VESTIGES

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OF

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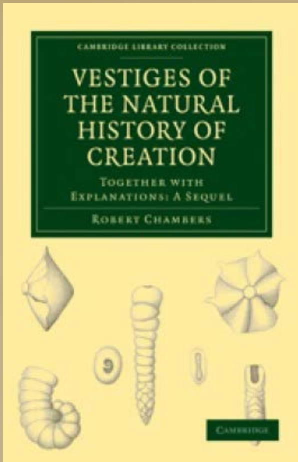
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VESTIGES OF THE NATURAL HISTORY OF CREATION
Together with Explanations: A Sequel
Robert Chambers
Cambridge

Chambers, Robert

THE BODIES OF SPACE,

THEIR ARRANGEMENTS AND FORMATION.

It is familiar knowledge that the earth which we inhabit is a globe of somewhat less than 8000 miles in diameter, being one of a series of eleven which revolve at different distances around the sun, and some of which have satellites in like manner revolving around them. The sun, planets, and satellites, with the less intelligible orbs termed comets, are comprehensively called the solar system, and if we take as the uttermost bounds of this system the orbit of Uranus (though the comets actually have a wider range), we shall find that it occupies a portion of space not less than three thousand six hundred millions of miles in diameter. The mind fails to form an exact notion of a portion of space so immense; but some faint idea of it may be obtained from the fact, that, if the swiftest race-horse ever known had begun to traverse it, at full speed, at the time of the birth of Moses, he would only as yet have accomplished half his journey.

It has long been concluded amongst astronomers, that the stars, though they only appear to our eyes as brilliant points, are all to be considered as suns, representing so many solar systems, each bearing a general resemblance to our own. The stars have a brilliancy and apparent magnitude which we may safely presume to be in proportion to their actual size and the distance at which they are placed from us. Attempts have been made to ascertain the distance of some of the stars by calculations founded on parallax, it being previously understood that if a parallax of so much as one second, or the 3600th of a degree, could be ascertained in any one instance, the distance might be assumed in that instance as not less than 19,200,000 millions of miles! In the case of the most brilliant star, Sirius, even this minute parallax could not be found; from which of course it was to be inferred that the distance of that star is something beyond the vast distance which has been stated. In some others, on which the experiment has been tried, no sensible parallax could be detected; from which the same inference was to be made in their case. But a sensible parallax of about one second has been ascertained in the case of the double star, *á á*, of the constellation of the Centaur,* and one of the third of that amount for the double star, 61 Cygni; which gave reason to presume that the distance of the former might be about nineteen millions of millions of miles, and the latter of much greater amount. If we suppose that similar intervals exist between all the stars we shall readily see that the space occupied by even the comparatively small number visible to the naked eye must be vast beyond all powers of conception.

The number visible to the eye is about three thousand; but when a telescope of small power is directed to the

* By the late Mr. Henderson, Professor of Astronomy in the Edinburgh University, and Lieutenant Meadows.

heavens, a great number more come into view, and the number is ever increased in proportion to the increased power of the instrument. In one place, where they are more thickly sown than elsewhere, Sir William Herschel reckoned that fifty thousand passed over a field of view two degrees in breadth in a single hour. It was first surmised by the ancient philosopher, Democritus, that the faintly white zone which spans the sky under the name of the Milky Way, might be only a dense collection of stars too remote to be distinguished. This conjecture has been verified by the instruments of modern astronomers, and some speculations of a most remarkable kind have been formed in connexion with it. By the joint labors of the two Herschels, the sky has been "gauged" in all directions by the telescope, so as to ascertain the conditions of different parts with respect to the frequency of the stars. The result has been a conviction that, as the planets are parts of solar systems, so are solar systems parts of what may be called astral systems—that is, systems composed of a multitude of stars, bearing a certain relation to each other. The astral system to which we belong, is conceived to be of an oblong, flattish form, with a space wholly or comparatively vacant in the centre, while the extremity in one direction parts into two. The stars are most thickly sown in the outer parts of this vast ring, and these constitute the Milky Way. Our sun is believed to be placed in the southern portion of the ring, near its inner edge, so that we are presented with many more stars, and see the Milky Way much more clearly, in that direction, than towards the north, in which line our eye has to traverse the vacant central space. Nor is this all. Sir William Herschel, so early as 1783, detected a motion in our solar system with respect to the stars, and announced that it was tending towards the star λ, in the constellation Hercules. This has been generally verified by recent and more exact calculations,* which fix on a point in Hercules, near the star 143 of the 17th hour, according to Piozzi's catalogue, as that towards which our sun is proceeding. It is, therefore, receding from the inner edge of the ring. Motions of this kind, through such vast regions of space, must be long in producing any change sensible to the inhabitants of our planet, and it is not easy to grasp their general character; but grounds have nevertheless been found for supposing that not only our sun, but the other suns of the system, pursue a wavy course round the ring *from west to east*, crossing and recrossing the middle of the annular circle. "Some stars will depart more, others less, from either side of the circumference of equilibrium, according to the places in which they are situated, and according to the direction and the velocity with which they are put in motion. Our sun is probably one of those which depart furthest from it, and descend furthest into the empty space within the ring."† According to this view, a time may come when we shall be much more in the thick of the stars of our astral system than we are now, and have of course much more brilliant nocturnal skies; but it may be countless ages before the eyes which are to see this added resplendence shall exist.

The evidence of the existence of other astral systems

* Made by M. Argelander, late director of the Observatory at Abo.

† Professor Mossotti, on the Constitution of the Sidereal System, of which the Sun forms a part.—*London, Edinburgh, and Dublin Philosophical Magazine*, February, 1843.

besides our own is much more decided than might be expected, when we consider that the nearest of them must needs be placed at a mighty interval beyond our own. The elder Herschel, directing his wonderful tube towards the *sides* of our system, where stars are planted most rarely, and raising the powers of the instrument to the required pitch, was enabled with awe-struck mind to see suspended in the vast empyrean astral systems, or, as he called them, firmaments, resembling our own. Like light cloudlets to a certain power of the telescope, they resolved themselves, under a greater power, into stars, though these generally seemed no larger than the finest particles of diamond dust. The general forms of these systems are various; but one at least has been detected as bearing a striking resemblance to the supposed form of our own. The distances are also various, as proved by the different degrees of telescopic power necessary to bring them into view. The farthest observed by the astronomer were estimated by him as thirty-five thousand times more remote than Sirius, supposing its distance to be about twenty millions of millions of miles. It would thus appear, that not only does gravitation keep our earth in its place in the solar system, and the solar system in its place in our astral system, but it also may be presumed to have the mightier duty of preserving a local arrangement between that astral system and an immensity of others, through which the imagination is left to wander on and on without limit or stay, save that which is given by its inability to grasp the unbounded.

The two Herschels have in succession made some other remarkable observations on the regions of space. They have found within the limits of our astral system and generally in its outer fields, a great number of objects which, from their foggy appearance, are called *nebulæ;* some of vast extent and irregular figure, as that in the sword of Orion, which is visible to the naked eye, others of shape more defined; others, again, in which small bright nuclei appear here and there over the surface. Between this last form and another class of objects, which appear as clusters of nuclei with nebulous matter around each nucleus, there is but a step in what appears a chain of related things. Then, again, our astral space shows what are called nebulous stars,—namely, luminous spherical objects, bright in the centre and dull towards the extremities. These appear to be only an advanced condition of the class of objects above described. Finally, nebulous stars exist in every stage of concentration, down to that state in which we see only a common star with a slight *bur* around it. It may be presumed that all these are but stages in a progress, just as if, seeing a child, a boy, a youth, a middle-aged, and an old man together, we might presume that the whole were only variations of one being. Are we to suppose that we have got a glimpse of the process through which a sun goes between its original condition, as a mass of diffused nebulous matter, and its full-formed state as a compact body? We shall see how far such an idea is supported by other things known with regard to the occupants of space, and the laws of matter.

A superficial view of the astronomy of the solar system gives us only the idea of a vast luminous body (the sun) in the centre, and a few smaller, though various sized bodies, revolving at different distances around it; some of these, again, having smaller planets (satellites) revolving around them. There are, however, some general features of the solar system which, when a profounder attention makes us acquainted with them, strike the mind very forcibly.

It is, in the first place, remarkable, that the planets all move nearly *in one plane*, corresponding with the centre of the sun's body. Next, it is not less remarkable, that the motion of the sun on its axis, those of the planets around the sun, and the satellites around their primaries,* and the motions of all on their axis, are *in one direction*—namely, from west to east. Had all these matters been left to accident, the chances against the uniformity which we find would have been, though calculable, inconceivably great. Laplace states them at four millions of millions to one. It is thus powerfully impressed on us, that the uniformity of the motions, as well as their general adjustment to one plane, must have been a consequence of some cause acting throughout the whole system.

Some of the other relations of the bodies are not less remarkable. The primary planets show a progressive increase of bulk and diminution of density, from the one nearest to the sun to that which is most distant. With respect to density alone, we find, taking water as a measure and counting it as one, that Saturn is $\frac{13}{32}$, or less than half; Jupiter, $1\frac{1}{24}$; Mars, $3\frac{2}{7}$; Earth, $4\frac{1}{2}$; Venus,

* The orbitual revolutions of the satellites of Uranus have not as yet been clearly scanned. It has been thought that their path is retrograde compared with the rest. Perhaps this may be owing to a *bouleversement* of the primary, for the inclination of its equator to the ecliptic is admitted to be unusually high; but the subject is altogether so obscure, that nothing can be founded on it.

$5\frac{11}{15}$; Mercury, $9\frac{9}{10}$, or about the weight of lead. Then the distances are curiously relative. It has been found that if we place the following line of numbers,—

0	3	6	12	24	48	96	192,

and add 4 to each, we shall have a series denoting the respective distances of the planets from the sun. It will stand thus—

4	7	10	16	28	52	100	196
Merc.	Venus.	Earth.	Mars.		Jupiter.	Saturn.	Uranus.

It will be observed that the first row of figures goes on from the second on the left hand in a succession of duplications, or multiplications by 2. Surely there is here a most surprising proof of the unity which I am claiming for the solar system. It was remarked when this curious relation was first detected, that there was the want of a planet corresponding to 28; the difficulty was afterwards considered as in a great measure overcome, by the discovery of four small planets revolving at nearly one mean distance from the sun, between Mars and Jupiter. The distances bear an equally interesting mathematical relation to the times of the revolutions round the sun. It has been found that, with respect to any two planets, the squares of the times of revolutions are to each other in the same proportion as the cubes of their mean distances,—a most surprising result, for the discovery of which the world was indebted to the illustrious Kepler. Sir John Herschel truly observes—"When we contemplate the constituents of the planetary system from the point of view which this relation affords us, it is no longer mere analogy which strikes us, no longer a general resemblance among them, as individuals independent of each other, and circulating about the sun, each according to his own peculiar nature, and connected with it by its own peculiar tie. The resemblance is now perceived to be a true *family likeness;* they are bound up in one chain—interwoven in one web of mutual relation and harmonious agreement, subjected to one pervading influence, which extends from the centre to the farthest limits of that great system, of which all of them, the Earth included, must henceforth be regarded as members.*

Connecting what has been observed of the series of nebulous stars with this wonderful relationship seen to exist among the constituents of our system, and further taking advantage of the light afforded by the ascertained laws of matter, modern astronomers have suggested the following hypothesis of the formation of that system.

Of nebulous matter in its original state we know too little to enable us to suggest how nuclei should be established in it. But supposing that, from a peculiarity in its constitution, nuclei are formed, we know very well how, by virtue of the law of gravitation, the process of an aggregation of the neighboring matter to those nuclei should proceed, until masses more or less solid should become detached from the rest. It is a well known law in physics that, when fluid matter collects towards or meets in a centre, it establishes a rotary motion. See minor results of this law in the whirlwind and the whirlpool—nay, on so humble a scale as the water sinking through the aperture of a funnel. It thus becomes certain that when we arrive at the stage of a nebulous star, we have a rotation on an axis commenced.

Now, mechanical philosophy informs us that the in-

* Astronomy, Cabinet Cyclopædia.

stant a mass begins to rotate, there is generated a tendency to fling off its outer portions—in other words, the law of centrifugal force begins to operate. There are, then, two forces acting in opposition to each other, the one attracting *to*, the other throwing *from*, the centre. While these remain exactly counterpoised, the mass necessarily continues entire; but the least excess of the centrifugal over the attractive force would be attended with the effect of separating the mass and its outer parts. These outer parts would then be left as a ring round the central body, which ring would continue to revolve with the velocity possessed by the central mass at the moment of separation, but not necessarily participating in any changes afterwards undergone by that body. This is a process which might be repeated as soon as a new excess arose in the centrifugal over the attractive forces working in the parent mass. It might, indeed, continue to be repeated, until the mass attained the ultimate limits of the condensation which its constitution imposed upon it. From what cause might arise the periodical occurrence of an excess of the centrifugal force? If we suppose the agglomeration of a nebulous mass to be a process attended by refrigeration or cooling, which many facts render likely, we can easily understand why the outer parts, hardening under this process, might, by virtue of the greater solidity thence acquired, begin to present some resistance to the attractive force. As the solidification proceeded, this resistance would become greater, though there would still be a tendency to adhere. Meanwhile, the condensation of the central mass would be going on, tending to produce a separation from what may now be termed the *solidifying crust*. During the contention between the attractions of these two bodies, or parts of one body, there would probably be a ring of attenuation between the mass and its crust. At length, when the central mass had reached a certain stage in its advance towards solidification, a separation would take place, and the crust would become a detached ring. It is clear, of course, that some law presiding over the refrigeration of heated gaseous bodies would determine the stages at which rings were thus formed and detached. We do not know any such law, but what we have seen assures us it is one observing, and reducible to, mathematical formulæ.

If these rings consisted of matter nearly uniform throughout, they would probably continue each in its original form; but there are many chances against their being uniform in constitution. The unavoidable effects of irregularity in their constitution would be to cause them to gather towards centres of superior solidity, by which the annular form would, of course, be destroyed. The ring would, in short, break into several masses, the largest of which would be likely to attract the lesser into itself. The whole mass would then necessarily settle into a spherical form by virtue of the law of gravitation; in short would become a planet revolving round the sun. Its rotary motion would, of course, continue, and satellites might then be thrown off in turn from its body in exactly the same way as the primary planets had been thrown off from the sun. The rule, if I can be allowed so to call it, receives a striking support from what appear to be its exceptions. While there are many chances against the matter of the rings being sufficiently equable to remain in the annular form till they were consolidated, it might nevertheless be otherwise in some instances;

that is to say, the equableness might, in those instances, be sufficiently great. Such was probably the case with the two rings around the body of Saturn, which remain a living picture of the arrangement, if not the condition, in which all the planetary masses at one time stood. It may also be admitted that, when a ring broke up, it was possible that the fragments might spherify separately. Such seems to be the actual history of the ring between Jupiter and Mars, in whose place we now find four planets much beneath the smallest of the rest in size, and moving nearly at the same distance from the sun, though in orbits so elliptical, and of such different planes, that they keep apart.

