A

MANUAL OF THE MOLLUSCA;

OR,

RUDIMENTARY TREATISE

OF

RECENT AND FOSSIL SHELLS.

BY

S. P. WOODWARD, F.G.S.

ASSOCIATE OF THE LINNEAN SOCIETY;
ASSISTANT IN THE DEPARTMENT OF MINERALOGY AND GEOLOGY
IN THE BRITISH MUSEUM; AND
MEMBER OF THE COTTESWOLDE NATURALISTS' CLUB.

ILLUSTRATED WITH
NUMEROUS ENGRAVINGS AND WOODCUTS.

PART III.

CONTAINING THE TUNICATA;
GEOGRAPHICAL DISTRIBUTION, ETC.; SUPPLEMENT,
AND INDEX.

LONDON:
JOHN WEALE, 59, HIGH HOLBORN.

MDCCCLVI.

LONDON:
PRINTED BY WILLIAM OSTELL,
HART STREET, BLOOMSBURY.

A

MANUAL OF THE MOLLUSCA.

PART III.

CLASS VI. TUNICATA, Lamarck.

(Order *Hetero-branchiata*, Blainville.)

The lowest order of Acephalous Mollusca are called *Tunicaries*, being protected by an elastic tunic in place of a shell. They are extremely unlike shell-fish in appearance, and are denied a place in most works on conchology; having no hard skeleton they neither furnish objects for the cabinet of the collector, nor materials for the speculations of the geologist.*

Many of the Tunicaries are curious objects when seen fresh from the sea; or still better when living in those miniature *aquaria*, which—thanks to Mr. Gosse—are now so popular.† The transparent sorts are beautiful even when preserved in spirits. To the naturalist they present many points of interest unknown amongst the other mollusca, for here he meets with compound animals, and the phenomenon of alternate generation; they afford excellent illustrations of the structure of the breathing-organ and mechanism of aquatic respiration; and they also exhibit the simplest form and condition of the vascular system, in which the blood no longer circulates in one unvarying direction, but ebbs and flows like the tides.‡ (pp. 31, 49.)

The principal forms of tunicated mollusca are given in plate 24, and the woodcut (fig. 224) represents one of the largest and simplest kind, which is drawn as if it were transparent, so as to shew the whole of its internal structure. These large solitary tunicaries are termed *Ascidians*, from their

* König supposed the *Sphaeronites* to be tunicaries allied to *Boltenia;* they are globular bodies, with a tessellated surface and two orifices, found in the Silurian strata, and belong to the order *Cystideae* amongst the *Echinodermata*. The genus *Eschadites* of König was also supposed to be a fossil tunicary; its nature is still problematical. See Murchison's "Siluria."

† At the gardens of the London Zoological Society there are examples of *Ascidium* and *Cynthia*, the compound and starlike *Botryllus* (pl. 24. fig. 8) and a delicate little pearly *Clavellina*, whose presence was first detected by Mr. Tennent the intelligent and obliging keeper of the aquarium.

‡ In *Appendicularia* Mr. Huxley finds no reversal of the current.

resemblance to a water-skin, or small leather bottle (*ascidium*). They attain a length of several inches, and are fixed to rocks or shingle, or sea-weed, but sometimes so slightly that they are brought up detached, and yet uninjured, by the dredge. Their appearance is sufficiently unpromising; their surface often rugged or concealed by adhering sand and fragments of shell; sea-weeds grow upon them, and small bivalves (*crenella*) burrow in their tunic. They are hollow and elastic, and have two orifices, from which (especially the terminal opening), they squirt water, as the bivalve shell-fish do when molested.

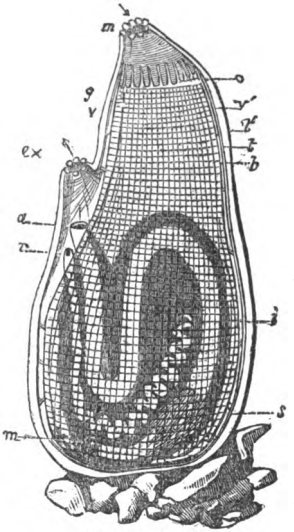


Fig. 224, Ascidian.†

If the soft outer shell (*t'*) is opened there will be found inside a second tunic (*t*) which is compared to the *mantle* of the bivalves; it is extremely muscular, the fibres circling round it closely, especially near the orifices, whilst some others are oblique and longitudinal. The mantle lines the tunic, but is only slightly attached to it at the two orifices, and at those points where the blood-vessels pass through.*

During life the outer tunic follows the contractions of the muscular mantle; and when the latter relaxes, the tunic returns to its original shape by virtue of its elasticity. But when preserved in spirit the mantle contracts to such an extent as to tear itself away from the tunic, and if such a specimen is opened the muscular sac looks like a little tunicary quite loose within the large one. Within this a third and more delicate tunic is formed by the respiratory or *branchial* sac (*b*) having only one external orifice by which it is suspended, a little within the terminal (or exhalent) opening of the outer tunics; as its texture is porous the water passes through it readily into the mantle cavity, and thence by the second

* In the thick pellucid test of *Ascidium mamillatum* the eye can discern an extensive network of vascular ramifications. The blood-vessels enter the test near the base. In the closely allied genus *Cynthia* there is no such vascular connexion, but the mantle is more strongly united to the test at the orifices; in Chelysoma the tunics are extensively united by muscular fibres. (Rupert Jones) The relation between the Ascidian test and mantle is that of the *epidermis* to the *cutis vera*, precisely as in the lamellibranchiate bivalves; the union of the two in the majority of Ascidians is exceedingly intimate in the fresh state. (*Huxley.*)

† Fig. 224, *Ascidium monachus*; *in.* incurrent; *ex.* excurrent orifice; *t'.* outer tunic; *t.* muscular tunic; *b.* branchial sac; *o.* tentacular fringe; *g.* nervous ganglion;

outlet (*ex.*) At the bottom of the *branchial sac* is the animal's mouth (*m*) or commencement of the digestive canal, which ends (at *a*), near the second external orifice. This digestive system is accompanied by other organs, forming the body of the animal, but it appears only like a thickening of one side of the muscular tunic.

If the animal presenting this organization be compared with the mussel (represented in fig. 30* p. 53,) or the *mya* (fig. 170, p. 244), it will be seen that each has a *test* lined by a mantle and furnished with an inhalent and an exhalent orifice; in each the respiratory cavity is separated from the channel of the out-going current by a sieve-like breathing organ, and in each the currents are produced and food brought to the mouth by microscopic *cilia* fringing the pores of the gill. The inhalent orifice of each is guarded by tentacles developed from the *mantle*,* and the exhalent opening is often furnished with a valve to prevent a reversal of the current when the animal expands after one of its occasional spasmodic contractions.

These points of *analogy* are so obvious and striking, as to have induced many naturalists to believe in a very close relationship between the Ascidians and bivalve shell-fish. We must, however, hesitate before we assume that the organs which perform identical functions, are themselves identical, ("homologous.") Mr. Hancock has pointed out (in the excellent memoir just referred to,) that the branchial sac of the Ascidian is not the anatomical equivalent of the gills of *mya*, but a portion of the alimentary canal;† and that the peculiarities of their circulation and mode of reproduction are more in harmony with what obtains amongst the higher zoophytes (*bryozoa*). A similar view is expressed by M. Milne Edwards in his memoir on the Composite Ascidians.‡

These statements are referred to more particularly, since of late years an

v. v'. referring to the space between the mantle and the branchial sac, indicate the dorsal and ventral sinuses of Milne-Edwards; *m.* mouth, at the bottom of the branchial sac; *s.* stomach, plaited lengthways; *i*, intestine, lying between the brachial sac and muscular tunic, on the further side; *a*, termination of the intestine; *r*, reproductive organ, ending in the cloaca.

* These tentacular filaments are not anatomically connected with the branchial sac as supposed by Farre and Owen. See Hancock on the Anatomy of the Freshwater *Bryozoa*. An. Nat. Hist. vol. V. p. 196.

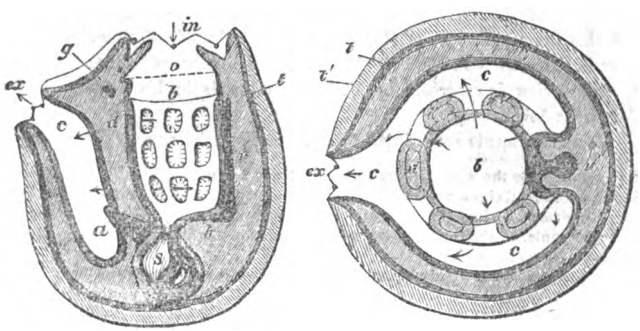
† Dr. Farre compared the Ascidian gill to the *pharynx* of the bryozoa; but M. Van Beneden and Mr. Hancock consider it homologous with the circle of oral tentacles in the retracted or undeveloped bryozoon.

‡ The Ascidians have less intimate analogies with the Mollusca, properly so called than is usually believed. They resemble, it is true, these animals in the arrangement of their digestive apparatus, and in some peculiarities of the respiratory system; but they depart from the Molluscan type in mode of circulation, in the metamorphosis which the fry undergo, and above all, in the singular power which most of them possess, of multiplying by gemmation. In these latter characters, so very important in a physiological point of view, they closely approach the polypes. (Milne-Edwards, Mem. Inst., France, 1842.)

opinion has been gaining ground with anatomists that not only the tunicaries, but the *bryozoa*, (or Ascidian Zoophytes of Dr. Johnston) should be regarded as *mollusca*; this view was recommended by Prof. Forbes, though not adopted by him, and is advocated by Prof. Allman and Mr. Huxley.

Those who have only seen the horn-coloured sea-weeds such as *Flustra* and *Notamia*, drifted by the wind on the sea-beach, may have admired their minute lace-work or chain-like cells, without once dreaming they were examining compound animals—shell-fish, anatomically considered. But the minute polypes which studded these zoophytes when alive, were undoubtedly as active, and in some respects as highly organized as the lower mollusca. The question is whether their organization is of the same kind, or *type*, as the molluscan, and in this respect their claims are nearly on a parallel with those of the *Tunicata*. The relation of the *bryozoa* is to the *Terebratulae*, as shown in their oral apparatus and muscular system (*Hancock*), but they have neither heart, arteries or veins, and the nutrient fluid is contained in the common visceral cavity. The ciliated gemmules of the bryozoa are not, however, more unlike molluscan larvæ* than are the tadpole-shaped fry of the tunicaries.

Before proceeding further with the description of the tunicaries, we are glad to avail ourselves of a diagram by Mr. Huxley, which will make it more intelligible.



225, *Longitudinal*, 226, *Transverse section*.

in. inhalent orifice; *ex*. exhalent orifice; *b*. branchial sac; *c*. atrium ("thoracic chamber" of Milne Edwards); *o*, tentacular filaments; *g*. nerve ganglion and auditory vesicle; *d*, thoracic vessel, (hypo-pharyngeal band); *v v'*, great vascular sinuses; *t'*, test; muscular mantle; *e*, endostyle; *s*, stomach; *a*, intestine; *h*, position of heart. The shading is accidently omitted on a small portion of the test by the letter *g*; the branchial sac (*b*) is connected with the wall of the atrium by (*branchio-parietal*) vessels crossing the cavity *c*, *c*.

* The embryo of *antiopa* (p. 196) is bell-shaped at first, with a fringe of long cilia round the rim which afterwards becomes the two-lobed *velum*.

In these figures the outer circle represents the test (*t'*) lined by the muscular mantle (*t*). The branchial sac in the centre (*b*) is perforated by a few large openings which are fringed with *cilia;* the arrows mark the direction of the respiratory currents which enter at the oral opening, passs through the branchial sac into the atrium or "thoracic chamber" (*c c*) and escape by the anal orifice (*ex*).

The *atrium* does not exist in the embryo; it is formed by an inflection of the tunics, and its ultimate extent varies in different genera. At first the whole space between the mantle and viscera is a common vascular *sinus*, as in the *bryozoa*, but the formation of the atrium divides it into two portions, one lining the mantle, the other investing the alimentary canal. The outer portion, or parietal sinus, is further subdivided by the union of its walls at definite points, leaving spaces and channels of various sizes and degrees of regularity. Of these, the principal are the dorsal and ventral sinuses (*v v'*) communicating by transverse channels.* The lower part of the alimentary canal continues surrounded by a vascular space termed the *peri-intestinal sinus*, whilst the pharyngeal portion with its vascular envelope becomes perforated to form the branchial sac.† It has been mentioned that the branchial openings are microscopic and innumerable in the solitary ascidians, whilst they are comparatively few and large in the social and compound species. In *Salpa* the branchial sac is so much reduced that the respiratory process must be exercised chiefly by the vascular lining of the mantle itself.

The heart is near the posterior or fixed end of the body; it is elongated, and slightly muscular, open at each end, and contracts progressively like the dorsal vessel of the anellides, the direction of its contractions being periodically reversed. The nervous system consists of filaments connected with a single ganglion placed in the sinus between the external orifices.‡ The organs of special sense are an auditory capsule sometimes containing an otolithe, (fig. 225. *g*) and coloured spots, supposed to be rudimentary eyes, placed between the segments of the outer openings.

The *neural* side, or that on which the nerve-ganglion is placed, should be considered *ventral* in these as in other invertebrate animals; and the *haemal* side, where the heart is situated, ought to be regarded as *dorsal*.§ The

* See the figure of *Salpa*, Pl. 24, fig. 22. The thick black lines represent the sinuses; the heart is near the lower end of the figure, outside the visceral nucleus. The sinuses have no visible lining membrane but resemble those already referred to (pp. 31, 198) as existing in all classes of mollusca.

† The resemblance of the pharyngeal sac of the tunicaries to the gills of fishes was pointed out by Mr. Goodsir in his memoir on the Lancelet (*amphioxus*).

‡ In Plate 21, the position of the nervous ganglion is indicated in several instances by a small star.

§ Milne-Edwards has employed these terms in an opposite sense, apparently

first flexure of the intestinal canal in the tunicaries is always to the haemal side, but it is usually turned again in the opposite direction.

The food of the ascidians, judging by the contents of their stomachs, consists chiefly of minute particles of the articulated sea-weeds and *diatomaceæ;* and it is a remarkable circumstance that the outer tunic of these animals contains *cellulose*, a ternary organic substance formerly supposed to be peculiar to vegetables.* They also contain radiated concretions, sometimes silicious, but more frequently calcarious, like the bodies found in *alcyonium* and *gorgonia.*

All the Tunicata appear to possess the power of reproduction by buds—or gemmation; but in one group the individuals, however produced, become entirely distict, in another they remain connected by a vascular canal, and in a third they become blended into a common mass. These three groups are the "solitary," "social," and "compound ascidians" of Milne-Edwards; these are all fixed in their adult state, whilst the two remaining families swim freely in the open sea, *Pyrosoma* being compound, and *Salpa* alternately aggregated and solitary. The separate individuals of these composite masses are termed Zoïds.

The sexes are united in all the Tunicata but *Doliolum* and *Appendicularia.* The young produced from eggs undergo a metamorphosis, which has been observed in many genera. The larvae are shaped like the tadpole of the frog; the body is oval and furnished with black eye specks, short tentacular processes, and a long tail by the vibrations of which they swim (Pl. 24, fig. 18). Ultimately they fix themselves, the tail is absorbed, and the young ascidian, or first zoïd of a compound tunicary, is developed.

The *tunicata* are found in all seas, from low-water to a considerable depth. Four genera are pelagic, and several belong to the Arctic province viz., *Boltenia, Chelyosoma, Synœcium* and *Cystingia.*

Mr. Huxley divides the Tunicaries into three groups—

1. *Ascidia Branchiales.* Branchial sac occupying the whole, or nearly the whole, length of the body; intestine lying on one side of it. (*Ascidiadæ—Perophora—Botryllus—Pyrosoma.*)

2. *Ascidia Intestinales.* Alimentary canal completely behind the branchial sac, which is comparatively small. (Other genera.)

3. *Ascidia Larvales.* Permament larval form. (*Appendicularia.*)†

guided by the analogy of the ganglionic side of the tunicata to the dorsal region of the *lamellibranchiata.* Still more confusion exists in the employment of the terms *anterior* and *posterior;* the *inhalent* orifice is anterior if compared with the mouth of a polype, but Milne-Edwards makes it *posterior.*

* Discovered by Dr. Schmidt, in 1845. The observation has been confirmed by M. M. Löwig and Kolliker, and by M. Payen, who gives the followiug as the chemical composition of the ascidian tunic;—Cellulose 60.34, azotised matter 27.00, inorganic 12.66. The cellulose portion is not acted upon by soda or hydrochloric acid.

† See Knight's "English Cyclopædia," article MOLLUSCA.

FAMILY I. Ascidiadae. Simple Ascidians.

Animal simple, fixed; solitary or gregarious; oviparous; sexes united; branchial sac simple or disposed in (8—18) deep and regular folds.

The simple ascidians were called *tethya* and well described in Aristotle's History of Animals.* Many of them are esteemed as articles of food in Brazil, China and the Mediterranean; at Cette they are regularly taken to market; and *Cynthia microcosmus*† furnishes a delicate morsel, much sought after.

Ascidium, Baster 1764. Sea-squirt.

Etym. Diminutive of *askos*, a skin-bottle.

Syn. Alina, Risso: Phallusia, Pirena, Ciona, Savigny.

Ex. A monachus, Cuv. fig. 224, Tenby.

Body sessile, covered with a coriaceous or gelatinous tunic; branchial orifice 8-lobed, furnished inside with a circle of simple tentacular filaments; anal 6-lobed; branchial sac not plaited, its meshes papillated.

The ascidia vary in length from 1 inch to 5 or 6 inches. The test is pale and semitransparent, the inner tunic orange or crimson, or sometimes marbled with crimson and white; the ocelli are red, or yellow with a central red spot. The surface of *A. echinatum* is studded with conical papillae, each with 4—7 radiating bristles. The ascidia range from low-water to 20 fathoms, attached to rocks, shells, and fuci.

Distr. Greenland, Spitzbergen, U. States, Europe, (especially in the north), Brit. 19 sp. Medit. New Zealand.

Molgula, Forbes.

Etym. Diminutive of *molgos*, a bag of skin.

Ex. M. arenosa, A. and H. (not M. tubulosa Rathke), Pl. 24, fig. 1.

Body more or less globular, attached or free; test membranous, usually invested with extraneous matter; orifices on very contractile, naked tubes; oral opening 6-lobed, anal 4-lobed.

M. arenosa is found in the muddy lochs and bays of the west of Scotland; it comes up in the dredge like a little ball of sand. At Tenby it occurs between tide-marks, and in the laminarian zone.

M. oculata was dredged, adhering to a scallop, in 25 fathoms, off Plymouth; its orifices are like dark eyes in a spectacle-formed frame. (*Forbes*).

Distr. 3 sp. Denmark, Brit.

* Linnaeus used the name *Tethyum* for the Tunicaries in the earlier editions of his "Systema Naturae," and recognising their resemblence to the bivalves, called the animal of the latter "a tethys." Afterwards he adopted Baster's name *Ascidium*, and used Tethys for a nudibranche; *Tethya* (Lam.) is now employed for a genus of globular sponges.

† So called from the little world of parasites that ofter grow upon it.

Cynthia, Savigny, 1816.

Etyn. A name of Diana, from Mt. Cynthos, Delos.

Syn. Stycla (pomaria) Sav. Caesira (quadridentata) Sav.

Ex. C. papillosa, Pl. 24, fig 2.

Body coriaceous, sessile, orifices 4-lobed, branchial sac plaited longitudinally, surmounted by a circle of tentacular filaments; ovaries two.

Sub-genera. Dendrodoa (glandaria) Mc Leay. Sub-cylindrical, smooth; orifices terminal, minute; ovary single, on left side.

Pandocia (mytiligera) Sav. Right ovary only developed.

Distr. Norway—Medit. Sometimes on sand and very slightly attached; or on oysters, stones and sea-weed, from low-water to 30 fathoms. Occasionally gregarious in vast numbers, forming large bunches in consequence of the interlacing of their root-fibres. The test is often orange-coloured or crimson. The branchial sac, in this and the following genera, is thrown into deep folds to increase its extent of surface. Greenland, Brit. 14 sp.

Pelonæa, Forbes and Goodsir.

Etym. Pelos, mud, *naio* to inhabit.

Ex. P. glabra, Pl. 24, fig. 3. Rothesay bay; 7 fms.

Body elongated, cylindrical, smooth or wrinkled; orifices terminal 4-cleft, on two small conical eminences; posterior end blunt pointed, villose with fine rootlets; mantle adherent to the test; no tentacles; ovaries 2, symmetrical.

Distr. 2 sp. N. Brit. Norway (Mc Andrew and Barrett).

Pelonæa resembles *Sipunculus,* one of the worm-like Echinoderms, *in appearance.* It is not free, but rooted in mud and quite as apathetic as the other ascidians.*

Chelyosoma, Broderip and Sby.

Etym. Chelyon tortoise-shell, *soma* body.

Type, C. Macleayanum, Pl. 24, fig. 4. Greenland.

Body depressed, oblong; test coriaceous, its upper surface composed of 8 polygonal plates; orifices small, prominent, 6-valved; gills plaited; tentacles simple.

Boltenia, Sav.

Named after Dr. Bolten, a Hamburgh naturalist.

Syn.? Bi-papillaria, Lam. 1816. Australia.

Ex. B. pedunculata, Pl. 24, fig. 5.

Body globular, pedunculated; test coriaceous, orifices lateral, 4-cleft; branchial sac longitudinally plaited; tentacles compound.

* Pelonæa is not so extraordinary as at first supposed. The very erroneous statement at p. 32, lines 27, 28, should be erased.

The young *Bolteniae* sometimes grow on the stem of the parent. The branchial orifice is nearest the stalk, but as the body is pendulous it becomes higher than the other opening, as usual amongst the ascidians. (Rupert Jones.) *B. reniformis*, Mc L. lives attached to stones in deep water; it is sometimes brought up by the fishing hooks. (*Gould.*) Elizabeth harbour, 70 fms. (*Ross.*)

Distr. N. Zealand; Greenland, (*B. ovifera*—Vorticella, L.) Mass. U. S.

Sub-genus ? Cystingia (Griffithi) Mc Leay, 1824. Arctic seas, Felix harbour and Fox's channel. *Test* sub-coriaceous, anal orifice irregular, terminal.

FAMILY II. Clavellinidae. Social Ascidians.

Animal compound, fixed; individuals connected by creeping tubular prolongations of the common tunic, through which the blood circulates, (or by a common gelatinous base).

These small or microscopic creatures are found on stones, shells and seaweed, adhering by numerous root-like projections of their outer tunic. They are so transparent and colourless that they may be examined without dissection (Pl. 24, figs. 6, 7). The position of the stomach is indicated by an orange-coloured spot; the œsophagus is long, and the intestine returns parallel to it. The heart and ovary are near the stomach. The gill, perforated by rows of holes, completely separates the branchial cavity from the cloaca; a series of membranous processes (*languettes*) project from its neural side. The creeping tube contains two channels through which the blood circulates in opposite directions.

Reproduction is effected by ova and by buds produced on filaments given off by the creeping tube. These off-shoots are hollow, and lined by a membrane continuous with the inner tunic of the ascidian; the circulation passes into them and they grow and branch and form buds containing little organized masses from which the internal organs are gradually developed. The branchial sac is perfectly outlined before it communicates with the interior, and the curved digestive tube is seen before the oral opening is formed. The new individual may continue united with the parent, or become completely free by the rupture of the connecting tube. (*Milne-Edwards.*)

Clavellina, Sav.

Etym. Clavelia, a small staff, *Syn.* ? Rhopalaca, Phi.

Type, C. lepadiformis, Pl. 24, fig. 6.

Body elongated, erect, more or less pedunculated; test smooth and transparent; orifices without rays; thoracic region usually marked with coloured lines.

Distr. Greenland, Brit. Medit. On rocks and stones at low-water.

PEROPHORA, (Wiegm.) Lister, 1834.

Etym. Pera, a sac, and *phoros* bearing.

Type, P. Listeri, Wiegman, Pl. 24, fig. 7.

Body pedunculated, suborbicular, compressed; thoracic region plain.

This curious little species was discovered by Mr. J. Lister at Brighton, growing on *Conferva elongata*. It occurs in groups consisting of several individuals, each having its own heart, respiration, and system of nutrition, but fixed on a peduncle that branches from a common creeping stem, and all being connected by a circulation that extends throughout. (Lister).

Mr. Forbes has dredged it adhering to weed on the coast of Anglesey; he remarks "it is beautifully transparent, appearing on the weed like little specks of jelly dotted with orange and brown. When dried, as it may often be met with on sea-weed cast on shore, these bodies appear like the minute ova of some mollusk." According to Mr. Huxley's view this genus differs widely from the last, being a "branchial ascidian" whilst *Clavellina* is an "abdominal" one.

SYNTETHYS, Forbes and Goodsir.

Type, S. Hebridicus, F and G. Croulin Id. near Applecross.

Animals compound, gelatinous, orbicular, sessile; *individuals* very prominent, arranged sub-concentrically in the common mass; branchial and anal orifices simple, not cut into rays.

Syntethys is a Clavellina with the habit of a *Diazona*. The only known species forms compact greenish translucent gelatinous masses of half a foot in diameter, and nearly equal height, affixed to rocks or stones by a short base. The individual ascidians are when full grown 2 inches in length. Their inner tunics are remarkably irritable, withdrawing themselves into the common mass when pinched. (*Forbes, Brit. Moll.* iv., 244).

FAMILY III. BOTRYLLIDAE, Compound Ascidians.

Animals compound, fixed, their tests fused, forming a common mass in which they are imbedded in one or more groups; individuals not connected by any internal union; oviparous and gemmiparous.

Milne-Edwards divides the compound ascidians into three tribes:—

1. *Botryllina*. Individuals united in systems around common excretory cavities (*cloacae*). Thorax and abdomen not distinct.

2. *Didemnina*. Thorax and abdomen distinct.

3. *Polyclinina*. Body divided into three distinct portions—1, thorax, with the branchial apparatus;—2, superior abdomen with the digestive organs;—3, post-abdomen, containing the heart and reproductive organs.

Tribe 1, Botryllina—Botryllians.

BOTRYLLUS, Gaertner, 1774.

Etym. *Botrys*, a cluster of grapes.

Syn. ? Pyura, Bl. Polycyclus, Lam.

Ex. B. violaceus, Pl. 24, fig. 8, two stars from a group.

Test gelatinous or cartilaginous, incrusting; systems numerous, prominent, round or star-shaped, with central cavities; individuals 6—20 in each system, lying horizontally, with the vent far from the simple branchial orifice.

Distr. 10 sp. U. States, Europe. Brit. 6 sp. On stones and sea-weed near low-water mark. *B. violaceus* is greenish grey, with dark blue stars, yellow in the centre round the common orifice. *B. racemosus*, *N. Zealand.*

BOTRYLLOIDES, M. Edw., 1841.

Ex. B. rotifera, Pl. 24, fig 9, a zoïd detached, with a cluster of reproductive germs.

Animals nearly vertical, in star-like groups irregular and ramifying; cloacae prolonged into the common mass, forming irregular channels, along each side of which the individuals are placed in linear series; orifices closely approximate.

Distr. European coasts, on roots of sea-weed and under sides of stones between tide marks. Brit. 4 sp.

Tribe 2, Didemnina. "Didemnians."

Division *a*, unistellate, (oral orifice rayed.)

DIDEMNIUM, Sav.

Etym. *Di-demnium* double-couch (or cavity).

Ex. D. gelatinosum, Pl. 24, fig. 10, zoïd detached.

Test coriaceous, polymorphous, incrusting; systems numerous, compressed, without central cavities or distinct circumscription; individuals scattered; abdomen pedunculate; ovary by the intestinal loop, increasing in length when the ova are fully developed.

Distr. Europe.

EUCŒLIUM, Sav.

Etym. *Eu-koilios* much excavated.

Ex. E. hospitiolum, Pl. 24, fig. 11.

Test gelatinous, incrusting; systems numerous, without central cavities or distinct circumscription: animals scattered or arranged quincuncially branchial orifice circular; anal minute; abdominal viscera beside the thorax.

Distr. Europe.

LEPTOCLINUM, M. Edw.

Etym. *Leptos* thin, *kline* tunic.

Type, L. maculosum Edw. (L. gelatinosum, F. and H. Pl. A, B. fig. 5.)

Test coriaceous or gelatinous, thin, incrusting; systems few; individuals grouped irregularly round common cloacal cavities; abdomen pedunculate, short, smaller than the thorax.

Distr. Brit. 6 sp. On roots of *laminariae;* in colour white, yellowish, or variegated with blue.

Division b. Bi-stellate Didemnians.

DISTOMUS, Gaertner.

Etym. Distomos two-mouthed. *Syn.* Polyzona, Flem.

Ex. D. fuscus Pl. 24, fig. 12, a detached zoïd.

Test semi-cartilaginous, polymorphous, sessile: systems numerous, usually circular; individuals 1 or 2 ranked at unequal distances from their common centre; both orifices 6-rayed.

Distr. Europe, S. Africa, Australia. Brit. 2 sp.

DIAZONA, Sav.

Etym. Dia-zonai in circles.

Ex. D. violacea, Pl. 24, fig. 13 Medit.

Test gelatinous, orbicular, sessile or somewhat pedunculate; tunicaries very prominent, arranged in concentric circles on an expanded disk, forming a single flower-like system; orifices 6-rayed; abdomen pedunculate; ovary inclosed in the intestinal loop.

Tribe 3. Polyclinina.

Division a, unistellate Polyclinians.

POLYCLINUM, Sav.

Etym. Polys many, *kline* cavities.

Ex. P. constellatum, Pl. 24, fig. 15.

Test gelatinous or cartilaginous, polymorphous, sessile or slightly pedunculate; systems numerous, convex, somewhat stellate, with central cloacal cavities; tunicaries 10—150, at very unequal distances from centres; abdomen much smaller than thorax, post-abdomen pedunculate.

Distr. 6 sp. Brit., Medit., Red Sea, India.

APLYDIUM, Sav. Sea-fig.

Etym. Aploos simple. *Ex.* A. lobatum, Pl. 24, fig. 14.

Test gelatinous or cartilaginous, sessile; systems very numerous, slightly prominent, annular or sub-elliptical, without central cavities; tunicaries (3—25) in single rows, equidistant from centres; branchial orifice 6-rayed; division of thorax and abdomen not always distinctly marked.

Distr. 6 sp. Europe, Red Sea. Attached to shells, &c., in deep water.

SIDNYUM, Sav.

Type, S. turbinatum, Sav. British coast. (F. and H. Pl. A, B. fig. 2.)

Test gelatinous, incrusting; systems numerous, conical, truncated and starred at the summit; tunicaries 5 or 6 to 10 or 12, forming a margin round a depressed centre; branchial orifice 8-toothed; vent simple, tubular; ovary pedunculate.

Found on the under surfaces of shelving rocks, at low-water spring tides, forming translucent amber-coloured masses.

AMOROECIUM, M. Edw.

Etym. Amoiros incomplete, *oikos* house.

Ex. A. argus, Pl. 24, fig. 17. A proliferum, (larva) fig. 18.

Test fleshy or coriaceous, polymorphous, incrusting or slightly pedunculate; systems numerous; tunicaries grouped round common apertures; abdominal divisions indistinct.

Distr. 4 sp. British Channel, Medit., Aegean.

Sub-genus Parascidium, M. Edw. P. flavum, 24, fig. 16. Oral openings 8-lobed, each accompanied by 2 oculiform points.

SYNOECIUM, Phipps, 1773.

Etym. Synoikos united house. *Type*, S. turgens, Pl. 24, fig. 19.

Test semicartilaginous, cylindrical, pedunculate, isolated or gregarious; systems single, circular, terminal, tunicaries 6—9; branchial orifice 6-rayed, anal of 6 unequal rays; post-abdomen sessile.

Division b. Bistellate Polyclinians.

SIGILLINA, Sav.

Etym. Sigillum, a seal, *Ex.* S. Australis, Pl. 24, fig. 20.

Test gelatinous, solid, conical, elongated, pedunculate, solitary or gregarious; systems single, of many individuals, in irregular circles one above another; orifices both 6-rayed; abdomen larger than thorax; post-abdomen long and slender.

FAMILY IV. PYROSOMIDÆ.

Animal compound, free, pelagic.

PYROSOMA, Péron, 1804.

Etym. Pyr (*pyros*) fire, *soma* body.

Ex. P. giganteum, Pl. 24, fig. 21.

Body cartilaginous, non-contractile, cylindrical, hollow, open at one end only; exterior covered by the numerous pointed zoïds, grouped in whirls interior mamillated and pierced by the exhalent orifices of the tunicaries.

The Pyrosomes are 2—14 inches long and ½—3 inches in circumference; they are composed of innumerable tunicaries united side by side, with their orifices so arranged that the inhalent openings are external, the exhalent inside the tube, and the result of so many little currents discharged into the cavity is to produce one general outflow, which impels the floating cylinder with its closed end foremost.

The ganglionic side of each zoïd is turned towards the open end of the tube; the respiratory cavity is large, and completely inclosed by a quadrangular net-work; the test and mantle are united and lined by a vascular sinus-system. There is an "endostyle" on the haemal side, as long as the branchial sac. The ventral column (hypo-pharyngeal band) supports a series of *languet*

The sexes are combined; reproduction takes place by *buds* developed amongst the adult zoïds, and by solitary *ova* connected with the inner tunic by a pedicle near the posterior termination of the endostyle; 2 or 3 ova are perceptible in the young zoïd at a very early period.

The Pyrosomes are often gregarious in vast numbers; in the Mediterranean they sometimes abound to such an extent as to clog the nets of the fishermen. They are phosphorescent at night. The light of *P. atlanticum* is very vivid and of a greenish blue colour; when touched the light appears in very minute sparks, issuing from each of the separate individuals, it first appears at the part touched, and gradually spreads over the body; it disappears after death. (*Müller*). Placed in a vessel of salt-water, and at rest, they emit no light, and the light excited by touching them gradually fades after the removal of irritation; but immersed in *fresh-water* they continue glowing with their brightest refulgence for several hours—as long as life remains. Péron first noticed them as "a phosphorescent band, stretched across the waves and occupying an immense tract in advance of the ship. Those most distinctly seen resembled incandescent cylinders of iron." Humboldt speaks of the *Pyrosomæ* as forming a light 1½ feet in diameter, by which the fishes were visible!

FAMILY V. Salpidæ.

Animals free, oceanic; alternately solitary and aggregated.

Salpa, Forskahl, 1775.

Etym. Salpe a luminous fish. *Syn.* Dagysa, Banks and Solander. Thalia, Brown. Biphora, Brug. Pegea and Jasis, Sav.

Ex. S. maxima, Pl. 24, fig. 22, solitary form.

Animal oblong, sub-cylindrical, truncated in front by the oral orifice, pointed posteriorly; anal orifice sub-terminal; *test* thin, transparent; muscular mantle incomplete, forming a set of transverse or oblique bands; mantle cavity lined by a system of vascular sinuses; gill rudimentary, forming an

oblique band across the interior; visceral nucleus posterior. *Sexes* combined; young produced by gemmation in chains, consisting of individuals unlike the parent and becoming oviparous, the alternate generations only being alike.

Distr. North sea, Brit. Medit. Australia, N. Zealand.

The individual Salpians are from ½ an inch to 10 inches in length; the chains vary from a few inches to many feet, but are often broken up, indeed the *adults* appear to be always separate. They swim with either end foremost, although the pointed end would seem the normal one, as the motion is produced by the forcibly expulsion of the water from the mantle. Each orifice is furnished with a valve, and there is no division between the atrium and respiratory cavity except the rudimentary gill, or "hypopharyngeal band." The Salpa-chains also swim, with a regular serpentine movement.

The solitary and aggregate forms differ so much that they were always named and described as distinct species before the remarkable discovery made by *Chamisso*,* that each form always produced the other. The free form of *S. democratica*, Forsk. is a four-sided prism, with a rough surface, and 8 prominent spines at the posterior end; it has 7 muscular bands which completely encircle the body. The aggregate form (*S. mucronata*, Forsk.) is ovoid, pointed behind, smooth, and has only 5 muscular bands, whose dorsal ends are separate. (*Huxley.*)†

The *solitary* Salpae always contain a chain of embryos winding spirally round the visceral nucleus; the embryos are attached in pairs to a double tube (or "proliferous stolon") connected with the sinus to the right of the heart. Sometimes they increase in size gradually from the heart outwards to the free end of the stolon, but usually the embryos are developed in groups, and each portion of the series when it is detached consists of young Salpas of the same size. These portions are liberated in succession through an aperture produced in the tunic opposite the extremity of the stolon.

The *aggregate* Salpae produce a single ovum at a time, which is attached by a pedicle to the posterior part of the respiratory cavity. It remains there until it has attained a considerable size, and exhibits the proliferous stolon already partly developed, and those external characters which permanently distinguish it from its parent.

It was in *Salpa* that Hasselt first observed the periodic change in the direction of the circulating currents. The heart itself is a muscular membrane not forming a complete tube, but open on one side. The dorsal sinus contains the long tubular filament (fig. 225, e) called the *endostyle*. In the ventral sinus is the ganglion, and the auditory vesicle containing 4 otolithes. The gill is a hollow column, or band, representing only the thoracic vessel ("hypo-pharyngeal band") of the Ascidians (fig. 226, d) and the respi-

* Chiefly known in England as the author of PETER SCHLEMIHL.

† Phil. Trans, 1851, Part II. p. 567.

ratory function is performed by the entire pallial cavity. The muscles of the Salpae consist of single layers of tranversely striped fibre.

Doliolum, Quoy and Gaimard.

Etym. Diminutive of *dolium* a cask. *Syn.* ? Anchinaea, Esch.

Type, D. denticulatum, Pl. 24, fig. 23.

Body transparent, cask-shaped, open at the ends, 2—10 lines in length; oral extremity a little prominent, with about 12 rounded denticulations; posterior end fringed; muscular bands 6, equidistant, besides the sphincters of the orifices; branchiae consisting of two bands stretched across the interior, one above (*epi*) and one below (*hypopharyngeal*), connected by transverse bars with one another and the parietes; mouth on the dorsal side, in front of the fourth band; heart above and in front of the mouth. (*Huxley.*)

Distr. 2 sp. Amboina, Vanicoro, N. Zealand.

Appendicularia, Chamisso.

Etym. Appendiculus, a small appendage.

Syn. Vexillaria, Müll. 1846. Oikopleura, Mertens, 1831.

Type, A. flabellum, Pl. 24, fig. 24.

Body ovoid, $\frac{1}{6}$—$\frac{1}{4}$ inch long, with a long curved tail or swimming-organ; smaller end perforated, leading into a large cavity lined by a sinus-system; gill represented by the ciliated pharynx, which communicates with the exterior by two funnel-shaped canals opening on the hæmal surface beside the rectum; œsophagus short, slightly curved, leading into a wide stomach; intestine turned forwards, ending on *dorsal* side in front of appendage; heart between lobes of the stomach; tail lanceolate, horizontally compressed. All the examples hitherto observed have been males. (*Huxley.*)

These minute creatures appear to be the lowest forms of the *Tunicata;* typifying in their adult age the larval state of the higher ascidians.

Distr. Behring's Straits, N. Brit. Tenby, Cape, New Guinea, S. Pacific.

Prof. Forbes relates that "when cruising off the north coast of Scotland in 1845, with Mr. Mc Andrew, their attention was attracted by the appearance of cloudy patches of red colouring matter in the water, and on procuring some and submitting it to microscopic examination, it was found to consist entirely of the curious and anomalous creatures called *Appendiculariæ*."*

* The most complete and accurate history of the class Tunicata is contained in the Article Tunicata of Todd's *Cyclopædia of Anatomy*, by Mr. T. Rupert Jones.

CONCLUSION.

CHAPTER I.

NUMERICAL ESTIMATE.

The number of living and fossil species of each genus of mollusca has been stated in the preceding pages, so far as they could be ascertained. With some modifications derived from recent data, these numbers give the following totals, by which the relative numerical development of the orders and families will be seen.

	Recent.	Fossil.
CEPHALOPODA. *Dibranchiata.*		
Argonautidæ	4	1
Octopodidae.....	58	—
Teuthidæ	91	31
Belemnitidæ	—	67
Sepiadæ	30	1
Spirulidæ	3	—
	186	100
Tetrabranchiata.		
Nautilidæ	4	174
Orthoceratidæ....	—	281
Ammonitidæ	—	904
	4	1,359
GASTEROPODA. *Prosobranchiata.*		
Strombidæ*	83	195
Muricidæ	870	697
Buccinidæ	1,048	352
Conidæ	856	390
Volutidæ.....	686	210
Cypræidæ	225	97
Naticidæ.....	245	340
Pyramidellidæ	216	322
Cerithiadæ.....	192	610
Melaniadæ.....	424	59
Turritellidæ†.....	196	290
Litorinidæ	315	220
Paludinidæ.....	132	110
Calyptræidæ	160	100
Turbinidæ	855	906
Haliotidæ	99	136
Fissurellidæ	194	72
Neritidæ	300	100
Patellidæ.....	130	100
Dentaliadæ.....	50	70
Chitonidæ	230	24
	7,506	5,391

* Including *Aporrhaïs.*

	Recent.	Fossil
Pulmonifera.		
Helicidæ	3,900	280
Limacidæ	72	4
Limnæidæ	160	155
(Marine)	86	28
(Ditto, shell-less) ..	16	0
	4,234	467
Operculated. Pulmonifera.		
Cyclostomidæ	700	23
Aciculidæ	26	1
	726	24
Tecti-branchiata.		
Tornatellidæ	50	152
Bullidæ	158	78
Aplysiadæ	79	4
Pleurobranchidæ....	9	—
Phyllidiadæ	10	—
	326	234
Nudibranchiata.		
British	90	—
Foreign	220	—
	310	—
Nucleobranchiata.		
Shell-less	14	—
Shell-bearing	30	100
	44	100
PTEROPODA.		
Hyaleidæ	50	32
Limacinidæ	16	—
Cliusidæ	13	—
	79	32

† With *Scalaria.*

	Recent.	Fossil.
BRACHIOPODA.		
Terebratulidæ	50	300
Spiriferidæ	—	254
Rhynchonellidæ	3	300
Orthidæ	—	200
Productidæ	—	100
Craniadæ	5	30
Discinidæ	7	50
Lingulidæ	7	38
	75	1,272
CONCHIFERA.		
Ostreidæ	270	1,062
Aviculidæ	85	570
Mytilidæ	112	242
Arcadæ	288	616
Trigoniadæ	3	136
Unionidæ	320	50
Chamidæ	50	50
Hippuritidæ	—	78
(CONCHIFERA.)		
Tridacnidæ	7	3
Cardiadæ	200	300
Lucinidæ	120	351
Cycladidæ	200	105
Astartidæ	46	373
Cyprinidæ	108	356
Veneridæ	573	260
Mactridæ	82	41
Donacidæ	73	40
Tellinidæ	315	200
Solenidæ	55	45
Myacidæ	90	250
Anatinidæ	66	400
Gastrochænidæ	23	34
Pholadidæ	64	50
	3,150	5,612
TUNICATA (about)	150	

Of the recent marine shell-fish some are in great measure animal feeders, while the rest live on algæ and infusoria.

Animal feeders.	
Cephalopoda	190
Proboscidean Gasteropoda	4,329
Dentaliadæ	50
Opistho-branchiata (part)	508
Nucleobranchiata	44
Pteropoda	79
	5,200

Vegetable feeders.	
Gasteropoda rostrifera	3,127
Opistho-branchiata (part)	128
Infusorial feeders.	
Bivalve shellfish	3,226
Tunicaries	150
	6,631
Pulmonifera	4,960

	Recent.		Fossil.
Fresh-water shells	1,504		800
Marine shells	10,002		13,300
Land snails	4,626		491
Total of Shell-bearing Mollusca	16,132	Total	14,591
Naked Mollusks	660		—
*Total of Recent Mollusca**	16,792	(British	4,590)

* The total number of living *Vertebrate* animals amounts to about 16,000; the number of Plants is estimated at 100,000, and the Insect class is supposed to include not less then 300,000 species.

Chapter II.

GEOGRAPHICAL DISTRIBUTION OF THE MOLLUSCA.

It is one of the most familiar facts in Natural History, that many countries possess a distinct Fauna and Flora, or assemblages of animals and plants peculiar to themselves; and it is equally true, though less generally understood, that the sea also has its provinces of animal and vegetable life.

The most important, or best known of these provinces are indicated on the accompanying map; different names, in some instances, and different letters and numbers being employed to distinguish the marine from the terrestrial regions.*

The division of the surface of the globe into natural history provinces ought to be framed upon the widest possible basis. The geographical distribution of every class of animals and plants should be considered, in order to arrive at a theory of universal application.

The *Land Provinces* hitherto proposed have been chiefly founded on botanical grounds, but the evidence afforded by insects, and the higher classes of animals, confirms the existence of these divisions.

The *Marine Provinces* have also been investigated by botanists; and the striking peculiarities of the fisheries have been taken into account as well as the distribution of shell-fish and corals.

In order to constitute a distinct province it is considered necessary that at least *one-half* the species should be *peculiar*, a rule which applies equally to plants and animals. Some genera, and sub-genera are limited to each province, but the proportion is different in each class of animals and in plants.†

Specific areas.—Species vary extremely in their range, some being

* The author regrets that, on account of the expense, this map appears without the advantage of colours. He would recommend those who are sufficiently interested in the subject, to colour their own copies, distinguishing the shores of the marine provinces by the following tints:—

Blue 1. Arctic province; 15. Magellanic.
Green. 2. Boreal; 11. Aleutian, 5. Aralo-Caspian.
Orange. 3. Celtic.
Purple. 4. Lusitanian; 10. Japonic; 12. Californian; 18, Trans-Atlantic.
Yellow. 6. W. African; 8. Indo-Pacific; 13. Panamic; 17. Caribbean.
Lake. 7. S. African; 9. Australo-Zealandic; 14. Peruvian; 16. Patagonian.

† The genera of plants amount to 20,000, and consist on an average of only 4 species apiece! The genera of shells commonly admitted are only 400 in number, and average 40 species each. It follows that the areas of the molluscan genera *(cæteris paribus)* ought to be 10 times as great as those of plants.

limited to small areas, while others, more widely diffused, unite the local populations into fewer and larger groups. Those species which characterise particular regions are termed "endemic;" they mostly require peculiar circumstances, or possess small means of migrating. The others, sometimes called "sporadic," possess great facilities for diffusion, like the lower orders of plants propagated by *spores*, and more easily meet with suitable conditions. The space over which a species is distributed is called a "centre," or more properly specific *area*. The areas of one-half the species are smaller (usually much smaller) than a single province.

