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O W Howe, Mrs. George W

DIMINUTION

OF

WATER ON THE EARTH,

AND ITS

PERMANENT CONVERSION

INTO

SOLID FORMS.

DAYTON, OHIO:
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A PAPER

PRESENTING FACTS AND SUGGESTIONS IN PROOF OF THE

THEORY OF THE GRADUAL AND CONTINUOUS DIMINUTION OF THE QUANTITY OF WATER UPON THE EARTH,

AND ITS

PERMANENT CONVERSION INTO

SOLID FORMS OF MATTER.

PREPARED, TO BE PRESENTED BEFORE THE

"American Association for the Advancement of Science,"

AT ITS MEETING IN

PORTLAND, MAINE, IN AUGUST, 1873,

BY MRS. GEO. W. HOUK,
OF DAYTON, OHIO.

DAYTON, OHIO:
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I.

The Decrease of Water Surface.

The evidences of the apparent subsidence of the water level upon the earth's surface, have been familiar to scientific observers for many centuries; and various theories have been advanced, from time to time, to account for it. Aristotle, Zanthus, Omar in the 10th Century, Leibnitz, Calcius, Vallisneri, Linnæus, Buffon and Gessner are among those who have noted the diminished extent of water surface upon the earth. Linnæus and some others accepted the theory of Leibnitz, that the Universal Ocean was received into cavern's which opened in the earth's crust.

There seems to have been no expression of similar views during the past century. Humboldt says: "We must not overlook the possibility of a diminution of the *quantity* of water, and a constant depression of the level of the seas, * * but in the actual condition of our planet there is no direct evidence of a real continuous increase or decrease of the sea, and we have no proof of any gradual change of its level." (Cosmos II. p——.)

As far back as 1692, Ray wondered, on the other hand, why the earth did not proceed more rapidly toward a general submersion when so much matter was carried into it by rivers and undermined in sea cliffs, which tended constantly to raise the surface of the waters. Lyell adds: "Certainly no deposition of sediment can occur without the displacement of a quantity of water equal in volume, which will raise the sea even to the antipodes."

From a knowledge of the incessant and immense deposits beneath the surface of the waters, there should be, *if the quantity of water remained constant*, a general elevation of water surface, and slow but certain advance of water upon land.

The great preponderance of facts, however, goes to prove that the land surfaces have actually gained upon the waters, although there are limited areas where the sea is said to be encroaching, as upon the coasts of Greenland and Norway and the wash of cliffs upon some exposed ocean shores.

The broad truth that every part of the earth's surface has at some time been under water is very pertinent. There is evidence of the action of water not only at heights far above the sea level and upon the interior of continents, but the horizontal formations, as those of the Pyrenees and the Cape of Good Hope prove the undisturbed condition of the strata.

The earlier deposits were more general in character and of greater extent, gradually diminishing as they advance in time and change in the structure of their organic remains. Since the beginning of the tertiary period the dry land in the Northern Hemisphere has been constantly on the increase. The immensely powerful erosive forces in the British Islands, where tens of thousands of feet of the solid rock formations have been washed out, leaving terraces and water marks hundreds of feet above the present ocean level—the raised beaches and water lines of Norway, Sweden, France, Italy, Greece—the advance of land around the entire borders of the Mediterranean Sea—land beyond Antwerp left dry within the historic period—and the well known great advances of all the deltas of the large rivers of the world—the glacial deposits, proving the Northern Oceans to have receded to their present levels from the lower latitudes of the temperate zones—the grand pages of the great Stone Book, spread out upon every continent, bear witness in unmistakable characters to the increase of land surface.

Although Sir Charles Lyell says it is impossible to invent any theory to account for the disappearance of so large a body of water as must have diappeared to explain geological facts, he adopts that of Mr. Darwin, of the sinking down of the ocean bed; commenting upon Ray's geological views he says "the preservation of the dry land may sometimes be effected by the subsidence of that part of the earth's crust covered by the ocean"—and again, "The sinking down of the bed of the sea is one of the means by which the submersion of land is prevented"—and he adds, "if we then inquire in what manner the force of earthquakes *must be regulated* in order to restore perpetually the inequalities of surface which the levelling power of water is constantly tending to efface, it will be found that *the amount of depression must exceed that of elevation.* If a counterpoise be derived from this source, *the quantity and elevation of land may forever remain the same*, and on the other hand *the force of the aqueous agents themselves might thus continue forever unimpaired.*"

This is a persistent and systematic cause of usefulness that is scarcely to be expected from earthquakes! and is really a revival of the earlier *cavern theory* of Liebnitz, for if the ocean's bed is depressed, it really forms an abyss for the superfluous waters to settle down in.

This means of escape from a serious dilemma will not bear the test of close examination. In thus relieving the surface of the earth of the volume of water, that must be displaced by the solid matter that is carried into every body of water existing upon it, by the subsidence of the bed of the Pacific Ocean, the evaporating surface is constantly diminished; not a delta can form—or the sands of the sea, or the land any where encroach upon the water without a decrease of evaporating surface, unless a *corresponding water area* is somewhere else exposed.

Evaporation is a very powerful physical agency. Prof. Maury, in "The Physical Geography of the Sea," gave to

the world, some years ago, a clear idea of its wonderful power and exquisite operations.

Although the torrid zone is the principal evaporating area of our globe, evaporation takes place from every water surface upon it—varying in quantity according to temperature, winds, &c., but transpiring even below zero, for in liquid matter, as in gaseous, there is at all times a constant action of repulsive force, or energy, tending to drive the particles asunder. *This is entirely a surface work;* as water acts only upon the solid surfaces, so the aerial forces act only upon the liquid surfaces, all the liquid matter beneath, being as removed from the atmospheric operations of nature, as the buried strata of the earth are from aqueous and atmospheric agencies.

Therefore, if it is indeed true that the land surfaces have encroached upon those of the water *anywhere*, this change in the relative quantities of land and water areas, must produce effects of such a marked and unmistakable character as to be discovered upon the continents, which receive the aqueous vapor evaporated from the water surfaces of the seas which supply their precipitation.

If there is less water surface, there will be less evaporation, less moisture in the atmosphere, less precipitation, a gradual lowering of all inland seas and lakes—and constantly lessening drainage, or smaller rivers returning to the oceans.

Such a slow but certain change in physical conditions would produce corresponding changes in organic life, uniform change instead of "uniformity without change," and "aqueous forces that would" *not* "remain forever unimpaired."

In studying the inland waters and drainage of the continents to determine whether there are any proofs of a decrease of precipitation, the salt lake regions afford the most striking evidences of a decrease of evaporating surfaces—and it is a significant fact that upon each of the great continents, and upon many islands, there are immense saline

deposits, which are indirect proofs of a decrease of evaporating surface. But there are in Asia, Africa, North and South America, still existing bodies of salt water that bear the most unmistakable witness to a constant decrease of precipitation in their gradually lowering levels.