It has been seen that there are mathematical proportions in the relative distances and revolutions of the planets of our system. It has also been suggested that the periods in the condensation of the nebulous mass, at which rings were disengaged, must have depended on some particular crisis in the condition of that mass, in connexion with the laws of centrifugal force and attraction. M. Comte, of Paris, has made some approach to the verification of the hypothesis, by calculating what ought to have been the rotation of the solar mass at the successive times when its surface extended to the various planetary orbits. He ascertained that *that rotation corresponded in every case with the actual sidereal revolution of the planets, and that the rotation of the primary planets in like manner corresponded with the orbitual periods of the secondaries.* The process by which he arrived at this conclusion is not to be readily comprehended by the unlearned; but men of science allow that it is a powerful support to the present hypothesis of the formation of the globes of space.*

The nebular hypothesis, as it has been called, obtains a remarkable support in what would at first seem to mili-

* M. Comte combined Huygens's theorems for the measure of centrifugal force with the law of gravitation, and thus formed a simple fundamental equation between the duration of the rotation of what he calls the producing star, and the distance of the star produced. The constants of this equation were the radius of the central star, and the intensity of gravity at its surface which is a direct consequence of its mass. It leads directly to the third law of Kepler, which thus becomes susceptible of being conceived *à priori* in a cosmogonical point of view. M. Comte first applied it to the moon, and found, to his great delight, that the periodic time of that satellite agrees within an hour or two with the duration which the revolution of the earth ought to have had at the time when the lunar distance formed the limit of the earth's atmosphere. He found the coincidence less exact, but still very striking, in every other case. In those of the planets he obtained for the duration of the corresponding solar rotations a value always a little less than their actual periodic times. "It is remarkable," says he, "that this difference, though increasing as the planet is more distant, preserves very nearly the same relation to the corresponding periodic time, of which it commonly forms the forty-fifth part,"—showing, we may suppose, that only some small elements of the question had been overlooked by the calculator. The defect changes to an excess in the different systems of the satellites, where it is proportionally greater than in the planets, and unequal in the different systems. "From the whole of these comparisons," says he, "I deduced the following general result:—Supposing the mathematical limit of the solar atmosphere successively extended to the regions where the different planets are now found, the duration of the sun's rotation was, at each of these epochs, sensibly equal to that of the actual sidereal revolution of the corresponding planet; and the same is true for each planetary atmosphere in relation to the different satellites.—*Cours de Philosophie Positif.*

tate against it—the existence in our firmament of several thousands of solar systems, in which there are more than one sun. These are called double and triple stars. Some double stars, upon which careful observations have been made, are found to have a regular revolutionary motion round each other in ellipses. This kind of solar system has also been observed in what appears to be its rudimental state, for there are examples of nebulous stars containing two and three nuclei in near association. At a certain point in the confluence of the matter of these nebulous stars, they would all become involved in a common revolutionary motion, linked inextricably with each other, though it might be at sufficient distances to allow of each distinct centre having afterwards its attendant planets. We have seen that the law which causes rotation in the single solar masses, is exactly the same which produces the familiar phenomenon of a small whirlpool or dimple in the surface of a stream. Such dimples are not always single. Upon the face of a river where there are various contending currents, it may often be observed that two or more dimples are formed near each other with more or less regularity. These fantastic eddies, which the musing poet will sometimes watch abstractedly for an hour, little thinking of the law which produces and connects them, are an illustration of the wonders of binary and ternary solar systems.

The nebular hypothesis is, indeed, supported by so many ascertained features of the celestial scenery, and so many calculations of exact science, that it may be considered as verging upon the region of our ascertained truths. Some further support I trust to bring to it; but in the meantime, assuming its truth, let us see what idea it gives of the constitution of what we term the universe, of the development of its various parts, and of its original condition.

Reverting to a former illustration—if we could suppose a number of persons of various ages presented to the inspection of an intelligent being newly introduced into the world, we cannot doubt that he would soon become convinced that men had once been boys, that boys had once been infants, and, finally, that all had been brought into the world in exactly the same circumstances. Precisely thus, seeing in our astral system many thousands of worlds in all stages of formation, from the most rudimental to that immediately preceding the present condition of those we deem perfect, it is unavoidable to conclude that all the perfect have gone through the various stages which we see in the rudimental. This leads us at once to the conclusion that the whole of our firmament was at one time a diffused mass of nebulous matter, extending through the space which it still occupies. So also, of course, must have been the other astral systems. Indeed, we must presume the whole to have been originally in one connected mass, the astral systems being only the first division into parts, and solar systems the second.

The first idea which all this impresses upon us is, that the formation of bodies in space is *still and at present in progress.* We live at a time when many have been formed, and many are still forming. Our own solar system is to be regarded as completed, supposing its perfection to consist in the formation of a series of planets, for there are mathematical reasons for concluding that Mercury is the nearest planet to the sun, which can, according to the laws of the system, exist. But there are other solar systems within our astral system, which are as yet in a less advanced state, and even some quantities of nebulous matter which have scarcely begun to advance towards the stellar form. On the other hand, there are vast numbers of stars which have all the appearance of being fully formed systems, if we are to judge from the complete and definite appearance which they present to our vision through the telescope. We have no means of judging of the seniority of systems; but it is reasonable to suppose that, among the many, some are older than ours. There is, indeed, one piece of evidence for the probability of the comparative youth of our system, altogether apart from human traditions and the geognostic appearances of the surface of our planet. This consists in a thin nebulous matter, which is diffused around the sun to nearly the orbit of Mercury, of a very oblately spheroidal shape.

This matter, which sometimes appears to our naked eyes, at sunset, in the form of a cone projecting upwards in the line of the sun's path, and which bears the name of Zodiacal Light, has been thought a residuum or last remnant of the concentrating matter of our system, and thus may be supposed to indicate the comparative recentness of the principal events of our cosmogony. Supposing the surmise and inference to be correct, and they may be held as so far supported by more familiar evidence, we might with the more confidence speak of our system as not amongst the elder born of Heaven, but one whose various phenomena, physical and moral, as yet lay undeveloped, while myriads of others were fully fashioned, and in complete arrangement. Thus, in the sublime chronology to which we are directing our inquiries, we first find ourselves called upon to consider the globe which we inhabit as a child of the sun, elder than Venus and her younger brother Mercury, but posterior in date of birth to Mars, Jupiter, Saturn, and Uranus; next to regard our whole system as probably of recent formation in comparison with many of the stars of our firmament. We must, however, be on our guard against supposing the earth as a recent globe in our ordinary conceptions of time. From evidence afterwards to be adduced, it will be seen that it cannot be presumed to be less than many hundreds of centuries old. How much older Uranus may be, no one can tell, far less how much more aged may be many of the stars of our firmament, or the stars of other firmaments than ours.

Another and more important consideration arises from the hypothesis; namely, as to the means by which the grand process is conducted. The nebulous matter collects around nuclei by virtue of the law of attraction. The agglomeration brings into operation another physical law, by force of which the separate masses of matter are either made to rotate singly, or, in addition to that single motion, are set into a coupled revolution in ellipses. Next centrifugal force comes into play, flinging off portions of the rotating masses, which become spheres by virtue of the same law of attraction, and are held in orbits of revolution round the central body by means of a composition between the centrifugal and gravitating forces. All, we see, is done by certain laws of matter, so that it becomes a question of extreme interest, what are such laws? All that can yet be said, in answer, is, that we see certain natural events proceeding in an invariable order under certain conditions, and thence infer the existence of some fundamental arrangement which, for the bringing about of these events, has a force and a certainty of action similar to, but more precise and unerring than those arrangements which human society makes for its own benefit, and calls laws. It is remarkable of physical laws, that we see them operating on every kind of scale as to magnitude, with the same regularity and perseverance. The tear that falls from childhood's cheek is globular, through the efficacy of that same law of mutual attraction of particles which made the sun and planets round. The rapidity of Mercury is quicker than that of Saturn, for the same reason that, when we wheel a ball round by a string and make the string wind up round our fingers, the ball always flies quicker and quicker as the string is shortened. Two eddies in a stream, as has been stated, fall into a mutual revolution at the distance of a couple of inches, through the same cause which makes a pair of suns link in mutual revolution at the distance of millions of miles. There is, we might say, a sublime simplicity in this indifference of the grand regulations to the vastness or minuteness of the field of their operation. Their being uniform, too, throughout space, as far as we can scan it, and their being so unfailing in their tendency to operate, so that only the proper conditions are presented, afford matter for the gravest consideration. Nor should it escape careful notice that the regulations on which all the laws of matter proceed, are established on a rigidly accurate mathematical basis. Proportions of numbers and geometrical figures rest at the bottom of the whole. All these considerations, when the mind is thoroughly prepared for them, tend to raise our ideas with respect to the character of physical laws, even though we do not go a single step further in the investigation. But it is impossible for an intelligent mind to stop there. We advance from law to the cause of law, and ask, What is that? Whence have come all these beautiful regulations? Here science leaves us, but only to conclude, from other grounds, that there is a First Cause to which all others are secondary and ministrative, a primitive almighty will, of which these laws are merely the mandates. That great Being, who shall say where is his dwelling-place, or what his history! Man pauses breathless at the contemplation of a subject so much above his finite faculties, and only can wonder and adore!

CONSTITUENT MATERIALS OF THE EARTH

AND OF THE OTHER BODIES OF SPACE.

The nebular hypothesis almost necessarily supposes matter to have originally formed one mass. We have seen that the same physical laws preside over the whole. Are we also to presume that the constitution of the whole was uniform?—that is to say, that the whole consisted of similar elements. It seems difficult to avoid coming to this conclusion, at least under the qualification that, possibly, various bodies, under peculiar circumstances attending their formation, may contain elements which are wanting, and lack some which are present, in others, or that some may entirely consist of elements in which others are entirely deficient.

What are elements? This is a term applied by the chemist to a certain limited number of substances (fifty-four or fifty-five are ascertained), which, in their combinations, form all the matters of every kind present in and about our globe. They are called elements, or simple substances, because it has hitherto been found impossible to reduce them into others, wherefore they are presumed to be the primary bases of all matters. It has, indeed, been surmised that these so-called elements are only modifications of a primordial form of matter, brought about under certain conditions; but if this should prove to be the case, it would little affect the view which we are taking of cosmical arrangements. Analogy would lead us to conclude that the combinations of the primordial matter, forming our so-called elements, are as universal, or as liable to take place everywhere, as are the laws of gravitation and centrifugal force. We must therefore presume that the gases, the metals, the earths, and other simple substances (besides whatever more of which we have no acquaintance), exist or are liable to come into existence under proper conditions, as well in the astral system, which is thirty-five thousand times more distant than Sirius, as within the bounds of our own solar system or our own globe.

Matter, whether it consists of about fifty-five ingredients, or only one, is liable to infinite varieties of condition under different circumstances, or, to speak more philosophically, under different laws. As a familiar illustration, water, when subjected to a temperature under 32° Fahrenheit, becomes ice; raise the temperature to 212°, and it becomes steam, occupying a vast deal more space than it formerly did. The gases, when subjected to pressure, become liquids; for example, carbonic acid gas, when subjected to a weight equal to a column of water 1230 feet high, at a temperature of 32°, takes this form: the other gases require various amounts of pressure for this transformation, but all appear to be liable to it when the pressure proper in each case is administered.

Heat is a power greatly concerned in regulating the volume and other conditions of matter. A chemist can reckon with considerable precision what additional amount of heat would be required to vaporize all the water of our globe; how much more to disengage the oxygen which is diffused in nearly a proportion of one-half throughout its solids; and, finally, how much more would be required to cause the whole to become vaporiform, which we may consider as equivalent to its being restored to its original nebulous state. He can calculate with equal certainty what would be the effect of a considerable diminution of the earth's temperature—what changes would take place in each of its component substances, and how much the whole would shrink in bulk.

The earth and all its various substances have at present a certain volume in consequence of the temperature which actually exists. When, then, we find that its matter and that of the associate planets was at one time diffused throughout the whole space now circumscribed by the orbit of Uranus, we cannot doubt, after what we know of the power of heat, that the nebulous form of matter was attended by the condition of a very high temperature. The nebulous matter of space, previously to the formation of stellar and planetary bodies, must have been a universal Fire Mist, an idea which we can scarcely comprehend, though the reasons for arriving at it seem irresistible. The formation of systems out of this matter implies a change of some kind with regard to the condition of the heat. Had this power continued to act with its full original repulsive energy, the process of agglomeration by attraction could not have gone on. We do not know enough of the laws of heat to enable us to surmise how the necessary change in this respect was brought about, but we can trace some of the steps and consequences of the process. Uranus would be formed at the time when the heat of our system's matter was at the greatest, Saturn at the next, and so on. Now this tallies perfectly with the exceeding diffuseness of the matter of those elder planets, Saturn being not more dense or heavy than the substance cork. It may be that a sufficiency of heat still remains in those planets to make up for their distance from the sun, and the consequent smallness of the heat which they derive from his rays. And it may equally be, since Mercury is twice the density of the earth, that its matter exists under a degree of cold for which that planet's large enjoyment of the sun's rays is no more than a compensation. Thus there may be, upon the whole, a nearly equal experience of heat amongst all these children of the sun. Where, meanwhile, is the heat once diffused through the system over and above what remains in the planets? May we not rationally presume it to have gone to constitute that luminous envelope of the sun, in which his warmth-giving power is now held to reside It may have simply been reserved to constitute, at the last, a means of sustaining the many operations of which the planets were destined to be the theatre.

The tendency of the whole of the preceding considerations is to bring the conviction that our globe is a specimen of all the similarly-placed bodies of space, as respects its constituent matter and the physical and chemical laws governing it, with only this qualification, that there are *possibly* shades of variation with respect to the component materials, and *undoubtedly* with respect to the conditions under which the laws operate, and consequently the effects which they produce. Thus, there may be substances here which are not in some other bodies, and substances here solid may be elsewhere liquid or vaporiform. We are the more entitled to draw such conclusions, seeing that there is nothing at all singular or special in the astronomical situation of the earth. It takes its place third in a series of planets, which series is only one of numberless of her systems forming one group. It is strikingly—if I may use such an expression—a member of a democracy. Hence, we cannot suppose that there is any peculiarity about it which does not probably attach to multitudes of other bodies—in fact, to all that are analogous to it in respect to cosmical arrangements.

It therefore becomes a point of great interest—what are the materials of this specimen? What is the constitutional character of this object, which may be said to be a sample, presented to our immediate observation, of those crowds of worlds which seem to us as the particles of the desert sand-cloud in number, and to whose diffusion there are no conceivable local limits?

The solids, liquids, and aeriform fluids of our globe are all, as have been stated, reducible into fifty-five substances hitherto called elementary. Of these, forty are well-characterized metals, twelve non-metallic bodies, and the remaining three solid substances of intermediate character, which form a connecting link between the two great groups. Among the non-metallic elements, four, viz., oxygen, hydrogen, nitrogen, and chlorine, are permanently gaseous; bromine is fluid at common temperatures; and the remainder (with the exception of fluorine, which has never been isolated, and whose physical characters are consequently unknown) are solid.

The body oxygen is considered as by far the most abundant substance in our globe. It constitutes a fifth part of our atmosphere, eight-ninths of the weight of water, and a large proportion of every kind of rock in the crust of the earth. Hydrogen, which forms the remaining part of water, and enters into some mineral substances, is perhaps next. Nitrogen, of which the atmosphere is four-fifths composed, must be considered as an abundant substance. The metal silicium, which unites with oxygen in nearly equal parts to form silicia, the basis of nearly a half of the rocks in the earth's crust, is, of course, an important ingredient. Aluminium, the metallic basis of alumina, a large material in many rocks, is another abundant elementary substance. So, also, is carbon, a small ingredient in the atmosphere, but the chief constituent of animal and vegetable substances, and of all fossils which ever were in the latter condition, amongst which coal takes a conspicuous place. The familiarly-known metals, as iron, tin, lead, silver, gold, are elements of comparatively small magnitude in that exterior part of the earth's body which we are able to investigate.