In each specific area there is frequently one spot where individuals are more abundant than elsewhere; this has been called the "metropolis" of the species. Some species which appear to be no-where common can be shown to have abounded formerly; and many probably seem rare only because their head-quarters are at present unknown. (*Forbes.*)

Specific centres are the points at which the particular species are supposed to have been created, according to those who believe that each has originated from a common stock (p. 56); these can only be known approximately in any case. The doctrine that each species originated from a single individual, or pair, created once only, and at one place, derives strong confirmation from the fact that so "many animals and plants are indigenous only in determinate spots, while a thousand others might have supported them as well."*

Generic areas.—Natural groups of species, whether called genera, families or orders, are distributed much in the same manner as species;† not for the

* Mrs Somerville's Physical Geography, II. 95.

† "What we call class, order, family, genus, are all only so many names for *genera* of various degrees of extent. Technically, a *genus* is a group to which a *name* (as *Ribes*) is applied: but essentially, *Exogens*, *Ranunculaceæ*, *Ranunculus*, are genera of different degrees.

One of the chief arguments in favour of the *naturalness* of genera (or *groups*), is that derived from the fact that many genera can be shown to be *centralized* in definite geographical areas (*Erica*, for example); *i.e.* we find the species gathered all, or mostly, within an area, which has some one point where the *maximum* number of species is developed.

But, in *geographical space*, we not unfrequently find that the same genus may have two or more areas, within each of which this phenomenon of a point of *maximum* number of species is seen, with fewer and fewer species radiating, as it were, from it.

In *time*, however (or, in other words, in *geological distribution*), so far as we know, each generic type has had an unique and continuous range. When once a generic type has ceased, it never re-appears.

A genus is an abstraction, a divine idea. The very fact of the centralization of groups of allied species, *i.e.* of genera, in space and time, is sufficient proof of this. Doubtless we make many so-called genera that are artificial; but a true genus is natural: and, as such, is not dependent on man's will." *E. Forbes.* (See An. Nat. Hist. July, 1852, and Jan. 1855, p. 45.)

same reason, since their constituents are not related by descent, but apparently from the intention of the Creator.

Sub-generic areas are usually smaller than generic; and the areas of orders and families are as a matter of course larger than those of the included genera. But it is necessary to remember that groups of the same denomination are not always of equal value; and since species vary in range, it often happens that specific areas of one class or family are larger than generic areas of another. The smallest areas are usually those of the forms termed *aberrant* (p. 61); the *typical* groups and species are most widely distributed. (*Waterhouse.*)

"When a generic area includes a considerable number of species, there may be found within it a point of maximum, (*metropolis*) around which the number of species becomes less and less. A genus may have more centres than one.—It may have had unbroken extension at one period, and yet in the course of time and change, may have its centre so broken up that there shall appear to be out-lying points. When, however, the history of a natural genus shall have been traced equally through its extension in *time* and *space*, it is not impossible that the area, considered in the abstract, will be found to be necessarily unique." (*Forbes.*)

To illustrate the doctrine of the *unity of generic areas* Prof. Forbes has given several examples, showing that some of the most exceptional cases admit of explanation and confirm the rule. One of these relates to the genus *Mitra* of which there are 400 species; it has its metropolis in the Philippine Islands and extends by the Red Sea to the Mediterranean and West Africa, the species becoming few, small, and obscure. Far away from the rest a single species is found on the coast of Greenland! But this very shell occurs fossil in Ireland along with another *mitra* now living in the Mediterranean. Another case is presented by the genus *Panopæa*, of which the six living species are widely separated,—*a*, in the Mediterranean; *b*, in Patagonia; *c*, at the Cape; *d*, Tasmania; *e*, New Zealand; *f*, Japan. Of this genus above 100 fossil species are known, distributed over many places within the wide area, on whose margin the relics of this ancient form of life seem to linger, like the last ripple of a circling wave.*

According to this view the specific centres are scattered thickly over the whole surface of the globe; those of the genera more thinly distributed; and the points of origin of the large groups become fewer in succession, until we have to estimate the probable position or scene of creation of the primary divisions themselves; and are led to speculate whether there may not have been some common focus—the centre of centres—from which the first and greatest types of life have emanated.

Boundaries of Natural History Provinces. The land provinces are sepa-

* The most striking and conclusive instances may be met with in the distribution of the higest classes of vertebrate animals.

rated by lofty mountains, deserts, seas, and climates; whilst the seas are divided by continents and influenced by the physical character of coast-lines, by climates and currents. These "natural barriers" as they were called by Buffon, retard or altogether prevent the migrations of species in particular directions.

Influence of Climate.—Diversity of climate has been the popular explanation of most of the phenomena of geographical distribution, because it is so well-known that some species require a tropical amount of warmth, whilst others can endure a great variety of temperature, and some only thrive amidst the rigours of the arctic regions. The character of the vegetation of the zones of latitude has been sketched by Baron Humboldt; Fabricius and Latreille have divided the world into climatal Insect-provinces; and Prof. E. Forbes has constructed a map of the *homoiozoic belts* or zones of marine life. To all these the remark of Mr. Kirby is applicable—that any division of the globe into provinces, by means of *equivalent* parallels and meridians, wears the appearance of an artificial and arbitrary system, rather than of one according to nature. Prof. Forbes has been careful to point out that although the "Faunas of regions under similar physical conditions bear a striking resemblance to each other"—this resemblance is produced, "not by identity of species, or even of genera, but by *representation*." (p. 56).

Origin of the Natural History Provinces.—Mr. Kirby appears to have been the first to recognize the truth that physical conditions were not the primary causes of the zoological provinces, which he "regarded as fixed by the will of the Creator, rather than as regulated by isothermal lines."* Mr. Swainson also has shown that the "circumstances connected with temperature, food, situation and foes, are totally insufficient to account for the phenomena of animal geography," which he attributes to the operation of unknown laws.†

The most important contribution towards a knowledge of these "unknown laws" has been made by Prof. E. Forbes, who was perhaps the first naturalist ever in a position to avail himself of the great storehouse of facts accumulated by geologists, respecting the distribution of organic life in "the former world." This subject will be referred to again in connection with the subject of Fossil Shells; meanwhile it may be stated, that according to this evidence, the Faunas of the Provinces are of various ages, and that their origin is connected with former (often very remote) geological changes, and a different distribution of land and water over the surface of the globe.

MARINE PROVINCES.

Amongst the genera of marine shells, there are some which have been considered particularly indicative of climate. From the Arctic list the follow-

* Introduction to Entomology.

† Treatise on Geography and Classification of Animals, Lardner's Cabinet Cyclopædia.

ing may be taken as examples of the shells of high latitudes; those marked * being found in the southern, as well as in the northern hemisphere:—

Buccinum.	Velutina.	*Crenella.
*Chrysodomus.	Lacuna.	*Yoldia.
*Trophon.	*Margarita.	*Astarte.
Admete.	——	Cyprina.
*Trichotropis.	*Rhynchonella.	Glycimeris.

The following have been thought peculiar to the warmer regions of the sea:

Nautilus.	Conus.	Columbella.	Perna.
Rostellaria.	Harpa.	Cypræa.	Vulsella.
Triton.	Oliva.	Nerita.	Tridacna.
Cancellaria.	Voluta.	Spondylus.	Crassatella.
Terebra.	Marginella.	Plicatula	Sanguinolaria.

But it must not be inferred that these genera were always characteristic of extreme climates. On the contrary, the whole of them have existed in the British seas at no very remote geological period. *Rhynchonella* and *Astarte* were formerly "tropical shells;" and since the period of the English chalk-formation there have been living *Nautili* in the North Sea, and Cones and Olives in the "London basin." It is not true that the same *species* have been at one time tropical, at another temperate, but the *genera* have in many instances enjoyed a much wider range than they exhibit now. Some of the "tropical" forms are more abundant and extend farther in the Southern hemisphere; several large Volutes range to the extremity of South America, and the largest of all inhabits New Zealand.

The tropical and sub-tropical provinces might be naturally grouped in three principal divisions, viz., the Atlantic, the Indo-Pacific, and the West-American,—divisions which are bounded by meridians of longitude, not by parallels of latitude. The Arctic province is comparatively small and exceptional; and the three most southern Faunas of America, Africa, and Australia differ extremely, but not on account of climate.

If only a small extent of sea-coast is examined, the character of its mollusca will be found to depend very much upon the nature of the shore, the tides, depth, and local circumstances, which will be referred to again in another page. But these peculiarities will disappear when the survey is extended to a region sufficiently large to include every ordinary variety of condition.

It has been stated that each Fauna consists of a number of peculiar species, properly, more than half; and of a smaller number which are common to some other provinces. By ascertaining the direction of the tides and currents, and the circumstances under which the species occur, it may be possible to determine to which province these more widely diffused mollusca originally belonged. And when species occur both recent and fossil it is easy to perceive the direction in which their migrations have taken place.

The Fauna of the Mediterranean has been critically examined by Prof. Forbes and M. Philippi, with this result,—that a large proportion of its population has migrated into it from the Atlantic, and a smaller number from the Red Sea, and that the supposed peculiar species are diminishing so rapidly with every new research in the Atlantic, that it can no longer rank as a province distinct from the Lusitanian.

When the Faunas of the other regions have been tested in the same manner, and disentangled, the result will probably be the establishment of a much greater number of provinces than we have ventured at present to indicate on the map.

It may be desirable to notice here the extraordinary range attributed to some of the marine species. These statements must be received with great hesitation; for when sufficiently investigated, it has usually proved that some of the localities were false, or that more than one species was included. The following are given by Dr. Krauss in his excellent monograph of the South African Mollusca:—

Ranella granifera: Red Sea, Natal, India, China, Philippines, New Zealand.

Triton olearius: Brazil, Mediterranean, Natal, Pacific.

Purpura lapillus: Greenland (Senegal, Cape).

Venus verrucosa: (W. Indies) Brit. Senegal, Canaries, Mediterranean, Red Sea, Cape (Australia).

Octopus vulgaris: Antilles, Brazil, Europe, Natal, Mauritius, India.

Argonauta argo: (Antilles), Medit. Red Sea, Cape.

Lucina divaricata is said to be "found on the shores of Europe, India, Africa, America, and Australia," (*Gray.*) In this case several species are confounded. The rock-boring *Saxicava* has been carried to all parts of the world *in ballast*, and it remains yet to be ascertained whether *the same species* occurs in a living state beyond the Arctic Seas and North Atlantic.

Lastly, the *money cowry* is always catalogued as a shell of the Mediterranean and Cape, although its home is in the Pacific, and it has no other origin in the Atlantic than the occasional wreck of one of the ships in which such vast quantities of the little shell are annually brought to this country to be exported again to Africa.

I. Arctic Province.

The North Polar Seas contain but one assemblage of *Mollusca*, whose Southern limit is formed by the Aleutian Islands in the Pacific, but in the North Atlantic is determined chiefly by the boundary of floating ice, descending as low as Newfoundland on the West, and thence rising rapidly to Iceland and the North Cape. A very complete general account of the Arctic Mollusca is given by Dr. Middendorff;* those of Greenland have been catalogued and

* Malaco-zoologia Rossica; Mem. del'Acad. Imp. des Sc. Petersb. T. 6, pt. 2, 1849.

described by Otho Fabricius and Möller;* and scattered notices occur in the Annals of Natural History,† and the Supplements to the Narratives of the Arctic Voyagers,—Phipps, Scoresby, Franklin, Back, Ross, Parry, and Richardson. The existence of the same marine animals in Behring's Sea and Baffin's Bay, was long since held to prove at least a former North-West passage; but the occurrence of recent sea shells in banks far inland, rendered it probable that even recent elevation of the land in Arctic America might have much reduced the passage. During the "Glacial period," this Arctic Sea, with the same fauna, extended over Britain; over Northern Europe, as far as the Alps and Carpathians; and over Siberia, and a considerable part of North America. The shells now living in the Arctic Seas, are found fossil in the deposits of "Northern Drift," over all these countries; and a few of the species yet linger within the bounds of the two next provinces, especially in tracts of unusual depth. The Arctic shells have mostly a thick greenish epidermis (p. 40.) they occur in very great abundance, and are remarkably subject to variation of form, a circumstance attributed by Professor E. Forbes to the influence of the mixture of fresh water produced by the melting of great bodies of snow and ice.

ARCTIC SHELL-FISH.

R. Russian Lapland. F. Finmark. I. Iceland. G. Greenland. D. Davis Straits (west coast). B. Behring's Straits. O. Ochotsk. * British species. ** Brit. fossils.

Octopus granulatus. G.
Cirroteuthis Müller. G.
Rossia palpebrosa. G. P. Regent Inlet.
Onychoteuthis Bergii. F. B.
„ Fabricii. G.
„ amœna. G.
*Ommastrephes todarus. F. Newf.

Limacina arctica G. O.
Spirialis stenogyra. F.
„ balea. G.
*Clio borealis N. Zemla. G.

---

*Nassa incrassata. F.
*Buccinum undatum, var. Kara. O.
„ hydrophanum. D. Prince Regent Inlet.
„ tenebrosum. R. G. B.
* „ Humphreysianum. R. G.
** „ cyaneum. F. D. G. Icy C. St. Lawrence.
„ glaciale. Kara. O. C.Parry. G. Spitzbergen.
Buccinum angulosum. N. Zemla, Icy C. Spitz.
„ tenue. N. Zemla. G.
„ Groenlandicum. D.
„ undulatum G.
„ scalariforme. G.
** „ ciliatum. G.
„ boreale (Leach). Baffin's B.
„ sericatum. D. P. Refuge.
„ Hollböllii (Mangelia, Mol.) G. F.
* „ Dalei. R. B.
*Fusus antiquus. N. Zemla. B.
** „ carinatus. G.
* „ contrarius. R. O.
„ deformis. R. Spitz.
** „ despectus. G. Spitz.
„ heros. C. Parry.
„ latericeus. G.
** „ Sabini. D. Mass.
„ pellucidus. D.
„ Kroyeri. G. Spitz.
„ decemcostatus. B. Newf.

* Index Molluscorum Grœnlandiæ. Hafn. 1842.

† Hancock, An. Nat. Hist. vol. 18, p. 323, pl. 5.

*Fusus Berniciensis. R. B.
„ Spitzbergensis. Spitz.
* „ Islandicus. F.
* „ gracilis. F. R. G. B.
*Trophon clathratus. R. G. B.
** „ scalariformis. Spitz. Newf. B.
** „ Gunneri. F. G.
** „ craticulatus. R. I. G.
* „ Barvicensis. F.
„ harpularius. F. U.S.
*Purpura lapillus. R. G. B.
Mangelia, 9 sp. G.
„ decussata. D.
*Bela turricula. F. G.
* „ rufa. F. G.
**Mitra Grœnlandica. G.
**Admete viridula. R. Spitz. G. B.
*Trichotropis borealis. F. G. B. P. Regent Inlet.
„ conica. G.
„ insignis. B.
„ bicarinata. B.
*Natica helicoides R. G. B.
** „ clausa, F. N. Zemla. G. Melville Id. P. Regent Inlet. B.
„ pallida. R. O.
„ flava. N. Zemla. B. Newf.
* „ pusilla (grœnlandica). G. Norway. Spitz.
„ nana. G.
*Velutina lævigata. R. B.
* „ flexilis. F.
„ zonata. R. G.
„ lanigera. G.
Lamellaria prodita. F.
„ Grœnlandica. G. B.
**Scalaria Grœnlandica. F. G. B.
„ borealis, (Eschrichti). G.
Amaura candida. G.
Chemnitzia albula. G.
Mesalia lactea. G.
Turritella polaris. G.
Aporrhais occidentalis. Labrador.
*Litorina obtusata. R.
* „ tenebrosa. N. Zemla. D.
„ Grœnlandica. G. F.
* „ palliata (arctica). G.
„ limata. F.
*Lacuna vincta. R. Newf. G.
„ labiosa. F. P. Refuge.
* „ crassior. R.
„ glacialis. G.
* „ pallidula. G.
* „ puteolus. F. Newf.
Lacuna frigida. F.
„ solidula. F.
Hydrobia castanea. R. G.
Rissoa scrobiculata. G.
„ globulus. G.
„ saxatilis. G.
*Skenea planorbis. G. F.
Margarita cinerea. F. U.S.
* „ undulata. R. G.
* „ alabastrum. F.
* „ helicina. G. White Sea. Spitz.
„ sordida. R. Spitz. G. B.
„ umbilicalis. D. B.
„ Harrisoni. D.
„ glauca. G.
„ Vahlii. G.
* „ costulata. G.
*Puncturella Noachina. F. G.
*Acmæa testudinalis. R. Iceland. G.
*Lepeta cæca. G. F. Spitz. C.Eden.
Pilidium rubellum. F. G. D.
*Chiton ruber. F. G. Spitz.
* „ albus. F. G.
Dentalium, entale. Spitz.

Bulla Reinhardi. G.
„ subangulata. G.
*Cylichna alba. G. F. Spitz.
„ turrita. G.
*Philine scabra. Norway. G.
„ punctata (Möll.) G.
Doris liturata. G
„ acutiuscula. G.
„ obvelata. G.
*Dendronotus arborescens. F. G.
Æolis bodocensis. G.
Tergipes rupium. G.
Euplocamus Holböllii. G.

---

*Terebratulina caput-serpentis. Spitz. F. Mass. Medit.
*Waldheimia cranium. F.
„ septigera. F.
Terebratella Spitzbergensis. Sp.
„ Labradorensis. Labr.
**Rhynchonella psittacea. R. Baffin's Bay, 76 deg. N. Melville, I. B.
*Crania anomala. Spitz.

---

*Anomia squamula. R.
* „ aculeata. R.

**Pecten Islandicus. F. N. Zemla. Spitz. G. B. St. Lawrence.
„ vitreus. F. Arctic America.
„ Grœnlandicus. R. Spitz. D.
Limatula sulcata. G. F.
*Mytilus edulis. R. G. B.
*Modiola modiolus. R. B.
*Crenella discors (lævigata). G. D. N. Zemla.
* „ decussata. R. G.
* „ nigra. N. Zemla. R. G. D.
„ faba. G.
„ vitrea G.
Arca glacialis. P. Regent Inlet.
Nucula corticata. G.
„ inflata. G. D.
Leda buccata. G.
„ macilenta. G.
** „ rostrata (pernula). F. Spitz. Arctic America.
** „ minuta (Fabr.) F Spitz. G. D.
„ lucida. F. (=navicularis? Spitz.)
* „ pygmæa. G. F Siberia.
**Yoldia arctica Gr. (myalis). G. U.S. Spitzbergen.
** „ lanceolata (arctica B. & S.) Icy Cape.
„ limatula. F. U S. Kamts.
„ hyperborea. Spitz.
** „ thraciæformis (angularis). G. Mass.
** „ truncata, Br. (Portlandica, Hit.) P. Refuge. Arctic America.
**Astarte borealis (arctica). F. Iceland. G.
** „ semisulcata (corrugata). Kara Sea. N. Zemla. Spitz, P. Regent Inlet. C. Parry. Icy Cape.
* „ elliptica. F. G. Spitz.
* „ sulcata. R. N. Zemla. O.
** „ crebricosta. F. Spitz. Newf.
„ crenata. P. Regent Inlet.
Astarte Warhami. Davis Str.
„ globosa. G.
* „ compressa. N. Zemla. G.
„ Banksii. Spitz. Baffin's B.
*Cardium edule var. rusticum. R.
„ Islandicum. N. Zemla. G.
** „ Grœnlandicum. Kara. Spitz. C. Parry. St. Lawrence.
„ elegantulum. G.
*Cryptodon flexuosus. G. F.
*Turtonia minuta. G. F.
*Cyprina Islandica. R. Labrador.
**Cardita borealis. Mass. O.
*Tellina calcaria. F. G. B.
** „ Grœnlandica. (=Balthica, L.) N. Zemla. Spitz. F. G. B.
** „ edentula. B.
*Mya truncata. R. Spitz. G. C. Parry. B
** „ Uddevallensis. St. Lawrence. D. P. Regent Inlet. Melville I.
* „ arenaria N. Zemla. G. O.
Saxicava rugosa (arctica). N. Zemla. Spitz. G. C. Parry. B.
* „ (Panopæa) Norvegica. White Sea. O.
Machæra costata. Labrador. O.
Glycimeris siliqua. C. Parry. Newf.
*Lyonsia Norvegica. F. O.
„ arenosa. G. D. P. Refug
Thracia myopsis. G.
Pandora glacialis. Spitz. Baff. (Leach.

Chelyosoma Macleayanum. G.
Cynthia glutinosa. G.
Ascidium, 9 sp. including:
* „ echinatum. G.
* „ conchilegum. G.
„ rusticum. G. Spitz.
Clavellina crystallina G.
Boltenia reniformis. G.
„ ciliata. G.
Syncœcium turgens. Spitz.
Cystingia Griffithi. Felix H.

II. Boreal Province.

The Boreal Province extends across the Atlantic from Nova Scotia and Massachusetts to Iceland, the Faeroe and Shetland Islands, and along the coast of Norway from North Cape to the Naze.

Of the 289 Scandinavian shells catalogued by Dr. Lovén,* 217, or 75 per

* Index Molluscorum Scandinaviæ; extracted from the "Ofversigt af K. Vet. Akad. Forh." 1846. The climate of Finmark is much less severe than Russian Lapland; Hammerfest has an open harbour all the year.

cent. are common to Britain, and 137 range as far as the North coast of Spain.

The boreal shells of America are described by Dr. Gould.* From these lists it appears that out of 140 sea-shells found on the coast of Massachusetts north of Cape Cod, more than half are common to Northern Europe.

Many of the species, it is believed, could only have extended their range so distantly, by means of continuous lines of connecting coast, now no longer in existence.†

Boreal Shells common to Europe and North America.

* British species.

*Teredo navalis.
*Pholas crispata.
*Solen ensis.
* (Panopæa) Norvegica.
*Mya arenaria.
* „ truncata.
*Thracia phaseolina (Conradi, Couth).
Mactra ponderosa (ovalis, G.)
? Montacuta bidentata.
*Turtonia minuta.
? Kellia rubra.
? Lepton nitidum (fabagella, Conr.?)
*Saxicava rugosa (arctica).
Tellina solidula, var. (fusca, Say).
* „ calcaria (sordida, Couth).
*Lucina borealis.
? „ divaricata.
*Cryptodon flexuosus.
*Astarte borealis.
* „ triangularis? (quadrans, G.)‖
*Cyprina Islandica.
?(Cardium Islandicum, U. S.—N. Zemla.)
Yoldia limatula.
„ arctica, Gr. (=myalis).
*Leda pygmæa.
* „ caudata.
? „ navicularis (lucida, Lovén?)
*Nucula tenuis.
*Mytilus edulis.
*Modiola modiolus.
*Crenella nigra.
* „ discors, L.
* „ decussata, (glandula, Tot.)
Pecten Islandicus.
? Ostrea edulis (borealis, Lam.?)
*Anomia ephippium.
* „ aculeata.
„ squamula?

*Terebratulina caput-serpentis.
*Rhynchonella psittacea.

*Dendronotus arborescens.
Polycera Lessonii?
? Amphisphyra hyalina (debilis?)
Cylichna alba (triticea, C.)
* „ obtusa (pertenuis).
*Philine quadrata (formosa, St.)

*Chiton cinereus.
* „ marmoreus.
* „ ruber.
* „ lævis.
* „ asellus.

* Report on the Invertebrata of Massachusetts. 1841.

† Forbes, Memoirs of the Geol. Survey, I. p. 379. Sir John Richardson, when speaking of the cod-tribe and turbot-tribe, says: "Most of the fish of this order feed on or near the bottom, and a very considerable number of the species are common to both sides of the Atlantic, particularly in the higher latitudes where they abound. It does not appear that their general diffusion ought to be attributed to migration from their native haunts, but rather that in this respect they are analogous to the owls, which, though mostly stationary birds, yet include a greater proportion of species common to the old and new worlds than even the most migratory families. Several of the *Scomberoideæ* (Mackerel-tribe) which feed on the surface, have been previously noted as traversing many degrees of longitude in the Atlantic: but the existence of the ground-feeding *Gadoideæ* in very distant localities must be attributed to a different cause, as it is not probable that any of them wander out of soundings or ever approach the mid-seas."—Report Zool. N. America, p. 218.

*Chiton albus.
*Dentalium (entale, L.?)
? Lepeta cæca (candida, C.)
*Acmæa testudinalis (amoena, S.)
*Puncturella Noachina.
*Adeorbis divisus (= Skenea serpuloides).
Margarita cinerea.
* „ costulata? (Skenea).
* „ helicina.
* „ undulata.
* „ alabastrum (= occidentalis?)
Litorina grœnlandica.
* „ tenebrosa (vestita).
„ palliata?
*Lacuna vincta (divaricata).
* „ puteolus (Montagui).
*Skenea planorbis.
*Velutina lævigata.
„ zonata.
*Lamellaria perspicua.
*Natica helicoides.
Natica clausa.
* „ pusilla.
*Scalaria grœnlandica.
(Ianthina communis).
Odostomia producta.
Cancellaria (admete) viridula.
*Trichotropis borealis.
*Fusus antiquus (tornatus).
* „ islandicus.
* „ propinquus.
„ ? rosaceus.
*Trophon muricatus.
* „ clathratus.
„ scalariformis.
„ harpularius.
*Purpura lapillus.
*Buccinum undatum.
* „ (Cominella) Dalei.
*Bela turricula.
* „ Trevelyana.
* „ rufa (Vahlii)?

**Ommastrephes sagittatus* and **Cynthia microcosmus* are also common to both sides of the North Atlantic. The genera,

Machæra,	*Glycimeris*,	*Cardita*, and
Solemya,	*Mesodesma* (*deauratum*).	*Crepidula*,

are peculiar to the American side of the Boreal Province.

Several other species now living on the coast of the U. States occur fossil in England: *e.g. Trophon cinereus*, Say., is believed to be the *Fusus Forbesi*, Strickland, of the Isle of Man; others are marked in the Arctic list.

III. Celtic Province.

The Celtic province, as described by Prof. E. Forbes, includes the British island coasts, Denmark, Southern Sweden, and the Baltic.* The fauna of this region (which includes the principal herring-fisheries) is essentially Atlantic; many of the species are of ancient origin, being known fossil in the Pliocene Tertiaries.

The British mollusca described by Forbes and Hanley amount to 682, viz.:—

14 Cephalopoda.	100 Pulmonifera.	175 Acephala.
220 Marine Univalves.	4 Pteropoda.	73 Tunicata.
91 Nudibranchiata.	5 Brachiopoda.	

Of this number two-thirds of the *Nudibranches*, 55 marine univalves, and

* The great work of Messrs. Forbes and Hanley contains all that is known respecting British *Testacea* up to the present time. The *Nudibranchiata* alone have been more fully described, in the publications of the Ray Society, by Messrs. Alder and Hancock. For the marine zoology of the coasts of Denmark the "Zoologia Danica" of O. F. Müller is still the most important work.

7 bivalve shell-fish, are, at present only known in British seas; but as most of these are minute or "critical" species it is considered they will yet be met with elsewhere.

A few of the species belong to the Lusitanian province, whose northern limits include the Channel Islands, and just impinge upon our coast.

Phasianella pullus.	Murex corallinus.	Cytherea chione.
Haliotis tuberculata.	Avicula Tarentina.	Petricola lithophaga.
Truncatella Montagui.	Galeomma Turtoni.	Venerupis irus.
Oncidium celticum.	Pandora rostrata.	Cardium rusticum, L. (tu-
Bulla hydatis	Ervilia castanea.	berculatum).
Volva patula.	Mactra helvacea.	

Of the *Gasteropoda* 54 are common to the seas both north and south of Britain; 52 range further south, but are not found northward of these islands; and 34 which find here their southern limit occur not only in Northern Europe, but most of them in Boreal America. Nearly half of the bivalves range both north and south of Britain; 40 extend southward only, and about as many more are found in Scandinavia, 27 of them being common to N. America. (*Forbes.*)

In the lists of Arctic and Boreal shells the British species are distinguished by an asterisk.

According to Mr. M'Andrew's estimate there are 406 British shell-bearing mollusca, of which

217	or 53 per cent.	are common to	Scandinavia.
246	or 61	„	„ North of Spain.
227	or 56	„	„ S. Spain and Medit.
97	or 24	„	„ Canary Islands.

The following are at present peculiar to Britain:—

Assiminea, sp.	Odostomia, 19 sp.?	Montacuta ferruginosa.
Jeffreysia, sp.	Buccinum fusiforme.	Argiope cistellula.
Otina otis.	Fusus Berniciensis.	Pecten niveus.
Rissoa, sp.	„ Turtoni.	Syndosmya tenuis.
Stylifer turtoni.	Natica Kingii.	Thracia villosiuscula.

The most common edible species are:—

Ostrea edulis.	Mytilus edulis.	Fusus antiquus.
Pecten maximus.	Cardium edule.	Litorina litorea.
„ opercularis.	Buccinum undatum.	

Amongst the species characteristic of the Celtic province—or most abundant in it—are the following:—

Trophon muricatus.	Litorina litoralis.	Venus striatula.
Nassa reticulata.	Trochus Montagui.	„ casina.
Natica Montagui.	„ millegranus.	Donax anatinus.
„ monilifera.	„ tumidus.	Solen ensis.
„ nitida.	Patella vulgata.	Pholas candida.
Velutina lævigata.	„ pellucida.	Mactra elliptica.
Turritella communis.	Acmæa virginea.	„ solida.
Aporrhais pes-pelecani.	Chiton cinereus.	Periploma prætenuis.
Rissoa cingillus.	Scaphander lignarius.	Thracia distorta.
Scalaria Trevelyana.	Tellina crassa.	Syndosmya prismatica.

The wide expanse of the Baltic affords no shell-fish unknown to the coasts of Britain and Sweden. The water is brackish, becoming less salt northward, till only estuary shells are met with, and the Litorinæ and Limnæans are found living together, as in many of our own marshes. This scanty list is taken from the Memoirs of Dr. Middendorff and M. Boll.

Buccinum undatum.
Purpura lapillus.
Nassa reticulata.
Litorina litorea.
Patella (tarentina).
Hydrobia muriatica.
Neritina fluviatilis.
Limnæa auricularia.
„ ovata.
Mytilus edulis.
Donax (trunculus).
Cardium edule var.
Tellina Balthica.
„ tenuis.
Scrobicularia piperata.
Mya arenaria.
„ truncata.

IV. Lusitanian Province.

The shores of the Bay of Biscay, Portugal, the Mediterranean, and N. W. Africa, as far as Cape Juby, form one important province, extending westward in the Atlantic as far as the Gulf weed bank, so as to include Madeira, the Azores, and Canary Islands.*

In the Atlantic portion of the province occur the following genera, not met with in the Celtic and Boreal seas, although two of them, *Mitra* and *Mesalia*, occur on the coast of Greenland.

Argonauta.
Philonexis.
Chiroteuthis.
——
Conus.
Pleurotoma.
Marginella.
Cymba.
Mitra.
Terebra.
Columbella.
Pisania.
Dolium.
Cassis.
Triton.
Ranella.
Cancellaria.
Sigaretus.
Crepidula.
Mesalia.
Vermetus.
Fossarus.
Planaxis.
Litiopa.
Truncatella.
Solarium.
Bifrontia.
Turbo.
Monodonta.
Haliotis.
Gadinia.
Siphonaria.
Auricula.
Pedipes
Ringicula
Umbrella.
Glaucus.
——
Carinaria.
Firola.
Atlanta.
Oxygyrus.
——
Cleodora.
Cuvieria.
Creseis.
——

* In the northern part of the Lusitanian province are the Pilchard fisheries; in the Mediterranean, the Tunny, Coral, and Sponge fisheries.

The Gulf-weed banks (represented in the map) extend from 19° to 47° in the middle of the North Atlantic, covering a space almost seven times greater than the area of France. Columbus, who first met with the *sargasso* about one hundred miles west of the Azores, was apprehensive that his ships would run upon a shoal. (*Humboldt.*) The banks are supposed by Prof. E. Forbes to indicate an ancient coast-line of the Lusitanian land-province, on which the weed originated. Dr. Harvey states that species of *Sargassum* abound along the shores of tropical countries, but none exactly correspond with the Gulf-weed (*S. bacciferum*). It never produces fructification—the "berries" being air-vesicles, not fruit—but yet continues to grow and flourish in its present situation, being propagated by breakage. It may be an abnormal condition of *S. vulgare*, similar to the varieties of *Fucus nodosus* (Mackayi) and *F. vesiculosus* which often occur in immense strata; the one on muddy sea-shores, the other in salt marshes, in which situations they have never been found in fructification. (*Manual of British Algæ, Intr.* 16, 17.)

Megerlia.	Chama.	Cardita.	Ervilia.
——	Crassatella.	Cytherea.	Panopæa.
Spondylus.	Lithodomus.	Petricola.	
Avicula.	Ungulina.	Venerupis.	
Solemya.	Galeomma.	Mesodesma.	

Spain and Portugal.

The coast of Spain and Portugal is less known than any other part of the province, but the facilities for exploration are in some respects greater than in the Mediterranean, on account of the tides. Shell-fish are more in demand as an article of food here than with us, and the Lisbon market afforded to Mr. M'Andrew the first indication that the genus *Cymba* ranged so far north.

On the coasts of the Asturias and Gallicia, especially in Vigo Bay, Mr. M'Andrew obtained, by dredging, 212 species, of a somewhat northern character, 50 per cent. of them being common to Norway, and 86 per cent. common to the south of Spain.

On the southern coast of the Peninsula 353 species were obtained, of which only 28 per cent. are common to Norway and 51 per cent. to Britain.

The identical species are chiefly amongst the shells dredged from a considerable depth (35—50 fathoms); the litoral species have a much more distinct aspect.

The shells of the coast of Mogador are generally identical with those of the Mediterranean and Southern Peninsula.

Canary Islands. The shells of the Canaries collected by MM. Webb and Berthelot,* and described by M. D'Orbigny, amount to 124, to which Mr. M'Andrew has added above 170. Of the 300 species 17 per cent. are common to Norway, 32 per cent. to Britain, and 63 per cent. to the coasts of Spain and the Mediterranean. Two only are W. Indian shells, *Neritina viridis* and *Columbella cribaria*. Of the African shells found here, and not met with in more northern localities, the most remarkable are:—

Crassatella divaricata.	Ranella lævigata.	Cymba proboscidalis.
Cardium costatum.	Cassis flammea.	Conus betulinus.
Lucina Adansoni.	,, testiculus.	,, Prometheus.
Cerithium nodulosum.	Cymba Neptuni.	,, Guinaicus.
Murex saxatilis.	,, porcina.	,, papilionaceus.

Madeira. Mr. M'Andrew obtained 156 species at Madeira, of which 44 per cent. are British, 70 per cent. common to the Mediterranean, and 83 to the Canaries. Amongst the latter are the two W. Indian shells before mentioned, and the following African shells:—

Pedipes.	Mitra fusca.	Patella crenata.
Litorina striata.	,, zebrina.	,, guttata.
Solarium.	Marginella guancha.	,, Lowei.
Scalaria cochlea.	Cancellaria.	,, Candei.
Natica porcellana.	Monodonta Bertheloti.	Pecten corallinoides.

* Hist. Naturelle des Iles Canaries; the list of shells is reprinted with the additions made by Mr. M'Andrew, as one of the Catalogues of the British Museum.

Azores. Amongst the litoral shells which range to the Azores, are Pedipes, Litorina striata, Mitra fusca, and Ervilia castanea; the other species obtained there are Lusitanian. (*M'Andrew.*)

The Mediterranean fauna is known by the researches of Poli, Delle Chiaje, Philippi, Verany, Milne-Edwards, Prof. E. Forbes, and Deshayes. In its western part it is identical with that of the adjacent Atlantic coasts; the number of species diminishes eastward, although reinforced by a considerable number of new forms as yet only known in the Mediterranean; and a few accessions (about 30) of a different character from the Red Sea. The total number of shell-bearing species is estimated at 600, viz.:—

Cephalopoda 1	Nucleobranchiata .. 6	Lamellibranchiata ...200
Pteropoda..... 13	Gasteropoda 370	Brachiopoda 10

On the coast of Sicily, M. Philippi has found altogether 619 marine mollusca, viz.:—

Bivalves 188	Pteropoda..... 13	Gasteropoda 319
Brachiopoda 10	Nudibranches..... 54	Cephalopoda 15

Of the 522 which are provided with shells, 162 have not been found fossil, and are presumed to be of post-tertiary origin, so far as concerns their presence in the Medit. The remaining 360 occur fossil in the newer tertiary strata, along with nearly 200 others which are either extinct or not known living on those coasts; a few of them are living in the warmer regions of Senegal, the Red Sea, and the West Indies:—

Senegal.	*Antilles.*	*Red Sea.*
Lucina columbella.	Lucina pennsylvanica.	Argonauta hians.
Cardium hians.	Vermetus intortus.	Dentalium elephantinum.
Terebra fusca.		Terebra duplicata.
	Morocco.	Phorus agglutinans.
	Trochus strigosus.	Niso terebellum.
		Pecten medius.
		Diplodonta apicalis.

Most of them, however, are of northern origin, such as:—

Saxicava rugosa.	Tellina crassa.	Rhynchonella psittacea.
(Panopæa) Norvegica.	Cyprina Islandica.	Patella vulgata.
Mya truncata.	Leda pygmæa.	Eulimella Scillæ.
Periploma prætenuis.	Limopsis pygmæa.	Buccinum undatum
Lutraria solenoides.	Ostrea edulis.	Fusus contrarius.

Of the 522 Sicilian testacea about 35 (including 10 oceanic species) are common to the West Indies—if the species have been correctly determined; 28 are stated, with more probability, to be common to West Africa, including *Murex Brandaris* and other common species; 74, including *Murex trunculus*, are common to the Red Sea; *Crania ringens* cannot be distinguished from the species found in New South Wales (*Davidson*); and *Columbella corniculum* ranges from the north coast of Spain to Australia, the specimens from these distant localities being only distinguishable as geographical

varieties. (*Gaskoin.*) Six other species are included in Menke's Australian Catalogue, but require verification.

The following genera, nine of which are naked molluscs, are supposed to be now peculiar to the Mediterranean; the small number of species show they are aberrant or expiring forms. *Cassidaria*, *Terebratula*, and *Thecidium* are ancient, widely-distributed genera, and the Mediterranean *Thecidium* occurs fossil in Brittany and the Canaries.

Histioteuthis, 2 sp.	Lobiger, 1.	Pedicularia, 1.
Verania, 1.	Pleurobranchæa, 1.	Terebratula, 1.
Gastropteron, 1.	Tethys, 1.	Morrisia, 2.
Doridium, 1.	Tiedemannia, 1.	Thecidium, 1.
Icarus, 1.	Cassidaria, 4?	Scacchia, 2.

The genera *Fasciolaria*, *Siliquaria*, *Tylodina*, *Notarchus*, *Verticordia?* *Clavagella*, and *Crania*, occur only in this portion of the Lusitanian province.

Amongst the peculiar species are:—

Nassa semistriata.	Argiope cuneata.	Artemis lupinus.
Fusus crispus.	Clavigella angulata.	Trigona nitidula.
Tylodina Rafinesquii	Spondylus Gussonii.	Lucinopsis decussata.
Crania rostrata.	Astarte bipartita.	

Ægean Sea. Prof. E. Forbes obtained 450 species of mollusca in the Ægean, belonging to the following orders:—

Cephalopoda..... 4	Nudibranches..... 15	Brachiopoda 8
Pteropoda 8	Opisthobranches .. 28	Lamellibranches 143
Nucleobranches..... 7	Prosobranches 217	Tunicata 22

Of these 71 were new species, but several have since been found in the Atlantic, and even in Scotland.* The only marine air-breather met with was *Auricula myosotis.*

Black Sea. In the northern part a few Aralo-Caspian shells are found, otherwise the Black Sea only differs from the Mediterranean in the paucity of its species; Dr. Middendorff enumerates 68 only. The water is less salt, and there is no tide, but a current flows constantly through the Dardanelles to the Mediterranean.†

V. Aralo-Caspian Province.

The only inland salt-seas that contain peculiar shell-fish are the Aral and Caspian. The shells chiefly consist of a remarkable group of Cockles which burrow in the mud (see fig. 213, p. 291). No explorations have been made with the dredge, but other species, probably still existing in these seas, have been found in the beds of horizontal limestone which form their banks and extend in all directions far over the *steppes*. This limestone is of brackish-

* Trans. Brit. Assoc. (for 1843) 1844, p, 130.

† A current from the Atlantic sets in perpetually through the Straits of Gibraltar, and there is scarcely any tide; it only amounts to 1 foot at Naples and the Euripus, 2 feet at Messina, and 5 at Venice and the Bay of Tunis.

water origin, being sometimes composed of myriads of *Cyclades*, or the shells of *Dreissena* and *Cardium*, as in the islets near Astrakhan. It is believed to indicate the former existence of a great inland sea, of which the Aral and Caspian are remnants, but which was larger than the present Mediterranean at an age previous to that of the Mammoth and Siberian Rhinoceros. The present level of the Caspian is 83 feet below that of the Black Sea; that of the Aral has been stated to be 117 feet higher than the Caspian, but is probably not very different; their waters are only brackish, and in some parts drinkable. The steppe limestone rises to a level of 200—300 feet above the Caspian; it spreads eastward to the mountains of the Hindoo Kush and Chinese Tartary, southward over Daghestan and the low region E. of Tiflis, and westward to the northern shores of the Black Sea. The extent to which it has been traced is represented by oblique lines on the map.* Some of the Caspian shells still exist in the Sea of Azof and the estuaries of the Dnieper and Dniester. Our information upon this seldom-visited region is derived from the works of Pallas, Eichwald,† Krynicki,‡ Middendorff, and Sir Roderick Murchison.

Aralo-Caspian Shells.

A, Aral; C, Caspian; B, Black Sea.

The Species marked * are found also in the steppe limestone.

*Cardium edule, L. C. (very small) B. Baltic.
„ edule, var. (rusticum, Chemn.) A. C. B. Icy Sea.
*Didacna trigonoides, Pal. C (Azof. M. Hommaire).
„ Eichwaldi, Kryn. (crassa, Eich.) C. B. (Nikolaieff).
Monodacna Caspia, Eich. C.
„ pseudo-cardium, Desh. (pontica, Eich.) B.
Adacna læviuscula, Eich. C.
„ vitrea, Eich. C. A.
* „ edentula, Pallas. C.
„ plicata, Eich. C. B. (Dniester, Akerman, Odessa).
„ colorata, Eich. C. B. (Azof, Dnieper).
*Mytilus edulis, L. C. B. (not in Middendorff's list.)
„ latus, Chemn. B.
*Dreissena polymorpha, Pal. C. B.

Paludinella stagnalis, L. (pusilla Eich.) C. B. (Odessa). Ochotsk.
* „ variabilis, Eich. C.
*Neritina liturata, Eich. C. on sea weed.
*Rissoa Caspia, Eich. C.
„ oblonga, Desm. B.
„ cylindracea, Kryn. B.‖

* From a sketch kindly prepared by Professor Ramsay.

† Geogr. des Kaspischen Meeres, des Kaukasus und des Südlichen Russlands, Berlin, 1838. Fauna Caspio-Caucasica, 1841.

‡ Bull. des Nat. Moscow, 1837.

‖ The *Velutina (Limneria) Caspiensis*, A. Ad. was founded on a specimen of *Limnæa Gebleri, Midd.* (1851) from Bernaoul, Siberia.

The following species are described by Eichwald, from the steppe limestone. (Murchison, Russia, p. 297.)

"Paludina" Triton.
„ exigua.
Rissoa conus.
„ dimidiatus.
Bullina Ustuertensis.
Mactra Caspia.
„ Karagana.
Cyclas Ustuertensis.
Mytilus rostriformis.
Donax priscus.
Monodacna propinqua.
„ intermedia.
„ Catillus.
Adacna prostrata.

No other inland bodies of salt water are known to have peculiar marine shells; those of the modern deposits, in Mesopotamia (at Sinkra and Warka), collected by Mr. W. K. Loftus, are species still abounding in the Persian Gulf. *

VI. West African Province.

The tropical coast of Western Africa is rich in conchological treasures, and far from being wholly explored. The researches of Adanson,† Cranch (the naturalist to the Congo expedition‡), and the officers of the Niger expedition, have left much to be done. Dr. Dunker has described 149 species in his *Index Moll. Guineæ, coll. Tams.* Cassel, 1853.

At *St. Helena*, Mr. Cuming collected 16 species of sea-shells, 7 of them new. *Litorina Helenæ* is found on the shore of St. Helena, and *L. miliaris* and *Nerita Ascensionis*, at Ascension.

West African Shells.

Onychoteuthis, 3 sp.
Cranchia, 2 sp.
Strombus rosaceus.
Triton ficoides.
Ranella quercina.
Dolium tessellatum.
Harpa rosea.
Oliva hiatula.
Pusionella.
Nassa Pfeifferi.
Desmoulinsia.
Purpura nodosa.
Rapana bezoar.
Murex vitulinus.
„ angularis.
„ megaceros.
„ rosarius.
„ duplex.
„ cornutus.
Clavella? filosa.
„ afra.
Lagena nassa.
Terebra striatula.
„ ferruginea.
? Halia priamus.
Mitra nigra.
Cymba.
Marginella.
Persicula.
Pleurotoma mitriformis.
Tomella lineata.
Clavatula mitra.
„ coronata.
„ bimarginata.
„ virginea.
Conus papilionaceus.
„ genuinus.
„ testudinarius.
„ achatinus.
„ monachus.
Natica fulminea.
Cypræa stercoraria.
Cypræa picta.
Vermetus lumbricalis.
Cerithium Adansonii.
Turritella torulosa.
Mesalia.
Litorina punctata.
Collonia.
Clanculus villanus.
Haliotis virginea.
„ coccinea.
Nerita Senegalensis.
„ Ascensionis.
Pecten gibbus.
Arca ventricosa.
„ senilis.
Cardium ringens.
„ costatum.
Lucina columbella.
Ungulina rubra.
Diplodonta rosea.
Cardita ajar.

* A species of coral (*Porites elongata*, Lam.) now living at the Seychelles has been said to be found in the Dead Sea. (v. Humboldt's Views of Nature, Bohn, ed. p. 260.)

† Hist. Nat. de Senegal, 4to. Paris, 1757. This able but eccentric naturalist destroyed the utility of his own writings by refusing to adopt the bi-nomial nomenclature of Linnæus, and employing instead the most barbarous chance-combinations of letters he could invent.