It is deemed unnecessary in this paper to refer especially to these remarkable localities, as their peculiar characteristics are too interesting not to be familiar to all physicists.

The Dead Sea, the most remarkable of these grand evaporation gauges, is about 1,300 feet below the level of the Mediterranean Sea. The whole Aralo-Caspian, and Red Sea formations bear the most undoubted evidence of a decrease of precipitation and constant lowering of water level upon the continent of Asia.

Lieut. Maury has demonstrated such to be the fact.

Lake Tadjara, the great salt lake of Central Africa, is 500 feet below the ocean level, and is salting up. The Bahr Assal, which once formed its continuation, has shrunk to an elliptical basin, is half filled with water of the deepest cerulean blue, and half with a glittering sheet of sand white salt. Southern Africa is also said to have similar formations.

The lake of Utah is the basin which receives the drainage of this inland North American water shed. Its surface is lowering, its waters salting up, and the channel which once received the excess of drainage and returned it to the ocean is distinctly traceable, as are channels from most of the other salt lakes.

Lake Titicaca is but slightly brackish, and is supposed not to have been standing long enough to show any remarkable decrease of level, existing as it does upon the last emerged continent of South America.

If Maury has proved that the water surfaces that supply the precipitation of Western Asia have diminished in extent, these salt lakes and saline deposits *upon every continent* and many islands, bear witness to the *general truth that the evaporating surfaces have everywhere deceased.*

The value of these bodies of inland salt water, as *geological witnesses* of change, results from their very nature. Saline waters hold a large amount of solid matter in solution and mechanical suspension. Their deposits are large, well defined and unmistakable in character. There is in the neighborhood of the Dead Sea a range of hills 7 miles long and 300 feet high, said to be formed *entirely of rock salt.* Similar formations of chloride of sodium are to be met with in all the salt lake regions, and not only there, but in many places now far removed from present salt water areas. These deposits generally occur with marls, sandstone, gypsum, etc., and in some cases, infusoria, bromides, iodides, iron, etc. are to be met with.

These saline deposits are to be found throughout the crust of the earth—"In the British Islands in trias or new red sandstone—in the oolitic strata in the Salzburg Alps—with cretaceous green sands in Spain—with chalk and tertiary rocks in the district of the Pyrenees—and in the carboniferous and older strata." "It is thus the product of all ages."

The assertion that the present waters of the earth may have held all this now solid salt in solution, at different times, cannot stand before the accumulating proofs that there is actually less water upon the earth's surface than formerly. It becomes indeed a proof that there is less liquid—or water surface—for if this now solid salt were once again dissolved, or in liquid form, its increased surface area would afford increased evaporating surface. Only pure water is evaporated, all solid particles are left behind, so that if it shall be proved that *the elements of pure water have been used in the operations of nature*, either from the evaporated or precipitated waters, there must have been *always* upon every part of the earth's surface, at every period of the formation of the solid crust, an excess of evaporation over preciptation, gradual supersaturation of inland bodies of salt waters and their final entire dessication.

The existence of some of the lower forms of life throughout almost the entire growth of the solid crust, since the formation of the lowest fosiliferous strata, proves that the general condition of the ocean waters have not materially or radically changed. The temperature of water has very little effect upon its power of dissolving chloride of sodium, boiling water taking up very little more than cold—pure water or oxygen and hydrogen only being used in large quantities in the vital processes—the solid saline matter in the earth's crust becomes a sort of measure of the amount of pure water that has been used up, or such an amount as would be necessary to restore these saline and accompanying deposits to the general condition of the present ocean waters.

The analysis of the Dead Sea water has rather led to the conclusion that there is little probability that this sea once formed part of the general oceanic surface, and at the time of its separation was of the same general constitution—or that the other saline continental regions originated in a general extension, and subsequent contraction of oceanic waters. A careful comparison, however, of Dead Sea water—which may be considered a representative of this class of formations, although apparently very different—*including the contiguous Dead Sea solid formations*—and ocean water—will prove that this sea probably once formed part of the ocean, or at a later period, of the Mediterranean Sea.

The specific gravity of Dead Sea water is 1227. In 100 parts of Dead Sea water there are 26.416, of solid matter—while in ocean water, 3.505. Its solid ingredients, compared with those of ocean water, are thus given by careful analysis:

		DEAD SEA.	OCEAN WATER.
Chloride of	Magnesium	14.589	.360
"	Sodium	7.855	2.700
"	Calcium	3.107	
"	Potassium	.658	.070
Bromide	"	.137	.235
Sulphate	Lime	.070	.140

Although the proportion of these various solids might be thought to vary beyond all hope of satisfactory comparison, upon studying the solid formations of the Dead Sea coast, the differences are greatly lessened.

The extraordinarily large proportion of chloride of magnesium in the Dead Sea may be owing to the indefinite quantity that these very dense salt waters are capable of holding in a state of mechanical suspension, and to the *absence of organic life*, which in the ocean is constantly secreting this solid matter into solid masses. It is certainly true, that magnesian limestone and gypsum are found associated with rock salt here, as they are all over the world, and that the position of the limestone formations of the Dead Sea indicate their deposit when its waters stood at a much higher level than they do now, or that they took place when they were nearly if not exactly upon a level with ocean waters, and were similar if not identical in composition, and the existence of marine polyps to create such matter was undoubted; and such deposits continued as long as other conditions permitted the continuation of the existence of this organic life, ceasing only with its extinction.

The excess of chloride of calcium, as well as the small proportion of sulphate of lime, may be accounted for by the same absence of organic life from the period of the supersaturation of the Dead Sea with chloride of Sodium. This supersaturation being relieved by solid deposits whenever it became excessive—the enormous deposits upon the Dead Sea shores show why the proportion actually existing in the water is so much less than that of the magnesium.

If the saline deposits of the continents bear such unequivocal testimony to the decrease of general evaporating surface, the fresh water lakes should add their more meagre evidences in proof of the same fact.

The North American and other lakes do show higher water lines than those forming at present, and lacustrine or

fresh water silts occur upon every continent, and are well defined; but the very purity of these fresh waters forbids large deposits, and they are generally determined by the peculiar placidity of their formations and the presence of fresh water shells.

Europe, which is the only continent that has no inland salt sea cut off from oceanic circulation, has, however, a wonderful witness to decreasing precipitation in the glaciers of the Alps, which are said to be of less extent than formerly; the ancient glaciers' lines of erosion and deposit can be distinctly traced, notwithstanding the obliterating effects of atmospheric agencies.

So remarkable are the evidences of glacial action in the North temperate zone, both in Europe and America, at a period succeeding that of tropical warmth in the same latitudes, that the glacial epoch is recognized as a distinct geological era, and the causes which produced this sudden change of temperature and other physical conditions have never been satisfactorily explained.