It is remarkable of the simple substances that they are generally in some compound form. Thus, oxygen and nitrogen, though in mixture they form the aerial envelope of the globe, are never found separate in nature. Carbon is pure only in the diamond. And the metallic bases of the earths, though the chemist can disengage them, may well be supposed unlikely to remain long uncombined, seeing that contact with moisture makes them burn. Combination and re-combination are principles largely pervading nature. There are few rocks, for example, that are not composed of at least two varieties of matter, each of which is again a compound of elementary substances. What is still more wonderful with respect to this principle of combination, all the elementary substances observe certain mathematical proportions in their unions. When in the gaseous state, one volume of them unites with one, two, three, or more volumes of another, any extra quantity being sure to be left over, if such there should be. Combinations by weight are also governed by fixed and unchanging laws, of the greatest beauty and simplicity. It is hence supposed by some that matter is composed of infinitely minute particles or atoms, each of which belonging to any one substance, can only (through the operation of some as yet hidden law) associate with a certain number of the atoms of any other. There are also strange predilections amongst substances for each other's company. One will remain combined in solution with another, till a third is added, when it will abandon the former and attach itself to the latter. A fourth being added, the third will perhaps leave the first, and join the new comer.

Such is an outline of the information which chemistry gives us regarding the constituent materials of our globe. How infinitely is the knowledge increased in interest, when we consider the probability of such being the materials of the whole of the bodies of space, and the laws under which these everywhere combine, subject only to local and accidental variations.

In considering the cosmogonic arrangements of our globe, our attention is called in a special degree to the moon.

In the nebular hypothesis, satellites are considered as masses thrown off from their primaries, exactly as the primaries had previously been from the sun. The orbit of any satellite is also to be regarded as marking the bounds of the mass of the primary at the time when that satellite was thrown off; its speed likewise denotes the rapidity of the rotary motion of the primary at that particular juncture. For example, the outermost of the four satellites of Jupiter revolves round his body at the distance of 1,180,582 miles, showing that the planet was once about 3,675,501 miles in circumference, instead of being, as now, only 89,170 miles in diameter. This large mass took rather more than sixteen days six hours and a half (the present revolutionary period of the outermost satellite) to rotate on its axis. The innermost satellite must have been formed when the planet was reduced to a circumference of 309,075 miles, and rotated in about forty-two hours and a half.

From similar inferences, we find that the mass of the earth, at a certain point of time, after it was thrown off from the sun, was no less than 482,000 miles in diameter, being sixty times what it has since shrunk to. At that time, the mass must have taken rather more than twenty-nine and a half days to rotate (being the revolutionary period of the moon), instead of, as now, rather less than twenty-four hours.

The time intervening between the formation of the moon and the earth's diminution to its present size, was probably one of those vast sums in which astronomy deals so largely, but which the mind altogether fails to grasp.

The observations made upon the surface of the moon by telescopes tend strongly to support the hypothesis as to all the bodies of space being composed of similar matters subject to certain variations. It does not appear that our satellite is provided with that gaseous envelope which, on earth, performs so many important functions. Neither is there any appearance of water upon the surface ; yet that surface is, like that of our globe, marked by inequalities and the appearance of volcanic operations. These inequalities and volcanic operations are upon a scale far greater than any which now exist upon the earth's surface. Although, from the greater force of gravitation upon its exterior, the mountains, other circumstances being equal, might have been expected to be much smaller than ours, they are, in many instances, equal in height to nearly the highest of our Andes. They are generally of extreme steepness, and sharp of outline, a peculiarity which might be looked for in a planet deficient in water and atmosphere, seeing that these are the agents which wear down ruggedness on the surface of our earth. The volcanic operations are on a stupendous scale. They are the cause of the bright spots of the moon, while the want of them is what distinguishes the duller portions, usually but erroneously called *seas*. In some parts, bright volcanic matter, besides covering one large patch, radiates out in long streams, which appear studded with subordinate *foci* of the same kind of energy. Other objects of a most remarkable character are ring-mountains, mounts, like those of the craters of earthly volcanoes, surrounded immediately by vast and profound circular pits, hollowed under the general surface, these again being surrounded by a circular wall of mountain, rising far above the central one, and in the inside of which are terraces about the same height as the inner eminence. The well-known bright spot in the south-east quarter, called by astronomers, *Tycho*, and which can be readily distinguished by the naked eye, is one of these ring-mountains. There is one of 200 miles in diameter, with a pit 22,000 feet deep; that is, twice the height of Etna. It is remarkable, that the maps given by Humboldt of a volcanic district in South America, and one illustrative of the formerly volcanic district of Auvergne, in France, present features strikingly like many parts of the moon's surface, as seen through a good glass.

These characteristics of the moon forbid the idea that it can be at present a theatre of life like the earth, and almost seem to declare that it never can become so. But we must not rashly draw any such conclusions. The moon may be only in an earlier stage of the progress through which the earth has already gone. The elements which seem wanting may be only in combinations different from those which exist here, and may yet be developed as we here find them. Seas may yet fill the profound hollows of the surface; an atmosphere may spread over the whole. Should these events take place, meteorological phenomena, and all the phenomena of organic life, will commence, and the moon, like the earth, will become a green and inhabited world.*

* Among the most extraordinary phenomena of natural science must be placed those relating to the fall of *meteoric stones*. The fact itself, so long doubted, has now been established by an accumulation of the most positive and unexceptionable evidence. The stones have been seen to fall, and taken up in a still heated state;—there can be no manner of doubt about the fact, although the explanation is extremely difficult. All these stones are found on examination to resemble each other in their general characters; they usually consist of an earthy material, having disseminated through

It is unavoidably held as a strong proof in favor of any hypothesis, when all the relative phenomena are in harmony with it. This is eminently the case with the nebulous hypothesis, for here the associated facts cannot be explained on any other supposition. We have seen reason to conclude that the primary condition of matter was that of a diffused mass, in which the component molecules were probably kept apart through the efficacy of heat; that portions of this agglomerated into suns,

its substance globules and small masses of metallic iron containing nickel in the state of alloy. The stones are often covered by a thin vitreous crust, as if partial fusion had commenced. It is well known, also, that large masses of soft, malleable iron, also containing nickel, are found in several places far removed from each other, lying loose upon the earth, as in South America and in Siberia, and no doubt can exist of the meteoric origin of these masses. It has been conjectured that these meteoric stones proceed from the moon, having been shot out from volcanoes with such violence as to be brought within the reach of the earth's attraction. A view now more general supposes the existence in space of very numerous small bodies, moving in more or less regular orbits around the sun and larger planets, which at certain periods undergo such perturbation that their motion becomes completely deranged, and they at length fall upon the surface of the earth or other planet, whose attraction has been the exciting cause of the derangement of their orbits. Whatever may be their real origin, they are by common consent looked upon as foreign to the earth; their physical constitution is completely different from any known minerals. But what is exceedingly remarkable, and particularly worthy of notice as strengthening the argument that all the members of the solar system, and perhaps of other systems, have a similar constitution, *no new elements* are found in these bodies; they contain the ordinary materials of the earth, but associated in a manner altogether new, and unlike anything known in terrestrial mineralogy.—*Note by a Correspondent.*

which threw off planets; that these planets were at first very much diffused, but gradually contracted by cooling to their present dimensions. Now, as to our own globe, there is a remarkable proof of its having been in a fluid state at the time when it was finally solidifying, in the fact of its being bulged at the equator, the very form which a soft revolving body takes, and must inevitably take, under the influence of centrifugal force. This bulging makes the equatorial exceed the polar diameter as 230 to 229, which has been demonstrated to be precisely the departure from a correct sphere which might be predicted from a knowledge of the amount of the mass and the rate of rotation. There is an almost equally distinct memorial of the original high temperature of the materials, in the store of heat which still exists in the interior. The immediate surface of the earth, be it observed, exhibits only the temperature which might be expected to be imparted to such materials, by the heat of the sun. There is a point a very short way down, but varying in different climes, where all effect from the sun's rays ceases. Then commences a temperature from an entirely different cause, one which evidently has its source in the interior of the earth, and which regularly increases as we descend to greater and greater depths, the rate of increment being about one degree Fahrenheit for every sixty feet; and of this high temperature there are other evidences in the phenomena of volcanoes and thermal springs, as well as in what is ascertained with regard to the density of the entire mass of the earth. This, it will be remembered, is four and a half times the weight of water; but the actual weight of the principal solid substances composing the outer crust is as two and a half times the weight of water; and this, we know, if the globe were solid and cold, should increase vastly towards the centre, water acquiring the density of quicksilver at 362 miles below the surface, and other things in proportion, and these densities becoming much greater at greater depths; so that the entire mass of a cool globe should be of a gravity infinitely exceeding four and a half times the weight of water. The only alternative supposition is, that the central materials are greatly expanded or diffused by some means; and by what means could they be so expanded but by heat! Indeed, the existence of this central heat, a residuum of that which kept all matter in a vaporiform chaos at first, is amongst the most solid discoveries of modern science,* and the support which it gives to Herschel's explanation of the formation of worlds is highly important. We shall hereafter see what appear to be traces of an operation of this heat upon the surface of the earth in very remote times; an effect, however, which has long passed entirely away. The central heat has, for ages, reached a fixed point, at which it will probably remain for ever, as the non-conducting quality of the cool crust absolutely prevents it from suffering any diminution.

* The researches on this subject were conducted chiefly by the late Baron Fourier, perpetual secretary to the Academy of Sciences of Paris. See his *Théorie Analytique de la Chaleur*, 1822.

THE EARTH FORMED—ERA OF THE PRIMARY ROCKS.

Although the earth has not been actually penetrated to a greater depth than three thousand feet, the nature of its substance can, in many instances, be inferred for the depth of many miles by other means of observation. We see a mountain composed of a particular substance, with strata, or beds of other rock, lying against its sloped sides; we, of course, infer that the substance of the mountain dips away under the strata which we see lying against it. Suppose that we walk away from the mountain across the turned up edges of the stratified rocks, and that for many miles we continue to pass over other stratified rocks, all disposed in the same way, till by and by we come to a place where we begin to cross the opposite edges of the same beds; after which we pass over these rocks all in reverse order till we come to another extensive mountain composed of similar material to the first, and shelving away under the strata in the same way. We should then infer that the stratified rocks occupied a basin formed by the rock of these two mountains, and by calculating the thickness right through these strata, could say to what depth the rock of the mountain extended below. By such means, the kind of rock existing many miles below the surface can often be inferred with considerable confidence.

The interior of the globe has now been inspected in this way in many places, and a tolerably distinct notion of its general arrangements has consequently been arrived at. It appears that the basis rock of the earth, as it may be called, is of hard texture, and crystalline in its constitution. Of this rock, granite may be said to be the type, though it runs into many varieties. Over this, except in the comparatively few places where it projects above the general level in mountains, other rocks are disposed in sheets or strata, with the appearance of having been deposited originally from water. But these last rocks have nowhere been allowed to rest in their original arrangement. Uneasy movements from below have broken them up in great inclined masses, while in many cases there has been projected through the rents rocky matter more or less resembling the great inferior crystalline mass. This rocky matter must have been in a state of fusion from heat at the time of its projection, for it is often found to have run into and filled up lateral chinks in these rents. There are even instances where it has been rent again, and a newer melted matter of the same character sent through the opening. Finally, in the crust as thus arranged, there are, in many places, chinks containing veins of metal. Thus, there is first a great inferior mass, composed of crystalline rock, and probably resting immediately on the fused and expanded matter of the interior:

next, layers or strata of aqueous origin; next, irregular masses of melted inferior rock that have been sent up volcanically and confusedly at various times amongst the aqueous rocks, breaking up these into masses, and tossing them out of their original levels. This is an outline of the arrangements of the crust of the earth, as far as we can observe it. It is, at first sight, a most confused scene; but after some careful observation, we readily detect in it a regularity and order from which much instruction in the history of our globe is to be derived.

The deposition of the aqueous rocks, and the projection of the volcanic, have unquestionably taken place since the settlement of the earth in its present form. They are indeed of an order of events which we see going on, under the agency of intelligible causes, down to the present day. We may therefore consider them generally as comparatively recent transactions. Abstracting them from the investigations before us, we arrive at the idea of the earth in its first condition as a globe of its present size—namely, as a mass, externally at least, consisting of the crystalline kind of rock, with the waters of the present seas and the present atmosphere around it, though these were probably in considerably different conditions, both as to temperature and their constituent materials, from what they now are. We are thus to presume that that crystalline texture of rock which we see exemplified in granite is the condition into which the great bulk of the solids of our earth were agglomerated directly from the nebulous or vaporiform state. It is a condition eminently of combination, for such rock is invariably composed of two or more of four substances—silica, mica, quartz, and hornblende—which associate in it in the form of grains or crystals, and which are themselves each composed of a group of the simple or elementary substances.

Judging from the results and from still remaining conditions, we must suppose that the heat retained in the interior of the globe was more intense, or had greater freedom to act in some places than in others. These became the scenes of volcanic operations, and in time marked their situations by the extrusion of traps and basalts from below—namely, rocks composed of the crystalline matter fused by intense heat, and developed on the surface in various conditions, according to the particular circumstances under which it was sent up; some, for example, being thrown up under water, and some in the open air, which contingencies are found to have made considerable difference in its texture and appearance. The great stores of subterranean heat also served an important purpose in the formation of the aqueous rocks. These rocks might, according to Sir John Herschel, become subject to heat in the following manner:—While the surface of a particular mass of rock forms the bed of the sea, the heat is kept at a certain distance from that surface by the contact of the water; philosophically speaking, the mass radiates away the heat into the sea, and (to resort to common language) is cooled a good way down. But when new sediment settles at the bottom of that sea, the heat rises up to what was formerly the surface; and when a second quantity of sediment is laid down, it continues to rise through the first of the deposits, which then becomes subjected to those changes which heat is calculated to produce. This process is precisely the same as that of putting additional coats upon our own bodies; when, of course, the internal heat rises through each coat in succession, and the third (supposing there is a fourth above it) becomes as warm as perhaps the first originally was.

In speaking of sedimentary rocks, we may be said to be anticipating. It is necessary, first, to show how such rocks were formed, or how stratification commenced.

Geology tells us as plainly as possible, that the original crystalline mass was not a perfectly smooth ball, with air and water playing around it. There were irregularities in the surface,—irregularities, trifling, perhaps, compared with the whole bulk of the globe, but probably larger than any which now exist upon it. These irregularities might be occasioned by inequalities in the cooling of the substance, or by accidental and local sluggishness of the materials, or by local effects of the concentrated internal heat. From whatever cause they arose, there they were—granitic mountains, interspersed with seas which sunk to a great depth, and by which, perhaps, the mountains were wholly or partially covered. Now, it is a fact of which the very first principles of geology assure us, that the solids of the globe cannot for a moment be exposed to water, or to the atmosphere, without becoming liable to change. They instantly begin to wear down. This operation, we may be assured, proceeded with as much certainty in the earliest ages of our earth's history, as it does now, but probably upon a much more magnificent scale. The matters worn off, being carried into the neighboring depths, and there deposited, became the components of the earliest stratified rocks, the first series of which is the *Gneiss and Mica Slate System*, or series, examples of which are exposed to view in the Highlands of Scotland and in the West of England. We have evidence that the earliest strata were formed in the presence of a stronger degree of heat than what operated in subsequent stages of the world, for the laminæ of the gneiss and of the mica and chlorite schists are contorted in a way which could only be the result of a very high temperature. It appears as if the seas in which these deposits were formed, had been in the troubled state of a caldron of water nearly at boiling heat. Such a condition would probably add not a little to the disintegrating power of the ocean.

The earliest stratified rocks contain no matters which are not to be found in the primitive granite. They are the same in material, but only changed into new forms and combinations; hence they have been called by Dr. Lyell, metamorphic rocks. But how comes it that some of them are composed almost exclusively of one of the materials of granite; the mica schists, for example, of mica—the quartz rocks, of quartz, &c.? For this there are both chemical and mechanical causes. Suppose that a river has a certain quantity of material to carry down, it is evident that it will soonest drop the largest particles, and carry the lightest farthest on. To such a cause is it owing that some of the materials of the worn down granite have settled in one place and some in another.* Again, some of these materials must be presumed to have been in a state of chemical solution in the primeval seas. It would be of course in conformity with chemical laws, that certain of these materials would be precipitated singly, or in modified combinations, to the bottom, so as to form rocks by themselves.