‡ Appendix to Capt. Tuckey's Narrative (1818), by Dr. Leach.

Artemis africana.
,, torrida.
Cyclina Adansonii.
Trigona bicolor.
,, tripla.
Cytherea tumens.
Cytherea africana.
Venus plicata.
Tellina.
Strigilla Senegalensis.
Gastrana polygona.
Mactra depressa.
Mactra rugosa.
,, nitida.
Pholas clausa.
Tugonia anatina.
Discina radiosa.

VII. South African Province.

The fauna of South Africa, beyond the tropic, possesses few characters in common with that of the western coast, and is more like the Indian Ocean fauna, as might be expected from the direction of the currents. But, together with these it has a large assemblage of marine animals found nowhere else, and the "Cape of Storms" forms a barrier between the populations of the two great oceans, scarcely less complete than the far-projecting promontory of South America. The coast is generally rocky, and there are no coral-reefs; accumulations of sand are frequent, and sometimes very extensive, like the Agulhas Bank. The few deep sea-shells which have been obtained off these banks possess considerable interest, but explorations in boats are said to be difficult, and often impossible on account of the surf. Shells from the Cape are too frequently dead and water-worn specimens picked up on the beach. The shell-fish of South Africa have been collected and described by Owen Stanley, Hinds, A. Adams, and, especially, by Dr Krauss, who has published a very complete monograph.* Of 400 sea-shells recorded in this work, above 200 are peculiar, and most of these belong to a few litoral genera. Only 11 species are common to the coast of Senegal, whilst 18 are found in the Red Sea.

South African Shells.

Panopæa natalensis.
Solen marginatus.
Mactra spengleri.
Gastrana ventricosa.
Nucula pulchra, Hinds.
(L'Agulhas bank, 70 fm.)
Pectunculus Belcheri, 120 fm.
Modiola Capensis.
,, pelagica, Forbes.
Septifer Kraussi.

Terebratulina abyssicola, 132 fm.
Terebratella (Kraussia),
,, rubra.
,, cognata.
,, pisum.
,, Deshayesii, 120 fm.

Chiton, 16 sp.
Patella, 20 sp.
,, cochlea.
,, compressa.
,, apicina.
,, longicosta, &c.
Helcion pectinata.
Siphonaria, 5 sp.
Pupillia (aperta).
Fissurella, 10 sp.
Crepidula, 4 sp.
Haliotis sanguinea.
Delphinula granulosa.
,, cancellata.
Trochus, 22 sp.
Turbo sarmaticus.
Litorina Africana (7 sp.)
Phasianella, 6 sp.
Bankivia varians.
Turritella, 4 sp.

Pleurotoma, 6 sp.
Clionella (sinuata).
Typhis arcuatus.
Triton dolarius
,, fictilis, 50-60 fm.
Harpa crassa.
Cominella ligata.
,, lagenaria.
,, limbosa.
,, tigrina.
Bullia lævissima.
,, achatina.
,, natalensis.
Nassa plicosa.
,, capensis.
Cyclonassa Kraussi.
Eburna papillaris.
Columbella, 5 sp
Ancillaria obtusa.
Mitra, 5 sp.

* Die Südafrikanischen Mollusken, 4to. Stutt. 1848.

Imbricaria carbonacea.
Voluta armata.
„ scapha.
„ abyssicola, 132 fm.
Marginella rosea.
Trivia ovulata.
Cypræa, 22 sp.
Luponia algoënsis.
Cyprovulum (capense).
Conus, 8 sp.
Octopus argus.
Sepia, 4 sp.

The following are stated to be common to the Cape and European seas.*

Saxicava (arctica?) Greenland, Medit.
Tellina fabula, Brit. Medit.
Lucina lactea, Medit. Red Sea.
„ fragilis, Medit.
Venus verrucosa, W. Indies? Brit. Senegal, Canaries, Red Sea, Australia?
Tapes pullastra, North Sea.
„ geographica, Medit.
Arca lactea, Medit.
Chama gryphoides, Medit. Red Sea.
Pecten pusio, Brit.
Diphyllidia (lineata?) N. Brit. Medit.
Eulima nitida, Medit.
Purpura lapillus ?? (not in Medit.).
Nassa marginulata.
Octopus vulgaris? Brit.
Argonauta argo, Medit.

VIII. Indo-Pacific Province.

This is by far the most extensive area over which similar shell-fish and other marine animals are distributed. It extends from Australia to Japan, and from the Red Sea and east coast of Africa to Easter Island in the Pacific, embracing three-fifths of the circumference of the globe and 45° of latitude. This great region might indeed be subdivided into a number of smaller provinces, each having a particular association of species, and some peculiar shells; such as the Red Sea, the Persian Gulf, Madagascar, &c.; but a considerable number of species are found throughout the province, and their general character is the same.† Mr. Cuming obtained more than 100 species of shells from the eastern coast of Africa, identical with those collected by himself at the Philippines, and in the eastern coral islands of the Pacific.‡ This is pre-eminently the region of coral reefs, and of such shell-fish as affect their shelter. The number of species inhabiting it must amount to several thousands. The Philippine Islands have afforded the greatest variety, but their apparent superiority is due, in a measure, to the researches of Mr. Cuming; no other portion of the province has been so thoroughly explored.§

Amongst the genera most characteristic of the Indo-Pacific, those marked (*) are wholly wanting on the coasts of the Atlantic, but half of them occur fossil in the older tertiaries of Europe. Those *in italics* are also found on the west coast of America.

* Marks of doubt are added to some of the species, and other are quite omitted.

† See Mrs. Somerville's Physical Geography, II. p. 233.

‡ Journal Geol. Soc. 1846, vol. II. p. 268.

§ Mr. Cuming collected 2500 species of sea-shells at the Philippines, and estimates the total number at a thousand more. The genera most developed are *Conus* 120 sp., *Pleurotoma* 100, *Mitra* 250, *Columbella* 40, *Cypræa* 50, *Natica* 50, *Chiton* 30, *Tellina* 50.

*Nautilus.	*Magilus.	Stomatella.	Hemicardium.
*Pterocera	*Melo.	Gena.	*Cypricardia.
*Rimella	*Mitra.*	*Broderipia.	*Cardilia.
*Rostellaria.	*Cylindra.	*Rimula.	*Verticordia.
*Seraphs.	*Imbricaria.	*Neritopsis.	*Pythina.
Conus.	Ovulum.	*Scutellina.	Circe.
Pleurotoma.	*Pyrula* (type).	*Linteria.	*Clementia.
*Cithara.	*Monoptygma.	*Dolabella.	*Glaucomya.
**Clavella.*	Phorus,	*Hemipecten.	*Meröe.
*Turbinella (typ.)	Siliquaria.	*Placuna.	Anatinella.
Cyllene.	*Quoyia.	*Malleus.	Cultellus.
Eburna.	*Tectaria.	*Vulsella.	*Anatina.
Phos.	*Imperator.*	*Pedum.	*Chæna.
Dolium.	Monodonta.	*Septifer.	*Aspergillum.
Harpa.	Delphinula.	*Cucullæa,	*Jouannetia.
*Ancillaria.	Liotia.	*Hippopus.	**Lingula.*
*Ricinula.	*Stomatia.	*Tridacna.	*Discina.*

The strictly litoral species vary on each great line of coast: for example, *Litorina intermedia* and *Tectaria pagodus* occur on the east coast of Africa; *Litorina conica* and *melanostoma*, in the Bay of Bengal; *Litorina sinensis* and *castanea*, and *Haliotis venusta*, on the coast of China; *Litorina scabra* and *H. squamata*, in N. Australia; *H. asinina*, New Guinea; and *L. picta*. at the Sandwich Islands.

Red Sea (Erythræan).

Of the 408 mollusca of the Red Sea, collected by Ehrenberg and Hemprich, 74 are common to the Medit. from which it would seem that these seas have communicated since the first appearance of some existing shells. Of the species common to the two seas 40 are Atlantic shells which have migrated into the Red Sea by way of the Medit. probably during the newer pliocene period; the others are Indo-Pacific shells which extended their range to the Mediterranean at an earlier age.

The genera wanting in the Medit. but existing in the Red Sea, show most strikingly their diversity of character, and the affinity of the latter to the Indian fauna.

Pterocera.	Ancillaria.	Siphonaria.	Limopsis.
Strombus, 8 sp.	Harpa.	Placuna.	Tridacna
Rostellaria.	Ricinula.	Plicatula.	Crassatella.
Turbinella.	Magilus.	Pedum.	Trigona.
Terebra.	Pyramidella.	Malleus.	Sanguinolaria.
Eburna.	Parmophorus.	Vulsella.	Anatina.
Oliva.	Nerita.	Perna.	Aspergillum.

Other genera become abundant, such as *Conus*, of which there are 19 species in the Red Sea, *Cypræa* 16, *Mitra* 10, *Cerithium* 17, *Pinna* 10, *Chama* 5, *Circe* 10.

Persian Gulf.

The marine zoology of the Persian Gulf and adjoining coast has not been yet explored, although the E. India Company maintains a squadron of five or six ships constantly cruising in the Gulf.* The following shells were picked up on the beach at Kurachee by Major Baker, with many others evidently new, but not in a satisfactory state for description. (1850.)

Rostellaria curta.
Murex tenuispina var.
Pisania spiralis.
Ranella tuberculata.
„ spinosa.
„ crumena.
Triton lampas.
Bullia, n. sp.
Eburna spirata.
Purpura persica.
„ carinifera.
Columbella blanda.
Oliva subulata.
„ Indusica.
„ ancillaroides.
Cypræa Lamarckii.
„ ocellata.
Natica pellis-tigrina.
Sigaretus sp.
Odostomia sp.
Phorus corrugatus.
Planaxis sulcata.
Imperator Sauliæ.
Monodonta sp,
Haliotis sp.
Stomatella imbricata.
„ sulcifera.
Fissurella Ruppellii.
„ Indusica.
„ salebrosa.
„ dactylosa.
Fissurella funiculata.
Pileopsis tricarinatus.
Nerita ustulata.
Dentalium octangulatum.
Ringicula sp.
Bulla ampulla.
Anomia achæus.
„ enigmatica.
Pecten sp.
Spondylus sp.
Plicatula depressa.
Mytilus canaliculatus.
Arca obliquata.
„ sculptilis, &c.
Chama sp.
Lucina sp.
Cardium fimbriatum.
„ latum.
„ impolitum.
„ pallidum.
„ assimile.
Venus pinguis.
„ cor.
„ purpurata.
Meroë Solandri.
„ effossa.
Trigona trigonella?
Artemis angulosa.
„ exasperata.
„ subrosea?
Venerupis sp.
Petricola sp.
Tapes sulcosa.
„ Malabarica.
Cypricardia vellicata.
Cardita crassicostata?
„ calyculata.
„ Tankervillii.
Mactra Ægyptica, &c.
Tellina angulata.
„ capsoides.
Mesodesma Horsfieldii.
Psammobia sp.
Syndosmya sp.
Semele sp.
Solen sp.
Solecurtus politus.
Donax scortum.
„ scalpellum.
Sanguinolaria diphos.
„ violacea.
„ sinuata.
Corbula sp.
Diplodonta sp.
Anatina rostrata.
Pandora sp.
Martesia sp.
Pholas australis.
„ Bakeri, Desh.
„ orientalis.
(Meleagrina v. p. 261.)

At the *Cargados* or St. Brandon shoals, north of Mauritius, *Voluta costata*, *Conus verrucosus*, *Pleurotoma virgo*, and *Turbinella Belcheri* have been obtained by dredging.

IX. Australo-Zelandic Province.

Most remote from the Celtic seas, this province is also most unlike them in its fauna, containing many genera wholly unknown in Europe, either living or fossil, and some which occur fossil in rocks of a remote period. The province includes New Zealand, Tasmania, and extra-tropical Australia, from

* The "Brindled Cowry," (*Cypræa princeps*) from the Persian Gulf, was valued at £50; the only known specimen is in the British Museum.

Sandy Cape on the east, to the Swan River. The shells, which are nearly all peculiar, have been catalogued by Gray,* Menke,† and Forbes.‡ Of the following genera some are peculiar (*), others attain here their greatest development:—

*Pinnoctopus.	*Macgillivraia.	Cypricardia.	Imperator.
*Struthiolaria.	*Amphibola.	Mesodesma.	Monoptygma.
Phasianella	*Trigonia.	Terebratella.	Siphonaria.
Elenchus.	*Chamostrea.	Spirula.	Pandora.
Bankivia.	*Myadora.	Oliva.	Anatinella.
Rotella.	*Myochama.	Conus.	Clavagella.
*Macroschisma.	Crassatella.	Voluta.	Placunomia.
Parmophorus.	Cardita.	Terebra.	Waldheimia.
Risella.	Circe.	Fasciolaria.	Crania.

Some of the genera of this province are only met with elsewhere at a considerable distance:—

Solenella—Chile.	Bankivia—Cape.	Rhynchonella—Arctic seas.
Panopæa—Japan.	Kraussia—Cape.	Trophon—Fuegia; ,,
Monoceros—Patagonia.	Solemya—Medit.	Assiminea—India; Brit.

Amongst the litoral shells of South Australia are *Haliotis elegans, H. rubicunda*, and *Litorina rugosa. Haliotis iris* and *Litorina squalida* are found on the shores of N. Zealand; and *Cyprovula umbilicata* in Tasmania.

Mr. Gray's New Zealand list amounts to 104 marine species, among which are three volutes, including *V. magnifica*, the largest of its genus; *Strombus troglodytes, Ranella argus*, the great *Triton variegatus;* 6 Cones, (all doubtful), *Oliva erythrostoma, Cypræa caput-serpentis, Ancillaria australis, Imperator heliotropium, Chiton monticularis*, &c.

Venus Stutchburyi and *Modiolarca trapezina* have been found at Kerguelen's Id. and *Patella illuminata* at the Auckland Ids.

X. Japonic Province.

The Japanese Islands and Corea represent the Lusitanian province. A few shells were collected here by Mr. A. Adams, but they are chiefly known through the Dutch dealers.§ *The Astarte Japonica* of the Catalogues is nothing more than *A. borealis*, and is stated to have come from Lapland by Jay and Cuming. *Panopæa Japonica* belongs to the same type with *P. intermedia* of the London Clay.

* Travels in New Zealand, by Dr. E. Dieffenbach. 8vo, London, 1843.

† Moll. Nov. Hollandiæ, 1843.

‡ Narrative of the Voyage of H.M.S. Rattlesnake, 1846-50, by J. Macgillivray. Supplement by Prof. E. Forbes.

§ For many years the Dutch have been allowed to send one ship annually to Japan for trade, whilst all other nations have been excluded; a state of things which the Americans will perhaps alter. The work of Siebold, on the Natural History of Japan, does not contain any account of the shells.

Octopus areolatus.
Sepia chrysopthalma.
Sepiola Japonica.

Conus Sieboldi.
Pleurotoma Coreanica.
Terebra serotina.
„ stylata.
Eburna Japonica.
Cassis Japonica.
Murex eurypterus.
„ rorifluus.
„ plorator.
„ Burneti.
Cancellaria nodulifera.
Mitra.
Strombus corrugatus.
Cypræa fimbriata.
Cypræa miliaris.
Radius birostris.
Cerithium longicaudatum.
Imperator Guilfordiæ.
Haliotis Japonica.
„ discus.
„ gigantea.
Bulla Coreanica.
Siphonaria Coreanica.
Pecten asperulatus
„ Japonicus.
Spondylus Cumingii.
Nucula mirabilis.
„ Japonica.
Cardium Bechei.
Crassatella compressa.
Diplodonta alata.
„ Coreanica.
Isocardia Moltkiana.
Venus Japonica.
Cyclina orientalis.
Cytherea petechialis.
Artemis sericea.
„ bilunata.
„ Sieboldi.
„ Japonica.
Circe Stutzeri.
Tapes Japonica.
Petricola radiata.
Solen albidus.
Panopæa Japonica.
Terebratulina Japonica.
„ angusta.
Waldheimia Grayi.
Terebratella Coreanica.
„ rubella.

XI. Aleutian Province.

The Boreal province is represented on the northern coasts of the Pacific, where, according to Dr. Middendorff, the same genera and many identical species are found. In addition to those indicated in the Arctic list (p. 355), the following species occur at the Shantar Ids. in the Sea of Ochotsk (O), Saghalien, the Kuriles (K), Aleutians and Sitka (S).

Patella (scurra). S.
Acmæa, 3 sp. S.
Pilidium commodum. O.
Paludinella, 3 sp. O.
Litorina, 6 sp. O. K. S.
Turritella Eschrichtii. S.
Margarita sulcata. A.
Trochus, 6 sp. S.
Scalaria Ochotensis.
Crepidula Sitchana.
„ minuta. S.
„ grandis. A.
Fissurella violacea. S.
„ aspera. S.
Haliotis Kamtschatica.
„ aquatilis. K.
Velutina coriacea. K.
„ cryptospira. O.
Trichotropis inermis. S.
Purpura decemcostata. (Mid.) S.
„ Freycineti. O. S.
„ septentrionalis. S.
Pleurotoma Schantarica.
„ simplex. O.
Murex monodon. S.
„ lactuca. S.
Fusus (Chrysodomus) Sitchensis.
„ decemcostatus. A.
„ Schantaricus.
„ Behringii.
„ Baerii. A.
„ luridus. S.
Buccinum undatum var. Schantaricum.
„ simplex. O.
„ Ochotense.
„ cancellatum. A
„ ovoides. O.
Pisania scabra. A.
Bullia ampullacea. O.
Onychoteuthis Kamtschatica.

Terebratella frontalis. O.
Placunomia macroschisma. O.
Pecten rubidus. S.
Crenella vernicosa. O.
„ cultellus. Kamts.
Nucula castrensis. S.
Pectunculus septentrionalis. A.
Cardita borealis. O.
Cardium Nuttalli. S.
„ Californicum. S.
Saxidomus Petiti. S.

Saxidomus giganteus. S.
Petricola cylindracea. S.
„ gibba. S.
Tellina lutea. A. nasuta. S.
„ edentula. A.
Lutraria maxima. S.

The influence of the Asiatic coast-current is shewn in the presence of two species of *Haliotis*, whilst affinity with the fauna of W. America is strongly indicated by the occurrence of *Patella* (*scurra*), three species of *Crepidula*, two of *Fissurella*, and species of *Bullia*, *Placunomia*, *Cardita*, *Saxidomus*, and *Petricola*, which are more abundant, and range farther north than their allies in the Atlantic.

Provinces on the Western coast of America.

The mollusca of the Western coast of America are equally distinct from those of the Atlantic and those inhabiting the central parts of the Pacific.

Mr. Darwin states in his Journal (p. 391) that "not one single sea-shell is known to be common to the Islands of the Pacific and to the west coast of America," and he adds that "after the comparison by Messrs. Cuming and Hinds of about 2000 shells from the Eastern and Western coasts of America, only one single shell was found in common, namely the *Purpura patula*, which inhabits the West Indies, the coast of Panama, and the Gallapagos." Even this single identification has since been doubted. Mr. Cuming, who resided many years at Valparaiso, did not discover any West India species on that coast, and M. D'Orbigny makes the same observation. On the other hand M. Mörch of Copenhagen says he has received *Tellina operculata* and *Mactra alata* from the west coast and also from Brazil; and M. Deshayes gives the following extraordinary ranges in his "Catalogue of *Veneridæ* in the British Museum:"

Artemis angulosa, Philippines—Chile.
Cytherea umbonella, Red Sea—Brazil.
„ maculata, W. Indies—Philippines, Sandwich.
„ circinata, West Indies—West coast America.

In these instances there is doubtless some mistake, either about the locality or the shell. As regards the last, Mr. Carrick Moore has shown that the error has arisen from confounding the *Cytherea alternata* of Broderip with *C. circinata* of Born. M. D'Orbigny collected 628 species on the coast of S. America,—180 from the eastern side, and 447 from the Pacific coast, besides the *Siphonaria Lessonii* which ranges from Valparaiso in Chile to Maldonado on the coast of Uruguay.* These shells belong to 110 genera, of which 55 are common to both coasts, while 34 are peculiar to the Pacific, and 21 to the Atlantic side of S. America; an extraordinary amount of diversity, attributable partly to the different character of the two coasts—the

* The dispersion of this coast shell may perhaps have taken place at the time when the channel of the river S. Cruz formed a strait, joining the Atlantic and Pacific oceans, like that of Magellan. (Darwin, p. 181.) Mr. Couthouy makes 3 sp. *S. Lessonii*, nearly smooth, Atlantic coast; *S. antarctica*, ribbed. Pacific coast; and *S. lateralis*, thin, oblique, Fuegia.

eastern low, sandy or muddy, the western rocky, with deep water near the shore.*

The comparison of the shells of Eastern and Western America is of considerable interest to geologists; for if is true that any number of living species are common to the Pacific and Atlantic shores, it becomes probable that some portion of the Isthmus of Darien has been submerged *since* the Eocene Tertiary period. Any opening in this barrier would allow the Equatorial current to pass through into the Pacific—there would be no more Gulf Stream—and the climate of Britain might from this cause alone, become like that of Newfoundland at the present day.

XII. Californian Province.

The shells of Oregon and California have been collected and described by Mr. Hinds,† Mr. Nuttall‡, and Mr. Couthouy, naturalist of the American Exploring Expedition.§

Shells common to U. California and Sitka. (Middendorff.)

Tritonium scabrum.
Litorina modesta.
„ aspera.
Fissurella violacea.
Fissurella aspera.
Trochus ater.
„ mœstus.
„ Fokkesii.
Trochus euryomphalus.
Petricola cylindracea.
Lutraria maxima.

Scarcely any species are common to this province (extending from Puget Sound to the peninsula) and the Bay of California, which belongs to the Panamic province. The following list probably contains some shells which should be referred to the latter.

Fusus Oregonensis.
Murex Nuttalli.
Monoceros unicarinatus.
„ punctatus.
Cancellaria urceolata.
Trivia Californica.
Natica herculea.
„ Lewisii.
Calyptræa fastigiata.
Crepidula exuviata.
„ navicelloides.
„ solida, &c.
Imperator Buschii.
Haliotis Cracherodii.
„ fulgens.
„ corrugata.
Fissurella crenulata.
„ cucullata.
Puncturella, 2 sp.
Dentalium politum.
Patella, 15 sp.
Acmæa scabra.
„ pintadina.
Chiton Mertensii.
„ scrobiculatus, &c.
Cleodora exacuta.
——
Waldheimia Californica.
Discina Evansii.
——
Anomia pernoides.
Placunomia cepa.
Hinnites giganteus.
Perna, 1. Pinna, 2.
Mytilus, 1, Pecten 2.
Mytilimeria Nuttalli.
Modiola capax.
Chama exogyra.
Cardita ventricosa.
Cardium, 4. Lucina, 3.
Cypricardia Californica.
Chironia Laperousii.
Solecardia eburnea.
Venus Californiensis.
„ callosa.
Artemis ponderosa
Saxidomus Petiti.
„ Nuttalli.
„ giganteus.
Venerupis cordieri.
Petricola mirabilis.
Mactra, 2. Donax, 1.
Tellina Bodegensis.
„ secta, &c.
Semele decisa.
Cumingia californica.
Sanguinolaria Nuttalli.

* Voyage dans l'Amérique Méridionale. 1847, t. v. p. v.

† Voyge of H. M. S. Sulphur; Zoology by R. B. Hinds, 4to. 1844.

‡ Described by T. A. Conrad, Journ. Acad. N. S. Philadelphia, 1831.

§ Gould in Bost. Nat. Hist. Soc. Proceedings, 1846; and U. S. Exploring Exped. (Commander Wilkes) vol. xii. Mollusca, with Atlas. 4to. Philad. 1852.

Lutraria Nuttalli.	Cyathodonta undulata.	Machaera maxima.
Platyodon cancellatus.	Sphenia californica.	Mya præcisa.
Amphichæna Kindermanni.	Periploma argentaria.	Panopæa generosa.
Lyonsia, l. Thracia, l.	Solecurtus subteres.	Pholas Californica.
Pandora, l. Saxicava, 2.	Machaera lucida.	,, concamerata.

XIII. Panamic Province.

The Western coast of America, from the Gulf of California to Payta in Peru, forms one of the largest and most distinct provinces. The shells of Mazatlan and the Gulf have been imperfectly catalogued by Menke and are now under examination by Mr. P. Carpenter, who states that they amount to about 500 species, of which perhaps half are common to Panama and Peru; a *very few* are common to the west coast of the Promontory and very few (including *Purpura patula* and *Mactra similis*) to the West Indies; still fewer to the Pacific coasts and islands, and one or two identical or closely analogous with Senegambian and British species, (e. g. *Kellia suborbicularis*.)

The late Prof. C. B. Adams of Amherst published, in 1852, a very valuable work on the shells of Panama, in which the total number of species found in the province is estimated at 1500, of which "perhaps none exist beyond—all of the few examples which are supposed to have a wider range, are more or less doubtful." He remarks that "in general there is a great dissimilarity between the shells of this and the Caribbean Province" in which he had himself collected extensively; the number of large species was much greater in Panama.*

The river-openings of this coast are bordered by mangroves, amongst which are found *Potamides*, Arcas, Cyrenas, Potamomyas, Auriculas and Purpuras, whilst *Litorinæ* climb the trees and are found upon their leaves. The ordinary tide at Panama amounts to 16 or 20 feet, the extreme to 28 feet, so that once a fortnight a lower zone of beach may be examined and other shells collected; the beach is of fine sand, with reefs of rocks in the bay.

Gallapagos Islands.—Out of 90 sea-shells collected here by Mr. Cuming 47 are unknown elsewhere; 25 inhabit Western America, and of these 8 are distinguishable as varieties; the remaining 18 (including one variety) were found by Mr. Cuming in the Low Archipelago, and some of them also at the Philippines. (*Darwin*, p. 391.)

Litoral shells common to Panama and the Gallapagos (C. B. Adams.)

Cypræa rubescens	Columbella atramentaria.	Ricinula reeviana.
Mitra tristis.	,, bicanalifera.	Cassis coarctata.
Planaxis planicostatus.	,, hæmastoma.	Oniscia tuberculosa.
Purpura carolinensis.	Columbella nigricans.	Conus brunneus.

* Mr. Adams found but one shell common to the two sides of the Isthmus—*Crepidula unguiformis*—wich is said to be found throughout the warmer latitudes, but is really an abnormal form of many distinct species of Crepidula, caused by growing in the interior of other shells.

Conus nux.
Strombus granulatus.
Turbinella cerata.
Pleurotoma eccentrica.
Hipponyx radiata.
Fissurella macrotrema.
Fissurella nigro-punctata.
Siphonaria gigas.

Panama shells.

Strombus gracilior.
Murex erythrostomus.
„ regius.
„ imperialis.
„ radix.
„ brassica.
„ monoceros, &c.
Rapana muricata.
„ Kiosquiformis.
Myristica patula.
Ricinula clathrata.
Purpura, many sp.
Monoceros, many sp.
„ brevidentatus.
„ cingulatus.
Clavella ? distorta.
Oliva porphyria.
„ splendidula, &c.
Northia pristis.
Harpa crenata.
Malea ringens.
Mitra Inca, &c.
Terebra luctuosa, &c.
Conus regularis, &c.
Pleurotoma, many sp.
Cancellaria goniostoma.
„ cassidiformis.
„ chrysostoma.
Columbella, many sp.
Columbella strombiformis.
Marginella curta.
Cypræa nigro-punctata.
Trivia.
Pyrula ventricosa.
Natica glauca.
Pileopsis hungaricoides.
Crucibulum auriculatum, &c.
Trochita mamillaris.
Crepidula arcuata &c.
Litorina pulchra.
Turritella Californica.
Truncatella, 2 sp.
Cœcum, 8 sp.
Imperator unguis, &c.
Trochus pellis serpentis.
Vitrinella, 12 sp.
Nerita ornata.
Patella maxima.
——
Discina strigata.
„ Cumingii.
Lingula semen.
„ albida.
„ audebardi.
——
Placunomia foliacea.
Ostrea æquatorialis.
Spondylus princeps.
Pecten magnificus.
Arca lithodomus, &c.
Pectunculus tessellatus, &c.
Nucula exigua.
Leda, 5 sp.
Cardium senticosum,
„ maculosum.
Cardita laticosta.
Gouldia Pacifica.
Cytherea, many sp.
Venus gnidia.
„ histrionica.
Artemis Dunkeri.
Trigona crassatelloides.
Cyclina subquadrata.
Venerupis foliacea.
Petricola californica, &c.
Tellina Burneti.
Cumingia coarctata.
Semele, 7 sp.
Saxicava purpurascens.
Gastrochæna.
Solecurtus lucidus.
Lyonsia brevifrons.
Pandora arcuata, &c.
Pholas melanura, &c.
Parapholas.
Jouannetia pectinata.

XIV. Peruvian Province.

The coast of Peru and Chile, from Callao to Valparaiso, affords a large and characteristic assemblage of shells, of which only a small part have been catalogued, although the district has been well explored, especially by D'Orbigny, Cuming and Philippi. M. D'Orbigny collected 160 species, one half of which are common to Peru and Chile, whilst only one species found at Callao was also met with at Payta, a little beyond the boundary of the region. Mr. Cuming obtained 222 species on the coast of Peru, and 172 in Chile. The Island of Juan Fernandez is included within this province. Only a few of the Peruvian shell-fish can be here enumerated.

Onychoteuthis peratoptera.
——
Æolis Inca.
Doris Peruviana.
Diphyllidia Cuvieri.
Posterobranchæa.
Aplysia Inca.
Tornatella venusta.
Chiton, many species.
Patella scurra.
Acmæa scutum.
Crucibulum lignarium.
Trochita radians.
Crepidula dilatata.
Fissurella, many sp.
Liotia Cobijensis.
Gadinia Peruviana.

Litorina Peruviana.
„ araucana.
Rissoina Inca.
Cancellaria buccinoides.
Sigaretus cymba.
Fusus Fontainei.
Murex horridus.
Ranella ventricosa.
Triton scaber.
Nasa dentifera.
Columbella sordida.
Oliva Peruviana.
Rapana labiosa.
Monoceros giganteus.
„ crassilabris.
Monoceros acuminatus.
Purpura chocolata.
Concholepas.
Mitra maura.
—
Terebratella Fontainei.
„ Chilensis.
Discina lamellosa.
„ lævis.
—
Pholas subtruncata, &c.
Lyonsia cuneata.
Solen gladiolus.
Solecurtus Dombeyi.
Mactra Byronensis.
Mesodesma Chilensis.
Cumingia lamellosa.
Semele rosea, &c.
Petricola, many sp.
Saxidomus opacus, &c.
Cyclina Kroyeri.
Venus thaca.
Crassatella gibbosa.
Nucula, many sp.
Leda, many sp.
Solenella Norrisii.
Lithodomus Peruvianus.
Saxicava solida.

XV. Magellanic Province.

This region includes the coasts of Tierra del Fuego, the Falkland Ids. (Malvinas) and the Mainland of South America, from P. Melo, on the east coast, to Concepcion, on the west. It is described by M. D'Orbigny and Mr. Darwin (Journal, p. 177 et seq.). The southern and western coasts are amongst the wildest and stormiest in the world; glaciers in many places descend into the sea, and the passage round Cape Horn has often to be made amidst icebergs floating from the south polar continent.* The greatest tides in the straits amount to 50 feet. "In T. del Fuego the giant sea-weed (*Macrocystis pyrifera*), grows on every rock from low-water mark to 45 fathoms, both on the outer coast and within the channels; it not only reaches up to the surface, but spreads over many fathoms and shelters multitudes of marine animals, including beautiful compound Ascidians, various patelliform shells, Trochi, naked mollusca, cuttle-fish and attached bivalves. The rocks, at low-water, also abound with shell-fish, which are very different in their character from those of corresponding northern latitudes, and even when the genera are identical the species are of much larger size and more vigorous growth."†

Shells of the Magellanic province (* Falkland Islands).

Buccinum antarcticum.
„ Donovani?
Bullia cochlidium.
Monoceros imbricatus.
„ glabratus.
„ calcar.
Trophon Magellanicus.
Voluta Magellanica.
„ ancilla.
Natica limbata.
Lamellaria antarctica.
Litorina caliginosa.
Chemnitzia Americana.
*Scalaria brevis.
*Trochita pileolus.
Crepidula Patagonica.
Trochus Patagonicus.
*Margarita Malvinæ.
*Scissurella conica.
*Fissurella radiosa.
Puncturella conica.
Nacella cymbularia.
*Patella deaurata.
* „ barbara.
* „ zebrina.
Siphonaria lateralis.
Chiton setiger

* Familiar to the admirers of Coleridge's "Ancient Mariner," and graphically described in Dana's "Two Years before the Mast."

† Shell-fish are here the chief support of the natives as well as of the wild animals. At Low's harbour a sea-otter was killed in the act of carrying to its hole a large Volute, and, in T. del Fuego, one was seen eating a cuttle-fish. (*Darwin.*)

Doris luteola.	Waldheimia dilatata.	*Venus exalbida.
Æolis Patagonica.	Pecten Patagonicus.	*Cyamium antarcticum.
*Spongiobranchæa.	„ corneus.	Mactra edulis.
Spirialis? cucullata, 66° S.	Mytilus Magellanicus.	*Lyonsia Malvinensis.
——	*Modiolarca trapezina.	Pandora cistula.
Terebratella crenulata.	Leda sulculata.	Saxicava antarctica.
* „ Magellanica, many varieties.	*Cardita Thouarsii.	Boltenia coacta.
	*Astarte longirostris.	Octopus megalocyathus.

XVI. Patagonian Province.

From S. Catharina, south of the Tropic, to P. Melo. This coast-line has shifted considerably since the era of its present fauna. M. D'Orbigny and Mr. Darwin observed banks of recent shells, especially *Potamomya labiata*, in the valley of the La Plata and the Pampas around Bahia Blanca. Mr. Cuming also met with *Voluta Brasiliana*, and other living shells, in banks 50 miles inland. Of 79 shells obtained by M. D'Orbigny on the coast of N. Patagonia, 51 were peculiar, 1 common to the Falkland Ids. and 27 to Maldonado and Brazil. At Maldonado 37 species were found, 8 being special, 10 common to N. Patagonia, 2 to Rio, and 17 to Brazil. Of the latter 8 range as far as the Antilles; viz.:

Crepidula aculeata.	Mactra fragilis.	Modiola viator.
„ protea.	Venus flexuosa*.	Plicatula Barbadensis.
Pholas costata.	Lucina semi-reticulata.	

At Bahia Blanca, in lat. 39° S., the most abundant shells observed by Mr. Darwin (p. 243) were

Oliva auricularia.	Oliva tehuelchana.	Voluta angulata.
„ puelchana.	Voluta Brasiliana.	Terebra Patagonica.

M. D'Orbigny's list also includes the following genera and species:

Octopus tehuelchus	Æolis.	Leda.
Columbella sertularium.	Paludestrina.	Cytherea.
Bullia globulosa.	Scalaria.	Petricola.
Pleurotoma Patagonica.	Natica.	Corbula.
Fissurellidæa megatrema.	Chiton.	Pinna.
Panopæa abbreviata.	Solen.	Mytilus.
Periploma compressa.	Lutraria.	Lithodomus.
Lyonsia Patagonica.	Donacilla.	Pecten.
Solecurtus Platensis.	Nucula.	Ostrea.

XVII. Caribbean Province.

The Gulf of Mexico, the West Indian Islands, and the eastern coast of South America, as far as Rio, form the fourth great tropical region of marine life. The number of shells is estimated by Prof. C. B. Adams at not less than 1500 species. Of these 500 are described by M. D'Orbigny in Ramon de la Sagra's History of Cuba, and a small number of the Brazilian species in the same author's Travels in South America.

* The variety of *Venus flexuosa* found at Rio, can be distinguished from the West Indian shell, which is the *Venus punctifera* of Gray.

The coasts of the Antilles, Bermuda, and Brazil, are fringed with coral reefs, and there are considerable banks of gulf-weed at some distance from the coast of the Antilles.

West India Shells.

Argonauta.	Ommastrephes.	Cleodora.	Cheletropis.
Octopus.	Sepioteuthis.	Creseis.	Ianthina.
Philonexis.	Sepia.	Cuvieria.	Glaucus.
Loligo.	Spirula.	Atlanta.	Notarchus Plei.
Cranchia.	Hyalea.	Oxygyrus.	Aplysia.
Onychoteuthis			

Strombus gigas.
„ pugilis.
Murex calcitrapa.
Pisania articulata.
Enzina turbinella.
Triton pilearis.
„ cutaceus.
Fusus morio.
Fasciolaria tulipa.
Lagena ocellata.
Cancellaria reticulata.
Fulgur arnauum.
Terebra acicularis.
Myristica melongena.
Purpura patula.
„ deltoidea.
Oniscia oniscus.
Cassis tuberosa.
„ flammea.
„ Madagascariensis.
Columbella mercatoria.
„ nitida, &c.
Voluta vespertilio.
„ musica.
Oliva brasiliensis.
„ angulata.
„ jaspidea.
„ oryza, &c.
Ancillaria glabrata.
Conus varius, &c.
Clavatula zebra.
Marginella.
Erato Maugeriæ.
Cypræa mus.
„ exanthema.
„ spurca, &c.
Trivia pediculus.
Ovulum gibbosum.

Natica canrena.
Pyramidella dolabrata.
Planaxis nucleus.
Litorina zic-zac.
„ flava.
„ lineolata.
Tectaria muricata.
Modulus lenticularis.
ossarus
Truncatella caribbæa.
Torinia cylindracea.
Turritella exoleta.
„ imbricata.
Trochus pica.
Imperator tuber.
„ calcar.
Fissurella Listeri.
„ nodosa.
„ Barbadensis.
Nerita.
Neritina.
Hemitoma 8 radiata.
Hipponyx mitrula.
Pileopsis militaris.
Calyptræa equestris.
Crepidula aculeata.
Patella leucopleura.
Chiton squamosus.
Hydatina physis.

Bouchardia tulipa.
Discina antillarum.

Placunomia foliata.
Plicatula cristata.
Lima scabra.
Mytilus exustus.
Lithodomus dactylus.

Arca Americana.
Yoldia tellinoides.
Chama arcinella.
„ macrophylla.
Cardium lævigatum.
Lucina tigrina.
„ Pennsylvanica.
„ Jamaicensis.
Corbis fimbriata.
Coralliophaga.
Crassatella.
Gouldia parva.
Venus paphia.
„ dysera.
„ crenulata.
„ cancellata.
„ violacea.
Cytherea dione.
„ circinata.
„ maculata.
„ gigantea.
„ flexuosa.
Artemis concentrica.
„ lucinalis.
Cyclina saccata.
Trigona mactroides.
Petricola lapicida.
Capsula coccinea.
Tellina Braziliana.
„ bimaculata.
Strigilla carnaria.
Semele reticulata.
„ variegata.
Cumingia.
Iphigenia Brasiliensis.
Lutraria lineata.
Periploma inæquivalvis.
Pholadomya candida.

XVIII. Trans-Atlantic Province.

The Atlantic coast of the United States was supposed by Prof. E. Forbes to consist of two provinces, 1. the *Virginian*, from C. Cod to C. Hatteras,

and 2. the *Carolinian*, extending to Florida; but no data were supplied for such a division. The total number of mollusca is only 230, and 60 of these range further north, 15 being moreover common to Europe.

Dr. Gould describes 110 shells from the coast of Massachusetts south of Cape Cod, of which 50 are not found to the northward, but form the commencement of the proper American type. The shells of New York and the southern Atlantic States are described by De Kay, in the State Natural History of New York; this list supplies 120 additional species, of which at least a few are stragglers from the Caribbean province; *e.g. Chama arcinella, Iphigenia lævigata, Capsula deflorata.**

M. Massachusetts. Y. New York. SC. South Carolina. F. Florida.

Conus mus. F.
Fusus cinereus. M. SC.
Nassa obsoleta. M. F. (Mex.)
„ trivittata. M. SC.
„ vibex. M. F. (Mexico).
Purpura Floridana. (Mex.)
Terebra dislocata. V. SC.
Pyrula? papyracea. F.
Fulgur carica. M. SC.
„ canaliculatum. M. SC.
Oliva literata. SC.
Marginella carnea. F.
Fasciolaria distans. SC. (Mex.)
Columbella avara. M. Y.
Ranella caudata. M. Y.
Natica duplicata. Y. SC.
Sigaretus perspectivus. Y. SC.
Scalaria lineata. M. SC.
„ multistriata. M. Y.
„ turbinata. NC.
Cerithium ferrugineum. F.
„ 4 sp. M.
Triforis nigro-cinctus. M.
Odostomia, 6 sp. M. Y.
Turritella interrupta. M. Y.
„ concava. SC.
(Vermetus lumbricalis. M.?)
Calyptræa striata. Y.
Crepidula convexa. M. Y.
„ fornicata. M. F. (Mex.)
Litorina irrorata. Y.
Fissurella alternata. (Say) ?
Chiton apiculatus. M. SC.
Tornatella puncto-striata. M. Y.
Bulla insculpta. M. Y.

Ostrea equestris. SC. F.
Pecten irradians (*scallop*).
Avicula Atlantica. F.
Mytilus leucophantus. SC.
Modiola Carolinensis.
„ plicatula. M. Y.
Pinna muricata. SC.
Arca ponderosa. SC.
„ pexata. M. F.
„ incongrua. SC.
„ transversa. M. Y.
Solemya velum. M. Y.
„ borealis. M.
Cardium ventricosum. SC.
„ Mortoni. M. Y.
Lucina contracta. Y.
Astarte Mortoni. Y.
„ bilunulata. F.
Cardita incrassata. F.
Venus mercenaria. M. SC.
„ Mortoni. SC. F.
„ gemma. M. Y.
Artemis discus. SC.
Petricola dactylus. M. SC.
„ pholadiformis. Y
Mactra similis. SC. M.
„ solidissima. M. Y.
„ lateralis. M. Y.
Lutraria lineata. F.
„ canaliculata. V. F.
Mesodesma arctata. M. Y.
Tellina tenta. M. SC.
„ 8 sp. SC. F.
Semele æqualis. SC.
Cumingia tellinoides. M.
Donax fossar. Y.

* The sea-shells of the United States have also been collected and described by Say, Le Sueur, Conrad, and Couthouy.

Donax variabilis. G. F.
Solecurtus fragilis. M. SC.
„ caribbæus. M. F.
Corbula contracta. M. F.
Periploma Leana. M. Y.
Periploma papyracea. M. Y.
Lyonsia hyalina. Y.
Pandora trilineata. M. F.
Pholas costata SC. F.
„ semicostata. SC.

LAND REGIONS.

Distribution of Land and Fresh-water Shells.

The boundaries of the Natural-history land-regions are more distinctly marked, and have been more fully investigated, than their counterparts in the sea. Almost every large island has its own fauna and flora; almost every river-system its peculiar fresh-water fish and shells; and mountain-chains like the Andes appear to present impassable barriers to the "nations" of animals and plants of either side. Exceptions, however, occur which shew that beyond this first generalisation there exists a higher law. The British Channel is not a barrier between two provinces, nor is the Mediterranean; and the desert of Sahara separates only two portions of the same zoological region. In these and other similar instances the "barrier" is of later date than the surrounding fauna and flora.

It has been often remarked that the northern part of the map of the world presents the appearance of vastly-extended, continental plains, much of which is, geologically speaking, new land. In the southern hemisphere the continents taper off into promontories and peninsulas, or have long since broken up into islands. Connected with this is the remarkable fact that only around the shores of the Arctic Sea are the same animals and plants found through every meridian; and that in passing southward, along the three principal lines of land, specific identities give way to mere identity of genera, these are replaced by family resemblances, and at last even the families of animals and plants become in great measure distinct—not only on the great continents, but on the islands—till every little rock in the ocean has its peculiar inhabitants—the survivors, seemingly, of tribes which the sea has swallowed up. (*Waterhouse.*)

The two largest genera, or principal types of the land and fresh-water shells, *Helix* and *Unio*, have an almost universal range, but admit of many geographical subdivisions.* Amongst the land-snails are several species to which a nearly world-wide range has been assigned, sometimes erroneously as when *Helix cicatricosa* is attributed to Senegal and China, or *Helix similaris* Fér. to Brazil and India; and often correctly, but only because they have been carried to distant localities by human agency. Land-snails are in

* In cataloguing *Unionidæ* the river and country of each species should be stated. American authors are too often contented with recording such localities as "Nashville" and "Smithville," which are quite unintelligible. Almost as uncertain in their meaning are S. Vincent, S. Cruz, S. Thomas, Prince's Id.; whilst the latinized names of places often defy all attempts at re-translation.

favour with Portuguese sailors, as "live sea-stock;" and they have naturalized the common garden-snail of Europe (*Helix aspersa*) in Algeria, the Azores, and Brazil; and *Helix lactea* at Teneriffe and Mte. Video. *Achatina fulica* has been taken from Africa to the Mauritius, and thence to Calcutta, where it has been established by a living naturalist; and *Helix hortensis* has been carried from the old country to America, and naturalized on the coast of New England and the banks of the St. Lawrence. *Bulimus Goodalli*, indigenous to the West Indies and S. America, has been introduced into English pineries and to Mauritius. *Helix pulchella*, one of the small species found in moss and decayed leaves, inhabits Europe, the Caucasus, Madeira, the Cape (introduced), and N. America as far as the Missouri. *Helix cellaria* inhabits Europe and the Northern States of America, and has been carried abroad with the roots of plants, or attached to water-casks, and naturalized at the Cape and New Zealand.

The fresh-water *Pulmonifera—Limnæa, Physa, Planorbis, Ancylus*—and the amphibious *Succinea*, have a nearly world-wide range; and like aquatic plants and insects often re-appear, even at the antipodes, under familiar forms. The range of the gill-breathing fresh-water shells is more restricted.

The Old World and America may be regarded as provinces of paramount importance, having no species in common (except a few in the extreme north), and each possessing many characteristic genera.

America.	*Old World.*	*America.*	*Old World.*
Anastoma.	Zonites.	Choanopoma.	Pomatias.
Tridopsis.	Nanina.	Chondropoma.	Otopoma.
Sagda.	Vitrina.	Cistula.	Craspedopoma.
Stenopus.	Helicolimax.	Trochatella.	Diplommatina.
Proserpina.	Daudebardia.	Alcadia	Aulopoma.
Bulinus.	Achatina.	Stoastoma.	Pupina.
Odontostomus.	Achatinella.	Geomelania	Acicula.
Liguus.	Clausilia.	——	——
Glandina.	Paxillus.	Hemisinus.	Vibex.
Cylindrella.	Pupa.	Melafusus.	Pirena.
Megaspira.	——	Ceriphasia.	Melanopsis.
Simpulopsis.	Testacella.	Anculotus.	Paludomus.
Amphibulima.	Parmacella.	Melatoma.	Lithoglyphus.
Omalonyx.	Limax.	Amnicola.	Navicella.
——	Arion.	——	——
Philomycus.	Phosphorax.	Mülleria.	Ætheria.
Peltella.	Incilaria.	Mycetopus.	Iridina.
——	Oncidium.	Castalia.	Galatea.
Chilinia.	——	Monocondylæa.	Cyrenoïdes.
Gundlachia.	Latia.	Gnathodon.	Glaucomya.