It is probable that evaporation may account for it. If there were barriers of land or of ice that cut off the Arctic waters from free circulation with those of the temperate zone—and the geological formations of the British Islands indicate the removal of a large body of land there—the tropical region being one of excessive evaporation and the North temperate and Arctic that of precipitation and congelation, there would have been a rising of the level of Arctic ices and waters and a lowering of level of the waters of the South temperate and torrid zones, and perhaps the emergence of land there. The removal of such barriers either by igneous or aqueous forces, or by the decrease of precipitation and congelation lowering ice barriers, and the irruption of Northern waters, icebergs and ice floes to re-establish the lost level of the waters would account for the glacial deposits. The land re-emerging when evaporation once again had given the waters to the advancing organic creation.

"It has long been a matter of common observation that the rivers are cutting their channels through alluvial deposits of greater depth and extent than could have been formed by the present streams." Every individual whose attention has been at all directed to the subject, has observed small streams where apparently larger ones must have flowed at some former period; from the great rivers that drain whole continents, to the little streams that receive the drainage from the rains that fall upon the hills and lowlands everywhere, proving that some gradual decrease in the amount of drainage has taken place without any general disturbing physical causes, which would have deranged and changed the ancient channels.

The excess of evaporation over precipitation, of precipitation over drainage, at all times since the earliest emergence of land upon the globe, results from the fact that part of the aqueous vapor develops vegetable and animal organisms, being incorporated with the vital tissues and so cannot *all* be precipitated again, and part of the precipitation is also used in the same way, and thus the drainage cannot get all the precipitation. Thus the evaporating areas always receive less than they give, and must constantly decrease.

For ambient air is matter, and the seas
Less dense than earth, yet surely matter too,
Ever as land doth grow, so these decrease,
Each type of life the earth doth hide from view—
Throughout the solid crust where delvers shew—
Once in the waters or on land it grew,
Fed by the liquid and the foodful air
Ever in death earth's solid parts accrue
The fauna growing purer and more fair
Where richer floral growth the ancient rocks declare.

And surely does not many a type below
Prove vaster, warmer waters, richer air?
Beneath where now small forms tho' beautious grow,
Man finds the tropic monster in his lair;

And ruin forests beyond earths compare—
Creatures with ponderous wings mid air to soar,
Wings needful then, not now, nor ever more,
Does not each land declare "*The Sea was here!*"
Where not, Oh! Ocean? Thou wast everywhere!
But thou hast reared the earth, and never more
Can she with all her rivers, what thou gavest restore!

II.

Transformation of Terrestrial Matter.

The whole volume of matter which the attraction of gravitation holds together in the earth and its satellite, is the same in quantity as it was at the time of its separation from the other masses of the solar system, excepting the insignificant amount of meteoric matter which is added from time to time to the earthly mass by coming within range of its attraction.

If matter be indestructible, this must be so, for those forms, if such there be, that can escape beyond this universal law of gravitation are as yet beyond our investigations. We must, then, look for *change of form* only in an invariable quantity of material elements.

Upon this truth Pythagorus based his celebrated cosmogony more than 2,500 years ago.

The laws which governed the earthly mass in its first separation from the other masses of the solar system were the same that govern it now, and it must have had, in consequence of then existing temperature and other conditions, a certain volume as it has now a certain volume resulting from past and present conditions of temperature, etc.

The first change that took place producing this separation, altered the previous internal relations of this matter, and if the same laws continued to operate upon it, the effect *was to produce something different from that produced by the first change.*

Thus the operation of uniform laws would produce constant diversity. In obedience to the same laws, changes have

transpired in the forms of matter, through all past time, are still progressing and will continue, while the present laws and elements of matter exist, and from a human point of view, these changes, have been, are, and will be permanent.

It is said that the earth at a certain point of time after its separation from the sun "was no less than 482,000 miles in diameter, being 60 times what it has shrunk to."*

If this volume of matter was indeed so diffuse, the elements must have existed in very different forms from those in which they now exist. As a first attempt at forming an estimate from scientific theories of the volume and condition of the telluric mass at an inconceivably remote period, it is exceedingly important and interesting. It admits and confirms the great theory of Laplace, for from our present knowledge of the elements of matter, had the volume of the earth been so extended, the largest portion of it must have been in a gaseous state.

"The geometrical form of the earth itself, which indicates the mode of its origin is in fact its history. An elliptical spheroid of revolution gives evidence of having once been a soft or fluid mass."†

Whether this fluid body was the result of chemical combination and condensation of previously gaseous matter or not, it is another great fact in the meagre *positive* knowledge man has been able to acquire of the past condition of this sphere; if the predominance of gaseous matter was implied by the assertion of a diameter of the telluric mass, of 482,000 miles at an earlier period of time, the predominance of liquid matter seems to be proved by the present form of the now partially solidified oblate spheroid.

No conception can be formed of the intervals of time; but at the period of the first formation of solid matter evident in the earth's crust, the conditions of temperature, &c., must have been such as to permit solidification from a former liquid state.

*Vestiges. †Cosmos, Vol. I.–163.

That there had been a gradual cooling of the whole body up to this time can not be positively asserted, although it is probably true; the evidences of igneous action are undoubted, and still existing central heat undisputed—but the plane of the earth's granitic crust must have cooled in solidifying, and must have been still further greatly reduced in temperature before there could have been any deposit of water upon it, even if the elements had already combined to form aqueous vapor.

Of the action of water upon this earliest known formation of solid matter there is at length indubitable evidence, as there is at a still later period, of the existence of an atmosphere.

Thus we arrive at a point of time when the elements had combined here into the diversified forms of solid, liquid, and gaseous matter. Although this presumptive reasoning proves gaseous matter to have existed *first*, the actual evidence of its forming the earth's atmosphere does not appear until after the creation of organic life upon the land.

So constant and permanent these forms of matter seemed to the ancients, that they considered them the elements of nature; hereafter, the elements into which they have now been analysed may also be found to be compound. The results, however, thus far arrived at enable us to understand many of the processes of nature now transpiring; to assert that there is nothing unreasonable in the extreme diffusion of the known elements of matter to a volume of even more than 482,000 miles, nor of its having had, at a certain period, as its condensation progressed, an inconceivably high temperature, and that there will be continuous transformation and solidification until the liquid and gaseous forms of matter are entirely solidified, and the earth brought to the present condition of the moon.

The conclusion has long since been reached by astronomical observation that there is no water and no atmosphere

upon the moon's surface; nor can liquid matter exist in the fissures of its solid body, for the tendency of water to evaporation—all liquid matter acting in obedience to the law of repulsive force, especially when relieved from atmospheric pressure—would at once cause it to take a gaseous form. There is, however, as little evidence of this form of matter as of the liquid itself.