* De la Beche's Geological Researches.

COMMENCEMENT OF ORGANIC LIFE—SEA PLANTS, CORALS, ETC.

From the Primary Rocks, we pass into a group called the Clay Slate and Grauwacké Slate System, which, however, is found in some places resting immediately on the granite, the primary bed being there wanting. This system is largely developed in the west and north of England, and it has been well examined, partly because some of the slate beds are extensively quarried for domestic purposes. The sub-divisions are in the following order, beginning with the lowest:—1, hornblende slate; 2, chiastolite slate; 3, clay slate; 4, Snowdon rocks (grauwacké and conglomerates).

Hitherto nothing has been said of the fossils which constitute so important a part of geological science. It is now to be observed that, from an early portion of the rock series to its close, the mineral masses are found to enclose remains of the organic beings (plants and animals) which flourished upon earth during the time when those were forming; and these organisms, or such parts of them as were of sufficient solidity, have been in many cases preserved with the utmost fidelity, although for the most part converted into the substance of the enclosing mineral. The rocks may be said thus to form a kind of history of the organic departments of nature from perhaps near its beginning to the present time. This is a piece of knowledge entirely new to man, and it may be safely said that he has never made a merely intellectual acquisition of a more interesting or remarkable nature. I am to trace this history as well as existing materials will permit.

Some difficulty exists with regard to the very first chapter of Fauna's story. It is as yet undecided at what part of the rock series we have the earliest traces of the life which exists upon our globe. The primary rocks are usually said to be non-fossiliferous—that is, possessing no remains of plants or animals; and it would appear that the first undoubted objects of a fossil kind are the solid parts of polypiaria, crinoides, crustacea, and conchifera, found in the Mica Slate and Grauwacké Slate System. These cannot, however, be regarded as for certain the first of earth's tenants, seeing that "fragments apparently organic, and resembling the cases of infusoria [shelled animacules]"* have been detected in the primary rocks, and it is very clear that many other simple forms of being, such as the medusæ and acalephæ, which now swarm in our seas, might have peopled the early ocean, but left no memorial of their slight gelatinous forms in the mud constituting its bottom, particularly as that mud has evidently been afterwards subjected, in its rocky form, to a great degree of heat. So also might the fragile plants of the primary sea fail to come down to us.

* Ansted's Geology, ii., 60.

We are also called upon to remark the occurrence of a few limestone strata amongst the primary rocks. Limestone, a carbonate of lime, contains an element (carbon) which we have no reason to believe to have existed in the rock from which the primaries were derived. It is a challengeable stranger upon the face of the earth, and extremely important to the present question, in as far as it is the principal constituent of organic substance of almost every kind. Plants take in this substance from the atmosphere, where it is a subordinate ingredient; there are classes of animals (marine polypes), which appropriate it in connexion with lime from the waters of the ocean, provided it be there in solution: and this substance do these animals deposit in masses (coral reefs) equal in extent to many strata. It is fully ascertained of many strata of limestone higher in the series, that they are simply reefs of that kind changed by subjection to heat and pressure. It may be asked, then, does not this series of facts establish a strongly probable connexion between the *time* of the primary limestones and the earlier days or ages of organic creations?

It may not be out of place here to remark, that the primeval and subsequent history of this element is worthy of much attention. Sir Henry De la Beche estimates the quantity of carbonic acid gas locked up in every cubic yard of limestone, at 10,000 cubic feet. The quantity locked up in coal, in which its basis, carbon, forms from 64 to 75 per cent., must also be enormous. If all this were disengaged in a gaseous form, the constitution of the atmosphere would undergo a change, of which the first effect would be the extinction of life in all the land animals. Yet, if it has all been derived from the atmosphere, we must needs suppose that the atmosphere at one time contained it. Such an atmosphere would, of course, be incapable of supporting life in land animals. It is important, however, to observe that such an atmosphere would not be inconsistent with a luxuriant land vegetation; for experiment has proved that plants will flourish in air containing *one-twelfth* of this gas, or 166 times more than the present charge of our atmosphere. The results which we observe are perfectly consistent with, and may be said to presuppose, an atmosphere highly charged with this gas, from about the close of the primary rocks to the termination of the carboniferous series, for there we see vast deposits (coal) containing carbon as a large ingredient, while at the same time the leaves of the *Stone Book* present no record of the contemporaneous existence of land animals.

Of the fossils specified as being found in the mica slate and grauwacké slate system, the two first are examples of the humblest of Cuvier's four divisions of the animal kingdom, radiata; while the other two belong respectively to the two next divisions, articulata and mollusca. In common, though not very precise language, they are corals and shell-fish. Nothing uncommon or surprising is to be observed in their forms; but it is remarkable that, though they can readily be referred to existing *orders*, the species and even genera to which they belonged are no longer found on earth; nay, almost the whole had become extinct before the next group of strata was formed. Such changes of species we shall find to be of frequent occurrence throughout the subsequent ages. To descend to a few particulars:—The crinoids are an early and simple form of the large family of echinodermata (star-fishes);

the animal, though composed of innumerable minute calcareous masses, connected by a gelatinous substance, is merely a stomach surrounded by tentacula to provide itself with food, and mounted upon a many-jointed stalk, so as to bear a considerable resemblance to a flower growing on its stem. Of the crustacea of the system, the most remarkable forms are trilobites,—animals which continued to flourish to a great variety of species throughout several of the subsequent rock-formations, but which are now only faintly represented in a few obscure species. Some curious inferences have been made by Dr. Buckland from the prominent facet-covered eyes with which this creature was furnished, indicating that the sea in which it lived was a clear medium, as existing seas generally are, and that light was the same in character in those inconceivably remote ages as it is now.

Ascending to the next group of rocks, we find the traces of life become more abundant, the number of species extended, and important additions made in vestiges of fuci, or sea plants, and of fishes. This group of rocks has been called by English geologists, the *Silurian System*, because largely developed at the surface of a district of western England, formerly occupied by a people whom the Roman historians call Silures. It is a series of sandstones, limestones, and beds of shale (hardened mud), which are classed in the following subgroups, beginning with the undermost :—1, Llandeilo rocks (darkish calcareous flagstones); 2 and 3, two groups called Caradoc rocks: 4, Wenlock shale; 5, Wenlock limestone; 6, Lower Ludlow rocks (shales and limestones); 7, Aymestry limestone; 8, Upper Ludlow rocks (shales and limestone, chiefly micaceous). From the lowest beds upwards, there are polypiaria, though most prevalent in the Wenlock limestone; trilobites; brachiopodous mollusks, a vast number of genera (including terebratula, pentamerus, spirifer, orthis, leptæna); gasteropoda, and cephalopoda, of several orders and many genera (including turritella, orthoceras, nautilus, bellerophon). The cephalopoda are the most highly organized of the mollusca, possessing in some families an internal osseous skeleton, together with a heart, and a head having some resemblance in form and armature to that of the parrot tribes. This order was carnivorous, and acted the part of a police in keeping down the redundant life of the early seas. I may remark, that it is sometimes represented as having been co-existent with the humbler molluscous forms; and on this point conclusions have been drawn against the idea of a progress of animated being; but it seems to me, when the pre-Silurian era and its fossils are distinguished with sufficient care, that simpler mollusca, as well as radiata, preceded it.*

* Professor Phillips (*Treatise on Geology*, 1839) says expressly with regard to the clay slate and grauwacké system—"No gasteropods or cephalopods are as yet mentioned in these rocks in Britain, and we do not feel sufficiently acquainted with the geological age of the limestones of the Harz, to introduce any of the fossils of that argillaceous range of mountains." Gasteropods are considered by naturalists as next in organization to the cephalopods. Thus it will be observed, the Silurian system adds the *two highest* orders of the mollusca.

What produces, or at least countenances, mistakes of this kind, is the taking a number of rock systems together as one, and reckoning all the fossils of these systems as co-existent, when, in reality, those peculiar to the upper beds may be unconjectured ages more recent than those of the lower.

A little above the Llandeilo rocks, there have been discovered certain convoluted forms, which are now established as annelides, or sea-worms, a tribe of creatures still existing (nereidina and serpulina), and which may often be found beneath stones on a seā-beach. One of these, figured by Mr. Murchison, is furnished with feet in vast numbers all along its body, like a centipede. The occurrence of annelides is important, on account of their character and status in the animal kingdom. They are red-blooded and hermaphrodite, and form a link of connexion between the annulosa (white-blooded worms) and an humble class of the vertebrata.* The Wenlock limestone is most remarkable amongst all the rocks of the Silurian system, for organic remains. Many slabs of it are wholly composed of corals, shells, and trilobites, held together by shale. It contains many genera of crinoidea and polypiaria, and there is little reason to doubt that some beds of it are wholly the production of the latter creatures, or are, in other words, coral reefs transformed by heat and pressure into rocks. Remains of fishes, of a very minute size, have been detected by Mr. Phillips in the Aymestry limestone, being apparently the first examples of vertebrated animals which breathed upon our planet. In the upper Ludlow rocks, remains of six genera, of obscure character, have been for a longer period known.

The traces of fuci in this system are all but sufficient to allow of a distinction of genera. In some parts of North America, extensive though thin beds of them have been found. A distinguished French geologist, M. Brog-

* The inferiorly organized fishes, amphyioxus and myxene.

niart, has shown that all existing marine plants are classifiable with regard to the zones of climate; some being fitted for the torrid zone, some for the temperate, some for the frigid. And he establishes that the fuci of these early rocks speak of a torrid climate, although they may be found in what are now temperate regions; he also states that those of the higher rocks betoken, as we ascend, a gradually diminishing temperature.

We thus early begin to find proofs of the general uniformity of organic life over the surface of the earth, at the time when each particular system of rocks was formed. Species identical with the remains in the Wenlock limestone occur in the corresponding class of rocks in the Eifel, and partially in the Harz, Norway, Russia, and Brittany. The situations of the remains in Russia are fifteen hundred miles from the Wenlock beds; but at the distance of between six and seven thousand from those,—namely, in the vale of Mississippi, the same species are discovered. Uniformity in animal life over large geographical areas argues uniformity in the conditions of animal life; and hence arise some curious inferences. Species, in the same low class of animals, are now much more limited; for instance, the Red Sea gives different polypiaria, zoophytes, and shell-fish, from the Mediterranean. It is the opinion of M. Brogniart, that the uniformity which existed in the primeval times can only be attributed to the temperature arising from the internal heat, which had yet, as he supposes, been sufficiently great to overpower the ordinary meteorological influences, and spread a tropical clime all over the globe.

ERA OF THE OLD RED SANDSTONE—FISHES ABUNDANT.

We advance to a new chapter in this marvellous history—the era of the *Old Red Sandstone System.* This term has been recently applied to a series of strata, of enormous thickness in the whole mass, largely developed in Herefordshire, Shropshire, Worcestershire, and South Wales; also in the counties of Fife, Forfar, Moray, Cromarty, and Caithness; and in Russia and North America, if not in many other parts of the world. The particular strata forming the system are somewhat different in different countries; but there is a general character to the extent of these being a mixture of flagstones, marly rocks, and sandstones, usually of a laminous structure, with conglomerates. There is also a schist, showing the presence of bitumen; a remarkable new ingredient, since it is a vegetable production. In the conglomerates, of great extent and thickness, which form, in at least one district, the basis or leading feature of the system, inclosing water-worn fragments of quartz and other rocks, we have evidence of the seas of that period having been subjected to a violent and long-continued agitation, probably from volcanic causes. The upper members of the series bear the appearance of having been deposited in comparatively tranquil seas. The English specimens of this system show a remarkable freedom from those disturbances which result in the interjection of trap; and they are thus defective in mineral ores. In some parts of England the old red sandstone system has been stated as 10,000 feet in thickness.

In this era, the forms of life which existed in the Silurian are continued: we have the same orders of marine creatures, zoophyta, polypiaria, conchifera, crustacea; but to these are added numerous fishes, some of which are of most extraordinary and surprising forms. Several of the strata are crowded with remains of fish, showing that the seas in which those beds were deposited had swarmed with that class of inhabitants. The investigation of this system is recent; but already M. Agassiz has ascertained about twenty genera, and thrice the number of species. And it is remarkable that the Silurian fishes are here only represented in genera; the whole of the *species* of that era had already passed away. Even throughout the sub-groups of the system itself, the species are changed; and these are phenomena observed throughout all the subsequent systems of geological eras; apparently arguing that, during the deposition of all the rocks, a gradual change of physical conditions was constantly going on. A varying temperature, or even a varying depth of sea, would at present be attended with similar changes in marine life; and by analogy we are entitled to assume that such variations in the ancient seas might be amongst the causes of that constant change of genera and species in the inhabitants of those seas to which the organic contents of the rocks bear witness.

The predominating fishes of this system, and the only ones which (as far as fossils show) existed for some ages, are arranged by M. Agassiz in two orders, with a regard to their external covering, which that naturalist hold to be, in fishes, a reflection of the internal organization. Both, it is to be remarked at the very first, are manifestly of an inferior character to the two other orders which afterwards came into existence, and still are the principal fishes of our seas, these being covered by true scales, and respectively named ctenoid and cycloid, from the forms of that part of their organization. The two orders of early fish are covered with integuments considerably different in character; the one (*placoids*) with irregular enamelled plates, the other (*ganoids*) with regular enamelled scales, the first being not placed over each other, as scales are, but laid edge to edge, in the manner of a pavement. These characters, according to M. Agassiz, were accompanied by a rudimentary or cartilaginous skeleton, while the ctenoids and cycloids possess an osseous structure.

Of certain of the ganoids, it is remarked by every geologist, how much they approximate to the form and armature of the crustaceans, an order of the next lower department of the animal kingdom.

The *cephalaspis* may be considered as making the smallest advance from the crustacean character; it very much resembles in form the asaphus of lower formations, having a longish tail-like body inserted within the cusp of a large crescent-shaped head, somewhat like a saddler's cutting-knife. The body is covered with strong plates of bone, enamelled, and the head was protected on the upper side with one large plate, as with a buckler —hence the name, implying *buckler-head.* A range of small fins conveys the idea of its having been as weak in motion as it is strong in structure. The *coccosteus* may be said to mark the next advance to the perfect fish type. The outline of its body is of the form of a short thick coffin, rounded, covered with strong bony plates, and terminating in a long tail, which seems to have been the sole organ of motion. While the tail establishes this creature among the vertebrata and the fishes, its teeth, chiselled, as it were, out of the solid bone of the jaw, like the nippers of a lobster, and its mouth opening vertically, contrary to the usual mode of the vertebrata, enforce our placing it near the crustaceans. The *pterichthys* has also strong bony plates over its body, arranged much like those of a tortoise, and has a long tail; but its most remarkable feature, and that which has suggested its name, is a pair of long and narrow wing-like appendages attached to the shoulders, which the creature is supposed to have erected for its defence when attacked by an enemy.