The Land Provinces represented on the map are the principal Botanical Regions of Prof. Schouw, as given in the Physical Atlas of Berghaus; and it is proposed to inquire how far these divisions are confirmed by the land and fresh-water shells, more especially by the land-snails, (*Helicidæ, Limacidæ,*

and *Cyclostomidæ*), which have been so elaborately catalogued by Dr. L. Pfeiffer.*

The first Botanical region—that of Saxifrages and Mosses—has not been numbered on the map, although its boundary is given by the line of northern limit of trees. This line nearly coincides with the Isotherm of 32°, or permanent ground-frost; but in Siberia the pine-forests extend 15° further, owing to the absence of winter rains and the bright clear air.

In this region shells are very rare; Dr. Middendorff found *Physa hypnorum* in Arctic Siberia, and *Limnæa geisericola* (Beck) inhabits the warm springs of Iceland. The few species discovered by Möller in Greenland are supposed to be peculiar:—

Helix Fabricii.	Succinea Grœnlandica.	Limnæa Holböllii.
Pupa Hoppii.	Limnæa Vahlii.	Planorbis arcticus.
Vitrina angelicæ.	„ Pingelii.	Cyclas Steenbuchii.

1. Germanic Region.

The whole of Northern Europe and Asia, bounded by the Pyrenees, Alps, Carpathians, Caucasus, and Altai, constitutes but one province, with a fauna by no means proportioned in richness to its extent.†

The land-snails amount to more than 200, but nearly all (or at least five-sixths) are common to the Lusitanian region.‡

Helix	90	Pupa	44	Cyclostoma	1
Bulimulus	10	Clausilia	52	Acicula	1
Zua, Azeca, Cionella	5	Vitrina	5	Limax	9
		Succinea	5	Arion	4
		Balea	1	Carychium	1

The fresh-water shells belong to these genera and sub-genera:—

Limnæa	20	Velletia	1	Unio, sp. and vars.	20
Amphipeplea	2	Neritina, vars.	3	Anodon, vars.	20
Physa	5	Paludina and Bithynia	23	Alasmodon	3
Aplexa	1	Valvata	5	Cyclas	6
Planorbis	16	Conovulus (Alexia)	3	Pisidium	11
Ancylus	7	Dreissena	1		

The British land-shells amount to 74, fresh-water *pulmonifera* 24, fresh-water *pectinibranchiata* 7, marine *pulmonifera* 4; fresh-water bivalves 15. Of the species formerly thought peculiar, *Pupa anglica* and *Helix fusca* have been found in France, and *Helix lamellata* in Holsace. *Helix excavata* (Bean) is still unknown upon the Continent; and *Geomalacus maculosus* and

* The distribution of the *Cycladidæ* is taken from the British Museum Catalogue, by M. Deshayes.

† The mean temperature of the winter and summer months averages 36°—57°; in Western Europe autumn rains prevail, and summer rains in Eastern Europe and Siberia.

‡ It was the opinion of Prof. E. Forbes that *all* the species of the Post-pliocene land of Northern Europe and Asia had *originated* beyond the bounds of that region.

Limnæa involuta have only been met with in the south-west of Ireland, but are possibly Lusitanian species. *Dreissena polymorpha* has been permanently naturalized in canals (p. 267), and *Testacella Maugei* and *haliotidea* in gardens; *Bulimus decollatus* and *Goodalli* have been often established in greenhouses. Some species are now very scarce in England that were formerly abundant, as:—

Clausilia plicatula.	Vertigo Venetzii.	Succinea oblonga.
Vertigo minutissima.	Helix lamellata.	Acicula fusca.

Others which occur in the newer tertiary deposits have become quite extinct in England, such as:—

Helix fruticum, living in France and Sweden.
„ ruderata ..... Germany.
„ labyrinthica (Eocene) New England.
Paludina marginata..... France.
Corbicula consobrina ..... Egypt and India.
Unio litoralis ..... France and Spain.

On the other hand, some of the commonest living species have not been found fossil; *e.g. Helix aspersa, pomatia,* and *cantiana.* Several genera only occur fossil in the older tertiaries, viz.:—

Glandina.	Cyclotus.	Nematura.
Proserpina.	Megalomastoma.	Melania.
Cylindrella?	Craspedopoma.	Melanopsis.

The land and fresh-water shells of Scandinavia are 56, all common European species; *H. pomatia* has been naturalized at Stockholm.*

Dr. Middendorff gives the following list of Siberian shells in his *Sibirische Reise* (Band II. th. 1. Petersb. 1851):—

Helix carthusiana. Irkutsk
„ Schrenkii, M. Tunguska, 58°.
„ hispida, Beresov. Bernaul.
„ ruderata, Stanowoj Mtn.
„ pura, „
„ sub-personata, „; Ochotsk.
Pupa muscorum, Bernaul.
Zua lubrica, „
Succinea putris, „; Irkutsk.
Limnæa Gebleri, M. Bernaul.
„ auricularia, Nertschinsk.
„ ovata, Bernaul.
„ Kamtschatica, Mid.
„ peregra, Bernaul, Beresov.
„ stagnalis, „ Irkutsk.
„ palustris, „ „
„ truncatula, „ Tomsk.
„ leucostoma, Irkutsk.
Physa hypnorum, Bernaul; Taimyrlande.
Planorbis corneus, Bernaul; Beresov; Kirgisensteppe, Altai.
Planorbis complanatus, Altai.
„ albus, Bernaul, „
„ contortus, „
„ vortex, „
„ leucostoma, „
„ nitidus, Irkutsk.
Bithinia tentaculata, Bernaul.
„ Kickxii, R. Ami, Altai.
Valvata cristata, var. Sibirica, Bernaul, Beresov; Kamtschatka.
„ piscinalis, R. Ami.
Unio complanatus, Kamtschatka.
Unio Dahusicus, Mid. Schilka.
„ Mongolicus, M. Gorbitza, Dauria.
Anodon herculeus, M. Scharanai.
„ anatinus, Tunguska.
„ cellensis var. Beringiana, Kamtschatka.
Cyclas calyculata, Bernaul, R. Lena, R. Ami, S. Kamts.
Pisidium fontinale, Beresov.
„ obliquum, Bernaul, Tomsk.

* Norske Land- og Fersk-vands Mollusker, Joachim Friele, 1851.

2. Lusitanian Region.

The countries bordering the Mediterranean, with Switzerland, Austria and Hungary, the Crimea (*Taurida*), and Caucasus, form a great province (or rather cluster of provinces) to which Prof. E. Forbes applied the term *Lusitanian*. The Canaries, Azores, and Madeira are outlying fragments of the same region.*

In Southern Europe about 600 land-snails are found, of which above 100 are also spread over the Germanic region and Siberia; and 20 or 30 are common to Northern Africa. Besides these 60 others are found in Algeria and Egypt, 100 in Asia Minor and Syria, and 135 in the Atlantic Islands, making a total of nearly 900 species of *Helicidæ*.†

Of the 12 species of *Zonites* (proper) 10 are peculiar to Lusitania.

The species of *Bulimus*, *Achatina*, and *Pupa* are small and minute, belonging to the sub-genera *Bulimulus*, *Cionella*, *Zua*, *Azeca*, *Vertigo*, &c.; 4 (of which two are Algerian) have been referred to *Glandina*.

In this region are also found 22 species of *Cyclostomidæ* and 44 *Limacidæ*:—

Helix	392	Vitrina	11	Cryptella	1
Bulimus	80	Daudebardia	3	Cyclostoma	5
Succinea	8	Helicolimax	3	Craspedopoma	3
Achatina	25	Limax	28	Pomatias	10
Tornatellina	3	Arion	7	Acicula	4
Balea	4	Phosphorax	1		
Pupa	120	Testacella	2	Carychium	3
Clausilia‡	247	Parmacella	5		

The fresh-water shells are of the same genera as in the Germanic province, and their numbers about the same; with the addition of several species of *Melania*, *Melanopsis*, *Lithoglyphus*, and *Cyrena*. *Melanopsis buccinoides* is found in Spain, Algeria, and Syria, having become extinct in the intervening countries. Two species of *Lithoglyphus* inhabit the Danube; *Cyrena* (*Corbicula*) *Panormitana* is found in Sicily, two others in the Euphrates, and *C. consobrina* in the Alexandrian Canal.

The Lusitanian province includes numerous minor regions, the islands and mountain tracts especially being centres or *foci* where a number of peculiar species are associated with those living around. Thus, of species not as yet recorded from other localities, Switzerland has 28, the Austrian Alps 46, Carpathians 28, N. Italy and Dalmatia 100, Roumelia 20, Greece and its

* In the South of Europe rain seldom falls in summer, but is frequent at other seasons, especially in winter. The mean temp. is 54°-72°.

† The writer is greatly indebted to W. H. Benson, Esq. for information respecting the land-shells of the Lusitanian province, Africa, and the remote islands.

‡ Many of these cannot be considered *species*, in the sense here understood, but only as *races*, or geographical varieties.

Archipelago 90, Anatolia 50, Caucasia 20, Syria 30, Lower Egypt and Algeria 60, Spain 26, and Portugal 15 *Helicidæ* and 9 *Limacidæ*.

Mediterranean Islands.

Corfu, Cyprus, Rhodes, Syra, Candia, and Crete, have each a few peculiar land snails, amounting to 40 species altogether.

Balearic Isles. Helix Graellsiana, hispanica (var. balearica,) nyethii, minoricensis; and Cyclostoma ferrugineum, common to Spain and Algeria.

Corsica. Helix Raspaili, tristis, Clausilia 4 sp.

Sardinia. Helix Sardiensis, meda, tenui-costata, Pupa 2, Clausilia 1.

Malta has two peculiar species of Helix, and a Clausilia (*scalaris*).

Sicily has 40 peculiar Helices and 3 Limaces. This island is connected with N. Africa by a winding shoal with deep water on each side.

Madeira Group.

These ancient volcanic islands, 660 miles S. W. of Portugal, consist of Madeira, with Fora and 3 other islets called Dezertas, and Porto Santo, 26 miles to the N. E., with the rocky islets Ferro, Baxo and Cima.* The land-snails have been described by the Rev. R. T. Lowe,† and form the subject of a monograph by Dr. Albers;‡ the investigations of Mr. Vernon Wollaston have nearly doubled the number of known species, which now amount to 132. The *Vitrinæ* belong to the section *Helico-limax*; the Cyclostomas to the sub-genus *Craspedopoma*, and half the Pupas to *Vertigo*.

Arion	1	Bulimus	2	Cionella	3	Limnæa	1
Limax	4	Glandina	4	Pupa	23	Ancylus	1
Testacella	2	Azeca	3	Balea	1	Conovulus	3
Vitrina	3	Tornatellina	1	Clausilia	3	Pedipes (afra.)	1
Helix	76	Zua	2	Cyclostoma	2		

Of the 92 found in Madeira or the Dezertas, 70 are peculiar; 54, of which 39 are peculiar, inhabit Porto Santo and its islets; 11 others, of which 4 are widely diffused, are common to Madeira and Porto Santo. One species is peculiar to the Dezerta Grande; 1 species and 1 variety to the S. Dezerta (Bugio); 1 to the Northern (Cho); one variety to Ferro. Seven species are common to the Dezertas; 1 to the great and northern Dezertas; 5 to Madeira and Dezerta Grande; and 3 to Madeira, P. Santo, and the Dezertas. Of those species, which inhabit more than one island, the specimens from each locality are recognizable as distinct *races*,

* These islands, and also the Canaries and Azores, contain marine formations (volcanic grits and tufas) with Miocene Tertiary shells. The islet of Baxo is quarried for lime.

† Primitiæ et novitiæ Faunæ et Floræ Maderæ et Portus Sancti. 12mo. Lond., 1851. Descriptive list of all the species, by same author, Zool. Proc. *for* 1854, p. 161. The statements and numbers given above are taken from this last monograph, corrected by Mr. Wollaston.

‡ Malacographia Maderensis, 4to. Berlin, 1854, with figures of all the species.

or geographical varieties. *Helix subplicata* and *papilio* are found on the Ilheo Baxo; *H. turricula* on Cima. Of the total number (132) 111 species are peculiar to the Madeira group; 5 are common to the Canaries; 4 to the Azores, and 1 to the Guinea coast; 11 are common to S. Europe, besides 2 *Limnæids*, and 7 slugs, which may have been recently introduced viz. :—

Arion empiricorum	Helix cellaria.	Zua lubrica, var.
Limax variegatus.	„ crystallina.	„ folliculus.
„ antiquorum.	„ pisana.	Bulimus decollatus.
„ agrestis.	„ pulchella.	„ ventrosus, Fer.
„ gagates.	„ lenticula.	Balæa perversa (p. 166).
Testacella Maugei.	(„ lapicida, *fossil*).	Limnæa truncatula.
„ haliotidea.	Cionella acicula.	Ancylus fluviatilis.

Great quantities of *dead shells* of the land-snails are found in ancient sand-dunes near Caniçal, at the eastern extremity of Madeira, and in Porto Santo, including 64 of the living species and 13 which have not been found alive. As the fossil examples of several species are larger than their living descendants, it is possible that some of those reputed to be extinct have only degenerated. It is a remarkable fact that some of the commonest living species are not found fossil, whilst others, now extremely scarce, occur abundantly as fossils.*

Extinct land-snails of Madeira:

Helix delphinula, Lowe. M.
„ arcinella, Lowe, P.
„ coronula, Lowe, S. Desertá.
„ vermetiformis, Lowe, P.
„ Lowei, Fer. (porto-sanctana, var.?). P.
„ fluctuosa, Lowe (= chrysomela, Lowe). P.
„ psammophora, Lowe (phlebophora var.?). P.
„ Bowdichiana, Fer. (punctulata, major?). M. P.
Glandina cylichna, Lowe. P. Santo.
Cionella eulima, Lowe, P.
Pupa linearis, Lowe. M. (= minutissima, Hartm?)
„ abbreviata, Lowe. M.

The problem of the colonization of these islands receives additional light from the circumstances noticed at other oceanic islands, especially the Canaries and St. Helena. There is evidence that this mountain group has not arisen newly from the sea, and great probability that it has become insulated by the subsidence of the surrounding land.† The character and arrangement of its fauna is probably nearly the same now as when it formed part of a continent, and the diminution of its land-shells in variety and size

* *Helix tiarella*, W. and B. was supposed to be extinct, but in the last summer, (1855) Mr. Wollaston detected it alive in two almost inaccessible spots on the north coast of Madeira: it is not a native of the Canaries.

† See the Observations of Mr. James Smith, and of Sir C. Lyell and Mr. Hartung (Geol. Journ. 1854).

may be the result of a modern change of physical conditions brought about by human agency, as at St. Helena. The annual fall of rain is now 29.82 inches, whereas it was remarked by Columbus, 350 years ago, "that, formerly, the quantity of rain was as great in Madeira, the Canaries and the Azores, *as in Jamaica*, but since the trees, which shaded the ground, had been cut down, *rain had become much more rare.*" *

The *Azores* are a group of 9 volcanic islands, 800 miles W. of Lisbon, the loftiest being Pico, 7,613 ft. Only 13 land-shells have been found, of which 3 are common to the Canaries, 1 to the Canaries and Madeira, 3 to Madeira, 1 to the Canaries and C. de Verdes, and 2 are peculiar, viz.: *Helix Azorica* and *Bulimus cyaneus*. *Helix barbula* is also found in Portugal, *H. pisana* and *cellaria* are common to Madeira and Europe, and *H. aspersa* has been introduced recently.

The *Canary islands* are 60 miles W. of Africa, with a temperature of 60°—66° in the coolest half-year, and 78°—87° in the hottest. The landsnails are about 80 in number, including *Helix* 50, *Nanina* 1, *Vitrina* 3, *Bulimus* 16, *Achatina* 3, *Pupa* 5, *Limax* 1, *Phosphorax* 1, *Testacella* 2, *Cryptella* 1, and 4 *Cyclostomidæ*. Of these, 60 are peculiar, 12 are common to S. Europe, and 4 to the West Indies? 1 to Morocco, 1 to Algeria (also European), and 1 to Egypt. The fresh-water shells are *Physa* 2, *Ancylus* 1.

Helix ustulata and *McAndrei* are peculiar to the rocky islets known as the "Salvages" north of the Canaries.

The absence of W. African land-shells and the presence of W. Indian species may be explained by the currents, which come from the Antilles, as shown on the map. † Some of the European species may have been introduced (*e. g. Helix lactea, pisana, cellaria*); but the presence of 20 Lusitanian species, in a total of 80, is too remarkable to be accidental.

The *Cape de Verde Islands*, although much further to the south, are also much farther from the continent, being 320 miles West of C. de Verde; the mean temperature is 65°—70°, and the vegetation, as Dr. Christian Smith remarked, is more like that of the Mediterranean coast than W. Africa. Of the 12 land-shells, two are common to the Canaries and Azores.

Lusitanian species of wide distribution.

Helix amanda, Sicily — Palma.
„ planata, Morocco — Canaries.
„ lenticula, S. Europe — Madeira — Canaries.
„ rozeti, Sicily, Morea — Algeria — C. de Verde — Canaries.
„ lanuginosa, Majorca — Algeria — Palma.

* Cosmos, II. 660, Bohn ed. It seems likely that Jamaica itself has since undergone a similar change; the fall of rain is stated to be 49.12. whilst in the neighbouring islands it exceeds 100 inches.

† Long before the discovery of America it was observed that the westerly gales washed ashore stems of bamboos, trunks of pines, and even *living men in canoes*. —Humboldt, II. p. 462.

Helix simulata, Syria — Egypt — Lancerotte.
„ Michaudi, summit of Porto Santo — Teneriffe?
„ cyclodon, Azores — Canaries — C. de Verdes.
„ advena, (= *erubescens* Lowe,) Madeira—Azores — St. Vincent.
„ plicaria and planorbella, Canaries—Porto Rico?
Bulimus subdiaphanus, Canaries — Azores — C. de Verdes.
„ bœticatus and badiosus, Canaries—St. Thomas?

Ascension. This barren volcanic island, in the midst of the Atlantic Ocean, is not known to possess any terrestrial *Pulmonifera* beside a slug, the *Limax Ascensionis*. Mr. Benson thinks that some *Helicidæ* might possibly be found on the Green Mountain, 2840 feet high, where the garrison have their gardens. Mr. Darwin remarks "we may feel sure that at some former epoch, the climate and productions of Ascension were very different from what they now are."

St. Helena. (No. 28 of Map).

The Island of St. Helena is 800 miles S. E. of Ascension, and 1200 from the nearest African coast of Benguela. It is entirely volcanic. The indigenous plants are all peculiar, and not more related to those of Western Africa than to Brazil.* The land shells are also peculiar; 13 species have been described; viz:—*Helix*, 3 sp. *Bulimus* 5, *Achatina* 2, *Pupa* 1, *Succinea* (*Helisiga*), 2. As many more have been met with only in the condition of dead shells, rarely retaining their colour and translucency. They are found beneath the surface-soil in the sides of ravines worn by the heavy rains, at a height of 1200 to 1700 feet; "their extinction has probably been caused by the entire destruction of the woods, and the consequent loss of food and shelter, which occurred during the early part of last century."—(Darwin's Journal, p. 488). A living *Bulimus*, related to the extinct *B. Blofieldi*, is found feeding on the cabbage-trees, only on the highest points of the Island.

Extinct land-shells of St. Helena.†

Bulimus auris vulpinus.	Bulimus relegatus.
„ Darwini.	Helix bilamellata.
„ Blofieldi.	„ polyodon.
„ Sealei.	„ spurca.
„ subplicatus.	„ biplicata.
„ terebellum.	„ Alexandri.
„ fossilis.	Succinea Bensoni.

The large *Bulimus*, (fig. 91, p. 164) has no living analogue in Africa,

* "It might perhaps have been expected that the examination of the vicinity of the Congo would have thrown some light on the origin, if I may so express myself, of the Flora of *St. Helena*. This, however, has not proved to be the case; for neither has a single indigenous species, nor have any of the principal genera characterising the vegetation of that Island, been found either on the banks of the Congo, or on any other part of this coast of Africa."—R. Brown, Appendix to Captain Tuckey's Narrative of the Congo Expedition, (p, 476.) 1818.

† G. Sowerby in Darwin's "Volcanic Islands," p. 73. Forbes, Journ. Geol. Soc. 1852, p. 197.—Benson, An. Nat. Hist. 1851, VII. 263.

but is a member of of a group characteristic of tropical America (to which the names *Plecochilus*, *Pachyotis* and *Caprella* have been given) including *B. signatus*, *B. bilabiatus*, *B. goniostomus*, and especially *B. sulcatus* (Chilonopsis, Fischer) of St. Iago.* The four next species belong to the same type, but are smaller and slenderer. "The marine mollusks of the coast of St. Helena would lead us to infer the very ancient isolation of that island, whilst at the same time a pre-existing closer geographical relationship between the African and the American continents than now maintains is dimly indicated. The information we have obtained respecting the extinct and existing terrestrial mollusks would seem to point in the same direction, and assuredly to indicate a closer geographical alliance between St. Helena and the east coast of S. America than now holds."—(Forbes).

Tristan d'Acunha. (No. 29 of Map).

Two peculiar species of *Balea* (Tristensis and ventricosus) are found on this remote and lofty island, which attains an elevation of 8,236 feet.

3. African Region.

Tropical Western Africa, with its hot and swampy coasts and river-valleys is the region of the great *Achatinæ* and Achatina-like *Bulimi*, the largest of all living land-snails. Dr. Pfeiffer enumerates—*Vitrina* 3 sp. *Streptaxis* 7, *Helix* 8, *Pupa* 5, *Bulimus* 35, *Achatina* 39, *Succinea*, 3. *Streptaxis Recluziana* inhabits the Guinea Islands. *Helix Folini*, *Bulimus numidicus* and *fastigiatus*, *Pupa crystallum* and *sorghum*, *Achatina columna*, *striatella* and *lotophaga* are found on Princes Island. *Pupa putilla* on Goree Island. *Bulimus* (*Pseudachatina*) *Downesi*, *Achatina iostoma* and *Glandina cerea* at Fernando Po. The reversed river-snail (*Lanistes*) is generally diffused in the fresh waters of Africa; several species of *Potamides* and *Vibex* are found in the embouchures of the western rivers and *Pedipes* on the sea-shore. The freshwater bivalves of Senegal are similar to those of the Nile;—

Pisidium parasiticum, Egypt.		Iridina exotica,	Senegal.
Cyrenoides Duponti, Senegal.		„ rubens,	„
Corbicula, 4 sp.	Egypt.	Pleiodon ovatus	„
Iridina nilotica	„	Ætheria semilunata	„ Nile.
„ aegyptiaca	„	Galatea radiata	„

4. Cape Region.

Dr. Krauss describes 41 species of land-snail from South Africa, and Mr. Benson has furnished a list containing 22 others; these are all peculiar, except a *Succinea* which appears to be only a variety of the European

* As Dr. Pfeiffer includes this (with a sign of doubt) amongst the synonymes of *B. auris-vulpinus* he must have suspected that the specimens came from St. Helena and not from St. Iago. The only other group of Bulimi resembling the St. Helena shells occurs in the Pacific Islands:—*Bulimus Caledonicus* at Mulgrave I.—*B. auris zovinæ* at the Solomons, and *B. shongi* in New Zealand.

S. putris, and two European Helices (H. *cellaria* and *pulchella*) probably imported to the environs of the Cape. There are also 3 slugs, 9 freshwater Pulmonifera, 7 marine Pulmonifera, 5 freshwater bivalves and 5 univalves. The species found at the Cape, Algoa Bay, Natal, &c., are for the most part different—*Potamides decollatus*, *Clionella sinuata* and an *Assiminea* inhabit brackish waters.

Limax	1				
Arion	1				
		Limnæa	1	Paludina	3
		Physa	4	Ncritina	1
Vitrina	4	Physopsis	1		
Helix	29	Ancylus	1	Corbicula	1
Succinea	4	Planorbis	3	Cyclas	1
Bulimus	9			Pisidium	1
Pupa	6	Vaginulus	1	Unio	1
Achatina	5	Oncidium	1	Iridina	1
Cyclostoma	6	Auricula	6		

5. Yemen—Madagascar.

The S. W. Highlands of Arabia (Yemen) form a distinct Botanical province isolated by rainless deserts to the north. The land snails consist of a few species of *Helix* and *Bulimus*, *Cyclostoma lithidion*, and 3 species of the section *Otopoma*, a group also found in Madagascar. Two species are common to the island of *Socotra*, (No. 30) which also has a species (of *Pupa*) common to Madagascar. *Bulimus guillaini*, *Cyclostoma gratum*, *modestum* and *Souleyeti* are found on the island of Abd-el-Gouri.

Very few land shells have been collected on the mainland of Eastern Africa, although it is a rainy region, and well wooded in the southern part; 5 species only are recorded from Mogadoxa and Ibu, belonging to the genera *Helix*, *Bulimulus*, *Achatina*, *Pupa*, and *Otopoma*. On the Island of Zanzibar are found, *Achatina Rodatzi*, and *allisa*, *Cyclostoma Creplini*, and *Zanguebarica*; *Pupa cerea* is common to Zanzibar and Madagascar.

Madagascar itself is rich in land shells; Dr. Pfeiffer enumerates—*Helix* 28 *sp.*, *Bulimus* 6, *Succinea* 14, *Pupa* 1, *Achatina* 4, (one of which, *eximia*, is allied to *A. Columna*, *of W. Africa*), and 32 Cyclostomidæ, chiefly of the section with spiral ridges (*Tropidophora*), 3 of the division *Otopoma*. *Cyclostoma cariniferum* and *Cuvieri* are found on the Island of Nosse Be; *Helix guillaini* on S. Maria I. Amongst the fresh-water shells are *Melania amarula*, *Melavatria fluminea* and *Neritina corona*.

The land shells of the *Mascarene Islands* are all peculiar; we are indebted to Mr. W. H. Benson for most of the information existing in respect to them.

Comoro Islands.

Helix russeola and *Achatina simpularia* are found in Mayotte; *Cyclostoma pyrostoma* in Mayotte and Madagascar.

Seychelles, (No. 31 of Map).

Parmacella Dussumieri
Helix unidentata
„ Studeri
„ Souleyeti
„ Tranquebarica
Streptaxis Souleyeti
Bulimus ornatus
„ fulvicans
Cyclostoma insulare
„ pulchrum
Cyclotus conoideus

Mauritius, (32).

Parmacella perlucida
„ Rangii
„ mauritii
Helix philyrina
„ inversicolor
„ stylodon
„ mauritiana
„ mauritianella
„ rawsoni
„ semicerina
„ mucronata
„ nitella
„ rufa
„ similaris
„ suffulta
„ albidens
Helix Barclayi
„ odontina
Vitrina angularis
Tornatellina cernica
Gibbus Antoni
„ Lyonneti
Succinea sp.
Bulimus clavulinus
„ Mauritianus
Pupa pagoda
„ fusus
„ sulcata
„ clavulata
„ modiolus
„ funicula
„ versipolis
Pupa Largillierti
Cyclostoma Barclayi
„ Michaudi
„ carinatum
„ undulatum
„ insulare?
Cyclotus conoideus?
Otopoma Listeri
„ hæmastoma
Realia rubens
„ aurantiaca
„ multilirata
„ expansilabris
„ globosa
Megalomastoma croceum

Two large species of *Achatina (fulica* and *panthera)* abounding in the coffee plantations, are believed to have been introduced. The fall of rain in Mauritius is 35.25.

Bourbon, (No. 33).

Helix cælatura
„ detecta
„ delibata?
Helix tortula
„ Brandiana
Pupa Largillierti—Mauritius.

Rodriguez.

Cyclostoma articulatum Madagascar?
Streptaxis—pyriformis.

No. 34. *Kerguelen's Land.* Helix Hookeri was collected at this island when visited by the Antarctic Expedition.

6. Indian Region.

Proceeding eastward, in Asia, the species of *Achatina*, *Pupa*, *Clausilia*, *Physa*, *Limax*, and *Cyclostoma* rapidly diminish or quite disappear. Helices of the section *Nanina* become plentiful, amounting to 150 species, and *Bulimulus* and *Cyclophorus* attain their maximum. *Leptopoma* and *Pupina* are peculiar to the Asiatic islands.

Our catalogue of Indian land shells must be very imperfect, including only about 180 *Helicidæ* and 50 *Cyclostomidæ*. A very few of the Indian species are common to China and the Asiatic Islands, or even to Ceylon. The shells of northern India resemble those of the Lusitanian region; in the south they

approximate more to the large and vividly coloured species of the Asiatic Islands. In the Himalaya land shells are numerous, and ascend as high as the region of Junipers and Rhododendrons, 4,000—10,000 feet above the sea.

Helix	37	Pupa	7	Cyclophorus	26
Nanina	46	Clausilia	7	Leptopoma	1
Ariophanta	8	Vitrina	9	Pterocyclus	10
Streptaxis	3	Succinea	7	Cyclotus	3
Bulimus	40	Parmacella	2	Megalomastoma	4
Achatina	13	Cyclostoma	3	Diplommatina	3

Parmacella and *Vaginulus* are found in India, and the typical fresh-water species of *Oncidium*. Ordinary forms of *Limnæa* and *Planorbis* are abundant, and there is one species of *Ancylus*. *Physa* occurs only in a fossil state or is represented by the singular *Camptoceras* of Benson. *Hypostoma Boysii*, *Auricula Judæ* and *Polydonta scarabæus* are also Indian forms.

The gill-breathing fresh-water shells of India are very numerous, especially the Melanias and Melanatrias, and species of *Pirena*, *Paludomus*, *Hemimitra* (retusa), *Ampullaria*, *Paludina*, *Bithynia*, *Nematura* (deltæ), *Assiminea* (fasciata), *Neritina* (particularly crepidularia and Smithii) *and Navicella* (tessellata).

The brackish-water species of *Cerithidium*, *Terebralia*, and *Pyrazus* are mostly common to India and North Australia.

The fresh-water bivalves are a few ordinary forms of *Unio*, 3 species of *Cyrena*, a *Corbicula* (of which 6 species have been made), *Cyclas Indica*, *Arca scaphula*, *Glauconya cerea* and *Novaculina gangetica*.

Ceylon.—The land-shells of Ceylon have been investigated by Mr. Benson who has favoured us with a list of 112 species; they most resemble those of the Neilgherry hills, but are nearly all specifically distinct, and even some of the genera are peculiar. It seems entitled to rank as a province. *Helix Waltoni* and *Skinneri*, are examples of the most characteristic form of Helices, the Vitrini-form type (*Nanina*) is also common. *H. hæmastoma*, one of the most conspicuous species, found on trees at P. Galle, is common to the Nicobar Islands. The Achatinas belong to a distinct section (*Leptinaria*, Beck) also represented on the Continent. Some of the *Bulimi* approach the Philippine forms.

Helix	36	Succinea	1	Pterocyclus	5
Nanina	9	Pupa	3	Aulopoma	4
Vitrina	3	Achatina	7	Leptopoma	7
Streptaxis	2	Cyclophorus	12	Cataulus	10
Bulimus	11				

The fresh-water shells belong to the genera Limnæa, Physa, 2 species, (not found on the Continent); Planorbis, Melania, Tanalia 10 (peculiar), Paludomus, Bithynia, Ampullaria, Neritina, Navicella, Unio, and Cyrena.

At the Nicobar Islands are found—Cataulus tortuosus, Helicina Nicobarica and Pupina Nicobarica. *Helix castanea* is from Sumatra. (*Beck*).

7. China and Japan.

The few land-snails known from China are of Indian and Lusitanian types; viz.—Helix 12, Nanina 4, Streptaxis 1, (Cochin-China), Bulimus 5, Achatina 1, Pupa 1, *Clausilia* 11, Succinea 1, *Helicarion* 6, Cyclophorus, 1, Cyclotus 1, Otopoma 1. In the I. of Chusan Dr. Cantor discovered the genera *Lampania* and *Incilaria*. The most characteristic bivalves are *Glauconya Sinensis* and *Symphynota plicata*; 3 species (or varieties) of Cyrena and 9 Corbiculas are described by Deshayes, and a *Planorbis* by Dunker.

In the Japanese and Loo-choo Islands only 9 species of Helix, 2 of Nanina, 2 of Clausilia and 2 of Helicarion have been hitherto obtained.

8. Philippine Islands.

The extraordinary richness of these islands has been developed mainly by the researches of Mr. Cuming. The *Helicidæ* (above 300) are inferior in number only to those of Lusitania and the Antilles, and vastly superior in size and beauty of colouring. The *Cyclostomidæ* (55) are not much fewer than in India. Nearly all the species are confined to particular islands, and the repetition of forms makes it probable that many of them are geographical varieties. The climate is equable, with a temperature like that of S. China (66°—84°) woods are prevalent, and the rains heavy—all circumstances favourable to the *individual* abundance of land snails.

Helix	152	Clausilia	1	Cyclotus	6
Nanina	32	Vitrina	14	Megalomastoma	1
Helicarion?	3	Cyclophorus	15	Pupina	9
Bulimus	95	Leptopoma	16	Helicina	7

The Helices belong in great part to the section *Callicochlias* (Ag.) and *Helicostyla* (mirabilis) Fér. Some with sharply-keeled whirls have been called *Geotrochi* (Iberus of Albers.) The Bulimi are chiefly of the section *Orthostylus* (Beck), large and highly coloured, with a *hydrophanous* epidermis, the bands becoming translucent when wetted; others, like the well-known *B. perversus*, represent the typical Brazilian forms. To these islands belong most of the helicina-shaped *Cyclophori* (*Leptopoma*.)

The fresh-water shells are numerous; above 100 were obtained by Mr. Cuming, including many species of *Melania* (54?) *Navicella lineata* and *suborbicularis*, 5 sp. of *Glaucomya*, *Unio verecundus*, a *Corbicula*, and 11 sp. (?) of *Cyrena*.

Celebes and *Moluccas*. From these islands we have on record, at present, 16 sp. of Helix, Nanina 19, Bulimus 3, Vitrina 2, (viridis and flammulata, Quoy), Cyclophorus 1. In the fresh-water ponds and rivulets Mr. A. Adams found sp. of Melania, Assiminea, Ampullaria and Navicella; Auricula subulata, and Conovulus leucodon. Neritina sulcata was found on the foliage of trees several hundred yards from the water.

9. JAVA.

The Java group, including Floris and Timor, have been partially explored from the head-quarters of the Dutch settlement at Batavia. The land and fresh-water shells are nearly all peculiar, a few only being common to the Philippines and N. Australia; they have been described and figured by M. Albert Mousson (8vo. Zurich, 1849, 22 plates).

Helix	15	Platycloster?	3	Navicella	2
Nanina	8	Meghimatium	2		
Ariophanta	1			Unio and Symphynota	4
Bulimus	10	Limnæa	1		
Clausilia	6	Auricula	2	Alasmodon	2
Cyclophorus	4			Anodon	1
Cyclotus	2	Melania	5	Cyrena	7
Leptopoma	1	Ampullaria	1	Corbicula	4
Parmacella	3	Neritina	2		

10. BORNEO.

The land shells of this great island are almost unknown, and the only reason for mentioning it separately is the doubt whether it should be considered part of the Javanese Province, or associated with the Moluccas and Philippines.

Helix	12	Paxillus	1	Leptopoma	3
Nanina	8	Succinea	2	Cyclotus	1
Bulimus	1	Cyclophorus	2	Pterocyclus	2

The freshwater bivalves are Glaucomya rostralis, Corbicula tumida and Cyrena triangularis. *Pholas rivicola* was found burrowing in floating logs used as landing places, 12 miles from the sea, up the Pantai river. The mangrove swamps abound with Cerithidium, Terebralia Telescopium, Potamides palustris and Quoyia; Auricula Midae and Polydonta scarabæus inhabit the damp woods.

11. PAPUA AND NEW IRELAND.

The landshells of New Guinea are nearly all distinct from those of the Philippines and Moluccas and include some related to the Polynesian types. The Louisiade Islands to the south-east and New Ireland on the North of New Guinea are included with it.

Helix	26	Partula	3	Leptopoma	1
Nanina	4	Pupina	3	Cyclotus	1
Bulimus	2	Otopoma	1	Helicina	2

Cyrenæ are numerous in this region. *Cyclostoma australe* is common to the Australian Islands and New Ireland; *C. Massenæ* to Australia and New Guinea, and *C. Vitreum* to New Ireland, New Guinea, the Philippines and India.

12. Australian Region.

Both Fauna and Flora of Tropical Australia are distinct from those of New South Wales and Tasmania, the principal barrier being the desert character of the interior; but the localities of the landshells have not been defined with sufficient accuracy to shew whether they are equally distinct. The most complete list is given by Prof. E. Forbes, in the Appendix to Mc Gillivray's Narrative of the Voyage of H. M. S. Rattlesnake (1846-50); it specifies 48 Helices (of which *H. pomum* is the most conspicuous), 10 Bulimi, an Achatina, 6 Vitrinas (*Helicarion*) belonging to the main land, and one from the Lizard Islands, and a dextral *Balea* (australis). Pupa and Helicina (*Gouldiana*) are only found on the islets off the N. E. coast, and Pupina (*bilinguis*) at C. York and the adjacent islets; a portion of the province which is densely wooded, and lies within the *rain region* of the Asiatic Islands. *Cyclostoma bilabre* of Menke's Catalogue is probably West Indian. The fresh-water shells of Australia are *Planorbis Gilberti, Iridinae ?* (Victoria R.) *Unio auratus, cucumoides, superbus,* (*Hyridella*) *australis, Corbicula* 4 sp. *Cyrena* 3, *Cyclas egregia* (Hunter R.) *Pisidium semen* and *australe,* the last common to Timor.

13. S. Australia and Tasmania.

From extra-tropical Australia we have the following:—Helix 9, Helicarion 2, Bulimus 2, Succinea 1 (common to Swan R. and Tasmania) Limax olivaceus, and one Ancylus. Two of the largest land snails, *Helix Cunninghami* and *Falconeri*, are found in N. South Wales. The coasts of this region are thinly wooded, but much of it is rendered desert by want of rain; in N. S. Wales droughts recur at intervals of twelve years, and sometimes last three years, during which time scarcely any rain falls.

14. New Zealand.

The moist and equable climate of these islands (which have a mean temp. of 61°—63°) is favourable to the existence of numerous land snails. Nearly 100 species of land and fresh-water shells are already determined, and are all peculiar; the genus *Helix* musters 60 species, some of which (including the great *H. Busbyi*) resemble in shape the European *Helicellae;* Bulimus 3; Balea (peregrina), Vitrina 2 of peculiar form, Tornatellina 1, Cyclophorus cytora and Omphalotropis egea. There are two slugs, Limax antipodarum and Janella bitentaculata; two fresh-water *pulmonifera*, Physa variabilis and Latia neritoides; several marine air-breathers,—Oncidium (*Peronia*) 2, Siphonaria 3, Amphibola 1 (*avellana*). The other fresh-water shells are Melanopsis trifasciatus (a Lusitanian type), Assiminea antipodarum and Zelandiæ, Amnicola? corolla, Cyclas Zelandiæ and Unio Menziesii and Aucklandicus.

Vitrina zebra is found at the Auckland Islands.

15. Polynesian Region.

The Pacific Islands are partly the volcanic summits of submerged mountain ranges, usually fringed or surrounded with coral reefs; and partly *atolls* or lagoon islands, scarcely rising above the sea and presenting no vestige of the rock on which they are based. The low coral-islands form a long stream of archipelagos, commencing in the west with the Pelews, Carolines, Radack, Gilbert, and Ellice groups, then scattered over a wider space and ending eastwards in the Low Archipelago; they are chiefly, perhaps entirely, colonized by drift from the other islands.

The volcanic groups are the Ladrones, Sandwich Islands and Marquesas, to the north of the low coral zone; and to the south of it, the Salomons, New Hebrides, New Caledonia and Feejees,—the Friendly Islands, Navigator's and Cook's Islands,—Society and Austral Islands, ending with Pitcairn's and Elizabeth Island. Many of these are very lofty, and are perhaps the most ancient land in the world.* Their molluscan fauna is entirely peculiar, but it has most affinity with those of New Zealand and the Asiatic Islands, and great analogy with those of St. Helena, Brazil, and the W. Indies.

Salomons—New Hebrides—New Caledonia—Feejees.

The most remarkable land-shells of these islands are the great auriculoid, *Bulimi* (e. g. *B. auris-bovinæ* and *B. miltochilus* of the Salomons). *Acicula striata* and 2 sp. of *Cyrena* are found at Vanicoro; and *Physa sinuata Peronia acinosa* and *corpulenta*, and several Neritinas and coronated Melanias have been obtained at the Feejees.†

Helix	18	Bulimus	10	Cyclophorus	2
Nanina	2	Partula	6	Omphalotropis	1
Vitrina	6	Acicula	1	Helicina	6

Friendly Islands—Navigator's—Society Islands.

The principal lofty and rocky islands of the southern Pacific, at which land-shells have been obtained, are Tonga, Samoa, Upolu and Manua; Taheiti, Oheteroa, and Opara; Pitcairn's Island and Elizabeth Island. Each appears to have some peculiar species and some common to other islands; the little raised coral islet Aurora (*Metia*) N. E. of Taheiti, 250 feet in elevation, has four land snails which have been found nowhere else;—*Helix pertenuis, dædalea, Partula pusilla, Helicina trochlea.* "Samoa and the Friendly Islands must have intimate geological relations; the same forms, and many of the same species of land-shells occur on both groups; not a single Feejeean species was collected on either."—(*Gould.*)

* Islands composed partly of stratified rocks must be *newer* than those rocks; Volcanic Islands may be of any degree of antiquity.

† The Feejees (*Viti*) are more nearly allied to the westward islands, such as the New Hebrides, than the Friendly Islands. *Succinea* and *Partula*, so plentiful at the latter, are not found at the Feejees.—(Gould, U. S. Exploring Expedition,)

Helix 13	Tornatellina..... 6	Cyclophorus 5
Nanina 18	Pupa 3	Omphalotropis 6
Bulimus 1	Succinea 12	Helicina 13
Partula 15	Electrina 1	

The fluviatile shells are species of *Physa, Melania, Assiminea* (*Taheitana*), *Neritina*, and *Navicella;* the two last being often litoral, or even marine in their habit.

Low Coral-islands.

The Atolls, or lagoon-islands, are less prolific; 2 *Helices*, and 2 *Partulæ* are found at Oualan, in the Caroline Archipelago; and from Chain Island (*Annaa*), the centre of commerce in the eastern Archipelago, have been obtained.—*Helix* 2 sp., *Nanina* 1, *Partula* 1, *Tornatellina* 1, *Cyclophorus* 1, and *Melampus mucronatus*.

Sandwich Islands.

The land shells of these islands exceed 100, and are all, or nearly all, peculiar; there is one *Limax;* and in the fresh-waters are found *Limnæa volutatrix, Physa reticulata* (Gould), *Neritopsis*? *Neritina Nuttalli* and *undata*, and *Unio contradens* (Lea).

In the I. Kaui, two species of *Achatina* have been found; the Achatinellæ are elongated (*Leptachatina*, G.) and the Helices planorboid and multispiral. In Molokai the Achatinellæ are large and coloured. In Maui and Oahu the Helices are small and glabrous, or hispid, ribbed and toothed. In Hawaii, Succineas prevail, and Achatinellae are rare.—(*Gould*).

Helix 13	Achatina 3	Pupa 2
Nanina 4	Achatinella 56	Vitrina 2
Bulimus 5	Tornatellina..... 3	Succinea 10
Partula 4	Balea 1	Helicina 6

The Island of Guam, Ladrones, has 3 sp. of *Partula*, 2 of *Achatinella*, and 1 *Omphalotropis*. At the Marquesas have been found 3 sp. of *Nanina*, 1 *Partula* and 1 *Helicina*.

NEW WORLD.

16. Canadian Region.

The country drained by the Great Lakes and the river St. Lawrence possesses very few peculiar shells, and these mostly of fresh-water genera. It is chiefly remarkable for the presence of a few European species, which strengthen the evidence before alluded to (p. 358.) of a land-way across the north Atlantic having remained till after the epoch of the existing animals and plants.*

* For example, the common Heather (*Calluna vulgaris*), one of the most abundant *social* plants of Europe, characteristic of the moorland zone, and seldom rising above 3000 feet on the mountains of Scotland.—(*Watson.*) According to Pallas it abounds on the western flanks of the Ural Mountains, but disappears on their eastern side and is not found in Siberia. In the *Pliocene period* it appears to have spread itself nothward and westward to Iceland, Greenland and Newfoundland, where it still grows, *the only heath indigenous to the New World.*—(Humboldt.)

Helix hortensis (imported) coast of New England and banks of St. Lawrence.
„ pulchella (smooth var. only) Boston, Ohio, Missouri.
Helicella cellaria (glaphyra, Say ?) N. E. and middle States.
„ pura, nitida and fulva ?
Zua lubrica, North West Territory.
Succinea amphibia (= campestris, Say ?)
Limax agrestis (= unicatus, G.) Mass.
„ flavus, New York, introduced.
Vitrina pellucida (= Americana ?) **Limnæa palustris** (= elodes, Say ?)
Arion hortensis, New York (Dekay.) „ **truncatula** (= desidiosa ?)
Aplexa hypnorum (= elongata, Say ?)
Auricula deticulata, Mont., New York Harbour.
Alasmodon margaritiferus (= arcuatus, Barnes.)
Anodon cygneus (= fluviatilis, Lea ?)

The shells proper to Canada, or derived from the adjoining States, are only 6 sp. of Helix, 2 Succineas, and 1 Pupa; 8 sp. of *Cyclas* have been obtained from the region of Lake Superior.

The following species occur in New England:—

Helix	13	Physa	2	Unio	5
Succinea	2	Planorbis	11	Alasmodon	2
Pupa	7	Paludina	1	Anodon	2
Limnæa	7	Valvata	2	Cyclas	6
Ancylus	2	Auricula	1	Pisidium	1

Carychium exiguum, Say, is found in Vermont, and *Limnæa* (Acella) *gracilis* in Lake Champlain; *Valvata tricarinata* and *Paludina decisa* are characteristic forms.