The diameter of the telluric mass, at the time of its greatest extension, is supposed to have included the matter of the moon. The whole mass having the rotation that it had acquired as the circumference of the sun, as well as the individual motion that had resulted in its separation.

There was in the establishment of the earth's rotation no alteration whatever in its relation to the sun. All the matter that followed its attraction of gravitation, still occupied and moved in its appointed place in obedience to solar gravitation. There was not then, nor ever has been, nor ever will be as long as it moves in its orbit, any change in its external relations, or in the quantity of matter, which only changes its form.

When the matter of the moon moved in the circumference of the earthly mass, it was composed of most of the elements of the central body thrown promiscuously toward the circumference by centrifugal force, there being no cohesion in a gaseous body, and where this was counter balanced by the centripetal force, forming a comparatively quiescent plane favorable to the action of chemical affinity.

When this action began to produce internal or individual motion, there existed the *same conditions* throughout the entire body, as well as the *same elements*, under the control of the *same laws*. Must not then the moon have undergone similar changes to those which have transpired upon the earth? *Of the same matter originally in the same condition and under the operations of the same laws*, solidification, *through the action of chemical and vital agencies*, must have progressed and, being so much smaller in

volume, have produced its *ultimate* entire solidification, at a much earlier period—and the probable acceleration of its mean motion within the period of human observation.

Whether the giving off of heat and the consequent reduction of temperature and volume produces condensation, or whether the slower succeeding combinations of chemical affinity and finally of organic life tending to solidification, results in a reduction of temperature is a complex and difficult question beyond the range of the present subject—the existing temperature and conditions are *matters of fact.*

The atmosphere, the waters, organic life, the solidifying and solid crust of the earth are for the most part composed of the same elements of matter. To acquire any definite idea of the transformations of terrestrial matter that have resulted in the solidification of a vast amount of native gaseous elements, through their chemical liquefaction and subsequent consolidation, since the creation of living organisms upon this sphere—the results of research in several branches of science must be briefly collated, for these lose their distinctiveness, and seem to converge as we draw nearer and nearer the truth in investigating nature.

III.

Chemical and Geological Changes.

There are only thirteen (13) of the sixty-five (65) elements, still supposed to be simple, that make up the great bulk of terrestrial matter. Of these, only four (4) that are really important in this connection. These are the organic elements, oxygen, hydrogen, nitrogen, and the non-metallic solid, carbon.

Oxygen and nitrogen form the earth's atmosphere.

Oxygen and carbon, the carbonic acid gas mingled with it.

Oxygen and hydrogen, the invisible moisture, aqueous vapor, and all the water in and upon the crust of the earth.

Oxygen, carbon, hydrogen, and nitrogen form the whole mass of the organic creation, living and dead, except the small amount which would remain as ash, were such matter consumed at a red heat.

Silicon, alumnium, magnesium, calcium, potassium, sodium, sulphur, chlorine, and iron are the nine (9) principal inorganic elements, and with the two organic elements, oxygen and carbon—hydrogen and nitrogen being found in small quantities in mineral masses—make up more than $\frac{977}{1000}$ of the solid crust of the earth.

Mr. Dana happily calls these rock constituents "burnt compounds"—as they are put into stable conditions by uniting with a saturating quantity of oxygen—and ordinary combustion consists in union with oxygen and the formation of stable oxyds.

The metals sodium and potassium burn if put in contact with water and become oxyds. Calcium, by uniting with oxygen, becomes lime; magnesium, magnesia; silicon, silica; and aluminum, alumina. Thus saturated, or united with all the oxygen they are capable of taking up, they become inert matter, entering as ingredients into rocks, and fit for dead nature, they are the most refractory substances in the earth's crust—and excepting pure crystalline carbon, the least liable to change.

The primary or granite rocks of the earth's crust are aluminous silicates, being double compounds of oxygen and silicon; and oxygen and aluminum; these chemical compounds must have been formed from a fused state. There are no means of knowing in what condition the silicon, alumnium, magnesium, &c., of the now refractory burnt compounds, existed before their combination; it may reasonably be doubted whether they are not really compound substances formed during the earlier condensation of matter, at all events they or their elements must at some time have existed in a gaseous state, and as these changes progressed there was a wonderful transformation

of a vast amount of gaseous to liquid, and liquid to solid matter. The oxygen must have been ready for this union, and there must have been an enormous supply of this element, for every atom of the other elements have been consumed while the surplus of oxygen forms now at least half of the water, earth and air.

The comparatively quiescent plane of the earth's circumference would have been favorable not only to the action of chemical affinity, but to rapid crystalization and solidification. The whole mass of overlaying matter must have been gaseous. The presence of red heat or of flame had probably already effected the union of oxygen and hydrogen, the subsequent precipitation of particles of aqueous vapor and their conversion instantly to steam would have tended to a more rapid cooling of the overheated crust. The blare and tumult of the elements during the interval is inconceivable. Aqueous vapor condensing here and there, the moment it reached a higher altitude, or a cooler atmospheric current, produced the requisite reduction of temperature, falling toward or upon the glowing crust to be forced instantly upwards in vast gushing volumes of steam, perhaps decomposed, and its two gases reuniting with fearful explosions to reform aqueous vapor—external as well as internal forces rending and contorting the shrinking crust!

The disintegrating effects of steam are very powerful, and must have begun the work of forming the gneiss before the water rested upon the granitic base in liquid masses. This deposition would have occurred at the earliest possible period of the requisite reduction of temperature. Water is the most powerful of all solvents. "It absorbs and is absorbed by everything." This power is greatly increased by an increase of temperature, so that these primeval waters resting upon the granite not only must have had, but the deposit of the gneiss proves that they *did have*, power to hold in solution, or in mechanical suspension, all

substances whether simple or compound that existed upon the surface of the granite.

The first permanent deposit of liquid matter of the primeval ocean was filled with the various elements and compounds that were to build up and develop in new forms the succeeding solid matter of the earth's crust. The very material of the gneiss swelled the bulk of liquid matter. The gradual cooling of the waters would of itself decrease its capacity and produce precipitation; thus this first merely mechanical deposit altered both the quantity and the quality of the water.

The gneiss was a surface deposit—all the matter above it was liquid and gaseous. The waters had free motion everywhere to work upon and over the granite in forming it—must not then the whole fifteen or sixteen miles of superincumbent solid matter have come from that element? Wherever the granitic formation was covered by the gneiss, it was at once hid away to be used no more in the operations of nature, unless by its elevation and subsequent exposure upon the surface of the earth it should again become subject to the action of atmospheric forces. But even when now thus exposed, atmospheric and aqueous agencies are almost powerless in its disintegration in comparison with the hot and saline waters and aqueous vapors of the earlier ages of the world. To be of any use in the operations of nature, in the transformation and development of terrestrial matter, it must be reconverted into mobile forms, and all the solid crystalline granite now in the earth's crust is the exact amount that has never been made use of in any further natural processes.