The *holoptychius* is of a flat oval form, furnished with fins, and ending in a long tail; the whole body covered with strong plates which overlap each other, and the head forming only a slight rounded projection from the general figure. The specimens in the lower beds are not above the size of a flounder; but in the higher strata, to judge by the size of the scales or plates which have been found, the creature attained a comparatively monstrous size.*

* The head fountain of information on the early fishes is M. Agassiz's Fossil Ichthyology, a splendid but not readily accessible

The placoids are now slenderly represented by the shark, cestraceon, &c., of modern seas; the ganoids are all but unrepresented in our time. Of both classes, one invariable peculiarity has attracted much attention. "In all recent fish, with the exception of the shark family, the sturgeon and the long pike, the vertebral column terminates at the point where the caudal fin is given off, and this fin is expanded above and below the body, forming what is called a *homocercal* tail. In all those, without exception, which have been found in strata of the Palæozoic period [placoids and ganoids], the caudal fin is *heterocercal*, being formed of two unequal branches, the upper one expanded immediately from the vertebral column, while the lower one is given off at a point some distance from the extremity."* Now it is a remarkable fact, that this one-sided tail is a peculiarity in the more perfect fishes (as the salmon) at a certain stage in their embryonic history; as is also the inferior position of the mouth peculiar to the early fishes. More than this—in the earlier periods of embryonic life, there is no vertebral column. This organ is represented in embryos by a gelatinous cord, called the dorsal cord, which in maturity disappears as the vertebræ are formed upon it. M. Agassiz has satisfied himself that this was the nature of the organization of the early fishes, as it is that of the sturgeon of the present seas. It is not premature to remark how broadly these facts seem to hint at a parity of law affecting the progress

book. For more popular descriptions, reference may be made to "New Walks in an Old Field, by Hugh Miller," Edin., 1842, and to Jameson's Journal, July and October, 1844.

* Ansted's Geology, i., 185.

of general creation, and the progress of an individual fœtus of one of the more perfect animals.*

It is equally ascertained of the types of being prevalent in the old red, as of those of the preceding system, that they are uniform in the corresponding strata of distant parts of the earth; for instance, Russia and North America.

In the old red sandstone, the marine plants, of which faint traces are observable in the Silurians, continue to appear. It would seem as if less change took place in the vegetation than in the animals of those early seas; and for this, as Mr. Miller has remarked, it is easy to imagine reasons. For example, an infusion of lime into the sea would destroy animal life, but be favorable to vegetation. It has also been surmised by M. Agassiz, from an examination of the fishes of the ancient seas, that the ocean did not at first contain much salt, but gradually acquired its present infusion of that material; a theory, it may be remarked, which derives support from

* It is remarkable that, while the non-osseous fishes reach lower down in these points of organization than other orders, they rise higher in some points of development, and some of them even make an advance to the viviparous mode of reproduction. But it is well known that no family of animals is equally high in all points of structure and endowment, and that many forms generally humble have characteristics of a comparatively elevated kind. There are features of even the human organization that would place our race below some of the inferior animals, if these were to be made an exclusive criterion. In using as a standard the series of peculiarities presented in the embryotic progress of an individual of a different order, and thus assigning the non-osseous fishes a low place, M. Agassiz seems to me to be acting upon principles to which every day is adding strength and authority.

a recent suggestion, that the salt of the sea has been mainly brought thither, in the course of time, by rivers, these washing it in particles out of the land in common with other detritus, while it is obvious that rain does not restore it.* It is easy to suppose a comparative absence of salt in the early ocean affecting animal and vegetable marine life in different ways and degrees.

As yet there were no land animals or plants, and for this the presumable reason is, that no dry land as yet existed. We are not left to make this inference solely from the absence of land animals and plants ; in the arrangement of the primary (stratified) rocks, we have further evidence of it. That these rocks were formed in a generally horizontal position, we are as well assured as that they were formed at the bottom of the seas. But they are always found greatly inclined in position, tilted up against the slopes of the granitic masses which are beneath them in geological order, though often shooting up to a higher point in the atmosphere. No doubt can be entertained that these granitic masses, forming our principal mountain ranges, have been protruded from below, or, at least, thrust much further up, *since* the deposition of the primary rocks. The protrusion was what tilted up the primary rocks ; and the inference is, of course, unavoidable, that these mountains have risen chiefly, at least, since the primary rocks were laid down. It is remarkable that, while the primary rocks thus incline towards granitic nuclei or axes, the strata higher in the series rest against these again, generally at a less inclination, or none at all, showing that these strata were laid

* See Fownes's Actonian Prize Essay.

down after the swelling mountain eminences had, by their protrusion, tilted up the primary strata. And thus it may be said an era of local upthrowing of the primitive and (perhaps) central matter of our planet, is established as happening about the close of the primary strata, and beginning of the next ensuing system. It may be called the *Era of the Oldest Mountains*, or, more boldly, of the formation of the detached portions of dry land over the hitherto watery surface of the globe—an important part of the designs of Providence, for which the time was now apparently come. It may be remarked, that volcanic disturbances and protrusions of trap took place throughout the whole period of the deposition of the primary rocks ; but they were upon a comparatively limited scale, and probably all took place under water. It was only now that the central granitic masses of the great mountain ranges were thrown up, carrying up with them edges of the primary strata ; a process which seems to have had this difference from the other, that it was the effect of a more tremendous force exerted at a lower depth in the earth, and generally acting in lines pervading a considerable portion of the earth's surface. We shall by-and-by see that the protrusion of some of the mountain ranges was not completed, or did not stop, at that period. There is no part of geological science more clear than that which refers to the ages of mountains. It is as certain that the Grampian mountains of Scotland are older than the Alps and Apennines, as it is that civilisation had visited Italy, and had enabled her to subdue the world, while Scotland was the residence of "roving barbarians." The Pyrenees, Carpathians, and other ranges of continental Europe, are all younger than the Grampians or even the insignificant Mendip Hills of southern England. Stratification tells this tale as plainly as Livy tells the history of the Roman republic. It tells us—to use the words of Professor Phillips—that at the time when the Grampians sent streams and detritus to straits where now the valleys of the Forth and Clyde meet, the greater part of Europe was a wide ocean.

The last three systems—called, in England, the Cambrian, Silurian, and Devonian, and collectively the palæozoic rocks, from their containing the remains of the earliest inhabitants of the globe—are of vast thickness; in England, not much less than 30,000 feet, or nearly six miles.

SECONDARY ROCKS.

ERA OF THE CARBONIFEROUS FORMATION.

COMMENCEMENT OF LAND PLANTS.

We now enter upon a new great epoch in the history of our globe. There was now dry land. As a consequence of this fact, there was fresh water; for rain, instead of immediately returning to the sea, as formerly, was now gathered in channels of the earth, and became springs, rivers, and lakes. There was now a theatre for the existence of land plants and animals, and it remains to be inquired if these accordingly were produced.

The Secondary Rocks, in which our further researches are to be prosecuted, consist of a great and varied series, resting, generally unconformably, against flanks of the upturned primary rocks, sometimes themselves considerably inclined, at others, forming extensive basin-like beds, nearly horizontal; in many places much broken up and shifted by disturbances from below. They have all been formed out of the materials of the older rocks, by virtue of the wearing power of air and water, which is still every day carrying down vast quantities of the elevated matter of the globe into the sea. But the separate strata are each much more distinct in the matter of its composition than might be expected. Some are siliceous or arenaceous (sandstones), composed mainly of fine grains from the quartz rocks—the most abundant of the primary strata. Others are argillaceous—clays, shales, &c., chiefly derived, probably, from the slate beds of the primary series. Others are calcareous, derived from the early limestone. As a general feature, they are softer and less crystalline than the primary rocks, as if they had endured less of both heat and pressure than the senior formation. There are beds (*coal*) formed solely of vegetable matter, and some others in which the main ingredient is particles of iron (*the iron black band*). The secondary rocks are quite as communicative with regard to their portion of the earth's history as the primitive were.

The first, or lowest, group of the secondary rocks is called the *Carboniferous Formation*, from the remarkable feature of its numerous interspersed beds of coal. It commences with the beds of the *mountain limestone*, which, in some situations, as in Derbyshire and Ireland, are of great thickness, being alternated with chert (a siliceous sandstone), sandstones, shales, and beds of coal, generally of the harder and less bituminous kind (*anthracite*), the whole being covered in some places by the millstone grit, a siliceous conglomerate composed of the detritus of the primary rocks. The mountain limestone, attaining in England to a depth of eight hundred yards, greatly exceeds in volume any of the primary limestone beds, and shows an enormous addition of power to the causes formerly suggested as having produced this substance. In fact, distinct remains of corals, crinoidea, and shells, are so abundant in it, as to compose three-fourths of the mass in some parts. Above the mountain limestone commence the more conspicuous *coal beds*, alternating with sandstones, shales, beds of limestone, and ironstone. Coal is altogether composed of the matter of a terrestrial vegetation, transmuted by putrefaction of a peculiar kind, beneath the surface of water and in the absence of air. Some fresh-water shells have been found in it, but few of marine origin, and no remains of those zoophytes and crinoidea so abundant in the mountain limestone and other rocks. Coal beds exist in Europe, Asia, and America, and have hitherto been esteemed as the most valuable of mineral productions, from the important services which the substance renders in manufactures and in domestic economy. It is to be remarked, that there are some local variations in the arrangement of coal beds. In France, they rest immediately on the granite and other primary rocks, the intermediate strata not having been found at those places. In America, the kind called anthracite occurs among the slate beds, and this species also abounds more in the mountain limestone than with us. These last circumstances only show that different parts of the earth's surface did not all witness the same events of a certain fixed series exactly at the same time. There had been an exhibition of dry land about the site of America, a little earlier than in Europe.

Some features of the condition of the earth during the deposition of the carboniferous group, are made out with a clearness which must satisfy most minds. First we are told of a time when carbonate of lime was formed in vast abundance at the bottoms of profound seas, accompanied by an unusually large population of corals and encrinites; while in some parts of the earth there were patches of dry land, covered with a luxuriant vegetation. Next we have a comparatively brief period of volcanic disturbance (when the conglomerate was formed). Then the causes favorable to the so abundant production of limestone, and the large population of marine acrita, decline, and we find the masses of dry land increase in number and extent, and begin to bear an amount of forest vegetation, far exceeding that of the most sheltered tropical spots of the present surface. The climate, even in the latitude of Baffin's Bay, was torrid, and perhaps the atmosphere contained a larger charge of carbonic acid gas (the material of vegetation) than it now does. The forests or thickets of the period included no species of plants now known upon earth. They mainly consisted of gigantic shrubs, many of which are not represented by any existing types, while others are akin to kinds which, in temperate climes at least, are now only found in small and lowly forms. That these forests grew upon a Polynesia, or multitude of small islands, is considered probable, from similar vegetation being now found in such situations within the tropics. With regard to the circumstances under which the masses of vegetable matter were transformed into successive coal strata, geologists are divided. From examples seen at the present day, at the mouths of such rivers as the Mississippi, which traverse extensive sylvan regions, and from other circumstances to be adverted to, it is held likely by some that the vegetable matter, the rubbish of decayed forests, was carried by rivers into estuaries, and there accumulated in vast natural rafts, until it sunk to the bottom, where an over-layer of sand or mud would prepare it for becoming a stratum of coal. Others conceive that the vegetation first went into the condition of a peat moss, that a sink in a level then exposed it to be overrun by the sea, and covered with a layer of sand or mud; that a subsequent uprise made the mud dry land, and fitted it to bear a new forest, which afterwards, like its predecessor, became a bed of peat; that, in short, by repetitions of this process, the alternate layers of coal, sandstone, and shale, constituting the carboniferous group, were formed. It is favorable to this last view that marine fossils are scarcely found in the body of the coal itself, though abundant in the shale layers above and below it; also that in several places erect stems of trees are found with their roots still fixed in the shale beds, and crossing the sandstone beds at almost right angles, showing that these, at least, had not been drifted from their original situations. On the other hand, it is not easy to admit such repeated risings and sinkings of surface as would be required, on this hypothesis, to form a series of coal strata. Perhaps we may most safely rest at present with the supposition that coal has been formed under both classes of circumstances, though in the latter only as an exception to the former.

Upwards of three hundred species of plants have been ascertained to exist in the coal formation; but it is not necessary to suppose that the whole contained in that system are now, or ever will be, distinguished. Experiments show that some great classes of plants become decomposed in water in a much less space of time than others, and it is remarkable that those which decompose soonest, are of the classes found most rarely, or not at all, in the coal strata. It is consequently to be inferred that there may have been grasses and mosses at this era, and many species of trees, the remains of which had lost all trace of organic form before their substance sunk into the mass of which coal was formed. In speaking, therefore, of the vegetation of this period, we must bear in mind that it may have comprehended forms of which we have no memorial.

Supposing, nevertheless, that, in the main, the ascertained vegetation of the coal system is that which grew at the time of its formation, it is interesting to find that the terrestrial botany of our globe begins with classes of comparatively simple forms and structure. In the ranks of the vegetable kingdom, the lowest place is taken by plants of cellular tissue, and which have no flowers (*cryptogamia*), as lichens, mosses, fungi, ferns, sea-weeds. Above these stand plants of vascular tissue, and bearing flowers, in which again there are two great subdivisions; first, plants having one seed-lobe (*monocotyledons*), and in which the new matter is added within (*endogenous*), of which the cane and palm are examples; second, plants having two seed-lobes (*dicotyledons*), and in which the new matter is added on the outside under the bark (*exogenous*), of which the pine, elm, oak, and most of the British forest-trees are examples; these subdivisions also ranking in the order in which they are here stated. Now it is clear that a predominance of these forms in succession marked the successive epochs developed by fossil geology; the simple abounding first, and the complex afterwards.

Two-thirds of the plants of the carboniferous era are of the cellular or cryptogamic kind, a proportion which would probably be much increased if we knew the whole Flora of that era. The ascertained dicotyledons, or higher-class plants, are comparatively few in this formation; but it will be found that they constantly increased as the globe grew older.

The master-form or type of the era was the *fern*, or breckan, of which about one hundred and thirty species have already been ascertained as entering into the composition of coal.* The ferns are plants which thrive best in warm, shaded, and moist situations. In tropical countries, where these conditions abound, there are many more species than in temperate climes, and some of these are arborescent, or of a tree-like size and luxuriance.† The ferns of the coal strata have been of this magnitude, and that without regard to the parts of the earth where they are found. In the coal of Baffin's Bay, of Newcastle, and of the torrid zone alike, are the fossil ferns arborescent, showing clearly that, in that era, the present tropical temperature, or one even higher, existed in very high latitudes.

In the swamps and ditches of England there grows a plant called the horse-tail (*equisetum*), having a succulent, erect, jointed stem, with slender leaves, and a scaly catkin at the top. A second large section of the plants of the carboniferous era were of this kind (*equisetaceæ*) but, like the fern, reaching the magnitudes of trees. While existing equiseta rarely exceed three feet in height, and the stems are generally under half an inch in diameter, their kindred, entombed in the coal beds, seem to have been generally fourteen or fifteen feet high, with stems from six

* The principal genera are named sphenopteris, neuropteris, and pecopteris.

† A specimen from Bengal, in the staircase of the British Museum, is forty-five feet high.

inches to a foot in thickness. It is to be remarked that plants of this kind (forming two genera, the most abundant of which is the *calamites*) are only represented on the present surface by plants of the same *family*: the *species* which flourished at this era gradually lessen in number as we advance upwards in the series of rocks, and disappear before we arrive at the tertiary formation.

The club-moss family (*lycopodiaceæ*) are other plants of the present surface, usually seen in a lowly and creeping form in temperate latitudes, but presenting species which rise to a greater magnitude within the tropics. Many specimens of this kind are found in the coal beds; it is thought they have contributed more to the substance of the coal than any other family. But, like the ferns and equisetaceæ, they rise to a prodigious magnitude. The lepidodendra (so the fossil genus is called) have probably been from sixty-five to eighty feet in height, having at their base a diameter of about three feet, while their leaves measured twenty inches in length. In the forests of the coal era, the lepidodendra would enjoy the rank of firs in our forests, affording shade to the only less stately ferns and calamites. The internal structure of the stem, and the character of the seed-vessels, show them to have been a link between single-lobed and double-lobed plants, a fact worthy of note, as it favors the idea that, in vegetable as well as animal creation, a progress has been observed, in conformity with advancing conditions. It is also curious to find a missing link of so much importance in a genus of plants which has long ceased to have a living place upon earth.