The genera *Clausilia* and *Cyclostoma* are entirely wanting in Canada and the Northern states. The *Limacidæ* are represented by *Philomycus*, of which there are 9 reputed species, ranging from Mass. to Kentucky and South Carolina.

17. Atlantic States.

The parallel of 36° N. Lat. forms the boundary-line of two botanical regions in the U. States, but the evidence of the fresh-water shells, in which they are particularly rich, seems to favour a division into two hydrographical provinces,—the region of the Atlantic streams and the basin of the Mississippi. Above 50 fresh-water *Pulmonifera*, 150 *pectinibranchiata*, and 250 bivalves are reputed to be found in the States, and it is supposed that only a few species are common to both sides of the Alleghanies. *Cyclas mirabilis*, *Pisidium Virginicum*, *Cyrena Carolinensis*, and *Unio complanatus* and *radiatus* are characteristic of the eastern rivers; *Melania depygis* is said to be the only member of that large genus found eastward of the Hudson River. Of the American land-snails, 29 sp. of Helix, 6 Succineas, and 13 Pupas are enumerated from the Atlantic States. In Florida the propinquity of the West Indian Fauna is strongly indicated by the occurrence of the great *Glandina truncata*, by species of *Cylindrella*, and a *Helicina*. A Cuban species of

Chondropoma (C. dentatum), is also said to occur in Florida, and *Ampullaria depressa* in Florida and Georgia.

18. American Region.

The mass of American land and fresh-water shells are found in the central and southern states, the country drained by the Mississippi and its tributaries. The *Helicidæ* are not more remarkable for size and colour than those of northern Europe; the most characteristic forms belong to the subgenus *Polygyra* (or *Tridopsis*, Raf.), such as *Helix tridentata, albolabris, hirsuta,* and *septemvolris*. The truly North American forms all belong to three genera, viz.—Helix 43, Succinea 8, Pupa 3 species. In the Southern States are also found 5 sp. of Bulimus, 3 Cylindrellas, 2 Glandinas, and 5 Helicinæ, genera whose metropolis is in the Antilles or in tropical America.

The fresh-water univalves include above 100 species of *Melaniadæ* belonging to the genera *Ceriphasia, Melafusus, Anculotus, Melatoma,* and *Amnicola,* 15 *Paludinæ,* some keeled, and one muricated, (*P. magnifica*); and species of *Valvata, Limnæa, Physa,* (15) *Planorbis,* and *Ancylus,* (5).

The fresh-water bivalves are also extremely numerous; the *Unionidæ* are unequalled for their ponderous solidity, the rich tinting of their interiors, and the variety of their external forms.* *Gnathodon cuneatus, Cyrena floridana,* 16 sp. of *Cyclas,* and *Pisidium altile,* belong to this region.

19. Oregon and California.

The Fauna of the region beyond the Rocky Mountains is believed to be almost entirely distinct from that of the United States. *Arion* (foliolatus) and *Limax* (Columbianus,) genera not indigenous to eastern America, were found near Puget Sound, (*Gould*). We have no information respecting the land and fresh-water shells of Russian America, but from analogy we may expect to find a few there identical with those already mentioned as occurring in Siberia †

The shells of Oregon and California are as yet only imperfectly known by the researches of Mr. Nuttall and Mr. Conthouy.

Helix	22	Physa	1	Cyrena	2
Bulimus	1	Ancylus	2	Cyclas	1
Achatina	1	Planorbis	3	Unio	1
Succinea	4	Melania	2	Alasmodon	1
Limnæa	4	Potamides	2	Anodon	3

Limnæa fragilis, a Canadian species, is said to range westward to the Pacific; and *L. jugularis* to be common to Michigan, the North-west terri-

* The private cabinet of Mr. Jay contains above 200 species of North American *Unionidæ*, and very many varieties.

† The affinity between the *Mammalia* of the Old and New Worlds is greatest in eastern Asia and north-west America, and diminishes with distance from those regions. —(*Waterhouse*, in Johnston's Physical Atlas, No. 28.)

tory and Oregon(De Kay.) *Limnæa umbrosa*, Say? and *Planorbis corpulentus* Say, are found in the Columbia R.

20. Mexican Region.

The lowlands of the northern half of Tropical America constitute only one botanical region, extending from the R. Grande del Norte to the Amazon; but on zoological grounds it may be divided into two smaller areas. The Mexican province, including Central America, itself comprises three physical regions; the comparatively rainless and treeless districts of the west; the mountains or high table-lands with their peculiar flora; and the rainy wooded region that borders the Caribbean Sea. The land snails of Central America resemble those of the Antilles in the prevalence of some characteristic genera—*Glandina, Cylindrella* and *Helicina*,—of which very few species are found on the northern Coast of the Gulf of Mexico. The *Bulimi* are numerous but chiefly thin, translucent species.

Helix	33	Glandina	25	Cistula	7
Proserpina	1	Tornatellina	1	Cyclophorus	3
Bulimus	30	Pupa	1	Chondropoma	3
Succinea	6	Cylindrella	11	Megaloma	2
Achatina (Spiraxis)	12	Cyclotus	1	Helicina	22

Amongst the fresh-water shells are *Neritina picta, Cyclas maculata, Corbicula convexa*, and 7 species of *Cyrena*. From Mazatlan, Mr. Carpenter describes *Cyrena olivacea* and *Mexicana, Gnathodon trigonus, Anodon ciconia* (allied to the Brazilian *A. anserina*), *Physa aurantia* and *elata, Planorbis* sp. *Melampus olivaceus*. Two brackish-water species, *Cerithidium varicosum* and *Montagnei*—are common to S. America.

21. Antilles.

The West Indian Islands have supplied nearly 500 species of *Helicidæ*, a larger number than any province except the Lusitanian; and above 260 *Cyclostomidæ*, or nearly 3 times as many as India. They are also richest in generic forms, and the climate is highly favourable to the multiplication of individuals. The mean temp. of the Antilles is 59°—78°, and the annual fall of rain exceeds 100 inches in most of the islands.

Helix	200	Pupa	26	Cyclophorus	1
Stenopus	2	Cylindrella	73	Cyclotus	14
Sagda	20	Clausilia	1	Megaloma	8
Proserpina	5	Balea	1	Helicina	43
Bulimus	53	Succinea	16	Alcadia	17
Achatina	27	Chondropoma	15	Trochatella	16
Glandina	46	Choanopoma	53	Lucidella	6
Spiraxis	9	Adamsiella	10	Stoastoma	20
Tornatellina	1	Cistula	36	Geomelania	21

Probably every island has some peculiar species, and those of the great islands, like Cuba and Jamaica are nearly all distinct. To Jamaica belong

the species of *Stoastoma*, *Sagda* and *Geomelania*, the small subgenus *Lucidella*, the *Alcadias* and the mass of beautiful Cyclostomas with a decollated spire and fringed lip (*Choanopoma*, *Adamsiella*, *Jamaicia*, *Chondropoma*, part, and *Cistula*, part.* The solitary *Clausilia* is found in P. Rico, the *Balea* in Haiti, and the *Tornatellina* in Cuba; *Stenopus* is peculiar to St. Vincents. Bermuda has 4 Helices of which one is common to Texas and one to Cuba. The Chondropomas are found in Cuba and Haiti.

The West Indian *Achatinæ* belong to the subgenera *Glandina*, *Liguus*, and *Spiraxis*; the *Bulimi* are sharp-lipped and mostly small and slender (*Subulina*, *Orthalicus*). *Helix* (Sagda) *epistylium*, *H. Carocolla*, and *Succinea* (Amphibulima) *patula* are characteristic forms.

Although connected with Florida by the chain of the Bahamas, and with Trinidad by the Lesser Antilles, very few species are common to the mainland of either North or South America; the relation is generic chiefly.

The *Limacidæ* are represented by *Vaginulus* (Sloanei); and in the fresh-waters there are species of *Physa* (3,) *Planorbis*,8, *Ancylus* and the peculiar *Gundlachia*, *Valvata pygmæa*, *Ampullaria* (fasciata), *Paludestrina* (minute sp.) *Hemisinus*, and 2 sp. of *Pisidium*.

In the brackish-waters are *Cerithidium*, *Neritina* (e. g. meleagris, pupa, virginea, viridis), *Melampus* (coniformis) and *Pedipes quadridens*.

22. Columbian Region.†

The tract shaded in the map comprehends several minor regions; 1, the rainy and wooded states of New Granada and Ecuador; 2, the elevated and nearly rainless province of Venezuela, with a flora like that of the higher regions of the Andes; 3, the Guianas, including the Valley of the Amazon, where the forests are most luxuriant, and rain falls almost daily (amounting to 100 or even 200 inches in the year). Most of the low lands, like those of the Mexican Province, belong to the "Cactus Region" of botanists, and have a mean temp. of 68°—84°. Landshells are abundant in the forests and underwood of the lower zone of the mountains, where the temperature is 10° less and the rains more copious. *Bulimi* are the predominant forms, especially the succinea-shaped species, (e. g. *B. succinoides*).

Helix	37	Pupa	7	Cistula	1
Streptaxis	3	Clausilia	3	Bourciera	1
Bulimus	45	Cylindrella	1	Cyclotus	8
Succinea	9	Vitrina	1	Adamsiella	1
Tornatellina	1	Limax	1	Helicina	6
Achatina	10	Choanopoma	2	Trochatella	1
Glandina	5	Cyclophorus	2		

* A magnificent collection of Jamaica land shells has been presented to the British Museum by the Hon. E. Chitty whose researches were conducted with the late Prof. C. B. Adams.

† In 1821 the states of New Granada, Venezuela and Ecuador united to form the "Columbian Republic," but dissolved again in 1831.

The presence of several species of the old-world genera *Clausilia* and *Streptaxis*—both wanting in North America, becomes a significant fact when taken in connection with the affinities of the higher animals of South America and Africa. These imply a land-way across the Atlantic (at some *very remote* period,) more direct than would be afforded by the continent which is believed to have united the boreal regions at the close of the Miocene Age.*

Corbicula cuneata and 3 sp. of *Cyrena* are found in the Orinoco and smaller rivers; and the remarkable genus *Mülleria,* representing the African *Ætheria,* inhabits the Rio Magdalena. A sp. of *Ancylus* is recorded from Venezuela.

Galapagos Islands. No. 35.

The fauna and flora of these islands is peculiar, but related to tropical South America. The only known land-shells are 11 small and obscure species of *Bulimus,* of which the most remarkable is *B. achatinellinus.* Some of them are peculiar to particular islands, like the birds and reptiles, viz:—Chatham I. 2, Charles I. 3, Jacob I. 2, James I. 1. "The Archipelago is a little world within itself, or rather a satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions."—(Darwin's Journal, p. 377.)

23. Brazilian Region.

The "region of Palms and Melastomas," extending from the Amazon to the southern tropic, is one of the richest zoological provinces. It includes Bolivia, and the largest portion of Peru, all that lies to the east of the Andes. The greater part of the region is mountainous and rainy and densely wooded, but intersected by extensive plains (*Llanos*), some grassy and fertile, others dry, rocky and rainless, especially in the south; it is watered by numerous streams—the affluents of the Amazon and Plata. The hydrographical areas of these two great rivers have been represented on the map, but the southern boundary of the Brazilian Province extends beyond the line of water-shed to the tropic, including the head-waters of the Plata, in which the same remarkable fresh-water bivalves are found as in the Bolivian streams. (*D'Orbigny*). The mountains around the Lake Titicaca are the highest in the New World, and there M. D'Orbigny found several species of Helix up to the elevation of 14,000 feet; *Bulimus Tupaici* ranges to 9,000 feet. The large and typical species of *Bulimus* belong to this province; *B. ovatus* and *oblongus* are found near the coast, (p. 164,) and *B. maximus* farther inland. The auriculoid *Bulimi,* (*Otostomus,* and *Pachyotis,* Beck,) those with an

* In Lieut. Maury's physical map of the Atlantic, the contour of this former land is partly shewn by the 2000 fathom line, extending beyond the Canaries and Madeira, and sending out a promontory to the Azores. *Clausiliæ* are found in Eocene strata; perhaps even in the Coal-measures, (p. 160.)

angular mouth, (*Goniostomus*, Beck,) and the pupiform species, with a toothed aperture, (*Odontostomus*,) are characteristic of this region, and also some of the most elongated forms, (*Obeliscus*). The lamp snails (*Anastoma*) and *Megaspira*, genera inhabiting France during the Eocene period, are now peculiar to Brazil; *Simpulopsis* is also peculiar, and *Streptaxis* attains its maximum there. The *Cyclostomida* are few, and the other W. Indian forms have almost disappeared.

Helix	34	Glandina	1	Cyclophorus	2
Streptaxis	9	Tornatellina	1	Cyclotus	1
Anastoma	7	Vitrina	5	Cistula	1
Bulimus	172	Omalonyx	1	Helicina	12
Megaspira	2	Simpulopsis	5		

The land slugs are *Peltella palliolum, Vaginulus solea, and Limax andicolus*. The fresh-waters of the interior are rich in bivalves of peculiar genera;*—

Physa	1	Ampullaria	2	Unio	4
Ancylus	1	Corbicula	2	Iridina	1
Planorbis	4	Pisidium	1	Hyria	1
Paludestrina	2	Anodon	1	Castalia	2
Marisa	1	Monocondylæa	1	Mycetopus	3

24. Peruvian Region.

The long and narrow tract between the Andes and Pacific, extending from the equator to 25° S. lat. forms a distinct, though comparatively unproductive province, including the coast of Ecuador, Peru and Bolivia. It is warm and almost rainless; the clouds discharge themselves on the east side of the Andes, and rain is so rare on the west coast that in some parts it only falls two or three times in a century. In Peru, during great part of the year, a vapour rises in the morning, called the "garua;" it disappears soon after mid-day, and is followed by heavy dews at night.

Mr. Cuming collected 46 species of land snails in Peru; and Dr. Pfeiffer enumerates 100, but perhaps half the latter were from the eastern side of the Andes, belonging to the Brazilian Province. They are mostly *Bulimi*, and are smaller and less richly coloured than those of Bolivia and Brazil: *B. Denickei, solutus*, and *turritus* are peculiar forms. *Cistula Delatreana* is the only operculated land snail, and *Vaginulus limayanus* the only slug.

Helix	12	Pupa	1	Ancylus	1
Bulimus	79	Balea	1	Ampullaria	1
Succinea	5	Cistula	1	Paludestrina	2
Glandina	1	Physa	1	Cyrena	3
Tornatellina	1	Planorbis	3	Anodon	1

25. Argentine Region.

The "region of arborescent Compositæ" has afforded scarcely any land

* The American Expedition explored 40 Brazilian streams, and found only 1 *Ampullaria*, 1 *Melania*, and 1 *Planorbis*.—(Gould.)

snails, only 7 species of *Bulimus*, and 3 *Helices* are recorded, but some others may have been included with those of Brazil and Chile. From Bolivia this province is separated by the wide plains of the Great Desert, or northern prolongation of the Pampas; and all the eastern part has been submerged at a recent (geological) period; so that the only promising districts are Paraguay, and the eastern declivities of the Chilian Andes. The fresh-water shells of the La Plata and its tributaries are more remarkable; M. D'Orbigny gives the following:—

Chilinia	1	Cyclas	1	Byssoanodon	1
Planorbis	1	Pisidium	1	Monocondylæa	6
Ancylus	2	Corbicula	2	Mycetopus	1
Ampullaria	7	Unio	7	Castalia	1
Asolene	1	Anodon	10	Iridina	1
Paludestrina	7				

Ampullaria (Marisa) *cornu-arietis* is a characteristic shell; *Paludestrina lapidum* has a claw-like (non-spiral) operculum, and appears to belong to the *Melaniadæ*.

26. Chilian Region.

The northern part of Chile belongs to the same physical region with Peru, consisting of dry and rainless plains. Here the land snails are few and small, and only seen after the dews. At Valparaiso rain is abundant during the three winter months, and the southern coasts are luxuriantly wooded, and extremely wet. The characteristic pulmonifera are the fresh-water *Chilinias*. The genus *Buchanania* is doubtful. There are 25 sp. of Bulimus (including *B. Chilensis*, Plectostylus) and 4 of Helix; *Succinea Chiloensis*, *Ancylus Gayanus* (Valparaiso), *Planorbis fuscus*, *Paludestrina* sp. *Unio Chilensis*, *Pisidium Chilense* (Valdivia). *Helix Binneyana* is found on the Island of Chiloë.

The Island of *Juan Fernandez* (36) has at least 20 species of land shells, all peculiar to it:—

Helix quadrata	Omalonyx Gayana	Tornatellina minuta
„ arctispira	Achatina diaphana	„ trochiformis
„ pusio	„ splendida	Succinea Cumingi
„ tessellata	„ bulimoides	„ mamillata
„ ceroides	„ conifera	„ fragilis
„ marmorella	„ acuminata?	Parmacella Cumingi.
„ helicophantoides	Spiraxis consimilis	

In the adjoining Island, Masafuera, are found—

Tornatellina Recluzii	Succinea semiglobosa
Succinea rubicunda	„ pinguis

27. Patagonian Region.

The Pampas, or great plains of Patagonia are dry and rainless nearly all the year; the vegetation which springs up during the light summer rain becomes converted into natural hay for the support of the wild animals. In

Fuegia the mean temperature is 33°—50°, and there is rain and snow throughout the year; yet the bases of the mountains are clothed with forests of evergreen beech.* *Bulimus sporadicus* is found on the banks of the River Negro, and *B. lutescens* at the Straits of Magellan; *Helix lyrata* (costellata, D'Orb. ?) and H. *saxatilis* inhabit Fuegia. *Succinea magellanica* is also found at the Straits, and *Chilinia fluminea*, *Limnæa viatrix*, a *Paludestrina*, *Anodon puelchanus*, and *Unio Patagonicus* in the River Negro. *Peronia marginata* and *Potamides cælatus* were discovered in Fuegia by Mr. Couthouy.

The *Falkland Islands* are 300 miles east of Patagonia, and the only recorded shells are two species of *Paludestrina*. There is zoological evidence that these islands were united to the mainland of S. America at no very distant geological period. The flora consists of characteristic plants of Fuegia and Patagonia, mingled, and overspreading the whole surface; few species are peculiar. (J. D. Hooker).†

Since the preceding pages were in type we have seen the following remark by Dr. Gould, referring to certain statements about the distribution of shells (p. 354). "The doctrine of *distinct zoological regions* is well illustrated by the mollusca. The many thousand localities carefully noted on the records of the American Exploring Expedition go to prove beyond dispute, that no such random or wide-spread distribution obtains."

* Humming-birds are seen fluttering about delicate flowers, and parrots feeding amidst the evergreen-woods. (*Darwin*, p. 251.)

† Dr. Hooker has suggested that not only the Falkland Islands, but the far distant Tristan d'Acunha (p 390) and Kerguelen's-land (p. 392) may be mountain-tops of a continent which has been submerged since the epoch of their existing flora. "There are five detached groups of islands between Fuegia and Kerguelen's land, (a region extending 5,600 miles,) all partaking of the botanical peculiarities of the southern extremity of the S. American continent. Some of these detached spots are much closer to the African and Australian continents, whose vegetation they do not assume, than to the American; and they are situated in latitudes and under circumstances eminently unfavourable to the migration of species."

"The botany of Tristan d'Acunha (which is only 1,000 miles distant from the Cape of Good Hope, but 3,000 from the Straits of Magellan) is far more intimately allied to that of Fuegia than Africa. Of 28 flowering plants, 7 are natives of Fuegia, or typical of S. American botany."

"The flora of Kerguelen's-land is similar to, and many of the species identical with, those of the American continent. (Its geological structure) would bespeak an antiquity for the flora of this isolated speck on the surface of our globe, far beyond our power of calculation. We may regard it as the remains of some far more extended body of land."—(Botany of Antarctic Voyage, I. Pt. 2, 1847.)

GEOGRAPHICAL DEVELOPMENT.

Rough estimate of known Species proper to each Province.

	Marine Provinces.			Land Regions.	
I.	Arctic	100	1.	Germanic	100
II.	Boreal (New England)	200	2.	Lusitanian	900
			3.	African	150
III.	Celtic	250	4.	Cape	60
IV.	Lusitanian (Medit. Madeira, &c.)	450	5.	Mascarene	150
			6.	Indian	350
			7.	Chinese	50
V.	Aralo-Caspian (N. Euxine)	30	8.	Philippine	350
			9.	Javanese	80
VI.	West African (St. Helena)	500	10.	Bornean	30
			11.	Papuan	80
VII.	South African	350	12.	Australian	80
VIII.	Indo-Pacific	4000	13.	Austro-Tasmanian	50
IX.	Austro-Zelandic (Tasmania)	400	14.	Zelandic	80
			15.	Polynesian	300
X.	Japonic	300	16.	Canadian	30
XI.	Aleutian (Ochotsk)	100	17.	Atlantic States	60
			18.	American	80
XII.	Californian.	250	19.	Californian	30
XIII.	Panamic (Galapagos)	1000	20.	Mexican	170
			21.	Antillean	760
XIV.	Peruvian	500	22.	Equatorial	180
XV.	Magellanic (Falklands)	100	23.	Brazilian	260
			24.	Peruvian	100
XVI.	Patagonian	170	25.	Argentine	50
XVII.	Caribbean	1000	26.	Chilian	60
XVIII.	Trans-Atlantic	300	27.	Patagonian	10
	Sea-Shells	10,000		Land-Shells	4,600

The inequality of these provinces, in size and importance, is partly natural, and partly caused by the unequal facilities they present for sub-division. The "Indo-Pacific" is not of the same rank with the Japonic, but results from the fusion of several provinces. Mr. Waterhouse terms the great regions in which the large groups of animals are distinct, *ordinal* and *family* provinces; the smaller regions *generic* or *specific* provinces.—(Johnston's Physical Atlas, 28.)

Chapter III.

ON THE DISTRIBUTION OF THE MOLLUSCA IN TIME.

The historian of modern geology, Sir Chas. Lyell, has taught us to regard the stratified rocks as so many monuments, recording the physical condition and living inhabitants of the earth in past ages.

Each *formation* consists of a similar, and more or less complete series of limestones, sandstones, clay, coal, and other *strata*, representing the deep and shallow seas, the fresh-waters, and the terrestrial portions of the surface of the globe, at one particular period of time.*

The organic remains found in the strata exhibit no such repetitions, but are changed gradually and regularly, from the earliest to the latest formations; so that the *mass of species* in each period must have been peculiar and distinctive.

The important theory, that strata may be identified by fossils, was taught by William Smith, early in the present century, and is thus expressed in his *Stratigraphical System:* "Organized fossils are to the naturalist as coins to the antiquary; they are the antiquities of the earth; and very distinctly show its gradual, regular formation, with the various changes of inhabitants in the watery element."—"They are chiefly submarine, and as they vary generally from the present inhabitants of the sea, so at separate periods of the earth's formation they vary as much from each other; insomuch that each layer of these fossil organized bodies must be considered as a separate creation; or how could the earth be formed, *stratum super stratum*, and each abundantly stored with a different race of animals and plants."†

The "Prodrome" of M. D'Orbigny is a catalogue of the shells (and radiate animals) of each formation, from which it appears that the mass of the living population of the globe has been changed twenty times since the close of the First or Palæozoic Age; and although the fossils of the older rocks have not been generally classified with the same minuteness, yet enough is known to shew that at least ten great changes had taken place before the Secondary epoch.

In the following Table, the first column gives the names of the Formations, or Periods; the second contains those by which the principal strata are known.

* The coal-measures and chalk of England cannot indeed be called *similar*, but the Cretaceous formations of the whole *world* afford *mineral* types corresponding to perhaps every variety of Carboniferous rock.

† Stratigraphical System of Organized Fossils, 4to, Lond. 1817.

I. GEOLOGICAL TABLE.

	Formations or Periods.	Names of Strata.
Palæozoic Age.		
I.	1. Tremadocian.	Longmynd slate. (Bangor, Wicklow.) Lingula flags = Primordial group. Festiniog slate. Potsdam sandstone.
I.	2. Snowdonian.	Llandeilo flags / Caradoc sandstone } Bala or Coniston group.
II.	3. Wenlock.	May-hill sandstone = Clinton group. Woolhope and Dudley limestones.
II.	4. Ludlow.	L. Ludlow, Aymestry lime., U. Ludlow.
III.	5. Hercynian.	Spirifer sandstone; Rhine. } Killas, or Old Red Sandstone.
III.	6. Eifelian.	Plymouth limestone.
III.	7. Clymenian.	Petherwin limestone.
IV	8. Bernician.	Carboniferous limestone (shale and coal.)
IV	9. Demetian.	Coal-measures. (Millstone grit, coal, &c.)
V.	10. Permian.	Magnesian lime. = Zechstein. (Perm.)
Secondary Age.		
VI.	11. Conchylian.	New-red-sandstone = Bunter. (Muschel-kalk = Ceratite limestone.)
VI.	12. Saliferous.	Red marls = Keuper. Lias bone-bed.
VII.	13. Liassic.	L. Lias = *Sinemurien* & *Liasien*.
VII.	14. Toarcian.	Marlstone, Alum-shale. (Thouars.)
VII.	15. Bajocian.	Inf. Oolite, Fuller's-earth. (Bayeux.)
VII.	16. Bathonian.	Great Oolite. (Stonesfield slate; G. Ool. Bradford cl. Forest m. Cornbrash.)
VIII.	17. Oxfordian.	Kelloway rock = *Callovien*, D'Orb. Oxford clay. (White Jura.)
VIII.	18. Corallian.	Coral-rag and Calcarious grit.
VIII.	19. Kimmeridgian.	Kimmeridge clay. (Dorsetshire.)
VIII.	20. Portlandian.	Portland stone and Purbeck beds.
IX.	21. Wealden.	Hastings sand and Weald clay.
IX.	22. Neocomian.	Speeton clay? (Neuchatel.) Lower Green-sand, & *Aptien*, D'Orb.
X.	23. Albian.	Gault. (District of the Aube, or *Albe*.)
X.	24. Cenomanian.	Upper Green-sand. (Mans, *Cenomanum*.)
X.	25. Hippuritic.	Chalk-marl and L. Chalk = *Turonien*.
X.	26. Senonian.	Chalk with flints = Baculite limestone. Maestricht chalk = *Danien*, D'Orb.
Tertiary.		
XI.	27. Londinian.	Thanet sands, Plastic clay, London clay.
XI.	28. Nummulitic.	Bracklesham; Barton; I. Wight; = *Parisien*. Hempstead; Fontainbleau; = *Tongrien*.
XII.	29. Falunian.	Faluns of Touraine; Bordeaux, Vienna.
XIII.	30. Icenian.	Crag of E. Co. = *Sub-apennin*, D'Orb.

It must be observed that the number and magnitude of the "Formations" was determined by accident in the first instance, and afterwards modified to suit the requirements of theory, and to make them more nearly equal in value.*

According to MM. Agassiz and D'Orbigny, all, or nearly all the fossils of each formation are peculiar; very few species being supposed to have survived from one period to another. Sudden and entire changes of this kind only take place when the nature of the deposit is completely altered,—as when sands or clays rest upon chalk;—and in these instances there is usually evidence (in the form of beds of shingle, or a change of dip) that an interval must have elapsed between the completion of the lower stratum and the commencement of the upper.

We have seen that distinct faunas may be separated by narrow barriers in existing seas; and differences almost as great may occur on the same coast-line without the interposition of any barrier, merely in passing from a sea-bed of rock and weed to one of sand or mud, or to a zone of different depth. It would be unreasonable to expect the same fossils in a limestone as in a sandstone; and even in comparing similar strata we must consider the probability of their having been formed at different depths, or in distinct zoological provinces.

The most careful observations hitherto made, under the most favourable circumstances, tend to show that all sudden alterations have been *local*, and that the law of change over the whole globe, and through all time, has been gradual and uniform. The hypothesis of Sir C. Lyell—that species have been created, and have died out, *one by one*, agrees far better with facts, than the doctrine of periodic and general extinctions and creations.

As regards the Zoological value of the "formations," we shall be within the truth if we assume that those already established correspond in importance with geographical provinces; for at least half the species are peculiar, the remainder being common to the previous or succeeding strata. This will give to each Geological Period a length equal to three times the average duration of the species of marine shells.†

* The names of Formations are in great measure provisional, and open to criticism. Some of them were given by Brongniart and O. D'Halloy; others have been more recently applied by D'Orbigny, Sedgwick, Murchison, and Barrande; and some are adopted from popular usage. *Geographical* names, and those derived from characteristic fossils have been found the best, but no complete scheme of *zoological* nomenclature has been framed.

The epithet "Turonien" (25) is rejected, because it conveys the same meaning with "Falunian" (29), or Middle Tertiary, the type of which was taken from Touraine.

The term *Icenian* is proposed for the Pliocene strata, because their order of succession was first determined, by Mr. Charlesworth, in the eastern counties of England, the country of the ICENI.

† The exact value of these *periods* cannot be ascertained, but some notion of their length may be obtained by considering that the deposits in the valley of the Mississippi,

The distribution of species in the strata (or in time), is like their distribution in *space*. Each is most abundant in one horizon, and becomes gradually less frequent in the beds above and below; the locality of the newest rock in which it occurs being often far removed from that of the oldest.*

That species should be created at a single spot, and gradually multiply and diffuse themselves, is sufficiently intelligible. That, after attaining a certain climax of development, they should decline and disappear is a fact involved in mystery. But even if it depends on physical causes, and is not a law of all Being, its operation is equally certain, and does not appear to vary beyond moderate limits.

The deep-sea shells (such as *Rhynchonella, Terebratula,* and *Yoldia*), enjoy a longer range in time, as well as in space, than the litoral species; whilst the land and fresh-water shells are most remarkable for specific longevity.†

In each stratum there are some fossils which characterize small subdivisions of rock, just as there are living species of very limited range.

When species once die out they never reappear; one evidence of their having become extinct consisting in their replacement by other species, which fulfilled their functions, and are found in deposits formed under similar conditions. (*Forbes.*)

The total number of species is greater in the newest formations than in those of older date; but the ratio of increase has not been ascertained.‡

Distribution of Genera in Time. The doctrine of the Identification of strata by fossils derives its chief value from the fact that the development and distribution of Genera is as much subject to law as the distribution of species; and so far as we know, follows a similar law.

Groups of strata, like the Zoological provinces, may be of various magnitudes; and whilst the smaller divisions are characterized by peculiar *species*,

estimated to represent 100,000 years, have been accumulated since the era of many existing shells. The same may be said of the elevation of Mont Blanc, the formation of the Mediterranean Sea and other grand physical events. The great cities of antiquity—Rome, Corinth, and Egyptian Thebes, stand upon raised sea-beds, or alluvial deposits, containing recent shells.

* M. Agassiz and Prof. E. Forbes have represented, diagramatically, the distribution of genera in time, by making the horizontal lines (such as in p. 415) swell out in proportion to the development of the genera. Those whose commencement, climax, and end are ascertained may be represented by a line of this kind ——— Genera which attain their *maxima* in the present seas are thus expressed ———

+ Land and Fresh-water shells of existing species are found with the fossil bones of the *Mastodon* and *Megalonyx*, in N. America. (*Lyell.*)

‡ The number in each formation depends on the extent to which it has been investigated, and on the opinions entertained as to the strata referable to it. Prof. Phillips has discussed this subject in his work on Devonian fossils (p. 165), and in the "Guide to Geology."

the larger groups have distinct sub-genera, genera, and families, according to their size and importance.

Wm. Smith himself observed that "Three principal families of organized fossils occupy nearly three equal parts of Britain."

"*Echini* are most common in the superior strata;

"*Ammonites* to those beneath;

"*Producti* with numerous *Encrini* to the lowest."

This kind of generalization has justly been considered, by Prof. E. Forbes, of higher importance than the identification of strata by *species;* a method only applicable to moderate areas, and becoming less available with distance. Indeed it might be assumed that strata geographically distant, yet containing some identical species, must differ in age by the time required for the migration of those species from one locality to the other.

A table of the characteristic *species* of the English strata is of little use in America or India, except to shew how few and doubtful are the identical fossils. Whereas the characteristic genera, and order of succession of the larger groups are the same at the most distant localities; and whatever value there may be in the assumption that particular systems of rocks contain most workable coal, lead, or rock-salt, is not lessened by the circumstance that the species of fossils in those rocks are not everywhere the same, since the genera alone are sufficient to identify them.

Genera, like species, have a commencement, a climax, and a period of decline; the smallest usually range through several formations, and many of the typical genera equal the families in duration.

Groups of formations are called Systems, and these again are combined in three principal series—Palæozoic—Secondary—and Tertiary.

Thirteen geological systems, each having a number of peculiar genera are shewn in the accompanying table. (No. II.) Some of the genera cited have a wider range, like *Belemnites*, but are mentioned because of their abundance in one particular system. The names *in italics* are existing genera.*

The third table contains the names of some of the larger genera, arranged according to the order of their appearance. This diagram conveys the impression that the series of fossiliferous strata is not completely known; or that the beginning of many groups of fossils has been obliterated in the universal metamorphism of the oldest stratified rocks.†

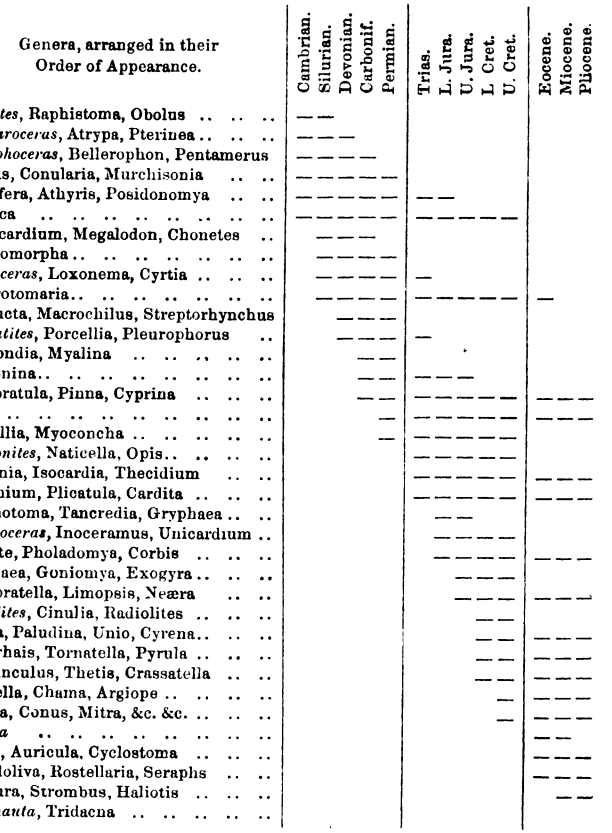
* The *Pliocene strata* contain no extinct genera, and represent only the commencement of the present order of things. All the deposits now taking place will not constitute an additional "Formation," much less a "Quaternary System."

† It was on this account Prof. Sedgwick proposed the term "Palæozoic. rather than "Protozoic," for the oldest fossiliferous rocks.

II. TABLE OF CHARACTERISTIC GENERA.

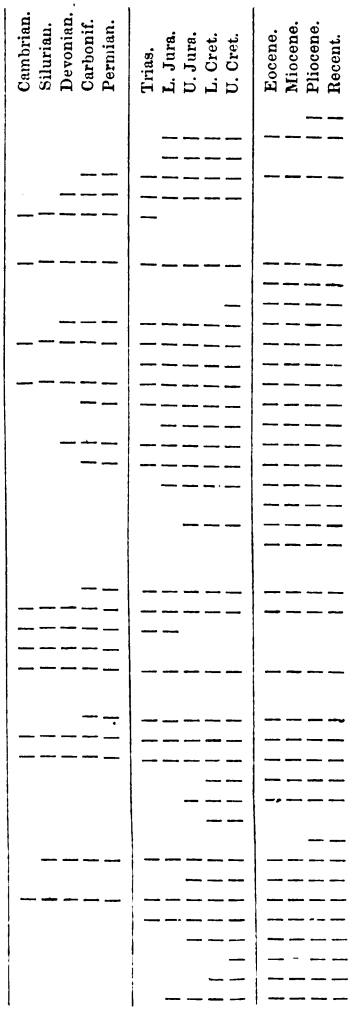
SYSTEMS.	GENERA AND SUB-GENERA.
1. CAMBRIAN, or Lower Silurian.	Camaroceras, Endoceras, Gonioceras, Pterotheca. Maclurea, Raphistoma, Holopea, Platyceras. Orthisina, Platystrophia, Porambonites, Pseudo-crania. Ambonychia, Modiolopsis, Lyrodesma.
2. SILURIAN.	Actinoceras, Phragmoceras, Trochoceras, Ascoceras. Theca, Holopella, Murchisonia, Atrypa, Retzia. Cardiola, Clidophorus, Goniophorus, Grammysia.
3. DEVONIAN.	Bactrites, Gyroceras, Clymenia, Apioceras, Serpularia. Spirifera, Uncites, Merista, Davidsonia, Calceola, Stringocephalus, Megalodon, Orthonota, Pterinea.
4. CARBONIFEROUS.	Nautiloceras, Discites, Goniatites, Porcellia. Naticopsis, Platyschisma, Metoptoma, Producta. Aviculo-pecten, Anthracosia, Conocardium, Sedgwickia.
5. PERMIAN.	Camarophoria, Aulosteges, Strophalosia. Myalina, Bakewellia, Axinus, Edmondia.
6. TRIAS.	Ceratites, Naticella, Platystoma, Koninckia, Cyrtia. Monotis, Myophoria, Pleurophorus, Opis.
7. L. JURASSIC.	Belemnites, Beloteuthis, Geoteuthis, Ammonites. Alaria, Trochotoma, Rimula, Pileolus, Cylindrites. Waldheimia, *Thecidium*, Spiriferina, Ceromya. Gryphæa, Hippopodium, Cardinia, Myoconcha.
8. U. JURASSIC.	Coccoteuthis, Acanthoteuthis, Leptoteuthis, Nautilus. Spinigera, Purpurina, Nerinæa, Neritoma. Pteroperna, Trichites, Hypotrema, Diceras. Trigonia, Pachyrisma, Sowerbia, Tancredia.
9. L. CRETACEOUS.	Crioceras, Toxoceras, Hamulina, Baculina. Requienia, Caprinella, Sphæra, Thetis.
10. U. CRETACEOUS.	Belemnitella, Conoteuthis, Turrilites, Ptychoceras. Hamites, Scaphites, Pterodonta, Cinulia, Tylostoma. Acteonella, Globiconcha, Trigonosemus, Magas, Lyra. Neithea, Inoceramus, Hippurites, Caprina, Caprotina
11. EOCENE.	Beloptera, Lychnus, *Megaspira. Glandina, Typhis.* *Volutilithes, Clavella, Pseudoliva, Seraphs, Rimella.* Conorbis, Strepsidura, Globulus, *Phorus*, Velates. Chilostoma, Volvaria, Lithocardium, Teredina.
12. MIOCENE.	Spirulirostra, Aturia, Vaginella, Ferussina, Halia, Proto, Deshayesia, *Niso, Cassidaria*, Carolia. Grateloupia, *Artemis, Tapes, Jouannetia.*
13. PLIOCENE.	*Argonauta, Strombus, Purpura, Trophon.* *Voldia, Tridacna, Circe, Verticordia.*

III. RANGE OF GENERA IN TIME.



The genera of the *older rocks* are believed to be nearly all extinct; for although the names of many recent forms appear in the catalogues of Palæozoic fossils, it must be understood that they are only employed in default of more exact information. *Buccinum*, *Melania*, and *Mya*, have been long since expunged; and *Modiola*, *Nucula*, and *Natica*, are only retained until the characters which distinguish them are better understood.

IV. RANGE OF FAMILIES IN TIME.



Distribution of Families of Shells in Time. Employing the term "families" for natural groups of genera, and adopting the smallest possible number of them, we find that sixteen, or nearly one-fifth, range through all the geological systems. Only seven have become extinct, viz.—

Belemnitidæ.	Spiriferidæ.	Hippuritidæ.
Ammonitidæ.	Orthidæ.	
Orthoceratidæ.	Productidæ.	

Three others are nearly extinct:—

Nautilidæ.	Rhynchonellidæ.	Trigoniadæ.

And several have passed their maximum, and become less varied and abundant than formerly, *e.g.*—

Tornatellidæ.	Cyprinidæ.	Anatinidæ.

The extinct families and genera appear to have attained their *maxima* more rapidly than their *minima;* continuing to exist, under obscure forms, and in remote localities, long after the period in which they flourished.

The introduction of new forms, also, is more rapid than the process of extinction. If four Palæozoic families disappear, twenty-six others replace them in the Secondary series; and three of the latter are succeeded by fifteen shell-bearing families in the Tertiaries and existing seas.

In consequence of this circumstance, the number of types is three times greater in the newer tertiary than it was at the Silurian period; and since there is no evidence or indication that the earth was ever destitute of life, either wholly or in part, it follows almost as a matter of necessity that the early types must have been more widely distributed and individually developed, than those of the present day.

From the following Table it will be seen that the number of Genera and Families increases with an amount of regularity, which cannot be accidental. Moreover the relation of these numbers is not liable to be much altered by the progress of discovery, or the caprice of opinion. The *discovery* of new types, is not likely to be frequent; the imposition of new names, in place of the old, will not increase the number of Palæozoic genera; and the establishment of fresh and arbitrary distinctions will affect all the groups in due proportion.

If the number of groups called "Systems" were reduced to seven, (viz. three Palæozoic, three Secondary, and one Tertiary, as shewn in the following table,) then the *average* duration of a genus of shells would be equal to a System of Formations.

The duration of the smallest well-defined Families of shells is about equal to one of the three great Geological Divisions, or Ages.

DEVELOPMENT OF FAMILIES, GENERA, AND SPECIES, IN TIME.

		Geological Systems.	Total of Genera.	Cephalopoda.	Gasteropoda.	Brachiopoda.	Conchifera.	Total Number of Species. (D'Orbigny).	Families.	
Palæozoic.	1	Cambrian	49	12	11	15	11	362	18	32
		Silurian	53	13	11	16	13	317	20	
	2	Devonian	77	14	20	23	20	1035	24	
	3	Carboniferous	79	11	26	19	23	835	30	
		Permian*	66	6	24	16	20	74	30	
Secondary.	4	Trias	81	9	25	16	31	713	35	57
	5	L. Jurassic	107	12	35	12	48	1502	42	
		U. Jurassic	108	13	36	9	50	1266	49	
	6	L. Cretaceous	123	20	41	9	53	784	52	
		U. Cretaceous	148	16	59	14	59	2147	56	
Tertiary.	7	Eocene	172	4	85	11	72	2636	60	78
		Miocene	187	3	97	11	76	2242	60	
		Pliocene	192	1	100	12	79	437	62	
		Recent	400	21	251	13	115	16,000	78	
		Recent & Fossil	520	56	280	34	150	30,000	85	

Order of appearance of the groups of Shells. The first and most important point shewn in the preceding Tables, is the co-existence of the four principal classes of *testacea* from the earliest period. The highest and the lowest groups were most abundant in the palæozoic age; the ordinary bivalves and univalves attain their climax in existing seas. If there be any meaning in this order of appearance it is connected with the general scheme of creation, and cannot be inquired into separately; but it may be observed that the last-developed groups are also the most typical, or *characteristic of their class.* (p. 61.)

The *Cephalopoda* exhibit amongst themselves unmistakable evidence of order in their appearance and succession. The tetrabranchiate group comes earliest, and culminates about the period of the first appearance of the more highly-organized cuttle-fishes.† The families of each division which are least unlike (*Orthoceratidæ and Belemnitidæ*) were respectively the first developed.

* Those genera are estimated as belonging to each System which occur in the strata *both above and below*, as well as those actually found in it.

† The *Palæoteuthis* of Bronn (not D'Orb.) appears to be a *fish-bone*, from the equivalent of the Old-red sandstone in the Eifel.

Amongst the *Brachiopoda* the hinge-less genera attained their maximum in the palæozoic age, and only three now survive, (*Lingula, Discina, Crania,*) —the representatives of as many distinct families. Of the genera with articulated valves, those provided with spiral arms appeared first and attained their maximum while the *Terebratulidæ* were still few in number. The subdivision with calcarious spires disappeared with the Liassic period, whereas the genus Rhynchonella still exists. Lastly, the typical group, *Terebratulidæ*, attained its maximum in the chalk period, and is scarcely yet on the decline. The number of sub-genera (as well as genera,) in each system, is stated in the preceding table, because this group shews a tendency to "polarity," or excessive development at the ends of the series.*

The genera of ordinary bivalves (*Conchifera*) are seven times more numerous in the newer tertiary than in the oldest geological system. The palæozoic formations contain numerous genera of all the families with an *open mantle; Cyprinidæ, Anatinidæ,* and the anomalous genus *Conocardium*. The mass of siphonated bivalves do not appear till the middle of the secondary age, and are only now at their maximum.

The *Gasteropoda* are represented in the palæozoic strata by several genera closely allied to the diminutive *Atlanta* and *Scissurella*, and by others perhaps related to *Ianthina*. The *Naticidæ*, and *Calyptræidæ* are plentiful, and there are several genera of elongated spiral shells referred to the *Pyramidellidæ*. In the secondary strata, *holostomatous* shells become plentiful; and in a few peculiar localities (especially Southern India) the genera of siphonated univalves make their appearance in strata of Cretaceous age. Fresh-water *Pulmonifera* of the recent genus *Physa* occur in the Purbeck strata, but the marine air-breathers and land-snails have not certainly been found in strata older than the Eocene tertiary.

Order of Succession of Groups of Shells.—It has been already pointed out that animals which are closely allied in structure and habits, rarely live together, but occupy distinct *areas*, and are termed "representative species." The same thing has been observed in the distribution of fossils; the species of successive strata are mostly representative.

At wider intervals of time and space, the representation is only generic, and the relative proportions of the larger groups are also changed.

The succession of forms is often so regular as to mislead a superficial observer; whilst it affords, if properly investigated, a valuable clue to the affinities of problematic fossils.

* See the anniversary address of Prof. E. Forbes to the Geological Society of London, Feb. 1854, p. 63. The hypothesis seems to have arisen out of an exclusive regard to the poverty of the Permian and Triassic strata in England, where they separate, like a desert, the palæozoic from the "neozoic" formations. The "Permian" should never have been esteemed more than a division of the Carboniferous system, and is poor in *species*, rather than in *types*. The Trias must be studied in Germany, or in the collection of Dr. Klipstein (in the Brit. Museum) to be properly appreciated.