The same is true of the gneiss, only its surface was exposed to the action of the water after its first deposition. What remains is the "measure and monument" of that part of this deposit that has been entirely withdrawn from the activities of nature.

"Assuming that the granite rocks constitute the true

hypogean group, that they immediately underlie and are intimately associated with the lowest stratified schists, we obtain a starting point in the crust of the earth from which to obtain an intelligible description of the systems which follow."

The fact of the *strictly surface growth of every deposit* can not be too strongly pressed; every atom at the time of its deposition was free to move in obedience to the waters and was left where they carried it, upon the surface, until they covered it up with succeeding atoms. The geological strata of the earth are monuments of those parts of every deposit that were thus covered away and have never been used again in the formation of subsequent deposits.

The Laurentian and Cambrian Systems, bearing evidences of preceding and continuous heat with traces of the earliest forms of vegetable and animal life—the Silurian, Devonian, Carboniferous, Permian, Triassic, Oolitic, Cretaceous and Tertiary Systems, are the remains of each deposit whose surface was used by and incorporated with the waters until the succeeding formation gradually covered it, and saved it from further disintegration. Reaching the present surface of the earth, in the post tertiary and superficial formations, it will be necessary to learn the exact relation which gaseous and liquid forms of matter bear not only to the oxydation of metals and the formation of hydrates, but to the development of organized bodies.

These deposits did not, of course, all occur at regular intervals, in regular gradation, one above the other, making everything plain and easy to be understood. If it had been so, the rocks and waters would have disclosed the truth long since. All the complex obliterating and intermingling forces have been at work from the first. Every cause must be allowed full weight, every effect must be duly considered. Nor is the action of igneous forces ignored wherever its effects are evident.

The earlier or lower strata appear to be more general and extensive—the fossils of the lowest and simplest forms—those least affected by changing conditions to extend through the longest eras of time. The later strata, as well as the later forms of life, are more local and limited in area and in time, and more complex in character.

Everything seems to tell us, now that we press the truth so closely to nature, that the rocks have been constantly increasing, as the mobile forms of matter have been decreasing in volume—the change transpiring under manifold conditions, and over shifting and changing areas of the earth's surface, and brought about by the operation of complex natural agencies. Thus uniform laws have necessarily produced constant diversity of results, and to human observation, permanent change.

IV.

Water Changed into Solid Form by Acidification, Alimentation and Respiration.

In 1774, Lavoisier showed that in the calcination of metals in the air, they acquired as much weight as the air lost. He also found oxygen to be the great agent in combustion, acidification, calcination, and respiration. All these processes were analogous, and consisted in the decomposition of atmospheric air, and the fixation of the pure or vital portion of it. The action of dilute acids on metals was also explained by the decomposition of water.

Notwithstanding an hundred years have passed since this discovery, its real bearing upon the physical history of the earth has never been recognized. Aerial or liquid oxygen changes its form by acidification as well as by cal-

cimation, and *when thus used the mobile forms of matter lose exactly the amount that the solid or solidifying matter gains.*

Thus the using up of the aeriform or liquid oxygen must have begun in the formation of the aluminous silicates of the granitic formations, and must have continued through all the past building up of the earth's crust, through the agency of the water and atmosphere, *the succeeding media of the supply of oxygen*, wherever oxydation or acidification have occurred to form chemical compounds, and where these compounds have remained undecomposed, they constitute part of the matter once belonging to the air or oceans, but now forming part of the solid crust.

The part that water performs in these changes is wonderful. Anstead says: "Water enters not only into the composition of every solid and of every liquid of which every living thing is composed, but is present in all mineral matter; even the most solid and compact marble contains a small percentage of water." "Wherever change has taken place at great depths, there water has acted as the chief agent." "Heat and chemical action could do little—they act by and with water, and thus produce their results."

"Tens of thousands of feet in the earth a slow but incessant crystalization goes on, in which water is entangled, and with minerals helps to form a part of the substance of each crystal." "Itself a liquid, it enters into all solids, almost as essential to solidity."

The large class of minerals known as hydrates, belonging to past as well as present formations, contain a certain proportion of "waters of crystallization" as essential to their formation.

What they thus gain, the liquid mass of matter must have lost. In alum, 46 parts in 100 are water—in epsom salts, 51—in gypsum, 21. The opal in its pure state is a hydrate of silica, consisting of from 90 to 95 per cent. silica, and from 5 to 10 water. All crystallization is indeed well known to be defined "as the process, natural or artifi-

cial, by which the particles of liquid or gaseous bodies are converted into crystal or solid bodies of regularly limited form."

Matter can not exist in solids, and at the same time in liquid or gaseous forms—so that the quantity of mobile matter must have decreased by the amount thus used.

The same truth applies yet more strikingly in the process of respiration, and not only of respiration but of alimentation.

All organic life is entirely dependent upon the mobile elements of matter. The atmosphere and waters have hitherto been considered rather as the media of life than as the *very material from which all organic life has been and is made up*. So absolutely necessary is water to all organic development, that it is supplied in many different ways, and in apparently inexhaustible quantities. *It is the very food* of animals as well as vegetables—nor is this any the less true because small portions of other elements are used with it, and absolutely necessary to its being able properly to develop organized bodies.

The mobile elements of matter have been consumed by every organism, from the foraminifera that fed upon the warm waters of the primeval ocean to the air-breathing and aquatic creatures that swarm the air, the earth and waters to-day.

The whole living creation holds such matter in solid forms now—having lost none of the organic elements of which it is composed. Of the quantity of this matter no idea can be formed, except by reflecting upon the universality of life. The earth, the water, and the air teem with living germs and organisms. The larger forms of the animal creation, and the great masses of vegetation, especially in the tropics, strike the eye by their immensity and extent. But as throughout all nature the ideas of comparison between great and small are continually confounded, so when we contemplate the immense extent and quantity of micro-

scopic life, developed by the researches of Ehrenberg,—in the deep seas, in the earth itself, and in the atmosphere—covering and coloring even the Polar snows, and existing in the refined tissues and fluids of living creatures, the mind becomes bewildered at the infinity it encounters upon either hand, and is profoundly impressed with this wonderful and universal presence of vitality.

Omitting the great mass of evidence as to the way in which the elements of water and air are used in the devleopment of both vegetable and animal organisms, the mere statement of their constituent elements will be sufficient.

With scarcely an exception, vegetable bodies consist entirely of carbon and water, or of the elements of water united with carbon in various proportions. Woody fibre or lignin is nearly identical in all trees and in the fibres of linen and cotton. It forms the trunks and branches of trees, and all the fibrous or woody parts of vegetable bodies—making up a large proportion of the bulk of vegetable matter, it consists of 50 parts of water and 50 of carbon.