The other leading plants of the coal era are without representatives on the present surface, and their characters are in general less clearly ascertained. Amongst the most remarkable are—the *sigillaria*, of which large stems are very abundant, showing that the interior has been soft, and the exterior fluted, with separate leaves inserted in vertical rows along the flutings—and the *stigmaria*, a plant apparently calculated to flourish in marshes or pools, having a short, thick, fleshy stem, with a dome-shaped top, from which sprung branches of from twenty to thirty feet long. Amongst monocotyledons were some palms (*flabellaria* and *næggerathia*), besides a few not distinctly assignable to any class.

The dicotyledons of the coal are comparatively few, though on the present surface they are the most numerous subclass. Besides some of doubtful affinity (*annularia*, *asterophyllites*, &c.), there were a few of the pine family, which seem to have been the highest class of trees at this era, and are only as yet found in isolated cases, and in sandstone beds. The first discovered lay in the Craigleith quarry, near Edinburgh, and consisted of a stem about two feet thick, and forty-seven feet in length. Others have since been found, both in the same situation, and at Newcastle. Leaves and fruit being wanting, an ingenious mode of detecting the nature of these trees was hit upon by some naturalists residing in the northern capital.* Taking thin polished cross slices of the stem, and subjecting them to the microscope, they detected the structure of the wood to be that of a cone-bearing tree, by the presence of certain "reticulations" which distinguish that family, in addition to the usual radiating and concentric lines. That particular tree was concluded to

* See Withan, on the Internal Structure of Fossil Vegetables, 1834.

be an araucaria, a species now found in Norfolk Island, in the South Sea, and in a few other remote situations. The coniferæ of this era form the dawn of dicotyledonous trees, of which they may be said to be the simplest type, and to which, it has already been noticed, the lepidodendra are a link from the monocotyledons. The concentric rings of the Craigleith and other coniferæ of this era have been mentioned. It is interesting to find in these a record of the changing seasons of those early ages, when as yet there were no human beings to observe time or tide. The rings are clearly traced; but it is observed that they are more slightly marked than is the case with their family at the present day, as if the changes of temperature had been within a narrower range.

Such was the vegetation of the carbonigenous era, composed of forms at the bottom of the botanical scale, flowerless, fruitless, but luxuriant and abundant beyond what the most favored spots on earth can now show. The rigidity of the leaves of its plants, and the absence of fleshy fruits and farinaceous seeds, unfitted it to afford nutriment to animals; and, monotonous in its forms, and destitute of brilliant coloring, its sward probably unenlivened by any of the smaller flowering herbs, its shades uncheered by the hum of insects, or the music of birds, it must have been a sombre scene to a human visitant. But neither man nor any other animals were then in existence to look for such uses or such beauties in this vegetation. It was serving other and equally important ends, clearing (probably) the atmosphere of matter noxious to animal life, and storing up mineral masses which were in long subsequent ages to prove of the greatest service to the human race, even to the extent of favoring the progress of its civilisation.

The animal remains of this era are not numerous, in comparison with those which go before, or those which come after. The mountain limestone, indeed, deposited at the commencement of it, abounds unusually in polypiaria and crinoidea; but when we ascend to the coal-beds themselves, the case is altered, and these marine remains altogether disappear. We have then only a limited variety of shell mollusks, with fragments of a few species of fishes, and these are rarely or never found in the coal seams, but in the shales alternating with them. At this time, the sauroids, a family of the ganoid fishes, are considered as at their apogee, or point of greatest abundance; a fact of some importance, seeing that, in teeth, bones, and scales, they make an advance to the lizard character, a type of a higher order of animals which we are soon to see entering upon the stage.* Of this link family is the Megalichthys Hibbertii, found by Dr. Hibbert Ware, in a limestone bed of fresh-water origin, underneath the coal at Burdiehouse, near Edinburgh. Others of the same kind have been found in the coal measures in Yorkshire, and in the low coal shales at Manchester.

* The sauroid fishes are often adduced as a proof that animals do not make their appearance in the series of rocks in the order of their comparative organization. But this allegation is of the same character with that respecting the cephalopoda (see p. 44). The sauroids are marked in the instructive chart of M. Agassiz (copied in Jameson's Journal, Oct., 1844), as commencing after the large family of Lepidoids, and as attaining their apogee considerably later. The subsequent rise of orders of fishes (ctanoids and cycloids) which do not so nearly approach the reptilian type, seems to me indifferent, as far as the present question is concerned.

Coal strata are nearly confined to the group termed the carboniferous formation. Thin beds are not unknown afterwards, but they occur only as a rare exception. It is therefore thought that the most important of the conditions which allowed of so abundant a terrestrial vegetation, had ceased about the time when this formation was closed. The high temperature was not one of the conditions which terminated, for there are evidences of it afterwards; but probably the superabundance of carbonic acid gas supposed to have existed during this era was expended before its close. There can be little doubt that the infusion of a large dose of this gas into the atmosphere at the present day would be attended by precisely the same circumstances as in the time of the carboniferous formation. Land animal life would not have a place on earth; vegetation would be enormous; and coal strata would be formed from the vast accumulations of woody matter, which would gather in every sea, near the mouths of great rivers. On the exhaustion of the superabundance of carbonic acid gas, the coal formation would cease, and the earth might again become a suitable theatre of being for land animals.

The termination of the carboniferous formation is marked by symptoms of volcanic violence, which some geologists have considered to denote the close of one system of things and the beginning of another. Coal beds generally lie in basins, as if following the curve of the bottom of seas. But there is no such basin which is not broken up into pieces, some of which have been tossed up on edge, others allowed to sink, causing the ends of strata to be in some instances many yards, and in a few several hundred feet, removed from the corresponding ends of neighboring fragments. These are held to be results of volcanic movements below, the operation of which is further seen in numerous upbursts and intrusions of fire-born rock (trap). That these disturbances took place about the close of the formation, and not later, is shown in the fact of the next higher group of strata being comparatively undisturbed. Other symptoms of this time of violence are seen in the beds of conglomerate which occur amongst the first strata above the coal. These, as usual, consist of fragments of the elder rocks, more or less worn from being tumbled about in agitated water, and laid down in a mud paste, afterwards hardened. Volcanic disturbances break up the rocks; the pieces are worn in seas: and a deposit of conglomerate is the consequence. Of porphyry, there are some such pieces in the conglomerate of Devonshire, three or four tons in weight. It is to be admitted for strict truth that, in some parts of Europe, the carboniferous formation is followed by superior deposits, without the appearance of such disturbances between their respective periods; but apparently this case belongs to the class of exceptions already noticed.* That disturbance was general, is supported by the further and important fact of the destruction of many forms of organic being previously flourishing, particularly of the vegetable kingdom.

* "Some of the most considerable dislocations, of the border of the coal fields of Coalbrookdale and Dudley, happened after the deposition of a part of the new red sandstone; but it is certain that those of Somersetshire and Gloucestershire were completed before the date of that rock."—*Phillips.*

ERA OF THE NEW RED SANDSTONE.

TERRESTRIAL ZOOLOGY COMMENCES

WITH REPTILES.

FIRST TRACES OF BIRDS.

THE next volume of the rock series refers to an era distinguished by an event of no less importance than the commencement of land animals. The *New Red Sandstone System* is subdivided into groups, some of which are wanting in some plaes: they are pretty fully developed in the north of England, in the following ascending order:—1, Lower red sandstone; 2, Magnesian limestone; 3, Red and white sandstones and conglomerate; 4, Variegated marls. Between the third and the fourth there is, in Germany, another group, called the Muschelkalk, a word expressing a limestone full of shells.

The first group, containing the conglomerates already adverted to, seems to have been produced during the time of disturbance which occurred so generally after the carbonigenous era. This new era is distinguished by a paucity of organic remains, as might partly be expected from the appearance of disturbance, and the red tint of the rocks, the latter being communicated by a solution of oxide of iron, a substance unfavorable to animal life.

The second group is a limestone with an infusion of magnesia. It is developed less generally than some others, but occurs conspicuously in England and Germany. Its place, above the red sandstone, shows the recurrence of circumstances favorable to animal life, and we accordingly find in it not only zoophytes, conchifera, and a few tribes of fish, but some faint traces of land plants, and a new and startling appearance—a reptile of saurian (lizard) character, analogous to the now existing family called monitors. Remains of this creature are found in cupriferous (copper-bearing) slate connected with the mountain limestone, at Mansfield and Glucksbrunn, which may be taken as evidence that dry land existed in that age near those places. The magnesian limestone is also remarkable as the last rock in which appears the leptæna, or productus, a conchifer of numerous species which makes a conspicuous appearance in all previous seas. It is likewise to be observed, that the fishes of this age, to the genera of which the names palæoniscus, catopterus, platysomus, &c., have been applied, vanish, and henceforth appear no more.

The third group, chiefly sandstones, variously colored according to the amount nnd nature of the metallic oxide infused into them, shows a recurrence of agitation, and a consequent diminution of the amount of animal life. In the upper part, however, of this group, there are abundant symptoms of a revival of proper conditions for such life. There are marl beds, the origin of which substance in decomposed shells is obvious; and in Germany, though not in England, here occurs the muschelkalk, containing numerous organic remains (generally different from those of the magnesian limestone), and noted for the specimens of land animals, which it is the first to present in any considerable abundance to our notice.

These animals are of the vertebrate sub-kingdom, but of its lowest class next after fishes,—namely, reptiles—a portion of the terrestrial tribes whose imperfect respiratory system perhaps fitted them for enduring an atmosphere not yet quite suitable for birds or mammifers.* The specimens found in the muschelkalk are allied to the crocodile and lizard tribes of the present day, but in the latter instance are upon a scale of magnitude as much superior to present forms as the lepidodendron of the coal era was superior to the dwarf club-mosses of our time. These saurians also combine some peculiarities of structure of a most extraordinary character.

The animal to which the name *ichthyosaurus* has been given, was as long as a young whale, and it was fitted for living in the water, though breathing the atmosphere. It had the vertebral column and general bodily form of a fish, but to that were added the head and breast-bone of a lizard, and the paddles of the whale tribes. The beak, moreover, was that of a porpoise, and the teeth were those of a crocodile. It must have been a most destructive creature to the fish of those early seas.

* The immediate effects of the slow respiration of the reptilia, are, a low temperature in their bodies, and a slow consumption of food. Requiring little oxygen, they could have existed in an atmosphere containing a less proportion of that gas to carbonic acid than what now obtains.

The *plesiosaurus* was of similar bulk, with a turtle-like body and paddles, showing that the sea was its element, but with a long serpent-like neck, terminating in a saurian head, calculated to reach prey at a considerable distance. These two animals, of which many varieties have been discovered, constituting distinct species, are supposed to have lived in the shallow borders of the seas of this and subsequent formations, devouring immense quantities of the finny tribes. It was at first thought that no creatures approaching them in character now inhabit the earth; but latterly Mr. Darwin has discovered, in the reptile-peopled Galapagos Islands, in the South Sea, a marine saurian from three to four feet long.

The *megalosaurus* was an enormous lizard—a land creature, also carnivorous. The *pterodactylus* was another lizard, varying in size between a cormorant and a snipe, and furnished with unusually prolonged anterior extremities, supposed to have served, like those of the bat tribe, as wings wherewith to pursue its prey in the air, though M. Agassiz, on the contrary, believes this animal to have been designed for an aquatic life. Crocodiles abounded, and some of these were herbivorous. Such was the iguanodon, a creature of the character of the iguana, but probably sixty feet in length, or twelve times that of its modern representative.

There were also numerous *tortoises*, some of them reaching a great size; and Professor Owen has found in Warwickshire some remains of an animal of the batrachian order,* to which, from the peculiar form of the teeth, he has given the name of labyrinthodon. Thus, three of

* The order to which frogs and toads belong.

Cuvier's four orders of reptilia (*sauria*, *chelonia*, *and batrachia*) are represented in this formation, the serpent order [*ophidia*] being alone wanting.

The variegated marl beds which constitute the uppermost group of the formation, present two additionnl genera of huge saurians,—the phytosaurus and mastodonsaurus.

The plants of this era are few and unobtrusive. Equiseta, calamites, ferns, Voltzia, and a few of the other families found so abundantly in the preceding formation, here present themselves, but in diminished size and quantity.

This seems to be the proper place to advert to certain memorials of a peculiar and unexpected character respecting these early ages in the sandstones. So low as the bottom of the carboniferous system, slabs are found marked over a great extent of surface with that peculiar corrugation or wrinkling which the receding tide leaves upon a sandy beach when the sea is but slightly agitated; and not only are these ripple-marks, as they are called, found on the surfaces, but casts of them appear on the under sides of slabs lying above. The phenomena suggest the time when the sand ultimately formed into these stone slabs, was part of the beach of a sea of the carbonigenous era; when, left wavy by one tide, it was covered over with a thin layer of fresh sand by the next, and so on, precisely as such circumstances might be expected to take place at the present day. Sandstone surfaces, ripple-marked, are found throughout the subsequent formations: in those of the new red, at more than one place in England, they further bear impressions of rain drops which have fallen upon them—the rain, of course, of the inconceivably remote age in which the sandstones were formed. In the

Greensill sandstone, near Shrewsbury, it has even been possible to tell from what direction the shower came which impressed the sandy surface, the rims of the marks being somewhat raised on one side, exactly as might be expected from a slanting shower falling at this day upon one of our beaches. These facts have the same sort of interest as the season rings of the Craigleith conifers, as speaking of a parity between some of the familiar processes of nature in those early ages and our own.

In the new red sandstone, impressions still more important in the inferences to which they tend, have been observed,—namely the footmarks of various animals. In a quarry of this formation, at Corncockle Muir, in Dumfriesshire, where the slabs incline at an angle of thirty-eight degrees, the vestiges of an animal supposed to have been a tortoise are distinctly traced up and down the slope, as if the creature had had occasion to pass backwards and forwards in that direction only, possibly in its daily visits to the sea. Some slabs similarly impressed, in the Stourton quarries in Cheshire, are further marked with a shower of rain, which we know must have fallen *afterwards*, for its little hollows are impressed in the footmarks also, though more slightly than on the rest of the surface, the comparative hardness of a trodden place having apparently prevented so deep an impression being made. At Hessberg, in Saxony, the vestiges of four distinct animals have been traced, one of them a web-footed animal of small size, considered as a congener of the crocodile ; another, whose footsteps having a resemblance to an impression of a swelled human hand, has caused it to be named the *cheirotherium.* The footsteps of the cheirotherium have been found also in the Stourton quarries. Professor Owen, who stands at the head of comparative anatomists of the present day, has expressed his belief that this last animal was the same batrachian of which he has found fragments in the new red sandstone of Warwickshire. At Runcorn, near Manchester, and elsewhere, have been discovered the tracks of an animal which Mr. Owen calls the rhynchosaurus, uniting with the body of a reptile the beak and feet of a bird, and which clearly had been a *link* between these two classes.

If geologists shall ultimately give their approbation to the inferences made from a recent discovery in America, we shall have the addition of perfect birds, though probably of a low type, to the animal forms of this era. It is stated to be in quarries of this rock, in the valley of Connecticut, that footprints have been found, apparently produced by birds of the order grallæ, or waders. "The footsteps appear in regular succession on the continuous track of an animal, in the act of walking or running, with the right and left foot always in their relative places. The distance of the intervals between each footstep on the same track is occasionally varied, but to no greater amount than may be explained by the bird having altered its pace. Many tracks of different individuals and different species are often found crossing each other, and crowded, like impressions of feet upon the shores of a muddy stream, where ducks and geese resort."* Some of these prints indicate small animals, but others denote birds of what would now be an unusually large size. One animal, having a foot fifteen inches in length (one-half more than that of the ostrich), and a stride of from four to six feet, has been appropriately entitled *ornithichnites giganteus*.