It is now generally admitted that the earlier forms of life, strange as many of them seem to us, were really less metamorphosed—or departed less widely from their ideal archetypes—than those of later periods and of the present day.* The types first developed are most like the embryonic forms of their respective groups, and the progression observed is from these general types to forms more highly specialized. (*Owen.*)

Migration of Species and diffusion of Genera in Former Times.—Having adopted the doctrine of the continuity of specific and generic areas, it remains to be shewn that such groups as are now widely scattered *can* have been diffused from common centres, and that the barriers which now divide them have not always existed.

In the first place it will be noticed that the mass of the stratified rocks are of *marine origin*, a circumstance not to be wondered at, since the area of the sea is twice as great as the land, and probably has always been so; for the average depth of the sea is much greater than the general elevation of the land.†

The mineral changes in the strata may sometimes be accounted for by changes in the depth of the sea, or an altered direction of the currents. But in many instances the sea-bed has been elevated so as to become dry land, in the interval between the formation of two distinct marine strata; and these alterations are believed to occur (at least) *once in each formation.*

If every part of what is now dry land has (on the average) been thirty times submerged, and has formed part of the sea-bed during two-thirds of all the past geological time;—there will be no difficulty in accounting for the migration of sea-shells, or the diffusion of marine genera.

On the other hand it may be inferred that every part of the present sea has been dry land many different times;—on an average not less than thirty times,—amounting to one-third of the whole interval since the Cambrian epoch.

The average duration of the marine species has been assumed at only one-third the length of a geological period, and this harmonises with the fact that so few (either living or extinct) have a world-wide distribution.

The life of the land-snails and of the fresh-water shells has been of longer

* Mr Darwin has pointed out that the *sessile* Cirripedes, which are more highly metamorphosed than the *Lepadidæ*, were the last to appear. The fossil mammalia afford, however, the most remarkable examples of this law. At the present day such an animal as the three-toed horse (*Hippotherium*) of the Miocene Tertiary would be deemed a *lusus naturæ*, but in truth the ordinary horse is far more wonderful. Unfortunately, a new "vulgar error" has arisen from the terms in which extinct animals have sometimes been described—as if they had been constructed upon *several distinct* types, and combined the character of several classes!

† The enormous thickness of the older rocks *in all parts of the world*, has been held to indicate the prevalence of deep water in the primæval seas.

average extent, enabling them to acquire a wide range, notwithstanding their tardy migrations.

But when we compare the estimated rate of change in physical geography with the duration of *genera* and *families* of shells, we not only find ample time for their diffusion by land or sea over large portions of the world, but we may perceive that such transferences of the scene of creation must have become inevitable.

Method of Geological Investigation.—In whatever way geological history is written, its original investigators have only one method of proceeding—from the known to the unknown—or backwards in the course of time.

The newest and most superficial deposits contain the remains of man and his works, and the animals he has introduced.

Those of pre-historic date, but still very modern, contain shells, &c., of recent species, but in proportions different from those which now prevail. (p. 384, 387). Some of the species may be extinct in the immediate neighbourhood of the deposits, but still living at a distance.

In the harbour of New Bedford are colonies of dead shells of the *Pholas costata*, a species living on the coast of the Southern States. At Brackle-sham, Sussex, there is a raised sea-bed containing 35 species of sea-shells living on the same coast, and 2 no longer living there, viz.—*Pecten polymorphus*, a Mediterranean shell; and *Lutraria rugosa*, still found on the coasts of Portugal and Mogador.

Tertiary Age.—If any distinction is to be made between "Tertiary" and "Post-tertiary" strata, the former term should be restricted to those deposits which contain some *extinct* species. And the newest of these, in Britain, contain an assemblage of Northern shells. Prof. Forbes has published a list of 124 species of shells from these "Glacial beds," nearly all of which are now existing in British seas.*

In most of the localities for glacial shells, the species are all recent; but at Bridlington, Yorkshire, and in the Norwich *Crag*, a few extinct species are found. (e. g. *Nucula Cobboldiæ*, Pl. 17, f. 18.) At Chillesford, Suffolk, *Yoldia arctica* and *myalis* occur of large size and in excellent preservation, with numerous specimens of *Mya truncata*, erect as they lived, in the muddy sea-bed. *Trophon scalariforme*, *Admete viridula*, *Scalaria grœnlandica*, and *Natica grœnlandica*, also occur in the Norwich Crag; and *Astarte borealis*, with several arctic forms of *Tellina*, are amongst the commonest shells, and frequently occur in pairs, or with their *ligament* preserved; the deposit is extensively quarried for shell-sand.

Raised sea-beds with Arctic shells at Uddevalla in Sweden, have been repeatedly noticed ever since the time of Linnæus. Captain Bayfield disco-

* The species which have retired further north are marked (**) in the preceding Arctic List, p. 355.

vered similar beds near Quebec, 50—200 feet above the River St. Lawrence, containing an assemblage of shells entirely arctic in character; whereas in the present gulf he obtained an admixture of the American representatives of Lusitanian types, *Mesodesma, Periploma, Petricola, Crepidula.*

The glacial deposits of the northern hemisphere extend about 15° south of the line of "northern limit of trees;" but this comparatively recent extension of the Arctic ocean does not appear to have much influenced, if it ever invaded, the inland basin of the Aralo-Caspian, which contains only one species common to the White Sea, *Cardium edule,* var. *rusticum.**

The older pliocene period is represented in England by the *Coralline Crag,* a deposit containing 340 species of shells. Of these 73 are living British species, but (with two or three exceptions) they are such as range south of Britain. (*Forbes.*) The remainder are extinct, or living only to the south, especially in the Lusitanian province; e. g. *Fossarus sulcatus, Lucinopsis Lajonkairii, Chama gryphoides,* and species of *Cassidaria, Cleodora, Sigaretus, Terebra, Columbella* and *Pyramidella.* It also contains a few forms belonging to an earlier age,—a *Pholadomya,* a true *Pyrula,* a *Lingula,* and a large *Voluta,* resembling the Magellanic species.

The shells of the newer tertiaries are always identical, at least *generically,* with those of the nearest coasts. Thus, in Patagonia, are found species of *Trophon, Crepidula, Monoceros, Pseudoliva, Voluta, Oliva, Crassatella,* and *Solenella.* The tertiaries of the United States contain species of *Fulgur, Mercenaria* and *Gnathodon.* The miocene shells of St. Domingo appear at first sight to be all of recent species, but on comparison prove to be mostly distinct.

The proportion of extinct species in the *Pliocene* tertiary, varies from 1—50 per cent. If a deposit contains more than 50 per cent. of extinct species it is referred to the *Miocene* period; and this test is particularly valuable since the modern deposits are often isolated, and frequently no assistance can be derived from superposition, or even from identity of species.

In the *Eocene* tertiaries we perceive the "dawn" of the present order of things. All, or very nearly all, the species are different, but a large proportion of the genera are still existing, though not always in the seas nearest to the localities where they occur fossil.

Thus in the London clay are found—*Rostellaria, Oliva, Ancillaria,* and *Vulsella,* genera still living in the Red Sea; and many species of *Nautilus, Rimella, Seraphs, Conus, Mitra, Pyrula, Phorus, Liotia, Cardilia,*—genera characteristic of the Indian Ocean; *Cyprovula, Typhis* and *Volutilithes,* now

* Mr. Wm. Hopkins of Cambridge has investigated the causes which may have produced a temporary extension of the Arctic phenomena in Europe; and considers the most efficient and probable cause would be a diversion of the Gulf-stream, which he supposes to have flowed up what is now the valley of the Mississippi.—(*Geol. Journal.*)

living at the Cape; *Clavella*, at the Marquesas, and *Pseudolira*, *Trochita*, and species of *Murex*, whose recent analogues are found on the Western shores of S. America.

The freshwater shells of this period are Old-World forms; *Melanopsis*, *Potamides*, *Lampania*, *Melanatria* and *Nematura*: whilst the land-shells form a group quite American in character; large species of *Glandina* and *Bulimus* (with reflected lip) *Megalomastoma* (*mumia*), a *Cyclotus* (with its operculum) like *C. Jamaicensis*, and the little *Helix labyrinthicus*.

Secondary Age.—In none of the older strata do we find indications of a warmer climate having prevailed, in the latitude of England, than that which marks the period of the London clay. And this is not more than can be accounted for by such a cause as the flow of an equatorial current from the direction of the Red Sea, until arrested by a continent to the south-west, as supposed by Mr. Prestwich, in the region of the Azores.

Some indications exist of a more moderate climate having obtained in the north polar regions; for remains of the *Ichthyosaurus* were found at Exmouth Id. the furthest point reached by Sir E. Belcher's expedition.

The peculiar physical conditions of the *Chalk period* are represented at the present day, not so much by the Coral-sea, as by the Ægean, where calcareous mud, derived from the waste of the *scaglia* regions, is being rapidly deposited in deep water. (*Forbes*).

The *Wealden period* was styled the "Age of Reptiles" by Dr. Mantell, who compared the state of England at that time with the present condition of the Galapagos Islands.

The *Oolitic period* finds its parallel in Australia, as long since pointed out by Prof. Phillips, and the comparison holds good to some extent, both for the Marine and Terrestrial Faunas.

The *Trias*, with its foot-prints of gigantic wingless birds, has been compared with the state of the Mascarene Islands only a few centuries ago, and with the New Zealand Fauna, where birds are still the highest aboriginal inhabitants.*

Palæozoic Age.—It has lately been suggested by Prof. Ramsay that signs of glacial action may be traced in some of the trappean conglomerates of the *Permian Period;* and Mr. Page has endeavoured to apply the same interpretation to phenomena of a much earlier date, in the old red sand-stone of Scotland.† Geologists generally have abandoned the notion, once very prevalent, of a universal high temperature in the earliest periods; a notion which

* In a paper read before the British Association, on the subject of the great extinct wingless birds of New Zealand, Prof. Owen suggested the notion of land having been propagated like a wave throughout the vast interval between Connecticut and New Zealand, since the Triassic period.

† See also the Rev. J. G. Cumming's "Isle of Man," (1849), p. 89.

they had derived from the occurrence of certain fossil plants, corals, and shells, in high latitudes.

The absence of remains of mammalia in the palæozoic formations, is at present a remarkable fact, but it is completely paralleled in the great modern zoological province of the Pacific Islands.

Baron Humboldt has speculated on the possibility of some land being yet discovered, where gigantic lichens and arborescent mosses may be the princes of the vegetable kingdom*. If such exist, to shadow the Palæozoic age, its appropriate inhabitants would be like the cavern-haunting *Proteus*, and the *Silures* which find an asylum even in the craters of the Andes.

What then is it which has chiefly determined the character of the present Zoological provinces? What law, more powerful than climate, more influential than soil, and food, and shelter; nay, often seemingly producing results opposed to *a priori* probability, and at variance with the suitableness of conditions?†

The answer is, that each fauna bears, above all things, the impress of the age to which it belongs. Each has undergone a series of vicissitudes up to the time when its barriers became fixed, and after its isolation it has known no further change, but decline.

As regards the great types of terrestrial organization, their point of common origin seems to have been the centre of the Old World. Here they appear to have been formed in succession, and diffused outwards in all possible directions, to the ends of the earth; each wave of life developing in its progress special forms adapted to the circumstances of the times, and exemplifying the modifications of which each type was capable.‡

Chapter IV.

ON COLLECTING SHELLS.

The circumstances under which shells are found is a subject so intimately connected with the methods of collecting them, as to make it undesirable to treat of them separately.

Naturalists distinguish between the *habitats*, or geographical localities of species, and the stations or circumstances in which they are found: to the latter subject only slight allusion has been hitherto made. (p. 11).

Land-shells are most abundant on calcareous soils, (p. 37) and in warm and moist climates. The British species are collected with advantage in autumn, when full-grown, and showing themselves freely in the dews of morning and evening. Some species, like *bulimus acutus*, are found only near the sea;

* Views of Nature, p. 221. Bohn's ed. † Burchell, in Darwin's Journal, p. 87.

‡ "The Tide of Vegetation has, in the intertropical Pacific Islands, set in a direction contrary to the prevailing winds; namely, from the Asiatic, and not from the American shores." (Hooker, l. c. p. 211, note.)

Bulimus Lackhamensis ascends beech-trees on the Chalk downs and Cotteswoldes; *Pupa Juniperi* and *Helix umbilicata* occur chiefly on rocks and stone walls. The moss-frequenting *Clausiliæ* may be obtained even in mild winter weather at the roots of trees; the small species of *Pupa* (or *Vertigo*) are sometimes taken abundantly when sweeping wet grass with an insect net; *Acicula fusca* lives at the roots of grass; *Cionella acicula* is found in old bones, (such as occur in Danish burial grounds!) and occasionally in moving garden-bulbs; *Helix aculeata* has been met with on the under sides of leaves (*e. g.* the sycamore), a few feet from the earth.

In tropical countries a large number of the land snails are *arboreal* in their habits. The West Indian Palms (such as *Oreodoxa regia*) are the chosen abode of many species of Helicidæ. Mr. Couthouy found *Bulimus auris leporis* on the orange and myrtle-trees near Rio, and *Partulæ* and *Helicinæ*, on the Dracænas and Bananas of the Polynesian Islands; and the sailors of H.M.S. Rattlesnake, in Captain Owen Stanley's expedition, became expert in collecting *Geotrochi* in the trees of the Australian islands.

The great tropical *Bulimi* and *Achatinæ* will sometimes lay their eggs in captivity.*

The following are examples of the elevations at which land-snails have been found. (pp. 162, 166.)

Helix pomatia, 5000 feet—Alps. (Jeffreys.)
— rupestris, 1200—5000 ft.
— bursatella, Gould, 2000—5000 ft. Taheiti.
Bulimus vibex 7000 ft. India. (Benson.)
— nivicola, and ornatus, 14,000 ft. ,,
— Lamarckianus, 8000 ft. New Granada.
Achatina latebricola, 4—7000 ft. Landour.
Pupa Halleriana, 1200—2500 ft. Alps.
— tantilla, 2,000 ft. Taheiti.
Clausilia Idæa, 5500 ft. Mr. Ida.
Vitrina glacialis, Forbes, 8000 ft. Mte. Rosa.
— annularis, 2000—3000 ft. Burgos. (M'Andrew.)
— Teneriffæ, 2000—6210 ft. Madeira.
Helicina occidentalis, Guilding, 2000 ft. St. Vincents.
(Limnæa Hookeri, 18000 ft. Thibet.)

The land-snails of warm and dry regions remain dormant for long periods (p. 19), and require no attention for many months after being collected.†

Freshwater shells are collected with an insect-net or "landing-net" of strength suited to the work of raising masses of weed. The strongly-rooted

* Such giants require to be collected in a basket, while the small land shells of open and rocky countries may be put in a cotton bag, hung on a coat button.

† Land and freshwater snails may be killed instantaneously with boiling water, if a few are done at a time; and cooled by removal to cold water. Every collector finds expedients for removing the animals more or less completely from their shells; those which, like *Clausilia*, retire beyond the reach of a bent pin may be drowned in tepid water.

flags and rushes may be pulled up with a boat-hook; and *Cyclades* as well as univalves, may be obtained by shaking aquatic plants over the net. For getting up the Pearl-mussels, the most efficient instrument is a tin bowl, perforated like a sieve, and fitted on the end of a staff, or jointed rod. (*Pickering.*)

In some situations the freshwater shells are all much eroded, (p. 41, 273,) or coated with a ferruginous deposit. It may be desirable to find out the localities where the specimens are in best condition before collecting extensively. The *opercula* should always be preserved with the shells to which they belong; those of the *Cyclostomidæ*, and *Melaniadæ* are particularly interesting.

The *Auriculidæ* are especially met with in damp places by the sea; in mangrove-swamps, and creeks and river-banks where the water becomes brackish. *Amphibola* and *Assiminea* are found in salt-marshes, *Siphonaria* and *Peronia* on the shore, between tide-marks.

Collecting Sea-shells.—The following remarks are from the pen of an experienced conchologist, Mr. W. J. Broderip.—"When the tide is at the lowest, the collector should wade among the rocks and pools near the shore, and search under overhanging ledges of rock as far as his arms can reach. An iron rake, with long close-set teeth, will be a useful implement on such occasions. He should turn over all loose stones and growing sea-weeds, taking care to protect his hands with gloves, and his feet with shoes and stockings against the sharp spines of *echini*, the back-fins of sting-fishes, and the stings of *medusæ*. In detaching chitons and limpets which are all to be sought for on rocky coasts, the *spatula* or case knife will prove a valuable assistant. Those who have paid particular attention to preserving chitons have found it necessary to suffer them to die under pressure between two boards. Ormers (*Haliotides*) may be removed from the rocks to which they adhere by throwing a little warm water over them, and then giving them a sharp push with the foot sideways, when mere violence would be of no avail without injuring the shell. Rolled madrepores and loose fragments of rock should be turned over; Cowries and other shell-fish frequently harbour under them. Numbers of shell-fish are generally to be found about coral-reefs." In coral-regions the services of *natives*, should be obtained, as they may render much assistance by diving or wading.

Advantage may be taken of *spring-tides*, especially at the equinoxes, to examine lower tracts of sea-shore than are ordinarily accessible. Many *bivalves* bury in sand and mud at extreme low-water, and may be obtained alive by digging with a spade or fork; others may be found boring in piles and rocks and require the hammer and chisel for their extraction.*

* *Bivalves* may be boiled, and their soft parts removed when the shells gape. Care should be taken not to injure the ligament, or hinge, especially in the genera like the *Anatinid*) provided with an *ossicle*.

Mr. Joshua Alder remarks that, "in collecting among rocks the principal thing is to look close, particularly in crevices and under stones. Minute species inhabiting sea-weed are best obtained by gathering the weed and immersing it for some time in a basin of sea-water, when the little mollusks will generally creep out. If the shells only are wanted, the surer and more ready way is to plunge the weed into fresh-water, when the animals immediately fall to the bottom."

The *floating mollusca* of the open sea, especially in tropical latitudes, are comparatively little known. Good drawings, and descriptions made from the life, are most valuable. "Of the animal of the *Spirula*, entire specimens are greatly wanted. If captured alive, its movements should be watched in a vessel of sea-water, to see whether it has the power of rising and sinking at will; its mode of swimming, and position during these movements, and when at rest. The chambered shell should be opened under water, to ascertain if it contain a gas, the nature of which should if, possible, be made out. The pearly nautilus requires the same observations, which would be attended with more precision and facility from its larger size." (*Owen.*)*

The *towing-net* used by Mr. Mc Gillivray "consisted of a bag of *bunting* (used for flags) two feet deep, the mouth of which was sewn round a wooden hoop 14 inches in diameter; three pieces of cord, a foot and a half long, were secured to the hoop at equal intervals and had their ends tied together. When in use the net was towed astern, clear of the ship's wake, by a stout cord secured to one of the quarter boats, or held in the hand. The scope of the line required was regulated by the speed of the vessel at the time, and the amount of strain caused by the partially submerged net."†

Trawling.—Mr. John W. Woodall, of Scarbro', has kindly furnished the following sketches and particulars;—"Fig. 227, is intended to represent a *trawl-net*, at work on the bottom of the sea. The side frames are of iron, the upper beam of wood, and the lower edge of the net is kept down to the ground by means of a chain, which is wolded or wrapped round with old rope. The beam is generally from 40 to 50 feet in length, and about 8 inches square. The net is about 30 yards in depth, and has a couple of pockets inside. The end is untied when the net is hauled on board for the purpose of taking the fish out. These nets can only be worked where the bottom of the sea is free from rocks. They are used by boats of 35 to 60 tons, manned by crews of from 4 to 6 men, and 2 to 3 or four boys. In the vicinity of Scarbro' they fish between the shore-reefs and the off rock which is 4—10 miles from land; the bottom is sand or clay, with 4—15 fathom water on the land-side, and 17—25 fathoms on the off side." Immense quantities of Crustacea and shell-fish are taken with the trawl, as well as ground-fish.

* Admiralty, Manual of Scientific Inquiry. 8vo. Lond. 1849.
† Voyage of H. M. S. Rattlesnake, vol. I. p. 27.

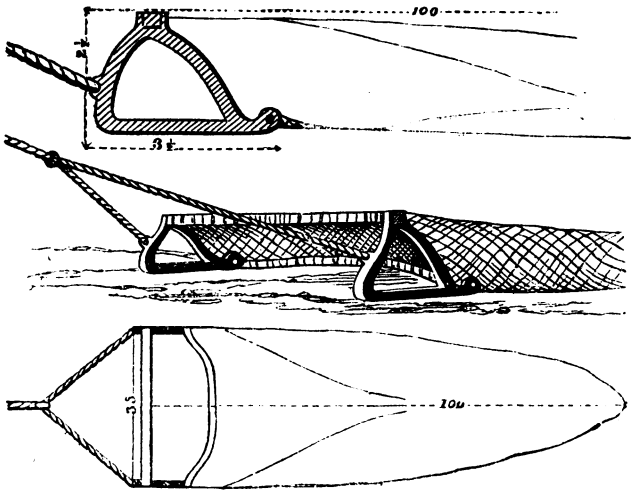


Fig. 227. A Trawl-net. A. Side view; C. Plan; B. Net in operation.

Kettle-nets.—On the flat, sandy coast of Kent and Sussex, the mackerel-fishery is pursued by setting up stakes 10 or 15 feet high, at distances of 10 feet apart, in lines running outwards from the shore at high-water, to low-water neap tides, where they are turned in the direction of the tide. To these stakes, nets are attached and leaded, which remain as long as the fish are on the coast. Cuttle-fish are frequently taken in these nets.

Deep-sea Fishery.—In North Britain an extensive ground-fishery is conducted by means of long lines,—often a mile in length—with hooks and baits every few yards. These lines are laid out at night, near the coast, and taken up the next morning. When used out at sea, the boats lay by for a few hours, and then take up the lines. The carnivorous whelks adhere to the baits (which have not been seized by fishes), and sometimes a bushel of them are taken in this way from a single line. *Rhynchonella psittacea*, *Panopæa Norvegica*, *Velutinæ*, and some of the scarce *Fusi*, have been obtained from these lines, the bivalves having been entangled accidentally by the hooks.

For trapping whelks on rocky ground a net may be made, such as is used for crabs and lobsters, by attaching a loose bag to an iron ring of a yard across. This is fastened to a rope by three equal strings, baited with dead fish, and let down from a vessel at anchor, or still better from a buoy. It is put down over-night, and hauled up gently in the morning.

Mr. D'Urban informs us that *Natica Alderi* and *monilifera* are fre-

quently found in the lobster-pots at Bognor, Sussex, which they enter to feed upon the bait.

Dredging.—The Dredges used in the Oyster and Whelk-fisheries are so rudely made as to injure the more delicate marine animals, and suffer all the minute things to escape. It is therefore necessary to have instruments specially adapted for the naturalist's work.

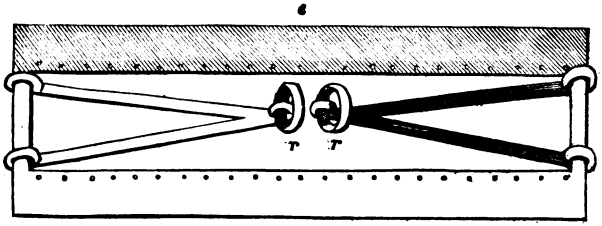


Fig. 228. Plan of the Framework of a Dredge, reduced to $\frac{1}{8}$.

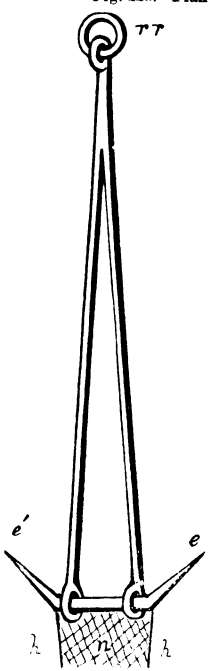


Fig. 229.

Fig. 228 is a plan, and Fig. 229 a side-view, of a small dredge, belonging to Mr. J. S. Bowerbank, and suited for such work as a private collector might do on the English coast. It is made of wrought iron, with moveable joints, so as to fold up and carry in the hand. The bag attached to the dredge is formed of two pieces of raw hide (*h*, *h*), connected at the ends and bottom by net (*n*) made of cod-line, to allow the water to escape; and is fastened to the frame with copper-wire, through the eyelet holes. The towing rope is attached to the rings (*r*, *r*), and when thrown overboard it scrapes with one or other of the cutting edges (*e*, *e'*). The opening is made narrow to prevent the admission of large and heavy stones.

Dredging should not be attempted in a *rowing-boat*, unless near shore, in smooth water, and with a depth not exceeding 5 or 10 fathoms. It may be managed in a light boat by two persons; one rowing, the other holding the rope of the dredge which is passed overboard near the stern.*

* "Weymouth is pre-eminently the best place on the British coast for dredging. I can reckon 195 marine species of shells that I have collected within a range of five miles, and ten more species may safely be added. The dredging is also easy and safe. The cost of a suitable boat and man is about 7s.6d. a day, *i. e.* from 10 or

The whelk and oyster-dredgers employ a decked sailing-vessel, and work several dredges simultaneously, each requiring a person to manage it. The dredges are put overboard on the weather-side, and the ropes made fast to a bulwark or thwart; each dredger holds the rope in his hand, after giving it a single turn round a thwart or "belaying-pin," to regulate the strain by means of the spare line. When a sufficient distance has been traversed, or the ropes strain with the weight of mud and stones, the vessel is brought to, and the dredges hauled up and emptied.*

The *length of line* required is about *double* the depth of the water. If the line is too short the dredge will only skim the bottom; if too long it will be in danger of getting fast. When the bottom is loose sand or soft mud, the line must be shortened, or the vessel have more way, or else the dredge will be apt to get buried.

The *strength of the line* ought to be sufficient to anchor the vessel in smooth water,—though not, of course, when there is much way on her,—so that if the dredge gets foul it is necessary to let out the spare line and relieve the strain, while the vessel is brought round. The dredge will then usually capsize, and may be hauled up.

If the bottom is at all rocky, a small strong dredge is best. The line must be shortened, and some additional precautions may be taken, such as fastening the rope to one ring of the dredge, and tieing the other with spun yarn, which will break under a sudden and dangerous strain, and release one end of the dredge.

In dredging on Coral-ground, Mr. Cuming employed a 3 inch hawser, and had a patent buoy attached to the dredge by a 1¼ inch rope. More than once the hawser parted, and the dredge was left down all night, but recovered the next day.

Mr. Mc Andrew's researches on the coast of Norway, were conducted in the "Naiad," a Yacht of 70 tons, and extended from the shore to 250 fathom water. The dredge employed was at least twice as strong and heavy as the one we have represented, and all forged in one piece, instead of folding up. The bag was fastened on the frame with thongs cut from the hide. Before using, it requires to be towed astern for a couple of hours to soften it. In three months work, only two cow-hides were used, and one of those was torn by accident on sharp rocks. Several spare dredges were on board (in case of emergency), but not used.

Dredging in deep water (50—300 fms.) can only be done in calm

11, a.m., to 4 or 5, p.m. Dredging can be carried on in Weymouth in almost any weather, the bay is so protected." (*R. Damon.*)

* The collector may go out with the fishermen, and superintend his own dredge, almost any time of the year, although oyster catching is illegal in the summer. The scallop-banks off Brighton are in 15 fms. water, and nearly out of sight of land. It is not always possible to work over them and return the same night.

weather, with a light breeze. The Yacht is brought to the wind (by putting up the helm), the foresheet hauled to windward, mainsail hauled up, and mizen taken in; the gaff topsail also hauled up; she then drifts to leeward, and the dredge is thrown overboard to windward, with the line made fast amidships; the spare line being coiled up so as to be given out readily. When the dredge is to be hauled in, the rope is passed through a moveable block, fixed to the shrouds, and the whole strength of the crew (15 hands) called into requisition if necessary. When the depth does not exceed 50 fathoms, the boat, with three men and the two dredgers, is used.

If the dredge gets fouled, the rope is passed into the boat, brought over the dredge, and hauled up. In very deep water (150 fm.) the line is carried forward and made fast to the bows, and the yacht itself hauled up till right over the dredge, which is then recovered without difficulty.

The contents of the dredge are washed, and sifted with two sieves, one "¼ inch," the other very fine. They are made of *copper wire*, and one fits into the other. The dredge is emptied into the coarse sieve and washed in the sea from the boat, or if in the yacht, they are placed in an iron frame, over the side of the vessel, and buckets of water poured on. The sediment retained in the fine sieve may be dried and examined at leisure, for minute shells.

The following "dredging-papers," kept on the plan recommended by Prof. E. Forbes, have been selected by Mr. Barrett, to illustrate the kind of shells found at various zones of depth.

NOTE.—The shell-fish obtained by dredging should be at once boiled, and the animals removed, unless wanted for examination (p. 441). The bivalves gape, and require to be tied with cotton; the *opercula* of the univalves should be secured in their apertures with wool. The small univalves may be put up in spirit, or *glycerine*, to save time. In warm climates the flies and ants assist in removing any remains of the animals left in spiral shells, and *chloride of lime* may be necessary to deodorize them.

M. PETIT DE LA SAUSSAYE has given very full instructions for collecting and preserving shells, in the *Journal de Conchyliologie* for 1850, p. 215, and 1851, pp. 102, 226.

It is stated that both the form and colour of molluscous animals may be preserved in a saturated solution of *hydro-chlorate of ammonia* (10 parts) and corrosive sublimate (1 part—first dissolved in alcohol), but the preparation is expensive and dangerous.

Dredges and other apparatus, glazed boxes, and glass tubes for specimens, may be obtained of G. SOWERBY, 70, Great Russell Street, Bloomsbury; and of R. DAMON, Weymouth.

DREDGING PAPERS, AND RECORDS OF RESEARCHES ON THE COAST OF NORWAY.

By R. Mc Andrew, Esq. and Lucas Barrett, Esq. F.G.S.

I.

Date.....July 1st, 1855.
Locality .....Tromsoë (Nordland).
Depth .....Between tide marks.
Ground .....Rock and sand.

Species.	Number of living specimens.	Number of dead specimens	Observations.
Mya truncata	6	Many.	In sand.
Tellina incarnata	Many.	Many.	In sand.
Astarte compressa	1	0	On sand.
—— borealis	3	Many.'''*	On sand.
Cardium edule	Many.	Many.	In sand.
Crenella discors	Many.	0	Covering the under sides of stones.
Acmæa testudinalis	Many.	0	On rock.
Margarita undulata	6	0	On weed.
—— helicina	8	0	On weed.
Litorina litorea	Many.	0	On rock.
—— rudis	Many.	0	On rock.
Lacuna vincta	2	0	On weed.
Natica pusilla	2	0	On sand.
—— clausa	Many.	0	On rock.
Purpura lapillus	Many.	Many.	On rock.
Buccinum undatum	Many.	0	On rock and sand.
—— cyaneum	Many.	0	On rock.
Bela turricula	10	0	On rock.
Doris Johnstoni	8	0	

(Note.) No specimens of *Trochus*, or *Patella vulgata* occurred.

II.

Date .....July 5th, 1855.
Locality .....Near Hammerfest (Finmarken).
Depth .....7 to 20 fathoms.
Distance from shore ....Close to shore
Ground.....Nullipore and sand.

Saxicava arctica	4	0	Young.
Mya truncata	4	3	Young.
Thracia convexa	4	0	In sand.
Tellina proxima	0	4'	
Mactra elliptica	1	0	
Venus ovata	3	0	
—— striatula	Many.	0	

* The accented numbers in the column of "dead specimens" refer to disunited valves of *Conchifera* and *Brachiopoda*.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Cyprina Islandica	Many	Many.	
Astarte compressa	Many.	0	
Cardium fasciatum	6	0	
Modiola modiolus	1	4	
——— phaseolina	3	0	
Leda caudata	2	1	
Pecten Islandicus	0	2	
Chiton asellus	2	0	
—— marmoreus	2	0	
Acmæa virginea	3	2	
—— testudinaria	0	1	
Patella pellucida	6	0	
Dentalium entale	4	2	
Trochus tumidus	Many.	Many.	
——— cinerarius	1	0	
Margarita helicina	12	0	
——— undulata	Many.	Many.	
——— cinerea	6	2	
Velutina lævigata	0	1	
Buccinum undatum	0	3	
Trophon clathratus	1	0	
——— Gunneri	1	0	
Bela rufa	1	0	
—— turricula	0	4	
Mangelia nana	2	0	

III.

Date .....July 3rd, 1855.
Locality .....Island of Arnöe (Finmarken).
Depth .....7 to 22 fathoms.
Distance from shore ....Half a mile.
Ground.....Laminaria and red weed.

Saxicava arctica	3	Many.	
Thracia convexa	1	0	
Venus ovata	1	3	
Cyprina Islandica	2	Many.	
Astarte crebricostata	Many.	Many.	
—— elliptica	12	Many.	
—— compressa	Many.	Many.	
Cardium fasciatum	Many.	Many.	
Cryptodon flexuosus	1	6	
Modiola modiolus	1	Many.	
Crenella decussata	Many.	Many.	
Leda pernula	Many.	Many.	
Pecten Islandicus	3	Fragments.	Young.
Anomia Ephippium	Many.	0	
——— aculeata	Many.	0	
Chiton marmoreus	4	0	

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Dentalium entale	4	Many.	
Trochus tumidus	Many.	Many.	
——— cinerarius	Many.	Many.	
Margarita cinerea	Many.	Many.	
——— undulata	Many.	Many.	
——— helicina..	Many.	Many.	
Lacuna vincta	Many.	Many.	
Litorina littoralis	3	0	
Rissoa parva	Many.	0	
Natica clausa	4	0	
——— pusilla	0	1	
Velutina lævigata	3	0	
——— flexilis	1	0	
Trichotropis borealis	3	0	
Nassa incrassata	1	0	
Mangelia nana..	8	0	
Bela turricula	Many.	0	
Trophon Gunneri	12	0	
——— clathratus	3	0	

IV.

Date .....July , 1855.
Locality .....Vigten Island (N. Drontheim).
Distance from shore ....Quarter of a mile.
Depth .....30 fathoms.
Ground.....Coral-bank.

Arca nodulosa	3	5	
Leda caudata	2	0	
Yoldia lucida	3	0	
Astarte sulcata	3	4′	
Pecten Islandicus	0	2′	
Lima excavata	0	1′	
Lucina Sarsii	0	1	
Cryptodon flexuosus	2	0	
Modiola phaseolina	10	0	
Anomia ephippium	Many	0	
Venus ovata	0	2	
Terebratulina caput-serpentis ..	20	Many.	
Chiton asellus	4	0	
Puncturella noachina	2	0	
Emarginula fissura	1	2	
——— crassa	0	1	
Margarita cinerea	1	0	
——— alabastrum	1	0	
Trophon barvicensis	1	0	

V.

Date .....June 23rd, 1855.
Locality .....Omnaesöe (Nordland).
Depth .....30 to 50 fathoms.
Distance from shore .....Half a mile.
Ground.....Stones and sand.
No. of hauls..... .....Four.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Saxicava arctica	6	2	
Tellina proxima	0	1	
Venus ovata	2	0	Small.
Cyprina Islandica	2	Many.	
Astarte elliptica	4	0	
—— compressa	6	0	
Cardium fasciatum	2	0	
——— suecicum	5	4	
Modiola phaseolina	200	Many.	Large.
Crenella nigra	0	1	Large.
Nucula nucleus	0	5	
—— tenuis	4	Many.	
Leda caudata	2	0	
Arca pectunculoides	12	10	Large.
Pecten striatus	2	0	
—— tigrinus	3	6	
—— similis	1	0	
—— islandicus	0	1	Large and Recent.
Terebratula cranium	80	10	
Terebratulina caput-serpentis ..	1	0	
Crania anomala	12	0	Many stones had on them the attached valve.
Chiton Hanleyi	3	0	
Lepeta cœca	4	0	
Acmæa virginea	10	6	
Pilidium fulvum	Many.	4	
Puncturella noachina	2	1	
Trochus millegranus	2	0	
Eulima polita	1	0	
Natica nitida	3	2	
—— helicoides	0	1	
—— pusilla	0	1	
Velutina lævigata	1	0	
Trichotropis borealis	6	3	Large.
Nassa incrassata	1	0	
Fusus antiquus	0	2	Carinated Var
Trophon clathratus	0	1	
Mangelia turricula..	1	0	
Tornatella fasciata	0		
Buccinum undatum	6	0	Young.
Pleurotoma nivalis	10	15	

VI.

Date .....July 20th, 1855.
Locality .....North of Rolphsoe (Finmarken).
Depth .....130 to 180 fathoms.
Distance from shore .....Half a mile.
Ground.....Sand.
No. of hauls .....Two.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Cyprina Islandica..	0	3	
Neæra cuspidata	0	2′	
Leda caudata	0	3′	
Yoldia lucida	1	2′	
Pecten Islandicus	0	Many.	Small.
——— similis	0	1	
Arca pectunculoides	1	0	
Syndosmya prismatica..	0	1	
Cryptodon flexuosus	0	1	
Mactra elliptica	0	2′/6′	
Cardium fasciatum	0	2	
——— suecicum..	0	3	
Astarte sulcata	1	0	
Anomia ephippium	Many.	0	
Crenella decussata..	2	Many.	
——— nigra	0	2′	
Terebratula cranium	3	6	
Rhynchonella psittacea	1	2	
Dentalium entale	Many.	Many.	
Puncturella noachina	Many.	0	
Lepeta cœca	2	0	
Pleurotoma nivalis	1	2	
Fusus ? sp.	0	Fry.	
Buccinum Humphreysianum ..	0	1	
Bela turricula	2	0	
Margarita cinerea	3	4	
——— undulata	0	2	
——— alabastrum	0	1	

VII.

Date .....July 25th, 1855.
Locality.....Off the Island of Arnöe (Finmarken).
Depth .....200 fathoms.
Distance from shore ..Four miles.
Ground.....Mud.

Pecten similis..	0	2′	
Cryptodon flexuosus	4	0	
Neæra cuspidata	0	1	
Arca pectunculoides	1	3	

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Nucula tenuis	2	0	
Yoldia lucida	4	6	
Modiola phaseolina	2	0	
Cardium suecicum..	2	0	
Crenella decussata..	1	0	
Astarte crebricostata	0	4′	
Terebratula cranium	0	2	
Dentalium entale	1	2	
——— sp...	1	8	
—— quinquangulare (Forbes).	1	0	
Eulima bilineata	2	2	
Eulimella Scillæ	0	3	
Mangelia trevelliana	0	1	
Bela rufa	0	1	
Philine quadrata	0	1	

DREDGING PAPERS, OR RECORDS OF RESEARCHES IN THE ÆGEAN SEA.

By Professor E. Forbes

I.

Date.....May 29th, 1841.
Locality .....Nousa Bay, Paros.
Distance from shore .....Within the Bay.
Depth .....Five to six fathoms.
Ground .....Mud and sandy mud.

Pinna squamosa	0	1	
Modiola tulipa..	1	0	In sandy mud.
Pecten polymorphus	4	6	
——— hyalinus	1	0	
Nucula margaritacea	0	40′	In dark mud.
Cytherea chione	0	1	
——— venetiana	1	3-5′	
——— apicalis	1	2-12′	
Artemis lincta	0	1′	
Tapes virginea..	0	5′	
Venus verrucosa	0	5′	
Tellina donacina	0	1-3′	
——— balaustina	0	2′	
Syndosmya alba	0	2-10′	
Lucina lactea	0	2-28′	
——— squamosa	0	3′	
——— rotundata	0	4′	

Species.	Number of living specimens.	Number of living specimens.	Observations.
Cardium rusticum	0	1′	A strong valve.
——— exiguum	3	7′	
Cardita sulcata	0	1′	
Patella scutellaris	0	1	Washed in from shore.
Calyptræa Sinensis	0	2	
Bulla hydatis	0	1	
Turritella 3 plicata	0	1	
Trochus canaliculatus	0	4	
Cerithium lima	0	3	
——— vulgatum	12	8	
Murex fistulosus	1	0	In dark mud.
Aplysia depilans	1	0	
Ostræa plicatula	0	10′	

II.

Date.....Sept. 14, 1842.
Locality .....Gulf of Smyrna.
Depth .....26 fathoms.
Distance from shore .....Two miles and a half.
Ground .....Fine brown mud.

Avicula Tarentina	3	3	Full grown, adhering to each other.
Saxicava arctica	4	0	

III.

Date.....August 5, 1841.
Locality .....Off northern extremity of Paros.
Depth .....40 fathoms.
Distance from shore ....Three miles and a half.
Ground .....Weedy

Pecten pusio	5	4′	
——— opercularis	0	1	Small.
Nucula margaritacea	0	2′	
Cytherea apicalis	0	1′	
Cardita squamosa	1	1′	
Cardium papillosum	0	2	
Fusus fasciolaroides	1	0	New.
Murex brandaris	0	3	
Vermetus gigas	0	1	
——— corneus	3	0	New.
Trochus exiguus	8	2	
Turbo rugosus..	1	0	
Pleurobranchus sordidus	1	0	New.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Doris tenerrina	2		New.
—— gracilis	2		
—— coccinea	1		
Ascidium, four species			
Aplidium, two species			

IV.

Date.....Sept. 16th, 1841.
Locality .....Off Ananas Rocks.
Depth .....105 fathoms.
Ground .....Nullipore.
Distance from shore ..From Rocks three miles, from Milo ten miles.

Terebratula vitrea	0	2′	Dead and worn.
Megerlia truncata	30	100-20′	Of all ages.
Argiope decollata	100	400-6′	Of all ages.
—— seminulum	18	10-8′	
Morrisia anomioides	1	0	Adhering to T. vitrea.
			New.
Crania ringens	0	6′	
Lima elongata	0	5′	New
Pecten concentricus	0	1′	New.
—— fenestratus	0	2′	New.
Spondylus Gussoni	1	1′	
Arca lactea	1	7′	
—— scabra	0	2′	
Neæra cuspidata	0	1′	
—— attenuata	0	1′	New.
Fusus echinatus	0	2	
Pleurotoma crispata	0	2	Hitherto known only fossil.
—— maravignæ	0	2	New.
—— abyssicola	0	4	New.
Mitra philippiana	0	4	New.
Cerithium lima	0	8	
Trochus tinei	0	6	
—— exiguus	1	9	
Turbo sanguineus	0	24	Hitherto known only fossil in the Mediterranean basin.
Rissoa reticulata	4	11	
Emarginula elongata	0	8	
Pileopsis Hungaricus	0	1	Small.
Acmæa unicolor	1	24	New.
Atlanta Peronii	0	2	Incrusted with nullipore, and thus rendered solid.
Hyalea gibbosa	0	1′	
Cleodora pyramidata		3	
Criseis clava	0	7	
—— spinifera	0	10	

V.

Date.....Nov. 25th, 1841.
Locality .....S. extremity of Gulf of Macri.
Depth .....230 fathoms.
Distance from shore .....One mile (shore steep).
Ground .....Fine yellowish mud.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Terebratula vitrea	0	2′	
Syndosmya profundissima	0	3′	
Arca imbricata..	1	1′	
Dentalium quinquangulare.. ..	1	0	
Hyalea gibbosa	0	1	
Cleodora pyramidata	0	8	
Criseis spinifera	0	5	

The Distribution of the Mollusca in Depth has been investigated by MM. Audouin and Milne-Edwards, M. Sars, and Prof. E. Forbes. By these observers the sea-bed is divided into four principal regions:—

1. The Litoral zone, or tract between tide marks.
2. The Laminarian zone, from low-water to 15 fms.
3. The Coralline zone, from 15—50 fms.
4. The deep-sea coral zone, 50—100 fms. or more.

1. *The Litoral zone* depends for its depth on the rise and fall of the tide, and for its extent on the form of the shore. The shells of this zone are more limited in their range than those which are protected from the vicissitudes of climate by living at some depth in the sea.* In Europe the characteristic genera of *rocky* shores are *Litorina, Patella* and *Purpura;* of sandy beaches, *Cardium, Tellina, Solen;* gravelly shores, *Mytilus;* and on muddy shores *Lutraria* and *Pullastra*. On rocky coasts are also found many species of *Haliotis, Siphonaria, Fissurella,* and *Trochus;* they occur at various levels, some only at the high-water line, others in a middle zone, or at the verge of low-water. *Cypræa* and *Conus* shelter under coral-blocks, and *Cerithium, Terebra, Natica,* and *Pyramidella* bury in sand at low water, but may be found by tracing the marks of their long burrows. (*Macgillivray*).

2. *Laminarian zone.*—In this region, when rocky, the tangle (*Laminaria*) and other sea-weeds form miniature forests, the resort of the vegetable feeding mollusks—*Lacuna, Rissoa, Nacella, Trochus, Aplysia,* and various *Nudibranchiata*. On soft sea-beds bivalves abound and form the prey of *Bucci-*

* Some of the litoral shells, like *Purpura lapillus* and *Litorina rudis*, have no free-swimming larval condition, but commence life as crawlers, with a well-developed shell. Their habits are sluggish, and their diffusion by ordinary means must be exceedingly slow.

num, *Nassa*, and *Natica*. From low-water to the depth of one or two fathoms on muddy and sandy shores, there are often great *meadows* of grass-wrack (*Zostera*) which afford shelter to numerous shell-fish, and are the haunt of the cuttle-fish and calamary. In tropical seas, the reef-building corals often take the place of sea-weeds, and extend their operations to a depth of about 25 fathoms. They cover the bottom with living verdure, on which many of the carnivorous mollusks feed, while some, like *Ovulum* and *Purpura*, browse on the flexible *Gorgoniæ*. To this zone belong the oyster-banks of our seas, and the pearl-fisheries of the south; it is richer than any other in animal life, and affords the most highly coloured shells.

3. *Coralline zone*. In northern seas the belt of sea-weed that fringes the coast is succeeded by a zone where horny zoophytes abound, and the chief vegetable growth consists of *Nullipore* which covers rocks and shells with its stony-looking incrustations. This zone extends from 15 or 25, to 35 or 50 fathoms, and is inhabited by many of the predacious genera—*Buccinum*, *Fusus*, *Pleurotoma*, *Natica*, *Aporrhais*, *Philine*, *Velutina*; and by vegetable feeders, such as *Fissurella*, *Emarginula*, *Pileopsis*, *Eulima*, and *Chemnitzia*. The great banks of scallops belong to the shallower part of this region, and many bivalves of the genera *Lima*, *Arca*, *Nucula*, *Astarte*, *Venus*, *Artemis*, and *Corbula*.

