	13 15 N	30 9 E	36
Obeidia	36 57 N	40 40 E	27
Obenberg	48 20 N	13 22 E	16
Ober	46 49 N	9 50 E	17
Oberava, Lake	17 30 S	58 20 W	45
Oberdisching	48 18 N	9 50 E	14
Obereiden	47 17 N	8 33 E	17
Obergesteln	46 31 N	8 16 E	17
Oberheim	48 28 N	7 30 E	9
Oberkirk	48 31 N	8 5 E	14
‡Oberland, Bernese	46 32 N	8 0 E	17
Oberlangen	52 51 N	7 14 E	12
Obernau	49 59 N	9 3 E	14
Obernburg	49 51 N	9 5 E	14
Oberndorf (Bavaria)	48 30 N	13 35 E	14
Oberndorf (Bavaria)	50 14 N	9 31 E	14
Oberndorf (Wirtemberg)	48 18 N	8 32 E	14
Oberreid	46 26 N	7 29 E	17
Obersdorf	47 27 N	10 15 E	14
Obersitzko	52 40 N	16 26 E	15
Oberstein	49 45 N	7 21 E	14
Obertin	49 40 N	25 17 E	16
Oberwyl	46 39 N	7 25 E	17
Obeydah	13 30 N	30 58 E	34
Obi, Gulf of	73 0 N	75 0 E	28
Obi, River	67 0 N	67 0 E	28
Obidos (America)	1 45 S	56 0 W	43
*Obidos (Amer.)			41
Obidos (Portugal)	39 20 N	9 10 W	20
Obilesti	44 32 N	26 55 E	25
Obispo, El	27 59 S	70 42 W	44
Obon	40 55 N	0 42 W	20
Oborniki	52 37 N	16 45 E	15
Obriachau	57 25 N	4 20 W	7
Obrovaszo	44 12 N	15 43 E	16
Observatory Hill	41 18 S	146 45 E	48
Obva	58 20 N	55 0 E	23
Oby	1 30 S	127 45 E	49
Ocana (Colombia)	8 1 N	73 7 W	42
Ocana (Spain)	39 58 N	3 30 W	20
Ocean Isle	1 0 S	170 10 E	50
Ochazavia	42 54 N	1 8 W	20
Ochelbo	61 8 N	17 3 E	22
Ochil Hills	56 17 N	3 40 W	7
Ochlensdorf	51 23 N	11 7 E	21
Ochrida	41 4 N	20 47 E	25
Ochsenfurth	49 39 N	10 3 E	14
Ockero	57 45 N	11 40 E	22
Octockonace, R.	30 0 N	84 40 W	39
Ocmulgee, R.	31 40 N	81 25 W	39
Ocoa Bay	18 0 N	71 0 W	46
Ocolis	24 12 S	61 12 W	44
Ocopa	12 8 S	75 0 W	45
Odagsen	51 47 N	9 47 E	12
Oddam	55 48 N	8 40 E	21
Odell	45 8 N	73 16 W	38
Oden Wald	49 40 N	8 55 E	13
Odense	55 25 N	10 20 E	21
‡Odense	55 25 N	10 30 E	21
Odenwald	49 20 N	9 5 E	14
Oder, Little	51 42 N	9 55 E	12
Oder, River	53 30 N	14 35 E	15
Oderberg	52 55 N	13 55 E	15
Odernheim	49 47 N	7 45 E	14
Odeseixas	37 23 N	8 50 W	20
Odessa	46 35 N	30 30 E	23
Odeypoor	22 37 N	83 22 E	31
Odivoja	43 58 N	25 47 E	25
Odnodorka	65 0 N	56 50 E	23
Odoorn	52 51 N	6 44 E	11
Odorneh	34 10 N	44 0 E	27
Ody	17 5 N	36 14 E	36
Oe Fiord	66 0 N	18 30 W	21
Oedenbach	48 4 N	10 2 E	14
Oedenburg	47 41 N	16 40 E	16
Oedenrode	51 35 N	5 28 E	11
Oehlsheim	51 37 N	9 35 E	13
Oei	34 0 N	106 0 E	33
Oeiras	2 37 S	50 8 W	43
Oeiras, East	7 7 S	42 35 W	43
Oeland Island	57 0 N	16 40 E	22
Oellingen	49 3 N	10 59 E	14
Oellsnitz	51 21 N	13 38 E	13
Oels	51 15 N	17 23 E	15
Oelsburg	52 15 N	10 12 E	12
Oelsnitz	50 26 N	12 13 E	13
Oen	60 52 N	4 50 E	22
Oennach, River	48 9 N	10 41 E	14
Oensingen	47 18 N	7 44 E	17
Oerer, Den	52 56 N	5 2 E	11