The other principal compounds that are developed in the process of vegetable growth, are cellular fibre, gum, starch, cane and grape sugar, these, with the exception of the latter and lignin, consist of the *same elements in exactly the same proportion!*

Some of the principal vegetable acids and compound are thus represented by chemical symbols:

Water	H^2 O
Carbonic acid	O^2 C
Alcohol	H^6 O^2 C^4
Ether	H^5 O C^4
Acetic acid	H^3 O^3 C^4
Tartaric acid	H^{11} O^{10} C^8
Sugar	H^{11} O^{11} C^{12}
Starch	H^{10} O^{10} C^{12}
Oxalic acid	O^3 C^2*

"In crops as they are reaped and even as they are given for food, much water is present; *when artificially dried*, carbon forms $\frac{1}{2}$ their weight, oxygen more than $\frac{1}{3}$, hydrogen a little more than 5 per cent., and nitrogen rarely to more than $2\frac{1}{2}$ per cent."

When starch or gum becomes sugar, as in the germination of seeds and other vegetable processes, the transmutation is effected by the absorption of water; for with regard to their composition, a greater proportion of water only distinguishes sugar from starch, and the separation of oxygen from sugar causes it to be converted into fat!

In the ripening of fruit, the cane, is converted into grape sugar, by the absorption of additional oxygen. There seems to be some deficiency in this supply, or difficulty in some seasons in the vine getting the proper quantity at the proper time, which causes grapes to rot upon the vines about the time that their growth is attained, and they should begin to fill out, acquire some sweetness and ultimately ripen.

Animal food consists mainly of vegetable products, these assimilate the organic elements directly from their great liquid and gaseous reservoirs, and prepare them for the consumption of the animal creation.

The model man of Professor Quetelet, weighs 154 lbs., and consists of

116	lbs.	of water,
38	"	dry matter.
154		

Of the dry matter,

24	lbs.	are flesh and fat,
14	"	bone.
38		

The dry matter consisted of 28 lbs. of organic elements,
10 " inorganic "

So that there were altogether 144 lbs. of oxygen, carbon, hydrogen, and nitrogen, to 10 of all others.

If 100 lbs. of human blood be rendered perfectly dry, it will be reduced in weight to something less than 22 lbs.; and this dry matter consists of essentially the same substances as the several varieties of animal and vegetable food.

100 parts of *blood* contain
93 per cent. of fibrine, albumen, &c.,
2 " " fat, sugar, and starch,
5 " " saline or mineral matter.

100 parts of *fibrine* contain
54.454 of carbon,
7.069 " hydrogen,
15.762 " nitrogen,
22.715 " oxygen, sulphur, phosphorus.

100.000

100 parts of *albumen* contain
55 of carbon,
7 " hydrogen,
15 " nitrogen,
23 " oxygen.

100.000

Sugar ..... $H^{11} O^{11} C^{12}$
Starch ..... $H^{10} O^{10} C^{12}$
Fat. ..... $H^{36} O^{5} C^{37}$

It seems very singular that the solid matter of animals should contain nearly the same quantity of water as the liquid blood; but it is a still more striking fact, that the dry animal matter that remains, when lean muscular fibre and blood are fully dried, has the same composition:

DRY BEEF.		DRY BLOOD.
51.83	of carbon,	51.96
7.57	" hydrogen,	7.25
15.00	" nitrogen,	15.07
21.37	" oxygen,	21.30
4.23	" ashes,	4.41
100.00		100.00

Other parts of animals, wood, hair, skin, &c., are composed of the same elements, with less inorganic matter; horn containing only .07 per cent. of ash.

It will doubtless be admitted without the presentation of any further argument, that the whole body of mobile matter, as existing in the atmosphere and waters of the earth, has been diminished by the whole amount yielded to the existing living creation. There is less water and less atmosphere since these living organisms grew. If the sum of the whole be greater than any of its parts, or a part can not equal the whole, this must be true.

But it may be said these bodies will decay, and their elements will then be restored to their original mobile forms. The processes which renovate the earth are by no means so simple; "thousands of carcasses and whole forests of drift timber are buried every year, and perhaps so buried as to be imprisoned for whole geological epochs."

Bodies in water change slowly, and in the earth still more so. Professor Winchell, one of the most advanced geologists of the age, "doubts whether the requisite conditions of oxydation exists at great depths in the soil." "It needs only a fine covering of such deposits as are constantly taking place in the oceans and at the mouths of rivers to bury them away and prevent further decay." Upon the Siberian plains, and in the ices of the North, dead bodies have been discovered so entirely unchanged as to be greedily devoured by dogs. Native timber, with seeds, and even leaves and fruits, is found a very remark-

able state of preservation, after hundreds of years of burial or submersion in lakes and swamps or marshes. The more closely these deposits are studied, the more enormous they are found to be. In the tropical regions organized bodies decay rapidly, but above 45 degrees of of latitude, vegetable matter begins to accumulate in vast quantities, and animal bodies to be more frequently preserved.

"The quantity of timber which is conveyed from the land to the sea, by the sinking of ships of a large size, is enormous, for it is computed that 2,000 tons of wood are required for the building of one 74 gun ship; and reckoning 50 oaks, of 100 years growth, to the acre, it would require 40 acres of oak forest to build one of these vessels." The amount of organized matter thus preserved can only be conceived by a knowledge of naval statistics.

Even where an organized body seems to be entirely decomposed—part of it returning to gaseous and part to liquid form—solid parts of it may be washed away and buried so as to remain undecomposed for ages, for if they do change thus buried away, it will be but a molecular change that can not restore to their original forms their liquid or gaseous elements of matter.

The processes of petrefaction are as yet but very imperfectly understood. It is more than probable some subtle chemical or atomic change takes place in the internal structure of fossil remains. The formation of flints, apparently upon the nucleus of an organic body upon the floor of the seas, at various epochs during the chalk deposits, is remarkable and suggestive. It is said by Mr. Johnston that stale bread contains exactly the same amount of water as fresh bread—about one half—but that its hardening is caused by molecular change, and not by evaporation or the removal of any of its elements. This may be considered an inapt and homely illustration, but if such a change transpires in the open air where the elements would

be perfectly free to escape, is it likely that buried organized bodies could easily release their elements? More probably they undergo some similar, internal change, varying according to the adjacent elements or compounds, amount of pressure, &c.

Thus every passing generation of organic life has probably left traces of the matter that once formed it, incorporated with the solid strata of the earth's crust. Of the relative amount of such matter, no idea can be formed. All the dead organisms as yet undecomposed—all organic fragments, and all coral and indusial formations hold mobile elements in solid form; if this were not true, we should have no organically enriched soils, no deposits of guano, no peat or coal formations, no shell or bone beds, no organic remains in the crust of the earth.

But these we have. The rocky tablets of the crust disclose these organic remains throughout their entire depth. Aqueous and fossiliferous have become synonymous as applied to the earth's strata.