4. *Deep-sea Coral-zone*. From 50 to 100 fathoms the *Nullipore* still abounds, and small branching corals to which the *Terebratulæ* adhere. In northern seas the largest corals (*Oculina* and *Primnoa*) are found in this zone, and shells are relatively more abundant, owing to the uniformity of temperature at these depths. These deep-water shells are mostly small and destitute of bright colours; but interesting from the circumstances under which they are found, their wide range, and high antiquity. Amongst the characteristic genera are *Crania*, *Thetis*, *Neæra*, *Cryptodon*, *Yoldia*, *Dentalium*, and *Scissurella*. In the mud brought up from deep water may be often found the shells of *Pteropoda*, and other mollusca which live at the surface of the sea. In the Ægean Sea there is deep-water within one or two miles of the coast; but in the British Channel the depth seldom amounts to more than 20—40 fathoms.

When registering the results of dredging-operations, it is important to distinguish between *dead and living shells*, as in the preceding Tables; for almost every species is met with, in the condition of *dead shells*, at depths far greater than those in which it actually lives. On precipitous coasts the litoral shells fall into deep water, and are mingled with the inhabitants of other zones; currents also may transport dead shells to some distance over the bed of the sea. But the principal agents by which so many decayed and broken shells are scattered over the bed of the deep sea, must be the mollusk-eating fishes. Of 140 species of boreal shells described by Dr. Gould (p. 358)

more than half were obtained from the maws of fishes, in Boston market. Cod-fish do not swallow the large whelk-shells, but some idea of the number they consume may be derived from the fact that Mr. Warington has obtained the muscular foot and operculum of above 100 whelks, of large size, besides quantities of *crustacea*, from the maws of three cod-fish procured in the London market. Bivalve shells, like the Solens, and the rare *Panopæa Norvegica* are swallowed, and ejected again with eroded surfaces. The haddock swallows shells still more indiscriminately, and Mr. Mc Andrew has found great numbers of rare Pectens in them, but generally spoiled. The cat-fish and skate break up the strongest shell-fish with their teeth—accounting for the many angular fragments met with in the dredge, and in recent deposits.

The following are examples of shells obtained from great depths.

Norway. (Mc Andrew)

Living shells.

	Fathoms.
Cerithium metula	20—150
Margarita cinerea	10—130
Dentalium entale	200
Limea sarsii	120
Leda pygmæa	200
Yoldia limatula	120
Thetis koreni	40—100
Cryptodon flexuosus	200

Off the Cape. (Belcher.)

Buccinum? clathratum	126
Volutilithes abyssicola	132
Pectunculus Belcheri	120

Ægean. (Forbes.)

	Living.	Dead.
Terebratula vitrea	100	250
Argiope decollata	100	110
Crania ringens	90	150

Ægean. (Forbes.)

	Living.	Dead.
Murex vaginatus		150
Fusus muricatus	80—95	150
Nassa intermedia		45—185
Cerithium lima	3—80	140
Chemnitzia fasciata		110—150
Eulima distorta		69—140
Scalaria hellenica		110
Rissoa reticulata	55	185
Trochus exasperatus	10—105	165
Scissurella plica a		70—150
Acmea unicolor	60—105	150
Dentalium quinquangulare		150—230
Bulla utriculus		40—140
Spondylus Gussonii	105	
Pecten Hoskynsii		185—200
Arca imbricata	90—230	
Neæra cuspidata	12—185	
Thetis anatinoides		40—150
Kellia abyssicola	70—180	200
Syndosmya profunda ssima		80—185

Preserving molluscous animals for examination.

When shell-fish are killed by sudden immersion in hot water or strong spirit, great and unequal contraction is caused, distorting the muscular parts and rupturing the membranes.

Experiments have yet to be made for the discovery of means whereby these and other marine animals may be paralysed and killed, without altering the ordinary condition of their organs.*

Glycerine is the best medium for preserving such objects as the univalve

* The brittle-stars (*Ophiocoma*) are killed by sudden immersion in fresh-water; and the *Actiniæ* may be stupified by adding fresh-water drop by drop, until they lose the power of retracting their tentacles. But the bivalves (such as *Pholas*) may be kept in stale water till their valves fall off with incipient decomposition, and yet the muscular siphons retain their irritability, and contract slowly and completely, when placed in spirit.

shell-fish, intended for the examination of their lingual teeth; for if put up in strong spirit they become so hard that it is almost impossible to make good preparations from them, and in weak spirit they will not keep for any length of time.

Alcohol.—The cheapest alcohol for preserving natural history objects, at home, is sold as "methylated spirit;" it contains ten per cent. of ordinary wood spirit, and being undrinkable, is free of duty. When many specimens are put up together the spirit becomes much diluted, and should be changed. The soft tissues of bivalves, and spiral bodies of the univalves soon decompose in weak spirit. But for permanent use, in Museums, proof spirit may be diluted with an equal bulk of water. Cotton wool may be put with the specimens in spirit, especially with cuttle-fish, to preserve them from distortion by pressure.

Goadby's solution is prepared by dissolving ½ lb. of bay salt, 20 grains of arsenious acid, or white oxide of arsenic, and 2 grains of corrosive sublimate, in 1 quart of boiling rain-water.

Burnet's solution (chloride of zinc), largely diluted, is now used at the British Museum for the preservation of fishes and other objects, in glass jars. It has several advantages over spirit; being undrinkable, and not inflammable, and the concentrated solution (sold by all druggists) is much less bulky.

Muriate of Ammonia is recommended, by Mr. Gaskoin, for removing any unpleasant odours which may arise from preparations when taken out of spirit for examination. (See p. 430.)

A solution of *Chloride of Calcium* has been employed by Gen. Totten, U.S. Engineers, for preserving the flexibility of the epidermis in various shells. The solution of this deliquescent salt (which any one can make by saturating hydrochloric acid with marble), keeps the object which has been steeped in it permanently moist, without injuring its colour or texture; while its antiseptic properties will aid in the preservation of matters liable to decay. (Prof. J. W. Bailey, in Silliman's Journal, July, 1854.)

Aquaria.

The establishment of fresh-water and marine *aquaria* by Mr. Mitchell, in the gardens of the Zoological Society, and the writings of Mr. Philip Gosse, have popularized the subject of aquatic animals, and shewn how easy and interesting it is to keep a few of them alive, and watch their habits even in the midst of London. Instead of the solitary gold-fish in its globe of glass, we may now have a variety of fishes in a little world of aquatic plants and water-insects and fresh-water shells. Salt-water may be brought from the sea, or manufactured at home; and a glass jar or tank of any size, may be tenanted with small sea-fish and soldier-crabs, sea-anemones, shrimps, and periwinkles.*

* All the materials for fresh-water and marine aquaria, including live plants and fishes, may be obtained of W. A. Lloyd, 164, St. John Street Road, London.

The woodcut (Fig. 228) represents a marine aquarium designed by Mr. Gosse, with a small fountain in the centre, which not only adds to its ornamental appearance, but serves to aërate the water, or mix with it a greater amount of the *fixed air* which gill-breathing creatures respire.* An

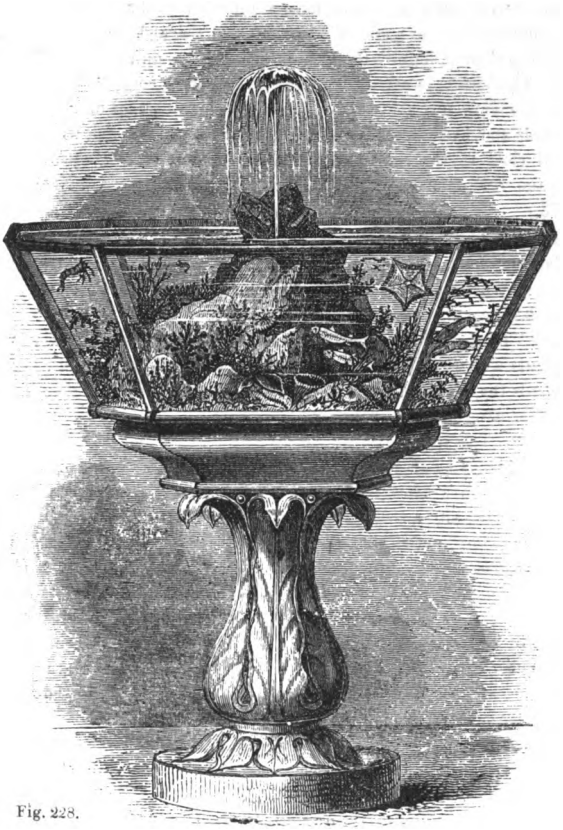


Fig. 228.

aquarium of this shape combines the advantage of a large surface *exposed to the air*, with the opportunity of watching its inhabitants through the glass sides. The form of *aquarium* best suited for aquatic animals, viz. a wide

* The use of the woodcut for this work, was kindly afforded at our request, by Mr. Gosse.

shallow pan, is the least convenient to keep; and therefore a large glass jar is usually adopted, or an oblong tank, made to fit the recess of a window, with slate ends and bottom, and plate-glass sides.

The most convenient form of tank, is that recommended by Mr. R. Warington; it is a four-sided vessel, having the back gradually sloping upwards from the bottom at an angle of 45 or 50 degrees, and the consequently extended top sloping slightly downwards and resting on the upper part of the back. The bottom is narrow, and the back may be covered with light rockwork, extending just above the water-line, to afford places of growth to the sea-weeds and fixed animals, and provide the litoral shell-fish with a feeding-ground close to the surface. The front and top of this aquarium are of glass, the rest of slate, fixed in a stout frame-work. (An. Nat. Hist. 14, p. 373.)

The aquarium should be covered, at least in towns, with a lid, or plate of glass, to check evaporation and exclude dust. If ventilation is necessary, the lid may be supported by small bent pieces of lead, hung on the rim of the tank.

The "balance of organic nature" is maintained in these aquaria by growing plants with the animals (p. 31, note). For fresh-water tanks, *Valisneria spiralis* is the best plant; but if there is space for the common flag (*Iris pseudacorus*) or water-plantain (*Alisma*) they will rise above the surface and blossom.* The *Anacharis alsinastrum* and *Hydrocharis* (like a miniature water-lily), may be grown at the surface. And if the tank is covered with a frame filling the window, some climbing plants may be trained in it, and the sides converted into a rockwork on which many ferns will thrive and expand their fronds in the moist air. (*Warington*).

For *marine aquaria* the green-weeds (*Ulva*, *Enteromorpha* and *Bryopsis*) are better oxygen-producers than the red sea-weeds, but the latter are so attractive as to be often tried.† The weed may become too luxuriant and require to be thinned in summer, but in the winter it dies down, and nearly disappears. Some of the threadlike weeds (diatomaceous algæ) are apt to gain admission, and in autumn break up spontaneously, filling the water with an opaque green cloud.

The surface of rockwork, in the aquarium is liable to be overspread, and the interior of the glass itself rendered opaque, by the early growth of *confervæ*. This may be in some degree prevented by keeping the water free from the grown plants, which are easily removed; and the green on the glass is kept in check by water-snails and periwinkles. These creatures occupy them-

* When small fishes are kept in an aquarium, however limited, in which the aquatic plants are grouped in the centre, they will swim round and round it in a little shoal

† Mr. Warington recommends the employment of glass tinted green for moderating the light when red sea-weeds are grown.

selves unceasingly in licking the glass (p. 161), and may be watched with a magnifier of moderate power.

Artificial salt-water.—The difficulty of obtaining sea-water has been obviated by the manufacture of salts for the formation of medicinal baths, by evaporating large quantities of the sea-water itself. This plan was suggested by Dr. E. Schweitzer, whose analysis of the water of the English Channel, taken off Brighton, shews the following salts in 100lbs. (or 10 gallons), stated in decimal fractions of the pound, and also in ounces and grains:—

Chloride of sodium	2.706	.....	43¼ ounces.	
—— magnesium ..	0.367	.....	6 ,,	
—— potassium....	0.076	.....	1¼ ,,	
Bromide of Magnesium	0.003	.....	21 grains	
Sulphate of magnesia..	0.230	.....	7½ ounces	} Crystals.
—— lime	0.140	.....	2¾ ,,	
Carbonate of lime	0.003	.....	21 grains	

As the weight of the salts amounts to 60¾ ounces, the true proportion of water to be mixed with them will be 3 pints less then 10 gallons.*

The *temperature* of the aquarium should not range below 50° nor above 70°. The mean temperature of the sea is estimated to be about 56° Fahr. with a variation of about 12° throughout the year. In hot summer days a screen is necessary against strong sunlight.† (*Warington*).

Many little points, in the management of the *aquarium*, will be determined by experience; such as the number of living animals it is capable of maintaining, and the sorts which may be safely kept together. Everything dead or decaying should be removed as soon as detected. The loss by evaporation may be supplied occasionally by sprinkling with distilled water.‡

* These salts are manufactured by Messrs, Brew and Schweitzer, 71, East Street, Brighton; the proportion ordered to be used is 6 oz. to the gallon of water, and stirred well until dissolved.

There are few inland towns without a fishmonger, through whom may be obtained live periwinkles (occasionally tenanted by the hermit-crab), and oyster-shells incrusted with *serpulæ* and sea-weed, some of which may be still living. The stickle-back is almost the only *fresh-water* fish capable of existing in a marine *aquarium*.

† In a sitting-room with a south aspect and good fire daily, the temperature of a thirty-gallon aquarium has been known to fall as low as 45° on several occasions, though screened at night by a blind. (Warington, An. Nat. Hist. 1855, p. 315.)

‡ Hand-book of the Marine Aquarium. P. H. Gosse. 12mo. Lond. 1855.

Chapter V.

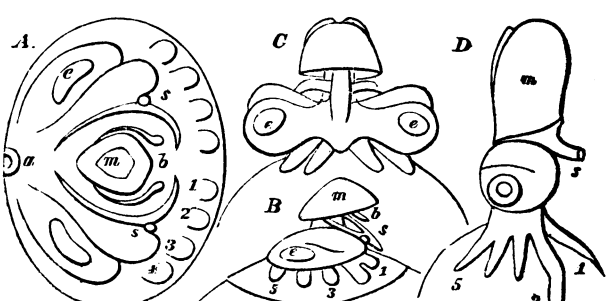
SUPPLEMENTARY NOTES ON THE MOLLUSCA.

Class, I. Cephalopoda.

Development, (p. 54.)—"All that is at present known upon this subject, is contained in the very beautiful memoir by Kölliker, who gives an elaborate account of the development of *Sepia*, *Loligo*, and *Argonauta*.*

"The process of yolk-division is partial, and the development of the embryo takes place within a distinct germinal area—whence a distinct yolk-sac is formed. This is proportionally very large in *Sepia* (Fig. 229) and *Loligo*, very small in *Argonauta* (Fig. 230) and therefore while the embryo is flattened and extended in the former genera, in the latter it more resembles the embryo of an ordinary Gasteropod.

"Development commences by the separation of the embryo into *mantle* and *body*, (foot). The part of the body in front of the mantle becomes the head; that behind it becomes the branchio-anal surface.



Fig, 229. *Development of the Cuttle-fish.* (Kölliker.)

A. Embryo two lines in diameter; *m*. mantle; *b*, branchial processes; *s*, siphonal processes; *a*, mouth; *e*, eyes; 1—5 rudimentary arms.
B. Side view of the embryo, when more developed.
C. Front view, at a later period.
D. Young cuttle-fish, still attached to the yolk-sac, with the tentacular arms (2) longer than the rest.

"The latero-posterior margins of the body are produced into four or five processes on each side, which become the *arms*.

"On each side of the mantle, between it and the head and arms, a ridge

* Entwickelungs geschichte der Cephalopoden. Zurich, 1844.

is formed upon the body. These ridges (*s. s.*) represent the *epipodium*; their anterior ends are continuous and attached, the posterior ends are at first free but eventually uniting, they form the funnel (D.*s.*). The rudimentary gills (*b.*) appear between the *epipodium* and mantle. The alimentary canal is at first straight; (the mouth being at *a*, the vent at *b*, in Fig. 229, A.)

"The embryo now grows faster in a vertical than in a longitudinal direction, so that it takes on the cephalopodic form. The intestine as a consequence, becomes bent upon itself; and the anterior pairs of arms grow over in front of the head and unite, so as eventually to throw the mouth nearly into the centre of the arms." (*Huxley.*)

At a later period of development (Fig. D.) the respiratory movements are performed by the alternate dilatation and contraction of the mantle; and the ink-bag is conspicuous by the colour of its contents, which are sufficient to blacken a considerable quantity of water. At the period of exclusion from the nidamental capsule, five layers of the shell of the young cuttle-fish have been formed; but except the nucleus, which is calcified, they are horny and transparent. The lateral fins are broader than in the mature animal.

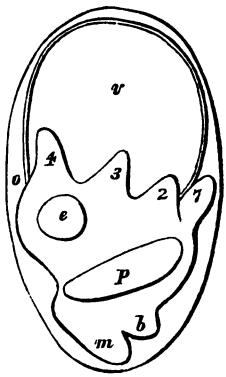


Fig. 230. *Argonaut*, embryo in the egg.

The observations of Madame Power respecting the young *Argonaut*, (quoted at p. 66), must have been made on the *Hectocotylus*. The embryo as described by Kölliker has simple, conical arms (1—4); and the elements of the funnel appear as a ridge (*p*) on each side of the body. In Fig. 230, *v*, is the yolk-sac; *o*, the position of the future mouth; *e*, the eye; *b*, the gill; *m*, mantle.

Octopoda, p. 65.—The account already given of the extraordinary condition of the male of the Argonaut and some other octopods has since been modified and extended by the observations of Dr. H. Müller* and M. Verany.†

According to Dr. Müller, the *Hectocotyle* of the Argonaut is an *arm irregularly metamorphosed*, spontaneously detached, (when the fluid formed in the true testis has been deposited in it,) enjoying an independent life, feeding on the female Argonaut, and fecundating by a true union.

The perfect male Argonauts are one inch in total length, and shell-less, (like the females of that size); their dorsal arms are pointed, not expanded. The testis is very large, and like that of the *Octopus* in structure

* Annales des Sciences Naturelles, t. 16, No. 3, and An. Nat. Hist., June, 1852.
† Moll. Medit 4° Genes. 1851. An. Sc. Nat. t. 16, 1852.

and situation; it contains *spermatozoa* of different degrees of development, and the excretory duct probably debouches into the *Hectocotylus*. The Hectocotylus is developed in a coloured sac, *which occupies the place of the third arm of the left side;* the sac is cleft by the motions of the Hectocotylus, which extends itself, whilst the sac becomes inverted and forms the violet coloured capsule on its back. The sac never contains more than one Hectocotylus, which is attached by its base, whilst the rest of it is free and coiled up. It has no enlargement like the male *Tremoctopus* (Pl. I. f. 3); the filiform appendage proceeds from the smaller extremity, and sometimes remains entangled in the coloured cyst on the back of the Hectocotylus, near its base. It has a chain of nervous ganglia in its axis, (like that in the arms of ordinary cuttle-fish.)

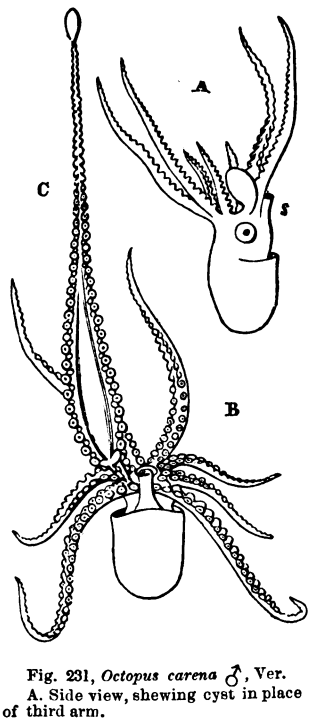


Fig. 231, *Octopus carena* ♂, Ver.
A. Side view, shewing cyst in place of third arm.
B. Ventral side of an individual more developed, with the Hectocotylus C.

M. Verany of Genca, found the male of "Octopus carena" (*Tremoctopus granulosus*, Cuv.) with the *right arm of the third pair* more developed than the others, and bearing an oval globe at its free extremity (Fig. 231, C.) This abnormal arm, agreeing with the *Hectocotylus octopodis* of Cuvier, was found to be developed in a cyst (A.) like that of the male Argonaut.

Fig. 232, *Lingual teeth of Sepia officinalis* (Cocken.)

The *Lingual dentition* of the cuttle-fish, as described by Lovèn, is most like that of the *Pteropoda* and *nucleobranchiata*. The central teeth are simple in *Sepia* and *Sepiola*, tricuspid in *Loligo*, and denticulated in *Eledone*. The lateral teeth, or *uncini*, are three on each side, and mostly simple and claw-like. There were 50 rows of teeth in the

specimen of *Sepia* examined, the ribbon increasing in breadth backwards to twice its diameter in front.

Sciadephorus, Reinh. and Prosch; Bostrychoteuthis, Ag, = Cirroteuthis, p. 68.

Chondrosepia (loliginiformis) Leuckart, = Sepioteuthis p. 70.

Owenia, Prosch, = Cranchia megalops, N. Atlantic.

Leachia (cyclura) Les. 1821; Perotis, Esch. = Loligopsis, p. 71.

Belemnites.—Prof. Buckman of Cirencester possesses a *phragmocone* from the lias, containing the fossil ink-bag.

HELICERUS (Fugiensis) Dana, Sill. Journ. 1848. Shell like a Belemnite, half an inch in diameter; *guard* thick, subcylindrical, fibrous; *phragmocone* slender, terminating in a fusiform *spiral nucleus*. In slate-rock, Cape Horn.

Conoteuthis Dupinianus occurs in the *Gault* of Folkstone. (Mus. Bower bank.)

NAUTILUS.—The gas with which the air-chambers of the pearly nautilus are filled, consists chiefly of nitogen, without a trace of carbonic acid. (*Vrolik*, An. Nat. Hist. 12, 1843.)

Nautilus regalis, Sby, London Clay, Highgate. This species is distinguished by *serrated lines* on its external surface, nearly, but not quite concident with the lines of growth. (*Wetherell*, Lond. and Edin. Phil. Mag. IX. p. 462.)

ORTHOCERAS.—The species figured (Pl. II. 14) is *O. Ludense*, of the Ludlow-rock, Herefordshire. *O. giganteum* is an Actinoceras, with a large beaded siphuncle, differing in structure, however, from the Silurian species; the vascular tubes (or interspaces) connecting the inner siphuncle with the air-chambers exist in only one plane, on the ventral (?) side, whereas in *A. Bigsbyi* they radiate equally in all directions.

Hormoceras, Stokes.—The structure of the siphuncle in this fossil is essentially the same as in *Actinoceras*; the specimen (fig. 48, p. 88) is now in the British Museum.

DISCOSORUS (conoideus) Hall, 1852, Pal. New York, 99. This fossil appears to be a siphuncle similar to those figured by Dr. Bigsby in 1824 (Geol. Trans. Pl. 30. f. 6.) and which have been correctly referred by Quenstedt to the *Orthocerata*. It resembles a *pile of disks*, and is more or less curved, and conical, the *smaller* end being *upwards* or towards the last chamber!

Conoceras (angulosus) Bronn, 1830, was founded on *a figure* of a weathered fragment of *Gonioceras*, as pointed out by M. Saemann.

Thoracoceras (vestitum) Fischer, 1844 = Melia, Fischer (not L.) 1829, Carb. limestone of Moscow; the siphuncle is small and lateral. According to M. D'Orbigmy there are 20 species, ranging from the L. Silurian to the Carb. System, found in the U. States and Europe.

Apioceras (trochoides) Fischer, 1844. Dev.—Carb. Europe, Brit. (e. g. *O. fusiforme*) Aperture sub-circular, not much contracted.

Gyroceras, D'Orb. (not Meyer) has been employed for the principal fossils included in *Cyrtoceras* by Goldfuss. The name was originally given by Meyer, to *G. gracilis*, Bronn (*Spirula*, Goldf. MS. 1832, *Lituites*, Quenstedt) which is the *Goniatites compressus* of D'Arch. and Vern.

Trigonoceras (paradoxicum) Mc Coy, is a form of *Nautiloceras*, D'Orb. (Cyrt. ægocerus, Münst.) with a sub-spiral shell.

Discites (Mc Coy) is closely allied to the last, differing in the whirls being compact. It may be doubted whether any of the Palæozoic "Nautilidae" really belong to that family.

Ascoceras.—This curious fossil (which has been recently found at Ludlow, by Mr. Salter) only resembles *Ptychoceras* in appearance. It is slightly curved, and has a dorsal siphuncle, but the septa are bent and prolonged forwards on the ventral side to such an extent as to give an appearance of the whole shell being doubled up.

Ammonites Jason, Reinecke (A. Gulielmi, Sby). The fossil figured, Pl. III 5, is *A. spinosus*, Sby. (=A. ornatus, Schl.) and is certainly distinct from the finely ribbed species which occurs with it, and to which the name *Jason* should be restricted.

CLASS II. GASTEROPODA.

Classification by lingual dentition.

The researches of Dr. Lovèn have been followed by many observations on genera not figured in his admirable memoir,* and by attempts to remodel the arrangement of the *Gasteropoda* by the aid of peculiarities in their dentition. Whatever improvements may be thus obtained, it does not appear desirable to introduce a new terminology for divisions long since well established, and already over-burdened with *classical* names.†

The patterns, or *types* of lingual dentition, are on the whole remarkably constant; but their *systematic value* is not uniform. It must be remembered that the teeth are essentially *epithelian cells*, and like other superficial organs liable to be modified in accordance with the wants and habits of the creatures. The instruments with which animals obtain their food are of all others most subject to these *adaptive* modifications, and can never form the *basis* of a philosophical system.‡

* Öfversigt af Kongl. Vetensk. Akad. Förhandl. 1847.

† The following names were proposed by Troschel (in Wiegman's *Handbuch der Zoologie*, 1848) and Gray (An. Nat. Hist.) for the principal types of lingual dentition.

a. Tænioglossa, teeth 3. 1. 3; Litorina, Natica, Triton,

b. Toxoglossa, teeth 1. 0. 1; Conus, Terebra?

c. Hamiglossa, teeth 1. 1. 1; Murex, Buccinum.

d. Rachiglossa, teeth 0. 1. 0; Voluta. Mitra?

e. Gymnoglossa, teeth 0; Pyramidella, Cancellaria, Solarium?

f. Rhipidoglossa, teeth 00. 1. 00; Nerita, Trochus.

‡ The carnivorous opossums have teeth adapted for eating flesh, but are not on that account to be classified with the placental carnivora.

The lingual teeth, like the *operculum*, have usually a structure characteristic of the genera or sub-genera, and are sometimes uniform thoughout a whole family or group of families. They also exhibit minute differences in closely allied mollusks, and promise to be of great value in the discrimination of critical species. Mr. Wilton has ascertained that *Patella athletica* may be distinguished from the common limpet of our coast by its teeth; and a similar difference exists between two Cape species, *P. apicina* and *P. longicostata*.

In the account already given of the structure and use of the lingual teeth (p. 27 and 160), it has been pointed out that the *Carnivorous* families have a *retractile proboscis*; and it may now be added that in many instances the aperture of this organ is furnished with a prehensile spiny collar (fig. 239 and 260), apparently for the purpose of holding the prey whilst the lingual organ is employed in drilling or abrading it. The *spinose collar* coexists with a *lower* mandible in *Doris;* but appears not to be found in the genera provided with an upper jaw. The spiny buccal plates of *Natica* and *Lamellaria* are united above, like the lateral jaws of *Æolis*, of which they seem to be a modification. The *vegetable feeders* have a *rostrum*, or non-retractile muzzle, and frequently a horny upper *mandible* (fig. 260), which is sometimes divided, and forms two lateral jaws, articulated above. The *chemical composition* of the lingual teeth has not yet been examined by a competent observer. It is not improbable that the opaque brown teeth of *Chiton*, *Patella* and *Nerita*, are chitinous, like the mandibles and pen of the calamary.*

ORDER I. NUCLEOBRANCHIATA.

Lingual membrane plane, widening backwards; teeth 3. 1. 3. (p. 199.) Firola, Carinaria, Atlanta.

Fig. 233. *Carinaria cristata*, L. (Wilton.)

* The animal basis of shell is a peculiar organic substance, termed *conchioline*, insoluble in water, alcohol and ether, and resisting the long-continued action of acids; in caustic alkali it dissolves very slowly; its composition is—H. 5, 9; C. 50, 0 N. 17, 5, and O. 26, 6, (M. E. Fremy, Ann. de Chimie, 1855, p 96.)

ORDER II. PROSOBRANCHIATA.

Section A. ZOOPHAGA, Lam. (*Proboscidea*, Troschel.)
[Family 1, *Strombidæ*: lingual teeth 3. 1. 3.] p. 104.

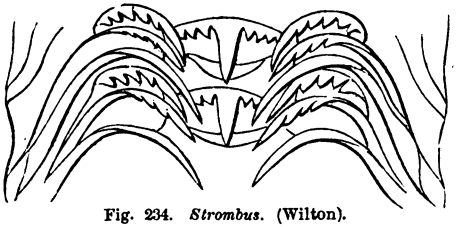


Fig. 234. *Strombus*. (Wilton).

Strombus (floridus) is described by Lovèn as having a non-retractile, produced *muzzle*, like *Aporrhais*. The teeth are 7 cusped; uncini—1 tridentate, 2 and 3 simple, claw-shaped. *S. gibberulus* is represented by Dr. Bergh with all the uncini denticulated.

The dentition of *Aporrhais* is most like *Strombus* and *Carinaria*; and quite unlike the *Cerithiadæ* with which it has been placed, in accordance with the views of Prof. Forbes. The animal is carnivorous. (p. 130.)

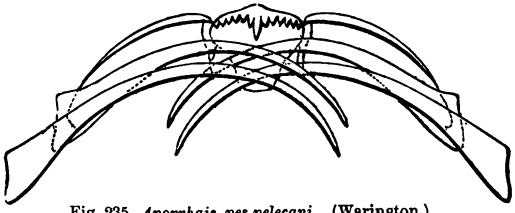


Fig. 235. *Aporrhais pes-pelecani*. (Warington.)

Fig. 236. Operculum of *Struthiolaria*.

[Family 2? *Cassidæ*: teeth 3. 1. 3.]

Cassis.	Dolium.	Ranella.
Cassidaria.	Pyrula.	Triton.

Fig 237. *Cassis saburon*. (Original.)

The spiny *buccal plates* of Cassis have been mistaken by Gray and Adams for the *teeth*, which in this genus, and also in *Triton*, are very minute and transparent.

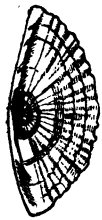


Fig. 238. Operc. of *Cassis*.

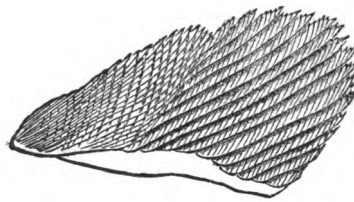


Fig. 239. One of the buccal plates of *Triton*, $\frac{4}{1}$o. (Wilton.),

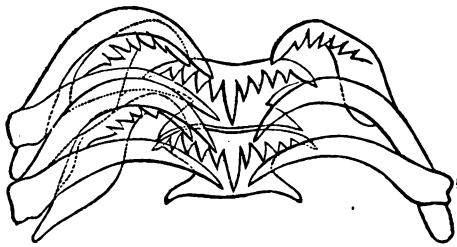


Fig. 240. *Teeth of Triton*, $\frac{24}{1}$o. (Wilton.)

Fig. 241. *Dolium perdix*. (Original.)

Fam. 3. *Muricidæ* (including *Buccinidæ*): teeth 1. 1. 1. (p. 28).

Murex.	Fusus.	Buccinum.	Oliva
Trophon.	Fasciolaria.	Chrysodomus.	Ancillaria.
Purpura.	Turbinella.	Nassa.	Harpa.

Fig. 242. *Murex tenuispina*. (Wilton.)

X 2

The lingual ribbon of *Murex*, *Purpura*, and most of the other members of the family, is very slender, and the teeth minute and glassy. It is quite certain that they drill holes in other shells to get at the animal; the process may be observed even in the confinement of a vivarium. The short, deeply notched canal of *Buccinum* and *Nassa* is related to their burrowing habits; Mr. Warington has observed that when *Nassa reticulata* burrows, it maintains a communication with the surface by means of its long recurved siphon.

Fig. 243. *Fasciolaria Tarentina.* (Wilton.)

The teeth of *Fasciolaria* resemble those of *Fusus Islandicus*. In *Buccinum undatum*, the median tooth has 5, or rarely 6 denticles; and Mr. Wilton has observed that *B. limbosum*, ♂ has the teeth 7 cusped, whilst in the females they are 6 cusped.

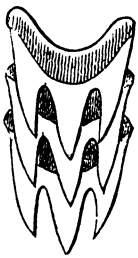


Fig. 244. *Voluta.* (Wilton).

Fam. 4. *Conidæ:* teeth 1. 0. 1. (see p. 117).

Conus. Pleurotoma. Cithara. Terebra?

Fam. 5. *Volutidæ:* teeth single, rachidian, or 1. 1. 1.

Voluta. Cymba. Melo. Marginella?

? Mitra Grœnlandica, teeth 0. 1. 0. minute, voluta-like; in more than 120 rows.

„ Caffra teeth 1. 1. 1. buccinoid.

„ episcopalis „ 1. 1. 1. resembling *Fasciolaria*.

Fam. 6. *Cypræidæ:* teeth 3. 1. 3. (p. 28).

Cypræa. Ovulum. Pedicularia. Erato?

In *Ovulum* the teeth are 2. 1. 2. the outermost broad, with pectinated margins. Lovèn describes the Cypræidæ as having a short, non-retractile muzzle, and places them between the *Naticidæ* and *Lamellaria*.

Fam. 7. *Naticidæ:* teeth 3. 1. 3. or 1. 1. 1.

Natica Sigaretus. Lamellaria. Velutina.

Fig. 245. *Natica monilifera.* (Wilton.)

Fig. 246. *Velutina lævigata.* (Warington.)

The mouth of Natica is armed with buccal plates, shorter and broader in proportion than those of *Triton* (p. 239), and a similar armature exists in *Lamellaria*.

The dentition of *Lamellaria* is described and figured by Lovèn, and in the elaborate monograph by

Dr. Rudolph Bergh. (Copenhagen, 1853.) It exhibits two modifications:—

1. *Lamellaria perspicua*, teeth 1. 1. 1., median with a bifid base, apex recurved, denticulated; laterals large, trapezoidal, hooked and serrulate.

2. *L. Grœnlandica* (Oncidiopsis, Beck.) and *L. prodita*, Lovèn, teeth 3. 1. 3., exactly as in *Velutina* (fig. 246)*. The dental canal is spiral.

Fam. 8. *Cancellariadæ*: teeth 3. 1. 3. or 0.

Cancellaria (teeth 0.) Trichotropis. Cerithiopsis?

Lovèn places *Trichotropis* in the same family with *Velutina*; Cancellaria is very closely allied, though it wants both teeth and operculum. Mr. Couthouy describes *Trichotropis cancellata* as having a muzzle like Litorina.

Fig. 247. *Trichotropis borealis*. (Warington.)

Fam. 9. *Pyramidellidæ*: teeth 0.

Pyramidella. Aclis. Eulima. Monoptigma. (Lea.)

The *Pyramidellidæ* are related to *Tornatella*, which has numerous similar teeth (p. 180).

? Scalaria; uncini numerous, similar.

? Ianthina; dentition like *Testacella* (if the two halves were united by their outer margins), p. 148.

SECTION B.—Phytophaga, Lam. (*Rostrifera*, Lovèn).

Fam. 10. *Turritellidæ*: teeth 3. 1. 3. (p. 132).

Turritella. Cæcum. Vermetus. Siliquaria.

Fam. 11. *Cerithiadæ*: teeth 3. 1. 3. (p. 127).

Cerithium. Triforis. Potamides. Planaxis?

Mr. Wilton has examined the dentition of four *Cerithiadæ*; the teeth are broad, as in *Melaniadæ*, with incurved and dentated summits. In *Cerithidium* the median teeth are slender with minute hooks.

Fam. 12. *Melaniadæ*: teeth 3. 1. 3. (p. 130).

Melania. Paludestrina. Tanalia. Melanopsis. Pirena.

Fig. 248. *Pirena atra*. (Wilton.)

Fam. 13. *Paludinidæ:* lingual teeth 3. 1. 3. (p. 138).

Paludina.	Paludomus?	Ampullaria.	Valvata.

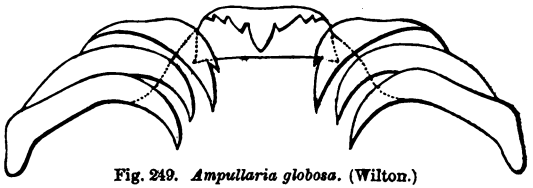


Fig. 249. *Ampullaria globosa.* (Wilton.)

The lingual uncini of *Paludina* and *Valvata* are denticulated; in *Ampullaria* the first and second uncini are tricuspid.

Fam. 14. *Litorinidæ:* teeth 3. 1. 3. (p. 134).

Litorina.	Tectaria.	Modulus,	Risella.
Fossarus.	Narica.	Solarium?	Phorus?
Lacuna.	Litiopa.	Rissoa.	Truncatella.

The teeth of *Phorus* are like those of *Atlanta.* (Mörch.)

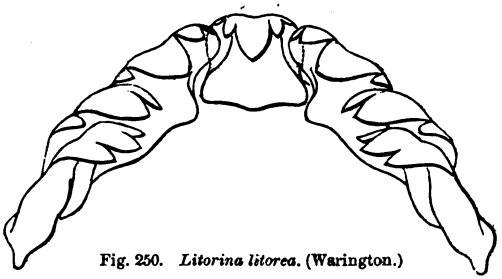


Fig. 250. *Litorina litorea.* (Warington.)

The lingual canal of the periwinkle passes from the back of the mouth under the œsophagus for a short distance, then turns up on the right side and terminates in a coil (like spare rope) resting on the plaited portion of the gullet. It is 2½ inches long, and contains about 600 rows of teeth; the part in use, arming the tongue, comprises about 24 rows.* The

* The opposite figure shows the manner in which a gasteropod may be laid out for examination, *under water*; the body requires to be fixed, and the cut edges of the mantle to be kept open with needle points. A convenient trough may be made of a plain earthenware *soap-dish*, by cutting a piece of sheet-cork (such as bootmakers use) to fit the bottom, and fixing it to a piece of sheet-lead of the same size with a couple of india rubber bands. The instruments required for dissecting are simply a pair of fine pointed scissors, a few broken needles, a penknife, or scalpel, and a pair of forceps with fine curved points.

dental ribbon of *Risella* is above 2 inches long, and coiled as in *Litorina*. (Wilton).

r, rostrum or muzzle.
k, buccal mass.
g, nervous ganglia (reproductive orifice, on the right side).
s, salivary gland.
œ, œsophagus.
l, lingual coil.
m, shell-muscle.
b, branchia or gill.
c, heart.
n, aorta.
e, stomach.
f, liver.
h, biliary canal.
i, intestine.
a, anus.
o, ovary.
d, oviduct.
u, nidament.
v, ovarian orifice.
x, renal organ.
y, mucus gland.

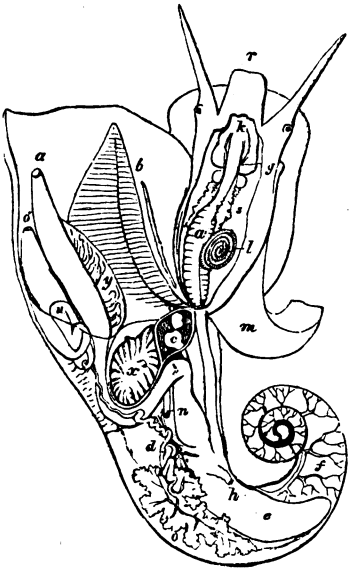


Fig. 251. *Litorina litoralis* ♀: (after Souleyet.) Animal removed from its shell; branchial cavity and back laid open.

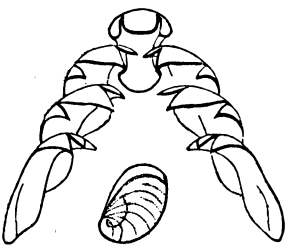


Fig. 252. Operculum and teeth of *Risella*. (Wilton.)

Fam. 15. *Calyptræidæ*: teeth 3. 1. 3. (p. 151.)

Calyptræa. Pileopsis. Hipponyx. Metoptoma.

The rostrum is prominent and split, but non-retractile; the median tooth hooked and dentate; the first, or first and second laterals serrated, the third claw-shaped and simple. Lovèn places this family next to the *Velutinidæ*.

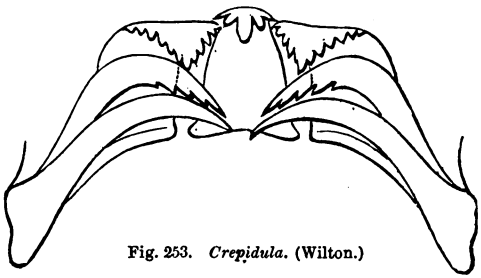


Fig. 253. *Crepidula.* (Wilton.)

(Section C. SCUTIBRANCHIATA, Cuv. *Rhipidoglossa*, Troschel.)

Fam. 16. *Turbinidæ:* lingual teeth 00. 5, 1, 5. 00 (pp. 28 and 142).

Fam. 17. *Haliotidæ*, p. 146. Fam. 18. *Fissurellidæ*, p. 149.

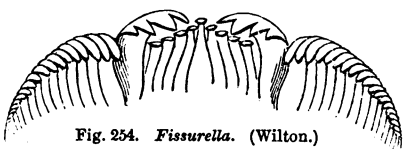


Fig. 254. *Fissurella.* (Wilton.)

Parmophorus differs from *Fissurella* in having a broad median tooth.

Fam. 19. *Neritidæ:* teeth 00. 3, 1, 3. 00 (p. 140).

Nerita. Neritopsis. Neritina. Navicella. Pileolus.

Fig. 255. *Navicella.* (Wilton).

Median tooth small; laterals 3,—1st large, trapeziform, 2, 3, minute; uncini numerous,—1st large, strong and opaque, the rest slender, translucent, with denticulate hooks.

(*Cyclobranchiata.* Cuv.)

Fam. 20. *Patellidæ:* p. 153. Fam. 21. *Dentaliadæ:* p. 156.

Fam. 22. *Chitonidæ.*

Patella. Nacella. Acmæa. Gadinia.

Fig. 257. *Chitonellus.* Tasmania. (Wilton.)

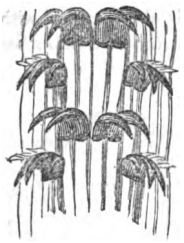


Fig. 256. *Patella vulgata.* (Original: Wilton.)

The Cape limpets (e.g. *P. denticulata*) have a minute central tooth, which is wanting in any other species hitherto examined. (*Wilton.*)

ORDER III. PULMONIFERA.

Section A. In-operculata. Lingual teeth numerous, similar. (p. 160.)

Section B. Operculata. Lingual teeth 3. 1. 3. (p. 175.)

Glandina (*Algira*) has teeth like the Testacelle (p. 169, Raymond, Journ. Conch. 1853).

The anomalous genera *Siphonaria* and *Amphibola* have a dentition like the inoperculate land-snails. (Wilton). *Otina* (*Velutina*) *otis* has teeth similar to *Conovulus*. (Clark.)

The many points of agreement between the *Litorinidæ* and *Cyclostomidæ* have been already pointed out (pp. 32, 174).

ORDER IV. OPISTHOBRANCHIATA.

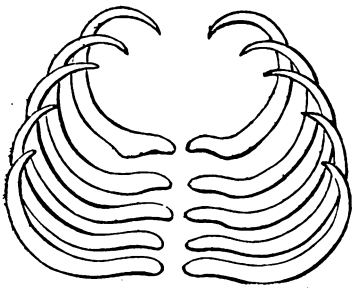


Fig. 258. *Philine aperta.* (Wilton.)

The lingual dentition is extremely varied in the *Bullidæ*. In Philine aperta there is no central tooth; and the laterals, which increase rapidly in size backwards, have a finely denticulated membranous inner edge.

In *Tornatella* and *Bulla* (physis) the rachis is unarmed, and the lateral teeth are numerous and similar; in *Acera*, *Cylichna*, and *Amphisphyra*, there is a minute central tooth.

ORDER V. NUDIBRANCHIATA.

Fig. 259. *Dendronotus arborescens*

The *Doridida* are distinguished by having a short and wide lingual membrane with numerous similar teeth; the Æolids have a narow ribbon with a single series of larger teeth. In *Dendronotus* a large central tooth is flanked by a few small denticulated teeth. (Alder and Hancock, Pl. II. fig. 8.)

The only Nudibranche with a solid upper jaw, is *Ægirus punctilucens* (A. and H. Pl. XVII. fig. 15). In other instances the two halves are arti-

culated and act as lateral jaws. In *Ægirus* the mouth is also furnished with membranous fringes (A. and H. Pl. XVII. fig. 14). *Ancula cristata* has a formidable spinous collar (Pl. XVII. fig. 7).

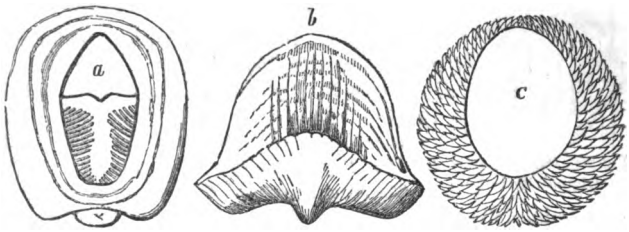


Fig. 260, *a*. Mouth of *Ægirus punctilucens*.
b. Horny upper mandible detached.
c. Prehensile collar of *Ancula*.
a, mandible; *x*, dental sac; *b*, insertion-plate of mandible; *c*, passage of mouth.

Note on the preparation of the Lingual Teeth as microscopic objects; by J. W. Wilton, Esq. The mollusk when taken from its shell must be pinned down in the dissecting trough, with needle-points passed through the sides of the muscular foot (fig. 251, and note). Water is then to be poured in till the animal is covered, and should be changed as often as the condition of the object renders it turbid. It is convenient to make these examinations under a simple lens, attached to an upright rod with a rack and screw, so that both hands may be free. A good light is necessary, and with lamp-light a bull's-eye condenser is useful. The lower point of the scissors should be passed into the mouth of the animal, and kept close to the upper side, which is to be cut open so as to expose the floor of the mouth, or *tongue*, with its teeth. When the cut edges have been pinned back, the whole length of the dental sack or canal may be carefully worked out with a lancet or other suitable instrument. Experience in this process may be gained by examining the periwinkle and whelk, or any others of which a number may be easily procured. The lingual ribbon, when detached, should be placed in a watch-glass of distilled water, and cleaned by repeated washings with a camel's-hair brush, and then placed in pure alcohol till wanted for mounting. If there is much difficulty in getting the membrane clean, it may be put for a time in *liquor potassæ*, care being taken to wash it in frequent change of water afterwards. Before mounting in balsam the preparation requires to be saturated with spirits of turpentine, which will more readily enter its structure if it be first soaked in *chloroform*. The slide is prepared by dropping a little Canada balsam on its centre, the quantity varying with the size and thickness of the object. The dental membrane is placed on the balsam with the side from which the teeth project upwards, and guided into the desired position; it is

then covered with thin glass previously warmed over the flame of a spirit lamp.