Oerrel	52 43 N	10 38 E	12
Oesede	52 13 N	8 1 E	12
Oesel Island	58 30 N	22 30 E	23
Oeste, Lake	27 18 S	63 50 W	44
Oesteroe	62 20 N	6 50 W	21
Oettern	51 57 N	8 50 E	12
Oetting	48 13 N	12 37 E	14
Oettingen	48 56 N	10 35 E	14
Ofanto, River	41 20 N	16 16 E	19
*Ofen			16
Offagne	49 54 N	5 6 E	10
Offedio	42 19 N	12 59 E	18
Offenberg	48 28 N	7 58 E	14
Offenhausen	49 25 N	11 20 E	14
Offerdals	63 30 N	14 0 E	22
Offido	42 57 N	13 40 E	18
Ofoden	68 30 N	16 22 E	22
Ofoden Fiord	68 28 N	16 0 E	22
‡Ogahden	8 0 N	46 30 E	36
Oge	61 5 N	8 40 E	22
Ogliastro	37 57 N	13 25 E	19
Oglu	37 22 N	34 20 E	27
Ogmo	13 30 N	101 55 E	32
Ohaba	45 30 N	23 0 E	16
Ohanez	37 7 N	2 50 W	20
Oheteroa	22 0 S	150 30 W	50
Ohevahoa	9 30 S	139 7 W	50
Ohitabooah	10 15 S	138 30 W	50
Ohio, River	36 58 N	89 20 W	39
‡Ohio State	40 0 N	84 0 W	39
Ohiwa	37 55 S	177 25 E	51
Ohof	52 26 N	10 20 E	12
Ohrdrut	50 54 N	10 45 E	13
Oibe, River	8 45 N	37 15 E	36
Oike, River	58 0 N	4 35 W	7
Oirschot	51 30 N	5 16 E	11
‡Oise Depart.	49 20 N	2 25 E	9
Oise, River	48 56 N	2 4 E	9
Oisterwyk	51 35 N	5 11 E	11
Oiteiro	2 0 S	53 30 W	43
Oje Fiord	69 38 N	17 20 E	22
Ojes de la Punta	31 0 N	106 30 W	40
Ojo de Agua	26 22 S	63 48 W	44
Ojo de Agua, South	30 42 S	63 24 W	44
Ojo Caliente, Al	30 45 N	105 0 W	40
Ojobargo	8 45 N	74 45 W	42
Ojogina, River	66 5 N	153 0 E	28
Oka, R. (Asia)	55 40 N	102 0 E	28
Oka, R. (Europe)	56 20 N	44 26 E	23
Okhansk	57 40 N	55 10 E	23
Okhotsk	59 20 N	143 15 E	28
Oki	36 10 N	133 10 E	33
Okladnikova, L.	65 40 N	46 0 E	23
Okmeh	21 12 N	30 40 E	36
Okota, River	59 20 N	143 15 E	28
Okotsk, Sea of	57 0 N	150 0 E	1
Olaky, Jebel	24 37 N	34 45 E	36
Olaky, Wady	22 30 N	34 0 E	36
Olan Mouren	37 30 N	101 0 E	33
Olapa	18 15 N	94 38 W	40
Olart	52 32 N	6 20 W	8
Oiash	39 0 N	37 40 E	27
Olba, Cape	22 5 N	36 58 E	36
Olba, Jebel	22 0 N	36 30 E	36
*Olberg, Mount			15
Old Aberdeen	57 10 N	2 5 W	7
Old Berkoup	52 57 N	6 7 E	11
‡Old Castile	41 40 N	4 0 W	20
*Old Castile, Table-land of			20
Old Fort	73 28 N	122 10 W	37
Old Harbour	17 50 N	77 10 W	46
Old Head	58 43 N	2 58 W	7
Old House	49 15 N	81 27 W	38
Old Kraal	28 0 S	18 28 E	35
Old Leighlin	52 44 N	7 4 W	8
Old Meldrum	57 22 N	2 17 W	7
Old Providence Isle	13 12 N	81 28 W	40
Old Thie	34 15 N	103 10 E	33
Oldedyk	53 30 N	7 13 E	17
Oldenburg (Denmark)	54 20 N	10 57 E	21
Oldenburg (Germany)	53 9 N	8 17 E	12
‡Oldenburg (Germany)	53 0 N	8 10 E	12
Oldendorf	49 4 N	9 43 E	14
Oldendorf, North	53 36 N	9 14 E	12
Oldenzaal	52 19 N	6 53 E	11
Olderdorf	53 20 N	7 47 E	12
Oldesloh	53 48 N	10 25 E	21
Oldeterp	53 4 N	6 3 E	11