The question as to *how much* matter has thus changed form will depend upon future investigation, a better understanding of mineralization, a more careful analysis of fossil organic remains, and accurate comparisons of the relative areas of land and water at different geological areas,—a work happily begun.

Whenever organic remains, either those of recent date or of the most ancient strata, are exposed to disintegration and decomposition, they are in a condition to be returned to their original elements. When coal is burned, the matter the atmosphere and water lost thousands and thousands of years ago, they thus once again receive; so with the washing of salt beds and other solid deposits, the mobile elements of matter only recover this small fraction of the entire amount they previously lost.

V.

Change in Species and in Human History and Development.

Mr. Darwin's theory of evolution, or "the origin of species by natural selection," as an independent scientific theory, has seemed from the first *inadequate to explain the grand and systematic series of changes* that have brought the countless varieties of species that now exist upon the earth, to their present condition.

The gradual revolution produced by the continual transmutation of matter, *is the great corresponding cosmical cause of change that has given direction to the operation of natural selection*, unfitting the earth at every period of past time, for the continuation of the propagation of *identical organisms*—save such as are of the simplest possible structure.

The strongest individuals of existing species adapt themselves to changing conditions, not only slowly varying with them, *but improving and attaining a higher state of development.* Other grades of physical powers, adapting themselves *more or less perfectly* to altering external circumstances, the weaker dying off as fast as *it becomes impossible for them to adapt themselves to any further change.* Past conditions never returning, there can *never* be a return to past types; and the various peculiarities long observed in the nature of succeeding organic remains in the earth's crust, will be explained by this theory—while other branches of science will be found to be involved in such a general cause of change, and it is hoped will be advanced by its promulgation.

It is the "*known cause*" by which "stations" must unquestionably be modified, *producing changes every where over the whole earth, at every period of time.* These transmutations are gradual, the cause that produces them must act

gradually; they have been permanent, the cause must have been constantly modified by them, operating gently and gradually, from moment to mement, year to year, age to to age, *imperceptible always at every present period of time.* Imperceptible *to-day*, such change must nevertheless be transpiring; and there are few, when the idea is once presented and reflected upon, who will not perhaps recall some corroborating evidences of its truth, even within the range of their own experience or observation.

This wonderful system of change extends not only through the inferior organic creation, but includes man, his history, his intellectual and spiritual development. These higher faculties, however superior to his merely physical powers, are certainly dependent upon them, and upon external conditions, during the life of this physical organization.

Whatever may be thought now of the connection between vital, electric, and nervous or brain phenomena, and the subtle gases, hydrogen and nitrogen, the usual if not constant presence of one of these at least, when electrical phenomena occurs, artificially or naturally, and the mysterious but constant presence of the other in vital germs and organisms, together with their frequent interdependence, is certainly worthy of consideration.

"The electricity of the atmosphere, whether considered in the upper or the lower strata of clouds, in its silent, problematical, diurnal course, or in the explosion of the lightning and thunder of the tempest, *appears to stand in a manifold relation to all phenomena, of the distribution of heat, of the pressure of the atmosphere, and its disturbances of hydrometric exhibitions*, and, probably, also of the *magnetism of the external crust of the earth. It exercises a powerful influence on the whole animal and vegetable world, not merely by meteorological processes*, as precipitation of aqueous vapors, and of acids and ammonical compounds, to which it gives rise, but also as *an electric force acting directly on the nerves, and promoting the circulation of the organic juices.*

"This is not a place in which to renew the discussion that has been started, regarding the *actual source of atmospheric electricity* when the sky is clear, a phenomenon which has been alternately ascribed to the evaporation of impure liquids impregnated with earths and salts, *to the growth of plants, or to some other chemical decomposition on the surface of the earth*, to the unequal distribution of heat in the strata of the air, and finally, according to Peltier's intelligent researches, *to the agency of a constant charge of negative electricity in the terrestrial globe.* Limiting itself, to the results yielded by the electrometric observations, such, for instance, as are furnished by the ingenious electro-magnetic aparatus first proposed by Colladon, the physical description of the universe should merely notice *the incontestable increase of the intensity of the general positive electricity of the atmosphere*, accompanied by an *increase of altitude*, and *the absence of trees*, its *daily variations*, at its *variations at different seasons of the year*, *at different distances from the equator*, and in the different relations of continental and oceanic surface. The electric equilibrium is less frequently disturbed where the aerial ocean rests upon a liquid base, *than where it impends over land*, and it is very striking to observe how in extensive seas, small insular groups, effect the condition of the atmosphere and occasion the formations of storms, &c."

"The term climate, in its most general sense, indicates all the changes in the atmosphere, which sensibly effect our organs, as temperature, *humidity*, *variations of the barometrical pressure*, the calm state of the air, the action of opposite winds, *the amount of electric tension*, *the purity of the atmosphere, or its admixture with more or less gaseous exhalations*, and, finally, the degree of ordinary transparency and clearness of the sky, which is not only important with respect to the increased radiation from the earth, *the organic development of plants*, and the ripening of fruits, but also in reference to *the feelings and mental condition of man.*"

"The processes of the absorption of light, liberation of

heat, and the variations in the *elastic and electric tension, and in the hygrometric condition of the vast aerial ocean, are all so intimately connected together*, that each individual meteorological process is modified by all the others, and *these meteorological processes of the atmosphere are the controlling causes* on which depends the agricultural and pastoral pursuits of the inhabitants of extensive tracts of continents."

It can but be concluded, from these ideas so forcibly and fully expressed by the profound and acute author of Cosmos, that electricity is in some way, not yet understood, not only intimately connected with, but dependent upon the operations of nature as explained by the gradual diminution of the mobile forms of matter, and that some of the organic chemical elements must be concerned in electric phenomena.

According to Whewell, "*the identity of electric and chemical forces is a well proved truth*, from which future speculations must advance as a starting point." The identity of organic and chemical elements being also an admitted truth—the identity of chemical, vital, electric and nervous forces can not be denied.

Terrestrial physical conditions must have been so far modified, and the formation of solid matter upon this sphere must have proceeded to a certain extent when organic life began to exist upon it. This organic life must have advanced with physical conditions through age upon age of change, during the whole formation of the rocky strata of the earth's crust, before the period arrived for the present highest type of physical organization, combined with the highest development of nervous or brain power as existing in man, to take its appointed place in the creation of God. There must have been the same fitness and adaptation in and between organic and inorganic, animate and inanimate nature, always. If these gradual changes in the forms of the matter of this globe have taken place, *the perfect adaptation of all things at all times* can not be too

strongly realized. At a certain period of time, in the beginning of this development, the subtler known elements of matter—hydrogen and nitrogen—eluding in part the great law of gravitation, or solidification, began to gain in quantity on the other grosser elements of gaseous and liquid matter—the carbon and oxygen that were helping so ceaselessly to build up the adamantine crust; these mysterious, chemical, vital, and nervous forces, performing the more exquisite work of operating with ever increasing vigor or intensity upon the nervous centres of the advancing animal creation, culminating in intellectual power. Nervous, and ultimately mental, development must have progressed under changed physical conditions, just as physical development had gone on—the various elements doing their appointed work in one case as in the other.