Mr. Warington and Mr. Fisher Cocken recommend *glycerine* (which may be obtained at Price's, of Vauxhall) as the best medium for microscopic objects; the glass covers are cemented on with hatter's-varnish (shell-lac dissolved in spirits of wine), and painted over afterwards with asphalt dissolved in turpentine, such as the varnish-makers supply.

SUPPLEMENTARY NOTES ON THE GENERA.

DIBAPHUS, Phi. 1847. *Conohelix edentulus*, Sw. (*Strombidæ*? p. 104.) Subcylindrical, spire acute; aperture narrow, linear, edentulous, excised at the base; lip thickened, rectilinear, rounded and abbreviated below.

RHIZOCHILUS (antipathum) Stp. 1850. Founded on a sp. of *Purpura*? which lives on the *antipathes ericoides*. When adult they attach themselves, singly or in groups, to the branches of the coral, or to each other, by a solid extension of the lips of the shell. The aperture becomes closed, with the exception of the respiratory canal.

Planaxis, p. 114 (Cerithiadæ?). This genus was placed with the *Buccinidæ* on the statement of Mr. Gray, that the animal was like *Purpura*.

BORSONIA (prima) Bellardi, 1838. Is a *Pleurotoma* with the columella plaited like *Mitra*. *Miocene*, Turin. *Eocene*, Brit.

PACHYBATHRON (cassidiforme) Gaskoin. *Shell* small, oblong, striated with lines of growth; spire small, depressed, with channelled suture; aperture with callous, denticulated lips, like *Cypræa*. *Distr.* 3 sp.

Calpurnus, Montf. (name) = Ovulum verrucosum. p. 122.

Volva (Fleming) = Ovulum patulum, (*Calpurna*, Leach.)

Radius (Montf.) Schum. = Ovulum volva.

DESHAYESIA (Parisiensis), Raulin, 1844, (p. 123). *Miocene*, France. Some additional species have been found with a similar oblique aperture and corrugated inner lip. Baron Ryckholt has described a species (*D. Raulini*), from the *Devonian*, Belgium. The relation of the genus is uncertain.

NATICELLA (Munsteri, D'Orb.) Münster, 1841. This genus, abounding in the Trias of St. Cassian, has been referred to *Natica* by D'Orbigny. A characteristic species occurs in the Green-sand of Blackdown, and has been named *Natica carinata*, J. Sby. (Narica, D'Orb.) It is exactly intermediate between *Narica* (p. 124) and Fossarus (p. 135) and appears to form with them a little group nearly related to *Lacuna* (p. 136.)

Velutina inhabits the laminarian Zone, and ranges to 40 fms. *V. lævigata* is sometimes brought in on the fishermen's lines, (off Northumberland), generally adhering to *Alcyonium digitatum* (Alder). Dr. Gould obtained it from the stomach of fishes.

MONOPTIGMA (melanioides) Lea = M. striata, Gray (name only.) Shell like *Chemnitzia*, rather fusiform, spirally grooved; columella slightly folded, with a sinus at the base. *Distr.* 12 sp. Indo-Pacific, (p. 126).

Menestho, Möller, (Turbo albulus, Fabr. Greenland) v. Chemnitzia.

Aclis (p. 132) ascaris, Turt. (= A. supra-nitida, Wood) has the apex sinistral, like the *Pyramidellidae*.

Vicarya (Verneuili) D'Arch. 1854. *Eocene*. Scinde. Shell like *Potamides*; aperture with a broad callosity spreading over the body whirl, outer lip with a deep narrow sinus like *Clionella*.

Holopella, Mc Coy, Turritella obsoleta, Sby. U. Silurian. Brit. Peristome *entire*, not produced in front.

Scoliostoma (Dannenbergii) Max. Braun, 1838. *Syn.* Cochlearia, F. Braun, 1841. Shell turreted, sometimes sinistral, whirls keeled or rounded, aperture more or less twisted, trumpet shaped, sometimes with a widely expanded outer peristome. *Fossil.* Devonian—Trias. Europe.

AMNICOLA, Gould and Haldemann, 1841 (p. 131) = Paludina porata, Say, inhabits the fresh waters of New England, gregarious on stones and submerged plants. The species are numerous.

PALUDOMUS, Sw. Shell turbinated, smooth or coronated; outer lip crenulated; olivaceous, with dark brown spiral lines. *Distr.* 24 sp. Himalaya, Bombay, Ceylon, Seychelles. This genus was founded on *Melania conica* and two other Indian species, having a concentric operculum, like *Paludina*. In Reeve's monograph it was made to include, primarily, a group of Cingalese shells for which Mr. Edgar Layard has revived Gray's MS. name TANALIA. The description at p. 131. applies to this latter group.

PETALOCONCHUS (sculpturatus) Lea, 1843. Sub-genus of *Vermetus*, p. 133. *Miocene*, U.S., St. Domingo, S. Europe. *Shell* with two internal ridges, running spirally along the columella, becoming obsolete near the apex and aperture.

Discohelix (calculiformis) Dunker, 1851. *Lias*, Gottingen. This name was proposed for the depressed *Euomphali* of the Lower Oolites, of which there are several species in Normandy and England. Shell usually sinistral, flat or concave above, aperture quadrangular.

Platystoma (Suessi) Hörnes, 1855. *Trias*, Hallstadt. Shell discoidal, sinistral? sculptured; peristome suddenly expanded, plain; aperture with an inner rim, circular, and deflected (upwards,) at right angles to the plane of the shell. Several examples have occurred.

BIFRONTIA, Desh. p. 135. *B. Zanclæa*, Phi. has been dredged alive off Madeira, by Mr. Mc Andrew, the operculum is like *Torinia* (fig. 82) from which the shell differs only in being more depressed.

PHILIPPIA (lutea) Gray, has a multi-spiral operculum, and the animal is like *Trochus*. (Philippi.)

PALUDESTRINA (lapidum) D'Orb. part. Fresh-waters of S. America.

Shell conic, few-whirled, epidermis green; aperture oblique, peristome abruptly reflected; operculum claw-like. The typical species appear to be *Melaniadæ*, but some small shells like *Hydrobia* have been included in the genus.

VITRINELLA (valvatoides). C. B. Adams, 1850. *Shell* minute, hyaline, turbiniform, umbilicated; aperture large, orbicular. *Distr.* 18 sp. W. Indies (5), Panama.

SCISSURELLA (crispata). Animal like *Margarita;* tentacles long, pectinated, with the eyes at their base; foot with two pointed lappets and two long slender pectinated cirri on each side; operculum ovate, very thin, with an obscure sub-spiral nucleus.

No part of the animal was external to the shell. The only living example occurred at Hammerfest, in 40–80 fm. water; when placed in a glass of sea-water it crawled up the side and scraped the glass with its tongue. It was pale and translucent when living, but turned inky black after immersion in alcohol. (*Barrett*, An. N. H. 17, p. 206.)

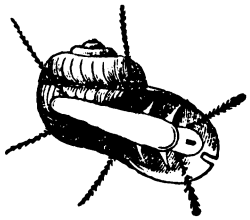


Fig. 261. *Scissurella.* 8/1

Mr. Jeffreys found *S. elegans*, D'Orb. plentifully alive in sea-weed on the coast of Piedmont. It has a multispiral operculum, like *Margarita*. In this species, as noticed by Mr. G. Sowerby, the *slit* in the peristome of the young shell is converted into a *foramen* in the adult, as in the Jurassic *Trochotoma*.

Catantostoma (clathratum) Sandberger, 1842. *Shell* like *Pleurotomaria;* last whirl deflected, peristome incomplete, slightly varicose, irregular. *Fossil.* Devonian, Eifel.

RAPHISTOMA (angulata). Hall, (p. 147). L. Silurian. U. States. Canada. Shell depressed, out lip sinuated. In *R. compacta* (Salter) the spire is sunk and basin-shaped, the umbilical side flat, and the last whirl a little disunited.

Holopea (symmetrica). Hall. 1847. (Ianthinidæ?) Outer lip sinuated near the base. *L. Silurian*, New York.

BROWNIA (Candei) D'Orb. 1853. (Atlantidæ?) A minute discoidal shell, associated with *Helicophlegma* in the first instance, but distinguished by the serrated keels on its whirls, and lateral notches to the aperture. Cuba.

CALCARELLA (spinosa) Souleyet. 1850. (Atlantidæ?) Shell sub-globose, dextrally spiral, horny, pellucid, with three acutely serrated keels; aperture thickened, entire. Lat. 3 lines. South Seas. (= Echinospira, Krohn.)

RECLUZIA, Petit, 1853. R. Jehennei, Red Sea. R. Rollandiana, Atlantic, and Mazatlan. *Animal* pelagic, resembling Ianthina; one inch long. *Shell* paludiniform, thin, with a brown epidermis; whirls ventricose; aper-

ture ovate-oblique, slightly effused at the base, margins dis-united; inner lip oblique, rather sinuated in the middle; outer lip acute, entire.

PATELLA, p. 154. The common limpet makes oval pits in timber as well as in chalk. Small individuals sometimes roost, habitually, on larger specimens, and make an oval furrow on the shell. The surface on which limpets roost, and some space around it, is often covered with radiating striæ not *parallel* like those *produced by their teeth on nullipore*. Mr. Gaskoin has a limpet-shell incrusted with nullipore, which other limpets have rasped all over. In M. D'Orbigny's collection of Cuban shells there is a group of oysters (*O. cornucopiæ*), with a colony of the *Hipponyx mitrula* sheltered in their interstices; these limpets have not only fed on the nullipore with which the oysters are incrusted, but have extensively eroded the epidermal layer of shell beneath.*

As to the *Calyptræidæ* generally, although furnished with lingual teeth (fig. 248) like those of the animal-feeding *Velutina*, and themselves manifesting carnivorous propensities (p. 151), it is difficult to understand how they can travel in quest of food.

The shape of some species of limpet is believed to vary with the nature of the surface on which they habitually live. Thus the British *Nacella pellucida* is found on the *fronds* of the tangle, and assumes the form called *N. lævis*, when it lives on their *stalks*. (Forbes.) The *Acmæa testudinalis* becomes laterally compressed and is called *A. alvea* when it grows on the blades of the *Zostera* (Gould); and *Patella miniata* of the Cape becomes a new "genus" (*Cymba*, Adams, not Broderip) when it roosts on the round stems of sea-weed, and takes the form called *P. compressa*. (Gray.)

TANYSTOMA (tubiferum) Benson, 1856. *Helicidæ*. Shell like *Anastoma*, minute, umbilicated; aperture disengaged, trumpet-like, toothed. Banks of the Irawadi, above Prome.

PFEIFFERIA (micans) Gray. *Helicidæ*. A *Nanina* without the mucus-pore at the tail. Philippines.

SPIRAXIS, C. B. Adams, 1850. *Type*, Achatina anomala, Pfr. Shell ovate-oblong, fusiform, or cylindrical; last whirl attenuated; aperture narrow, right margin usually inflected, columella more or less contorted, base scarcely truncated, furnished with a deeply-entering callous lamina. *Distr.* 30 sp. W. Indies, Mexico, Juan Fernandez.

JANELLA, Gray, 1850 (not Grat. 1826). *Syn.* Athoracophorus (!) Gould. *Type*. Limax bitentaculatus, Quoy. Elongate, limaciform, covered by a mantle with free margins; back grooved; tentacles 2, retractile, rising within the edge of the mantle; respiratory orifice to the right of the dorsal groove,

* A similar circumstance has been noticed in the fresh-water *Paludinæ* and *Ampullaria*, by Dr. Bland and Mr. R. Swift; in the absence of other food they devour the green vegetable matter incrusting one another's shells, and in doing this remove the *epidermis*, or even make holes in the shell.

reproductive orifice below it and beneath the mantle. *Distr.* New Zealand, on leaves.

TESTACELLA, p. 168. During winter and dry weather the Testacella forms a sort of cocoon in the ground by the exudation of its mucus. If this cell is broken, the animal may be seen completely shrouded in its thin opaque white mantle, which rapidly contracts until it extends but a little way beyond the margin of the shell. Fig. 262 represents *T. Maugei* (lately found by Mr. Cunnington, in fields near Devizes), just disturbed from its sleep; *s*, the shell; *m*, the contracted mantle.

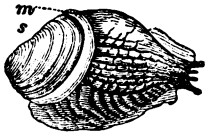


Fig. 262. *Testacella.*

LIMNÆIDÆ. Mr. R. Warington has observed that the fresh-water snails (and also *Neritina*) can lower themselves from aquatic plants by a mucous thread, *and reascend by the same;* a *Physa* could be lifted out of the water by its thread.

PLANORBULA, Haldemann, 1841. Planorbis armigerus, Say; aperture with 5 teeth, nearly closing the passage.

GUNDLACHIA (ancyliformis) Pfeiffer, 1850. Fresh-waters, Cuba. Shell thin, obliquely conic; apex inclined posteriorly; base closed for two-thirds by a flat, horizontal plate; aperture semicircular.

ADAMSIELLA (mirabilis) Pfeiffer, 1851 = Choanopoma, Pfr. (part) 1847. "Operculum thin, rather cartilaginous." *Distr.* 12 sp. Jamaica, Demarara. Named after the late Prof. C. B. Adams, of Amherst, Mass.

OPISTHOPORUS, Benson, 1855. O. biciliatus, Mouss. Shell like *Pterocyclus;* operculum double, margin grooved, interior concamerated. *Distr.* 4 sp. Singapore, Borneo, Java.

Aplysia (like Loligo, p. 69) has several shells when old.

Umbrella, p. 187, has a minute sinistral nucleus, like *Tylodina*.

STYLOCHILUS, Gould. Exped. shells. Aplysia longicauda Q. and G. Animal limaciform, cirrigerous, dilated at the sides, attenuated behind; neck distinct; tentacles 4, long, linear, papillose, far apart; lips dilated laterally into tentacular processes. *Distr.* 3 sp. New Guinea, on *Fuci*.

CHIORÆRA (leonina) Gould. Puget Sound. Appears to be a nudibranche resembling *Glaucus*, with oral cirri.

RHODOPE (Veranii) Kölliker, 1847. Animal minute, similar to *Limapontia?* worm-shaped, rather convex above, flat beneath; without mantle, gills, or tentacles. Upon algæ, Messina.

BRACHIOPODA.

In the summer of 1855, Messrs. M'Andrew and Barrett obtained, on the coast of Norway, living examples of *Rhynchonella psittacea, Waldheimia cranium, Terebratulina caput-serpentis*, and *Crania anomala*. The two last projected their *cirri* beyond the margins of the opened valves, and moved

them, as the Bryozoa move their oral tentacles; but in no instance were the *arms* extended. When the *Crania opened*, the upper valve turned upon its hinge-line. (Barrett, An. Nat. Hist.)

The anatomy of *Terebratula* and *Rhynchonella* has been further investigated by Dr. Gratiolet, Mr. Huxley, and Mr. A. Hancock.

The *pallial arteries* (mentioned p. 212, and figured p. 227, fig. 141) are regarded as "narrow bands from which the ovaria or testes are developed."

The nature of the organs previously described as *hearts* is rendered doubtful, as they appear to open *externally*, forming the "ovarian orifices" of Hancock; the plaited organs (*h*, *h*, fig. 165), described as *auricles*, are compared with nidamental glands.

Rhynchonella has two additional "hearts" above the others, one on each side of the liver. The peculiarity of the *ovarian spaces* in *Rhynchonella* and *Orthis* (described at p. 212, and represented in figs. 139, 140, 145, 147, letter *o*) is explained by the structure of the ovarian sinuses in the recent *Rhynchonella*; "the floor of this great sinus is marked out into meshes by the reticulated genital band, and from the centre of each mesh a flat band passes, uniting the two walls of the sinus, and breaking it up into irregular partial channels." The insertion of these *bands* produces the punctures in the shells represented in the figures above referred to. The membranes which support the alimentary canal are described, and explain the origin and nature of the *septa* in *Stringocephalus* and *Pentamerus*. The mode of termination of the alimentary canal is not yet satisfactorily made out.

Prof. Oscar Schmidt has observed the existence of flattened and radiated calcarious particles in the mantle, arms, and cirri of *Terebratulina caput-serpentis*; their occurrence appears to be very general in the Brachiopoda, and accounts for the frequent preservation of internal structures in fossil specimens.

Dr. Gratiolet has pointed out that the true function of the *cardinal muscles* of Terebratula was known to Prof. Quenstedt, and published by him in 1835. (Wiegm. Archiv. II. 220.)

Suessia (imbricata) Eugène Deslongchamps, 1855. (Dedicated to M. Suess.) Shell like *Spirifera*; texture fibrous; hinge area wide as the shell; foramen deltoid; large valve with two cardinal septa, and a prominent central septum, supporting a little plate; small valve with a tri-lobed cardinal process, and a broad 4-partite hinge plate, with processes from the outer angles of the dental sockets; crura of the spires united by a transverse band supporting a small process. *Fossil.* 2 sp. U. Lias, Normandy.

Davidsonia, p. 232. The upper valve sometimes exhibits markings derived from the surface on which the shell has grown.

Zellania (Davidsoni) Moore, 1855. (*Etym.* Zella, a lady's name?) Shell minute, orthi-form; texture fibrous; hinge area short, foramen angu-

lar, encroaching on both valves; interior of dorsal valve as in *Thecidium*, with a single central septum and broad margin. *Fossil.* Lias—G. Oolite, 3 sp. Brit.

ANOPLOTHECA, (lamellosa) Fr. Sandberger, 1856. Dev. Rhine. = Atrypa.

MEGANTERIS, Suess, 1856. Terebratula Archiaci, Vern. *Devonian*, Asturias. Shell with a long, reflected, internal *loop*.

CONCHIFERA.

Development.—The observations of Dr. Lovèn on the development of *Cardium pygmæum* and *Crenella marmorata* (referrred to at p. 51, note) have been confirmed by M. M. Keber and Webb, who observed similar phenomena in the ova of the river-mussel (*Anodon*). The body described by Lovèn as the *nucleus of the germinal vesicle* is regarded by these later observers as a tubular orifice, analogous to the micropyle in the vegetable ovum, by which the spermatozoa penetrate the yolk.

In *Anodon* the embryonic mass divides, partially, into two halves, each having its own mouth and intestine; and its own distinct though simple heart; and it is by the approximation and ultimate fusion of the two ventricles that the common rectum of the originally distinct intestines is intercepted. (Quatrefages —Lovèn.)

OSTREIDÆ, p. 253. The union of the *Ostreidæ* and *Pectinidæ*, as proposed by the authors of the "History of British Mollusca," has not proved satisfactory. The genus *Ostrea* stands quite alone, and distinct from all the *Pectinidæ* in the structure of its gills, which are like those of *Avicula*, and by resting on its *left* valve. The shell also is more nacreous than that of the scallops.

Dimya (Deshayesana) Rouault, 1859. Mém. Soc. Géol. b. III. 471. t. 15. fig. 3. *L. Eocene*, Paris. The figure is most like an oyster, and the "second adductor impression," on account of which it is named *Dimya*, is rather like the small anterior scar in *Pecten* (fig. 173, p. 249).

*Placuna** is essentially like *Anomia*, having the generative system attached to the right mantle-lobe, and the ventricle exposed. The mantle-margin is cirrated, and furnished with a *curtain*, as in Pecten; the foot is tubular and extensile, but has no distinct muscles except the small one, whose existence in *P. placenta* (Pl. XVI. fig. 6) we had predicated from examination of the shell (p. 256).† The small muscular impressions before and in the rear of the adductor are produced by suspensors of the gills.

Anomia. The description given at p. 255 requires correction; the lips

* Original figures and descriptions will be found in the An. Nat. Hist. 1855, p. 22.

† This organ appears to represent the *byssal-sheath* of Anomia, rather than the foot, as there is no other opening for the passage of a byssus.

are extremely elongated and plain, the striated portion (or *palpi*) almost obsolete, whereas in *Placuna* the plicated surface is sufficiently extensive. The outer gill-laminæ, in both genera, are furnished with a broad reflected margin.

Plicatula, p. 259. The animal is like *Spondylus* in every essential respect, and only resembles *Ostrea* in the foot being nearly obsolete.

Streblo-pteria (lævigata) Mc Coy, 1856. *Carb.* Brit. (*Aviculidæ*).

Mytilidæ. Modiola pelagica (*Myrina*, Adams), p. 266, has the mantle open; the shell is peculiar from the large size of the anterior muscular impression; and the subcentral umbones distinguish it from *Modiolarca*.

Hoplomytilus (crassus) Sdbgr. *Devonian*, Nassau. *Shell* with a muscular plate in the umbo, like *Septifer* (p. 265). The *Mytilus squamosus*, Sby. Magnesian limestone, Brit. has a similar plate.

Arcadæ. Scaphula (celox) Benson, the fresh-water Ark, p. 268. A second species has been found in the R. Tenasserim, Birmah. The hinge is edentulous in the centre, and the posterior teeth are laminar and branched; the elements of the posterior muscular impression are distinct.

Limopsis, p. 268. *Syn.* Pectunculina, D'Orb. Mr. M'Andrew has dredged *L. pygmæa*, living, on the coast of Finmark; it is a fossil of the *Pliocene* of England, Belgium and Sicily.

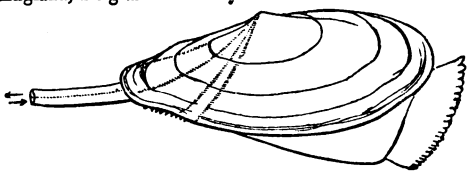


Fig. 263. *Yoldia limatula* (after Barrett).

Nuculidæ, p. 270. The *Yoldia limatula* has been dredged, alive, by Mr. M'Andrew, on the coast of Finmark. It is also found in Portland Harbour, Mass. The animal is very active, and leaps to an astonishing height, exceeding in this faculty the scollop-shells. (Dr. Mighels.)

Unionidæ, p. 276. Mülleria; Fig. 246 represents the left, or attached valve, showing the single muscular impression, and projecting spur with the nucleus, consisting of *both* valves of the fry, united, and filled up with shell.*

Hippuritidæ, p. 279. The structure of these shells has been more fully described in the Quarterly Journal of the Geol. Soc. London. In all the genera the shell consists of *three layers*, but the outermost, which is thin and compact, is often destroyed by the weathering of the specimens. The principal layer in the lower valve of the *Hippurite* is not really very different from the upper valve in structure; the laminæ are corrugated, leaving irregular pores, or tubes, parallel with the long axis of the shell, and often visible on the rim. The umbo of the upper-valve of the *Radiolite* is marginal in the young shell. (Geol. Journ. vol. xi. p. 40.)

* M. D'Orbigny very liberally placed his suite of specimens of this remarkable genus in the British Museum. Oct. 1854.

Fig. 246. *Mulleria lobata*, Fér. (Original.)

Tridacnidæ, p. 289. Animal of *Tridacna*, as seen on removing the left valve and part of the mantle within the pallial line.

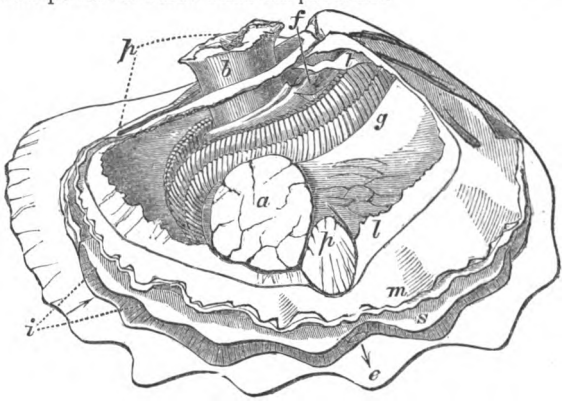


Fig. 265. *Tridacna crocea*, Lam. (Original).

a, the single adductor muscle; *p*, pedal muscle, and pedal opening in mantle; *f*, the small grooved foot; *b*, byssus; *t*, labial tentacles; *g*, gills; *l*, the broad pallial muscle; between *g* and *l* is the renal organ; *m*, the double mantle-margin; *s*, the siphonal border; *i*, inhalent orifice. *e*, valvular excurrent orifice. An. Nat. Hist. 1855, p. 190.

Lucinidæ, p. 294. Fig. 266, represents the animal of a species of *Diplodonta*, from the Philippines, as seen on removing the left valve, and part of the mantle within the pallial line; *b-c*, the large pedal opening; the arrows indicate the small plain *incurrent* orifice, and the valvular *excurrent* orifice; *f*, the foot, contracted in spirit; *p*, *p*, the large striated palpi; *l*, the liver; the outer gill has a simple margin, the inner is grooved and conducts to the mouth. This genus has higher claims than *Kellia* to be regarded as the type of a family.

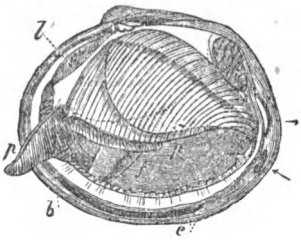


Fig. 266. *Diplodonta.*

Scintilla (Cumingi) Desh. 1856. Small shells resembling *Lepton*, p. 296; minutely punctate; ligament internal, oblique; hinge-teeth 1. 2; posterior laterals 1. 2. *Distr.* 37 sp. (?) Philippines, N. Australia, Panama.

Family 12a. *Astartidæ.*

Astarte. Opis. Crassatella. Circe? 'Cardita.

Astarte (borealis); mantle-margins free, plain, slightly cirrated in the branchial region, united posteriorly by the branchial septum, forming a single, excurrent orifice; pedal muscles (*p*. *p'*), distinct from adductors; gills flat, finely striated, destitute of internal partitions; outer gill narrow, elliptical, with a simple margin; inner gill grooved, conducting to the mouth.

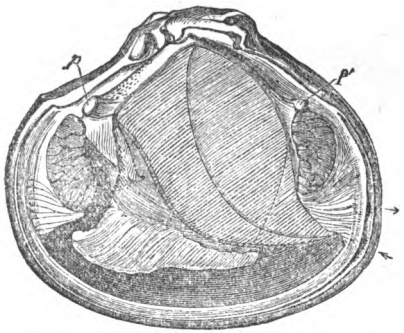


Fig. 267. *Astarte borealis*, var. semi-sulcata, Leach. $\frac{3}{2}$ Wellington Channel.

Gouldia (Pacifica) C. B. Adams. *Shell* minute, triangular, furrowed; hinge like *Astarte*, with lateral teeth; pallial line simple. *Dist.* 4 sp. Panama, W. Indies.

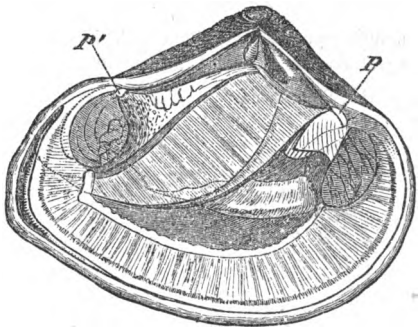


Fig. 268. *Crassatella pulchra.* Sandy Cape, J. B. Jukes.
Animal as seen on the removal of the *right* valve, and portion of the mantle.

Crassatella (pulchra) animal like *Astarte*; foot linguiform, slightly grooved; palpi short and broad, few-plaited; outer gill narrower in front.

Cypricardia rostrata, Lam. Philippines (p. 300). Animal with mantle-lobes united, and covered with wrinkled epidermis; siphonal orifices fringed; gills deeply plicated, anterior part of the outer gill *united to the inner;* dorsal border narrow, plaited; adductor muscles of two elements.

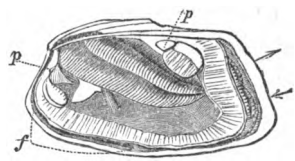


Fig. 269. *Cypricardia.*

Goniophora, Phillips, 1848. Cypricardia cymbæformis, Sby. *U. Silurian,* Brit. (*Mytilidæ*?)

Redonia, Rouault, Bull Soc. Geol. 8, 362. (= Pleurophorus? p. 301.) Shell oval, tumid; hinge with cardinal and posterior teeth; anterior adductor bounded by a ridge. *Fossil,* L. Silurian, Brittany, Portugal. (Sharpe.)

Carbonicola, Mc Coy, 1856 = Anthracosia, p. 303.

Omalia, Ryck. 1856 = Pullastra bistriata, Portl. *Carb.* Belgium.

Verticordia, p. 304. Syn. Trigonulina (ornata) D'Orb. Jamaica. Hinge-teeth 2. 2; right valve with a long posterior tooth. Epidermis of large nucleated cells, as in *Trigoniadæ,* to which family it undoubtedly belongs. (Pl. XVII. f. 26.)

Lucinopsis, p. 306. The type of this genus having been erroneously placed in *Cyclina* by M. Deshayes, he has proposed a new genus (*Lajonkairia*) for the second species, *L. decussata,* Phi. a fossil of the English *Pliocene,* but still living in the Medit.

Glaucomya, p. 307. See An. Nat. Hist. 1855, p. 23.

Sowerbya, p. 308. (Syn. Isodonta, Buv. p. 314). The cavity described as a "cartilage-pit" receives a tooth of the opposite valve.

Tellinidæ, p. 311. Psammobia.

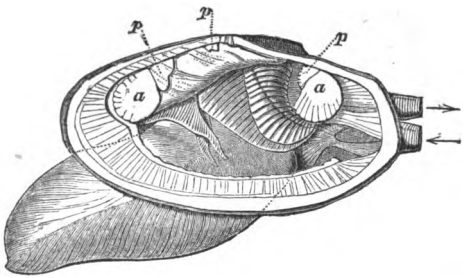


Fig. 270. *Psammobia pallida*, Desh. Red Sea. Left valve, part of the mantle, and retractor of the siphons removed. Siphons much contracted; *a,a*, adductors; *p,p*, pedal muscles.

Solenidæ, Glycimeris, p. 320. An. Nat. Hist. 1855, p. 99.

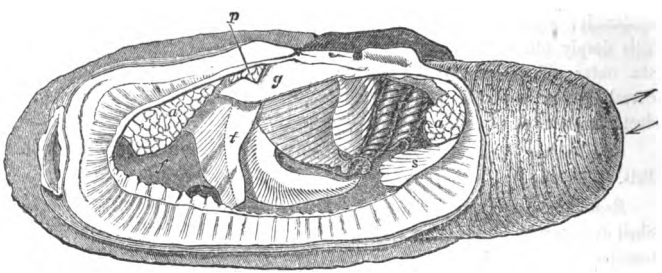


Fig. 271. *Glycimeris siliqua*, Chemn. Newfoundland.
a, a, adductor muscle; *p*, pedal muscle; *s*, siphonal muscle; *f*, foot; *t*, labial tentacles; *g*, gills, much contracted and crumpled.

Ribeiria (pholadiformis) Sharpe, 1853. Ged. Journ. Shell gaping at both ends; sub-ovate, rounded in front, elongated and rather attenuated behind; punctate-striate; casts of interior with a large umbonal impression (caused by a cartilage-plate, as in *Lyonsia?*) and a notch in front of it. *Fossil.* L. Silurian, Portugal. (*Anatinidæ*, p. 320.)

Scaldia, Ryckholt, 1856. Carb. Tournay. Shell like *Edmondia* (p. 323,) with a single cardinal tooth in each valve.

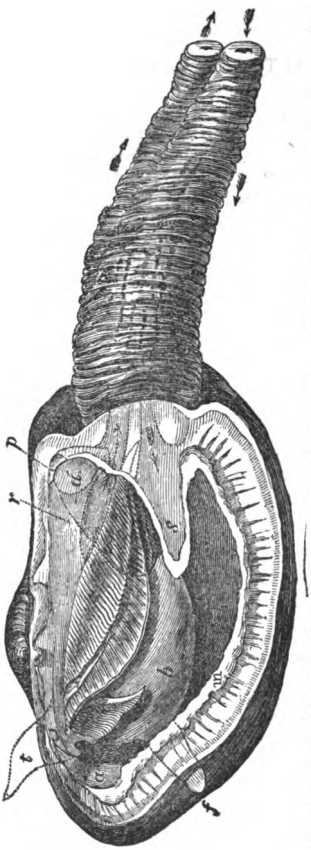


Fig. 272. *Panopæa glycimeris.*
$\frac{2}{7}$ The size of the original.
a, *a'*, adductor muscles; *p*, posterior pedal muscle; *r*, renal organ.

Myadæ. The description of the animal of *Panopæa*, at p. 319, was taken from the British species, *P. Norvegica*, which agrees both in the character of the shell and soft parts with *Saxicava*, and belongs to the *Gastrochænidæ*.

Fig. 272 represents the animal of the typical species of *Panopæa*, as seen on the removal of the left valve and thin part of the mantle. It was obtained on the coast of Sicily, and presented to the Gloucester Museum by Capt. Guise.

Mantle and siphons covered with thick, dark, wrinkled epidermis; siphons united, thick, contractile; pedal orifice small, in the middle of the anterior gape; foot small (*f*), body oval (*b*), with a prominent heel; pallial muscle (*m*) continuous, with a deep siphonal inflection (*s*); lips broad and plain, palpi triangular, deeply plaited (*t*); gills unequal, (much contracted in spirit), reaching the commencement of the siphons; inner gills prolonged between the palpi, plaits in pairs, each lamina being composed of vascular loops arranged side by side; margin grooved, dorsal border of inner lamina unattached; outer gills shorter and narrower, formed of a single series of branchial loops placed one behind the other, dorsal border wide and fixed.

Isoleda, Ryck. 1856 = Leda solenoides *and* Cucullella sp. p. 269.

Anomianella, (proteus) Ryck. *Carb.* Tournay = Crania?

Crenella (decussata) T. Br. 1827. p. 266 = Nuculocardia (divaricata) D'Orb. Cuba. = Myoparo, Lea (p. 269.) Brachydontes, Sw. p. 265, is more elongated; Lanistes (discors) Sw. nearly wants the crenulations.

ABBREVIATIONS OF AUTHOR'S NAMES.

C. B. Ad.	C. B. Adams, p. 375.
H. A. Ad.	H. and A. Adams.
Adans.	Adanson, p 366.
Ag.	Agassiz, p. 251.
Ant.	Anton, 1839.
A. & H.	Alder and Hancock.
Bar.	Barrande, 1852.
Bl.	De Blainville, 1825.
Broc.	Brocchi, 1814.
Brod.	Broderip, W. J.
Bron.	Brongniart, 1835.
Br.	Bronn, 1831—
T. Br.	T. Brown, 1827.
Buv.	Buvignier, 1852.
Charp.	Charpentier, 1837.
Chemn.	Chemnitz, 1780-95.
Chen.	Chenu, 1848—
Con.	Conrad, 1852—
Cuv.	Cuvier, 1799-1817.
D'Arch.	D'Archiac.
Defr.	Defrance, 1816-29.
Dh.	Deshayes, 1825—
D'Orb.	D'Orbigny, 1835—
Don.	Donovan, 1824-7.
Drap.	Draparnaud, 1805.
Eich.	Eichwald, 1828-30.
F. Edw.	F. Edwards, 1850—
E. & S.	Eydoux and Souleyet.
Fabr.	O. Fabricius, 1780.
Fér.	Férussac, 1819.
Flem.	Fleming, 1828.
F. & H.	Forbes and Hanley.
Gm.	Gmelin, 1788.
Gld.	Gould, 1841—
Gldf.	Goldfuss, 1826-44.
Hart.	Hartmann, 1840.
His.	Hisinger, 1837.
Johnst.	Johnston, G.
Kien.	Kiener, 1834—
K. & D.	Koch and Dunker.
Kon.	Koninck, 1837—
Küst.	Küster, 1837—
Lam.	Lamarck, 1799-1818.
L.	Linnæus, 1787.
Les.	Lesson, 1829.
Mant.	Mantell, 1822-54.
Mart.	Martin, 1793.
Marti.	Martini, 1769-74.
Mtyn.	Martyn, 1784.
Mc C.	Mc Coy, 1845—
Mke.	Menke, 1828.
Mid.	Middendorff, p. 354.
Möl.	Möller, p. 355.
Mont.	Montagu, 1803-8.
Montf.	Montfort, 1799-1820.
M. & L.	Morris and Lycett.
Mhl.	Muhlfeldt, 1811.
Müll.	Müller, O.F., 1773-6.
Münst.	Münster, 1826-43.
Nils.	Nilsson, 1822-7.
Quenst.	Quenstedt, 1852.
Q. & G.	Quoy and Gaimard.
Park.	Parkinson, 1804-11.
Pen.	Pennant, 1776-7.
Pf.	Pfeiffer, 1848—
Phi.	Philippi, 1836—
Ph.	Phillips, 1829—
Portl.	Portlock, 1843—
P. & M.	Potiez and Michaud.
Ris.	Risso, 1826.
Rois.	Roissy, 1805.
Röm.	Römer, F. A., 1836—
Sdgr.	Sandberger, G. and F.
Sav.	Savigny, 1816.
Schl.	Schlotheim, 1813-23.
Sch.	Schumacher, 1816.
Sol.	Solander, 1765.
Sby.	Sowerby, 1812-30.
J. Sby.	J. Sowerby, 1830—
G. Sby.	Geo. Sowerby.
G. B. S.	G. B. Sowerby, 1843.
Stp.	Steenstrup.
Sw.	Swainson, 1820-40.
Turt.	Turton, 1822.
Vern.	Verneuil, 1845.
Wahl.	Wahlenberg, 1821.

INDEX OF GENERA AND TECHNICAL TERMS.

The names of Genera commence with a capital letter, those *in italics* are Synonymes.

Atractodon, Charl. *v.* Chrysodomus.
Chilotrema, Leach, *v.* Carocolla.
Coleoceras, Portl. *v.* Orthoceras.
Cordieria, Roault, *v.* Borsonia.
Cryptodon, Conr. *v.* Lutraria.
Cypricia, Gray, *v.* Lutraria.
Ellipsolithes, Sby. *v.* Goniatites.
Gaimarda, Gould, *v.* Modiolarca.
Gladius, "Klein," *v.* Rostellaria.
Harpago, "Klein," *v.* Pteroceras.
Macoma, Leach, *v.* Psammotea.
Mazza, "Klein," *v.* Turbinella.
Neptunea, "Bolten," *v.* Chrysodomus.
Orthostoma, Buv. *v.* Acteonina.
Phascolicama, Val. *v.* Modiolarca.
Polyphemopsis, Portl. *v.* Macrochilus.
Ptychomphalus, Ag. *v.* Rotella.
Separatista, (helicina), Gray MS. = ?
Sidemina, Castelu. *v.* Apioceras ?
Spiricella, Rang, *v.* Pileopsis?
Thyatira, Leach, *v.* Cryptodon.
Tugali, Gr. *v.* Hemitoma.
Vasum, "Link," *v.* Cynodonta.
Xancus, "Link," *v.* Turbinella.

ERRATA AND ADDENDA.

It is earnestly recommended that the *corrections* be made *with pen and ink* at the places indicated.

Page 5 The foot-prints referred to in the note, are now ascribed, by Prof. Owen to some unknown Crustaceous animal.
23 second line from bottom *add* "but is more probably the seat of the olfactory sense."
29 line 7 *for* "communicating" *read* "comminuting."
32 lines 8 and 9 from bottom *erase* "in one family of tunicaries (*pelonæidæ*)."
93 line 3 *Aganides*, D'Orb. (not Montf, = *Aturia zic zac.*)
97 *Carinaria cymbium*, Desh. = C. cristata, L. sp. The same correction may be made at p. 200, and Pl. XIV., f. 19.
108 line 4 from below *for* "Strombus" *read* "Velutina."
109 line 20 *for* "Leiotomus" *read* "Leiostoma (bulbiformis)."
115 line 5 *add* "U. States, S. Domingo."
117 line 3 *Scaphula*, Sw. = Olivancillaria, D'Orb.
121 *erase* lines 28—30.
125 *erase* line 2, see p. 461.
„ line 5 *erase* "like Velutina;" see p. 459.
126 „ 6 *for* "Gray" *read* "Lea, part," see p. 462.
127 „ 10 *add* "*Type* L. sinuata, U. Devonian, Petherwin."
„ „ 15 *add* "*Syn.* Polyphemopsis, Portlock."
128 „ 16 *for* "old world only?" *read* "California."
„ „ 18 *for* "Vulsella," *read* "Ostrea."
131 „ 10 *for* "Eocene" *read* "Wealden."
„ „ 28 *for* "Authouy" *read* "G. & H.," see p. 462.
137 „ 10 *erase* "Paludestrina, D'Orb.," see p. 462.
144 „ 32 *for* "Otavia" *read* "Olivia."
145 „ 19 *for* "Eocene, Paris" *read* "*Type*, Euomphalus Serpula, Kon. *Carb.* Belgium."
153 „ 8 from bottom, *for* "jaws" *read* "upper jaw."
154 „ 16 *for* "tongue" *read* "dental canal."
„ „ 31 *for* "nocturnal" *read* "between tides."
156 „ 7 *add* "France."
228 „ 13 *for* "fig. 17" *read* "fig. 21."
184 „ 15 *for* "BULLÆA, Lam." *read* "PHILINE, Ascanius. 1772" and *erase* the foot-note.
237 last line *for* "more like" *read* "setose, like."
280 line 17 *erase* "Hippurite and."

Page 310 *for* "DIODONTA" *read* "GASTRANA," and *add* "*Syn.* Diodonta, F. & H. *not* Schum."
311 line 1 *for* "Greenland" *read* "Norway."
319 „ 8 from below, *for* "*Australis*" *read* "*Natalensis*."
320 SAXICAVA belongs to the *Gastrochænidæ*.
321 line 6 *erase* "*Cochlodesma*."
„ „ 30 *for* "without an" *read* "ossicle minute."
363 *Senegal; add* "Tellina lacunosa" *and* "Cymba olla."
364 line 13 *add* "*Typhis*."
383 „ 9 from below *for* "Holsace" *read* "Holstein."
391 „ 6 from below *for* "all" *read* "nearly all."
419 „ 21 *for* "alterations" *read* "alternations."
450 lines 12 and 13 the terms *dorsal* and *ventral* are transposed.
457 in the figure of *Risella* the central tooth is worn round, it should be pointed as in *Litorina*.

Plate II. f. 14 O Ludense, Sby. ½ Ludlow-rock.
III. f. 5 A. spinosus, Sby (ornatus, Schl. part.)
V. f. 12 *for* "W. America" *read* "Cape."
VI. f. 4 *for* "China" *read* "Cuba" D'Orb.
VIII. f. 23 *for* "Gray" *read* "Lam."
XI. f. 22 *for* "W. Indies" *read* "Cape."
XIV. f. 15 *for* "verrucosa, Gmel." *read* "scapula, Martyn."
„ f. 32 *for* "tridentata, Forsk." *read* "telemus, L."
„ *transpose* the numbers 46 and 47.
XIX. f. 1 *for* "China" *read* "W. Africa."
„ f. 22 *for* "Gray" *read* "Cailliaud."
XXI. f. 8 *for* "Diodonta" *read* "Gastrana."
„ f. 12 *for* "Bahamas" *read* "Peru."
„ f. 16 *for* "donacium, Lam." *read* "Chilensis, D'Orb."
XXII. f. 3 *for* "S. America" *read* "Penang."
XXIV. *for* "*Bortyllidæ*" *read* "*Botryllidæ*."
„ f. 1 *for* "tubulosa, Rathke" *read* "arenosa, A. & H."

Alaria, Morris and Lycett, 1851. *Ex.* Rostellaria trifida, Ph. Shell like *Aporrhais* (p. 129) but having no channelled process of the lip extending up the spire. In most species the expanded lip is repeated, as in *Cerithium*, or produced periodically, as in *Ranella* and *Spinigera*. Fossil in the Oolites; the species are very numerous.

Amberlya (nodosa) M. & L. 1851. Gt. Oolite, Minchinhampton. Resembling *Tectaria* (p. 134) but slightly notched in front like *Purpurina*.

Anaulus (bombycinus) Pfr. 1855, Sarawak, Borneo. Shell like *Mega-*

lomastoma, with a small tubular orifice at the suture leading into the body-whirl at a little distance from the aperture. *A. Lorraini* is found at Penang.

Brachytrema (Buvignieri) M. & L. 1854. Gt. Oolite, Minchinhampton. Shell turbinated, whirls ornamented, columella twisted, canal short and oblique. *Fossil*, 10 sp. Oolites.

Ceritella (acuta) M. & L. 2851. Gt. Oolite, Minchinhampton. Shell turreted, acute, last whirl large, canal short. (= Rissoina, D'Orb. part.) *Fossil* 9 sp.

Coccoteuthis, (latipinnis) Owen, 1855, Geol. Journ. XI., pl. VII., p. 124 = *Geoteuthis*, part. Pen rather calcarious, rounded in front, lateral wings small. Kim. Clay and Oxford Clay, S. of England.

Corbicella (Bathonica) M. & L. 1855. Gt. Oolite, Minchinhampton, oval, smooth, posterior side elongated; anterior lateral teeth wanting. *Fossil* 6 sp. Oolites.

Crossostoma (Prattii) M. & L. 1851. Gt. Oolite, Minchinhampton. *v. Liotia.* Columella toothed when young, concealed by callus in the adult.

Deslongchampsia (Eugenei) Mc Coy, MS. in M. & L. 1851, *Great Oolite*, Minchinhampton = Hemitoma, p. 151.

Diastoma, Desh. 1849 = Melania costellata, Lam.

Euspira, Ag. 1837. A subgenus of *Natica*, with angular whirls, *Fossil* Oolites.

Quenstedtia (oblita) M, & L. 1855. Gt. Oolite, Minchinhampton. Like *Psammobia;* pallial sinus small; ligament in a narrow groove; cardinal teeth 0. 1.

Resania (lanceolata) Gray 1853, An. N. H. p. 43, (same shell as *Vanganella Taylori*, Gray, An. N. H. 1853, p. 475). New Zealand = Lutraria, subgenus, p. 309.

Fossil land-shells of Madeira, p. 387. Of the eleven species now common to Madeira and P. Santo, only two (*Helix paupercula*, and *H. compacta*) occur *fossil* in both islands. And of the species now peculiar to one island, two occur fossil in both, viz. *Helix sphærula* of P. Santo, and *Cyclostoma lucidum* of Madeira. (Wollaston).

LONDON: PRINTED BY W. OSTELL, HART STREET, BLOOMSBURY.