* Dr. Buckland, quoting an article by Professor Hitchcock, in the American Journal of Science and Arts, 1836.

THE ERA OF THE OOLITE.

COMMENCEMENT OF MAMMALIA.

THE chronicles of this period consist of a series of beds, mostly calcareous, taking their general name (*Oolite System*) from a conspicuous member of them—the oolite—a limestone composed of an aggregation of small round grains or spherules, and so called from its fancied resemblance to a cluster of eggs, or the roe of a fish. This texture of stone is novel and striking. It is supposed to be of chemical origin, each spherule being an aggregation of particles round a central nucleus. The oolite system is largely developed in England, France, Westphalia, and Northern Italy; it appears in Northern India and Africa, and patches of it exist in Scotland, and in the vale of the Mississippi. It may of course be yet discovered in many other parts of the world.

The series, as shown in the neighborhood of Bath, is (beginning with the lowest) as follows:—1. Lias, a set of strata variously composed of limestone, clay, marl, and shale, clay being predominant; 2. Lower oolitic formation, including, besides the great oolite bed of central England, fullers' earth beds, forest marble, and cornbrash; 3. Middle oolitic formation, composed of two sub-groups, the Oxford clay and coral rag, the latter being a mere layer of the works of the coral polype; 4. Upper oolitic formation, including what are called Kimmeridge clay and Portland oolite. In Yorkshire there is an additional group above the lias, and in Sutherlandshire there is another group above that again. In the wealds (moorlands) of Kent and Sussex, there is, in like manner, above the fourth of the Bath series, another additional group, to which the name of the *Wealden* has been given, from its topographical situation, and which, composed of sandstones and clays, is subdivided into Purbeck beds, Hastings sand, and Weald clay.

There are no particular appearances of disturbance between the close of the new red sandstone and the beginning of the oolite system, as far as has been observed in England. Yet there is a great change in the materials of the rocks of the two formations, showing that, while the bottoms of the seas of the one period had been chiefly arenaceous, those of the other were chiefly clayey and limy. And there is an equal difference between the two periods in respect of both botany and zoology. While the new red sandstone shows comparatively scanty traces of organic creation, those in the oolite are extremely abundant, particularly in the department of animals, and more particularly still of sea mollusca, which, it has been observed, are always the more conspicuous in proportion to the predominance of calcareous rocks. It is also remarkable that the animals of the oolitic system are entirely different in species from those of the preceding age, and that these species cease before the next. In this system we likewise find that uniformity over great space which has been remarked of the Faunas of earlier formations. "In the equivalent deposits in the Himalaya Mountains, at Fernando Po, in the region north of the Cape of Good Hope, and in the Run of Cutch, and other parts of Hindostan, fossils have been discovered, which, as far as English naturalists who have seen them can determine, are undistinguishable from certain oolite and lias fossils of Europe."*

The dry land of this age presented cycadeæ, "a beautiful class of plants between the palms and conifers, having a tall, straight trunk, terminating in a magnificent crown of foliage."† There were tree ferns, but in smaller proportion than in former ages; also equisetaceæ, lilia, and coniferæ. The vegetation was generally analogous to that of the Cape of Good Hope and Australia, which seems to argue a climate (we must remember, a universal climate) between the tropical and temperate. It was, however, sufficiently luxuriant in some instances to produce thin seams of coal, for such are found in the oolite formation of both Yorkshire and Sutherland. The sea, as for ages before, contained algæ, of which, however, only a few species have been preserved to our day. The lower classes of the inhabitants of the ocean were unprecedentedly abundant. The polypiaria were in such abundance as to form whole strata of themselves. The crinoidea and echinites were also extremely numerous. Shell mollusks, in hundreds of new species, occupied the

* Murchison's Silurian System, p. 583.

† Buckland.

bottoms of the seas of those ages, while of the swimming shell-fish, ammonites and belemnites, there were also many scores of varieties. The belemnite here calls for some particular notice. It commences in the oolite, and terminates in the next formation. It is an elongated, conical shell, terminating in a point, and having, at the larger end, a cavity for the residence of the animal, with a series of air-chambers below. The animal, placed in the upper cavity, could raise or depress itself in the water at pleasure by a pneumatic operation upon the air tube pervading its shell. Its tentacula, sent abroad over the summit of the shell, searched the sea for prey. The creature had an ink-bag, with which it could muddle the water around it, to protect itself from more powerful animals, and, strange to say, this has been found so well preserved that an artist has used it in one instance as a pigment, wherewith to delineate the belemnite itself.

The crustacea discovered in this formation are less numerous. There are many fishes, some of which (*acrodus*, *psammodus*, &c.) are presumed from remains of their palatal bones, to have been of the gigantic cartilaginous class (*placoidean*), now represented by such as the cestraceon. It has been considered by Professor Owen as worthy of notice, that, the cestraceon being an inhabitant of the Australian seas, we have, in both the botany and ichthyology of this period, an analogy to that continent. The pycnodontes (thick-toothed), and lepidoides (having thick scales), are other families described by M. Agassiz as extensively prevalent. In the shallow waters of the oolitic formation, the ichthyosaurus, plesiosaurus, and other huge saurian carnivora of the preceding age, plied, in increased numbers, their destructive vocation.* To them were added new genera, the cetiosaurus, mosœsaurus, and some others, all of similar character and habits.

Land reptiles abounded, including species of the pterodactyle of the preceding age—tortoises, trionyces, crocodilians—and the pliosaurus, a creature which appears to have formed a link between the plesiosaurus and the crocodile. We know of at least six species of the pterodactyle in this formation.

Now, for the first time, we find remains of insects, an order of animals not well calculated for fossil preservation, and which are therefore amongst the rarest of the animal tribes found in rocks, though they are the most numerous of all living families. A single libellula (dragon fly) was found in the Stonesfield slate, a member of the lower oolitic group quarried near Oxford; and this was for several years the only specimen known to exist so early; but now many species have been found in a corresponding rock at Solenhofen, in Germany. It is remarkable that the remains of insects are found most plentifully near the remains of pterodactyles, to which they are presumed to have served as prey.

The first glimpse of the highest class of the vertebrate sub-kingdom—*mammalia*—is obtained from the Stonesfield slate, where there have been found several specimens of

* In some instances, these fossils are found with the contents of the stomach faithfully preserved, and even with pieces of the external skin. The pellets ejected by them (*coprolites*) are found in vast numbers, each generally enclosed in a nodule of ironstone, and sometimes showing remains of the fishes which had formed their food.

the lower jaw-bone of a quadruped evidently insectivorous, and inferred, from peculiarities of structure, to have belonged to the marsupial family (pouched animals).* It may be observed, although no specimens of so high a class of animals as mammalia are found earlier, such may nevertheless have existed: the defect may be in our not having found them; but other things considered, the probability is that heretofore there were no mammifers. It is an interesting circumstance that the first mammifers found should have belonged to the marsupialia, when the place of that order in the scale of creation is considered. In the imperfect structure of their brain, deficient in the organs connecting the two hemispheres—and in the mode of gestation, which is only in small part uterine—this family is clearly a link between the oviparous vertebrata (birds, reptiles, and fishes) and the higher mammifers. This is further established by their possessing a faint development of two canals passing from near the anus to the external surface of the viscera, which are fully possessed in reptiles and fishes, for the purpose of supplying aerated water to the blood circulating in particular vessels, but which are unneeded by mammifers. Such rudiments of organs in certain species which do not require them in any degree, are common in both the animal and vegetable kingdoms, but are always most conspicuous in families approaching in character to those classes to which the full organs are proper. This subject will be more particularly adverted to in the sequel.

* Fragments attributed to a cetaceous animal, another humble form of the mammal class, have likewise been found in the great oolite, near Oxford.

The highest part of the oolitic formation presents some phenomena of an unusual and interesting character, which demand special notice. Immediately above the upper oolitic group in Buckinghamshire, in the vicinity of Weymouth, and other situations, there is a thin stratum, usually called by workmen the *dirt-bed*, which appears, from incontestable evidence, to have been a soil, formed, like soils of the present day, in the course of time, upon a surface which had previously been the bottom of the sea. The dirt-bed contains exuviæ of tropical trees, accumulated through time, as the forest shed its honors on the spot where it grew, and became itself decayed. Near Weymouth there is a piece of this stratum, in which stumps of trees remain rooted, mostly erect or slightly inclined, and from one to three feet high; while trunks of the same forest, also silicified, lie imbedded on the surface of the soil in which they grew.

Above this bed lie those which have been called the Wealden, from their full development in the Weald of Sussex; and these as incontestably argue that the dry land forming the dirt-bed had next afterwards become the area of brackish estuaries, or lakes partially connected with the sea; for the Wealden strata contain exuviæ of freshwater tribes, besides those of the great saurians and chelonia. The area of this estuary comprehends the whole south-east province of England. A geologist thus confidently narrates the subsequent events: "Much calcareous matter was first deposited [in this estuary], and in it were entombed myriads of shells, apparently analogous to those of the vivipara. Then came a thick envelope of sand, sometimes interstratified with mud; and, finally, muddy matter prevailed. The solid surface beneath the waters would appear to have suffered a long continued and gradual depression, which was as gradually filled, or nearly so, with transported matter; in the end, however, after a depression of several hundred feet, the sea again entered upon the area, not suddenly or violently—for the Wealden rocks pass gradually into the superincumbent cretaceous series—but so quietly, that the mud containing the remains of terrestrial and fresh-water creatures was tranquilly covered up by sands replete with marine exuviæ."* A subsequent depression of the same area, to the depth of at least three hundred fathoms, is believed to have taken place, to admit of the deposition of the cretaceous beds lying above.

From the scattered way in which remains of the larger terrestrial animals occur in the Wealden, and the intermixture of pebbles of the special appearance of those worn in rivers, it is also inferred that the estuary which once covered the south-east part of England was the mouth of a river of that far-descending class of which the Mississippi and Amazon are examples. What part of the earth's surface presented the dry land through which that and other similar rivers flowed, no one can tell. It has been surmised, that the particular one here spoken of may have flowed from a point not nearer than the site of the present Newfoundland. Professor Phillips has suggested, from the analogy of the mineral composition, that anciently elevated coal strata may have composed the dry land from which the sandy matters of these strata were washed. Such a deposit as the Wealden almost necessarily implies a local,

* De la Beche's Geological Researches, p. 344.

not a general condition; yet it has been thought that similar strata and remains exist in the Pays de Bray, near Beauvais. This leads to the supposition that there may have been, in that age, a series of river-receiving estuaries along the border of some such great ocean as the Atlantic, of which that of modern Sussex is only an example.

ERA OF THE CRETACEOUS FORMATION.

The record of this period consists of a series of strata, in which chalk beds make a conspicuous appearance, and which is therefore called the cretaceous system or formation. In England, a long stripe, extending from Yorkshire to Kent, presents the cretaceous beds upon the surface, generally lying conformably upon the oolite, and in many instances rising into bold escarpments towards the west. The celebrated cliffs of Dover are of this formation. It extends into northern France, and thence north-westward into Germany, whence it is traced into Scandinavia and Russia. The same system exists in North America, and probably in other parts of the earth not yet geologically investigated. Being a marine deposit, it establishes that seas existed at the time of its formation on the tracts occupied by it, while some of its organic remains prove that, in the neighborhood of those seas, there were tracts of dry land.

The cretaceous formation in England presents beds chiefly sandy in the lowest part, chiefly clayey in the middle, and chiefly of chalk in the upper part, the chalk beds being never absent, which some of the lower are in several places. In the vale of the Mississippi again, the true chalk is wholly, or all but wholly absent. In the south of England, the lower beds are (reckoning from the lowest upwards), 1. *Shankland* or *greensand*, "a triple alternation of sands and sandstones with clay;" 2. *Galt*, "a stiff blue or black clay, abounding in shells, which frequently possess a pearly lustre;" 3. *Hard* chalk; 4. Chalk with flints; these two last being generally white, but in some districts red, and in others yellow. The whole are, in England, about 1200 feet thick, showing the considerable depths of the ocean in which the deposits were made.

Chalk is a carbonate of lime, and the manner of its production in such vast quantities was long a subject of speculation among geologists. Some light seemed to be thrown upon the subject a few years ago, when it was observed, that the detritus of coral reefs in the present tropical seas gave a powder, undistinguishable, when dried, from ordinary chalk. It then appeared likely that the chalk beds were the detritus of the corals which were in the oceans of that era. Mr. Darwin, who made some curious inquiries on this point, further suggested, that the matter might have intermediately passed through the bodies of worms and fish, such as feed on the corals of the present day, and in whose stomachs he has found impure chalk. This, however, cannot be a full explanation of the production of chalk, if we admit some more recent discoveries of Professor Ehrenberg. That master of microscopic investigation announces, that chalk is composed partly of "inorganic particles of irregular elliptical structure and granular slaty disposition," and partly of shells of inconceivable minuteness, "varying from the one-twelfth to the two hundred and eighty-eighth part of a line"—a cubic inch of the substance containing above ten millions of them! The chalk of the north of Europe contains, he says, a larger proportion of the inorganic matter; that of the south, a larger proportion of the organic matter, being in some instances almost entirely composed of it. He has been able to classify many of these creatures, some of them being allied to the nautili, mummuli, cyprides, &c. The shells of some are calcareous, of others siliceous. M. Ehrenberg has likewise detected microscopic sea-plants in the chalk.

The distinctive feature of the uppermost chalk beds in England is the presence of flint nodules. These are generally disposed in layers parallel to each other. It was readily presumed by geologists that these masses were formed by a chemical aggregation of particles of silica, originally held in solution in the mass of the chalk. But whence the silica in a substance so different from it? Ehrenberg suggests that it is composed of the siliceous coverings of a portion of the microscopic creatures, whose shell he has in other instances detected in their original condition. It is remarkable that the chalk *with* flint abounds in the north of Europe; that *without* flints in the south; while in the northern chalk siliceous animalcules are wanting, and in the southern present in great quantities. The conclusion seems hardly avoidable, that in the one case the siliceous exuviæ have been left in their original form; in the other dissolved chemically, and aggregated on the common principle of chemical affinity into nodules of flint, probably concentrating, in every instance, upon a piece of decaying organic matter, as has been the case with the nodules of ironstone in the earlier rocks, and the spherules of the oolite.

What is more remarkable, M. Ehrenberg has ascertained that at least fifty-seven species of the microscopic animals of the chalk, being infusoria and calcareous-shelled polythalamia, are still found living in various parts of the earth. These species are the most abundant in the rock. Singly they are the most unimportant of all animals, but in the mass, forming as they do such enormous strata over a large part of the earth's surface, they have an importance greatly exceeding that of the largest and noblest of the beasts of the field. Moreover, these species have a peculiar interest, as the only specific types of that early age which are reproduced in the present day. Species of sea mollusks, of reptiles, and of mammifers, have been changed again and again, since the cretaceous era; and it is not till a long subsequent age that we find the first traces of any other of even the humblest species which now exist; but here have these humble infusoria and polythalamia kept their place on earth through all its revolutions since that time,—are we to say, safe in their very humility, which might adapt them to a greater variety of circumstances than most other animals, or are we required to look for some other explanation of the phenomena?

All the ordinary and more observable orders of the inhabitants of the sea, except the cetacea, have been found in the cretaceous formation—zoophytes, radiaria, mollusks, crustacea (in great variety of species), and fishes in smaller variety. Down to this period, the placoid and ganoid fishes had, as far as we have evidence, flourished alone; now they decline, and we begin to find in their place fishes of two orders of superior organization, the orders which predominate in the present creation. These are osseous in internal structure, with corneous scales, the latter being circular in the one case, and pectinated or indented at one side in the other; hence the two orders are called respectively cycloid and ctenoid by M. Agassiz, who, as has been remarked, asserts that the outer covering of fishes is a sufficient indication of their whole structure. In Europe, no remains of the marine saurians have been found; they may be presumed to have become extinct in that part of the globe before this time.