If the now arid wilds of Arabia or Ethiopia, was the seat of the earliest civilization of the earth, the apparently rapid change in physical conditions there, must have tended to its speedy culmination and subsequent unfitness for further development, and the same stimulus of change, may have produced the development of civilization of the neighboring, and ultimately of the Western nations.

Whatever the descent of man has been, every change has transpired—through all the past—in perfect accordance with the laws of God, as revealed to man. The habitations and races of man changed perhaps in the earliest human epoch, somewhat as the habitations and species of other genera of organic beings changed. His increased knowledge gives more and more power to overcome the diversities of changing climates, and all other external disadvantages of place and surroundings.

Races and nations that do not develop and improve, and thus adapt themselves to changing physical, political and social conditions, doubtless becoming weaker, and perhaps extinct; while those that are brought to a more perfect state, their mental and spiritual faculties being constantly

developed—for the age of the strongest physical development is doubtless passed—will become the progenitors of nobler descendants.

The rapid brain or nervous development of the American people is not alone the result of antecedent, hereditary, historical, or political causes. Physical, external, conditions are operating with and upon these with immeasureable, irresistable power; hygrometrical, electrical, and other conditions are producing results than can only be surmised as yet; we can not grasp or understand them. For this sequence of thought carries us beyond the seen and tangible, but *not beyond that which really, actually exists.* The subtle, invisible, intangible gases are as truly matter as iron is matter. Oxygen, hydrogen, and nitrogen we can neither see, touch, taste, or smell in their native state. To our physical senses, though they had always existed right around us, yet unconfined, they had been to us as though they *were not.* In their chemical combinations, by experiments and observation of their effects, man has been able to learn not only of their existence, but something of their properties. He finds oxygen existing everywhere, in everything; in vast quantities in solid forms, as well as well as liquid and gaseous; hydrogen united with oxygen in liquid form; nitrogen mingled with gaseous oxygen. Hydrogen and nitrogen are, however, *most* abundant in their native mobile forms; they are *more abundant in living organisms than in dead; more in dead bodies than in fossil remains;* they are found in very small quantities in the geological strata of the earth, in proportion to the solid oxygen and carbon, although in sufficient quantity to effect its electrical condition.

If gaseous and liquid matter has solidified in that transformation, certain *parts* of the subtle gases, nitrogen and hydrogen, that existed with the oxygen before its solidification, have disappeared. Where are they? Do they not probably exist in proportionally increased quantities in a

free or gaseous state, possibly in combination with yet more subtle, unknown elements? If they existed in forms that man could take cognizance of, if he could follow them further, he could analyse, study them, and perhaps understand their nature and operations; as it is, he has been able to follow them beyond the range of his physical senses, and probably to their gradually increased, and increasing, proportional quantities in the earth's atmosphere, through the action of organic agencies, is to be ascribed, together with other causes, the increase of electrical intensity in the atmosphere, and other electrical phenomena, mental activity, and spiritual susceptibility.

These subtle, gaseous elements are, as it were, the connecting links between the seen and the unseen, the tangible and intangible, material and immaterial, temporal and eternal things, and they can but be involved in the procession of physical changes proceeding to their legitimate results, in the actual sequence of nature, with the more ponderable elements of matter, putting mankind, it may be, into communion with "those things which are above" fitting him more and more to receive the inspiration of His Spirit, and to learn of, and adore, the Great Creator of the Universe, who has made all things by the word of His Power.

The thought of the gradual diminution of water, the most wonderful, glorious, beautifying and gladdening of all terrestrial substances, can but be painful to us, constituted as we are.

But the same Almighty and Omniscient Power that has continuously controlled and moulded the adaptations of the physical universe to the perceptions and welfare of sentient beings, opening to us even in our own short lives new and unconceived sources of pleasure, with the development of our physical, intellectual and spiritual faculties, will doubtless still continue to preserve, between the living races of His creatures and external physical conditions,

that perfect adaptation that has always existed, and that seems to be an endless and progressive amelioration.

That matter has thus developed under His own immutable laws for countless ages, with faultless precision, in the vastest operations of the stupendous universe, and unerring perfection in the minutest details of everything, is one of the most glorious of His revealed attributes. And we can not doubt that this revelation will become more and more glorious, even to the far distant future, foretold 1800 years ago by the Beloved Disciple, who "SAW A NEW HEAVEN AND A NEW EARTH, AND THERE WAS NO MORE SEA."

NOTE.—The matter of this paper, as originally prepared, was made up in great part of extracts and illustrations from standard authorities, exhibiting physical facts so collated as to demonstrate the theory of the gradual diminution of water.

This abstract, having been made to present to "The American Association for the Advancement of Science," the most general and important ideas upon the subject, with the necessary and required brevity, may be found deficient in clearness, or proper arrangement, or in the illustrations necessary to a complete demonstration.

It has been difficult for an unpractised author, in so condensed a summary of a very extensive range of facts, to prepare a paper that will be suitable to the occasion.

A large number of valuable authorities have been freely used in the course of these investigations—and are *gratefully acknowledged.* The most important of them will be found in the following list:

Cosmos, Vestiges of Creation, Plurality of Worlds, Origin of the Stars (Ennis), Planetary and Stella Worlds, Astronomy of the Bible (Mitchell), Elements of Astronomy (Davis), Ecce Coelum, Kitto's Encyclopedia, American do., Malte Brun, Whewell's History of the Inductive Sciences, Lyell's Principles of Geology, Manual do., Antiquity of Man (Lyell), Descent of Man (Darwin), Origin of Species, do., Great Stone Book (Anstead), Advanced Text Book, Physical Geography and Hand Book (Page), Earth and Man (Guyot), Physical Geography (Somerville), Manual of Geology (Dana), Sketches of Nature (Winchell), Geology of the Stars, do., Physical Geography of the Sea (Maury), Roget's Animal and Vegetable Physiology (Bridgewater Treatise), Vegetable World (Figuer), Structure of Animal Life (Agassiz), Chemistry of Common Life and Agricultural Chemistry (Johnson), Johnson's Turner's Chemistry, Natural Laws of Husbandry (Liebig), Aspects of Nature (Humboldt), Analytical Class Book of Botany, Wonders of Heat (Cozin), Prehistoric Nations (Baldwin), Carthage and her Remains (Davis), Civil Policy in America (Draper), Chips from a German Workshop (Max Muller).

Errata

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disappoint