In America, however, remains of the plesiosaurus have been discovered in this part of the stratified series. The reptiles, too, so numerous in the two preceding periods, appear to have now too much diminished in numbers. One of the most remarkable was the mosœsaurus, which seems to have held an intermediate place between the monitor and iguana, and to have been about twenty-five feet long, with a tail calculated to assist it powerfully in swimming.

Fuci abounded in the seas of this era, and confervæ are found enclosed in flints. Of terrestrial vegetation, as of terrestrial animals, the specimens in the European area are comparatively rare, rendering it probable that there was no dry land near. The remains are chiefly of ferns, conifers, and cycadeæ, but in the two former cases we have only cones and leaves. There have been discovered many pieces of wood, containing holes drilled by the teredo, and thus showing that they had been long drifted about in the ocean before being entombed at the bottom.

The series in America corresponding to this, entitled the Ferruginous Sand formation, presents fossils generally identical with those of Europe, not excepting the fragments of drilled wood; showing that, in this, as in earlier ages, there was a parity of conditions for animal life over a vast tract of the earth's surface. To European reptiles, the American formation adds a gigantic one, styled the saurodon, from the lizard-like character of its teeth.

We have seen that footsteps of birds are discovered in America, in the new red sandstone. Some similar isolated phenomena occur in the subsequent formations. Dr. Mantell found some bones of birds, apparently waders, in the Wealden. The immediate connexion of that set of beds with land, may account, of course, for their containing a terrestrial organic relic, which the marine beds above and below did not possess. In the slate of Glaris, in Switzerland, corresponding to the English galt, in the chalk formation, the remains of a bird have been found. From a chalk bed near Maidstone, have likewise been extracted some remains of a bird, supposed to have been of the long-winged swimmer family, and equal in size to the albatross. These, it must be owned, are less strong traces of the birds than we possess of the reptiles and other tribes; but it must be remembered, that the evidence of fossils, as to the absence of any class of animals from a certain period of the earth's history, is only negative. Animals, of which we find no remains in a particular formation, may, nevertheless, have lived at the time, and it may only have been from unfavorable circumstances that their remains have not been preserved for our inspection. The single circumstance of their being little liable to be carried down into seas, might be the cause of their non-appearance in our quarries. There is at the same time a limit to uncertainty on this point. We see, from what remains have been found in the whole series, a clear progress throughout, from humble to superior types of being. Hence we derive a light as to what animals may have existed at particular times, which is in some measure independent of the specialties of fossilology. The birds are below the mammalia in the animal scale; and therefore they may be supposed to have existed about the time of the new red sandstone and oolite, although we find but slight traces of them in those formations, and, it may be said, till a considerably later period.

ERA OF THE TERTIARY FORMATION—MAMMALIA ABUNDANT.

The chalk-beds are the highest which extend over a considerable space; but in hollows of these beds, comparatively limited in extent, there have been formed series of strata—clays, limestones, marls, alternating—to which the name of the *Tertiary Formation* has been applied. London and Paris alike rest on basins of this formation, and another such basin extends from near Winchester, under Southampton, and re-appears in the Isle of Wight. A strip of it extends along the east coast of North America, from Massachusetts to Florida. It is also found in Sicily and Italy, insensibly blended with formations still in progress. Though comparatively a local formation, it is not of the least importance as a record of the earth during a certain period. As in other formations, it is marked, in the most distant localities, by identity of organic remains.

The hollows filled by the tertiary formation must be considered as the beds of estuaries left at the conclusion of the cretaceous period. We have seen that an estuary, either by the drifting up of its mouth, or a change of level in that quarter, may be supposed to have become an inland sheet of water, and that, by another change, of the reverse kind, it may be supposed to have become an estuary again. Such changes the Paris basin appears to have undergone oftener than once, for, first, we have there a fresh-water formation of clay and limestone beds ; then, a marine-limestone formation ; next, a second fresh-water formation, in which the material of the celebrated *plaster of Paris* (gypsum) is included ; then a second marine formation of sandy and limy beds ; and finally a third series of fresh-water strata. Such alternations occur in other examples of the tertiary formation likewise.

The tertiary beds present all but an entirely new set of animals, and as we ascend in the series, we find more and more of these identical with species still existing upon earth, as if we had now reached the dawn of the present state of the zoology of our planet. By the study of the shells alone, Mr. Lyell has been enabled to divide the whole term into four sub-periods, to which he has given names with reference to the proportions which they respectively present of surviving species—first, the eocene (from 'ηως, the dawn ; χαινος, recent) ; second the miocene (μειων, less) ; third, older pliocene (πλειων, more) ; fourth, newer pliocene.

EOCENE SUB-PERIOD.

The eocene period presents, in three continental groups, 1238 species of shells, of which forty-two, or 3·5 per cent. yet flourish. Some of these are remarkable enough ; but they all sink into insignificance beside the mammalian remains which the lower eocene deposits of the Paris basin present to us, showing that the land had now become the theatre of an extensive creation of the highest class of animals. Cuvier ascertained about fifty species of these, all of them long since extinct. A considerable number are *pachydermata*,* of a character approximating to the South American tapir: the names, palæotherium, anthracotherium, anoplotherium, lophiodon, &c., have been applied to them with a consideration of more or less conspicuous peculiarities; but a description of the first may give some general idea of the whole. It was about the size of a horse, but more squat and clumsy, and with a heavier head, and a lower jaw shorter than the upper; the feet, also, instead of hooves, presented three large toes, rounded, and unprovided with claws. The animals were all herbivorous. Amongst an immense number of others are found many new reptiles, some of them adapted for fresh water; species of birds allied to the sea-lark, curlew, quail, buzzard, owl, and pelican; species allied to the dormouse and squirrel; also the opossum and racoon; and species allied to the genette, fox, and wolf.

MIOCENE SUB-PERIOD.

In the miocene sub-period, the shells give eighteen per cent. of existing species, showing a considerable advance from the preceding era, with respect to the inhabitants of the sea. The advance in the land animals is less marked,

* Thick-skinned animals. This term has been given by Cuvier to an order in which the hog, elephant, horse, and rhinoceros are included.

but yet considerable. The predominating forms are still pachydermatous, and the tapir type continues to be conspicuous. One animal of this kind, called the *dinotherium*, is supposed to have been not less than eighteen feet long; it had a mole-like form of the shoulder-blade, conferring the power of digging for food, and a couple of tusks turning down from the lower jaw, by which it could have attached itself, like the walrus, to a shore or bank, while its body floated in the water. Dr. Buckland considers this and some similar miocene animals, as adapted for a semi-aquatic life, in a region where lakes abounded. Besides the tapirs, we have in this era animals allied to the glutton, the bear, the dog, the horse, the hog, and lastly, several felinæ (creatures of which the lion is the type); all of which are new forms, as far as we know. There was also an abundance of marine mammalia, seals, dolphins, lamantins, walruses, and whales, none of which had previously appeared.

PLIOCENE SUB-PERIOD.

The shells of the older pliocene give from thirty-five to fifty; those of the newer, from ninety to ninety-five per cent. of existing species. The pachydermata of the preceding era now disappear, and are replaced by others belonging to still existing families—elephant, hippopotamus, rhinoceros—though now extinct as species. Some of these are startling, from their enormous magnitude. The great mastodon, whose remains are found in abundance in America, was a species of elephant, judged, from peculiarities of its teeth, to have lived on aquatic plants, and reaching the height of twelve feet. The mammoth was another elephant, but supposed to have survived till comparatively recent times, as a specimen, in all respects entire, was found in 1801, preserved in ice, in Siberia. We are more surprised by finding such gigantic proportions in an animal called the megatherium, which ranks in an order now assuming much humbler forms—the edentata—to which the sloth, ant-eater, and armadillo belong. The megatherium had a skeleton of enormous solidity, with an armor-clad body, and five toes, terminating in huge claws, wherewith to grasp the branches, from which, like its existing congener, the sloth, it derived its food. The megalonyx was a similar animal, only somewhat less than the preceding. Finally, the pliocene gives us for the first time, oxen, deer, camels, and other specimens of the *ruminantia.*

Such is an outline of the Fauna of the tertiary era, as ascertained by the illustrious naturalists who first devoted their attention to it. It will be observed that it brings us up to the felinæ, or carnivora, a considerably elevated point in the animal scale, but still leaving a blank for the quadrumana (monkeys) and for man, who collectively form, as will be afterwards seen, the first group in that scale. It sometimes happens, however, as we have seen, that a few rare traces of a particular class of animals are in time found in formations originally thought to be destitute of them, displaying as it were a dawn of that department of creation. Such seems to be the case with at least the quadrumana. A jaw-bone and tooth of an animal of this order, and belonging to the genus macacus, were found in the London clay (eocene), at Kyson, near Woodbridge, in 1839. Another jaw-bone, containing several teeth, supposed to have belonged to a species of monkey about three feet high, was discovered about the same time in a stratum of marl surmounted by compact limestone, in the department of Gers, at the foot of the Pyrenees. Associated with this last were remains of not less than thirty mammiferous quadrupeds, including three species of rhinoceros, a large anoplotherium, three species of deer, two antelopes, a true dog, a large cat, an animal like a weazel, a small hare, and a huge species of the edentata. Both of these places are considerably to the north of any region now inhabited by the monkey tribes. Fossil remains of quadrumana have been found in at least two other parts of the earth,—namely, the sub-Himalayan hills, near the Setlej, and in Brazil (both in the tertiary strata) ; the first being a large species of semnopithecus, and the second, a still larger animal belonging to the American group of monkeys, but a new genus, and denominated by its discoverer, Dr. Lund, protopithecus. The latter would be four feet in height.

One remarkable circumstance connected with the tertiary formation remains to be noticed,—the prevalence of volcanic action at that era. In Auvergne, in Catalonia, near Venice, and in the vicinity of Rome and Naples, lavas exactly resembling the produce of existing volcanoes, are associated and intermixed with the lacustrine as well as marine tertiaries. The superficies of tertiaries in England is disturbed by two great swells, forming what are called anticlinal axes, one of which divides the London from the Hampshire basin, while the other passes through the Isle of Wight, both throwing the strata down at a violent inclination towards the north, as if the subterranean disturbing force had *waved* forward in that direction. The Pyrenees, too, and Alps, have both undergone elevation since the deposition of the tertiaries; and in Sicily there are mountains which have risen three thousand feet since the deposition of some of the most recent of these rocks. The general effect of these operations was of course to extend the land surface, and to increase the variety of its features, thus improving the natural drainage, and generally adapting the earth for the reception of higher classes of animals.

ERA OF THE SUPERFICIAL FORMATIONS.

COMMENCEMENT OF PRESENT SPECIES.

We have now completed our survey of the series of stratified rocks, and traced in their fossils the progress of organic creation down to a time which seems not long antecedent to the appearauce of man. There are, nevertheless, memorials of still another era or space of time which it is all but certain did also precede that event.

The first that calls for notice is the phenomenon to which geologists have applied the term denudation. Great hitches and slips are detected in superficial strata,—such as, if left in their original state, must have caused considerable inequalities on the face of the country; yet all is found as smooth—the joinings are all as much reduced to a common level—as if some gigantic artificial force had been used for the purpose. Again, a great valley has been scooped out in the midst of sedimentary strata, leaving the edges of these facing each other from the opposite sides, with perhaps here and there an isolated mass starting up to the height of the two sides, being composed of matter which has resisted the agency by which the adjoining matter was removed. There, it is thought, we see incontestable traces of the operation of moving water. The second fact we are called to notice is that, over the rock formations of all eras, in various parts of the globe, but confined in general to situations not very elevated, there is a layer of stiff clay, mostly of a blue color, mingled with fragments of rock of all sizes, travel-worn, and otherwise, and to which geologists give the name of diluvium, as being apparently the produce of some vast flood, or of the sea thrown into an unusual agitation. It seems to indicate that, at the time when it was laid down, much of the present dry land was under the ocean, a supposition which we shall see supported by other evidence. The included masses of rock have been carefully inspected in many places, and traced to particular parent beds at considerable distances. Connected with these phenomena are certain rock surfaces on the slopes of hills and elsewhere, which exhibit groovings and scratchings, such as we might suppose would be produced by a quantity of loose blocks hurried along over them by a flood. Another associated phenomenon is that called *crag and tail*, which exists in many places,—namely, a rocky mountain, or lesser elevation, presenting on one side the naked rock in a more or less abrupt form, and on the other a gentle slope; the sites of Windsor, Edinburgh, and Stirling, with their respective castles, are specimens of crag and tail. Finally, we may advert to certain long ridges of clay and gravel which arrest the attention of travellers on the surface of Sweden and Finland, and which are also found in the United States, where, indeed, the whole of these phenomena have been observed over a large surface, as well as in Europe. It is very remarkable that the direction from which the diluvial blocks have generally come, the lines of the grooved rock surfaces, the direction of the crag and tail eminences, and that of the clay and gravel ridges—phenomena, be it observed, extending over the northern parts of both Europe and America—*are all from the north and north-west towards the south-east*. We thus acquire the idea of a powerful current moving in a direction from north-west to south-east, carrying, besides mud, masses of rock which furrowed the solid surfaces as they passed along, abrading the north-west faces of many hills, but leaving the slopes in the opposite direction uninjured, and in some instances forming long ridges of detritus along the surface. These are curious considerations, and it has become a question of much interest, by what means, and under what circumstances, was such a current produced. One hypothesis is not without some plausibility. From an investigation of the nature of glaciers, and some observations which seem to indicate that these have at one time extended to the lower levels, and existed in regions (the Scottish Highlands an example) where there is now no perennial snow, it has been surmised that there was a time, subsequent to the tertiary era, when the circumpolar ice extended far into the temperate zone, and formed a lofty, as well as extensive accumulation. A change to a higher temperature, producing a sudden thaw of this mass, might set free such a quantity of water as would form a large flood, and the southward flow of this deluge, joined to the direction which it would obtain from the rotatory motion of the globe, would of course produce that compound of south-easterly direction which the phenomena require. All of these speculations are as yet far too deficient in facts to be of much value; and I must freely own that, for one, I attach little importance to them. All that we can legitimately infer from the diluvium is, that the northern parts of Europe and America were then under the sea, and that a strong current set over them.

Connected with the diluvium is the history of *ossiferous caverns*, of which specimens singly exist at Kirkdale in Yorkshire, Gailenreuth in Franconia, and other places. They occur in the calcareous strata, as the great caverns generally do, but have in all instances been naturally closed up till the recent period of their discovery. The floors are covered with what appears to be a bed of the diluvial clay, over which rests a crust of stalagmite, the result of the droppings from the roof since the time when the clay bed was laid down. In the instances above specified, and several others, there have been found, under the clay bed, assemblages of the bones of animals, of many various kinds. At Kirkdale, for example, the remains of twenty-four species were ascertained—namely, pigeon, lark, raven, duck, and partridge; mouse, water-rat, rabbit, hare, hippopotamus, rhinoceros, elephant, weasel, fox, wolf, deer (three species), ox, horse, bear, tiger, hyena. From many of the bones of the gentler of these animals being found in a broken state, it is supposed that the cave was a haunt of hyenas and other predaceous animals, by which the smaller ones were here consumed. This must have been at a time antecedent to the submersion which produced the diluvium, since the bones are covered by a bed of that formation. It is impossible not to see here a very natural series of incidents. First, the cave is frequented by wild beasts, who make it a kind of charnel-house. Then, submerged in the current which has been spoken of, it receives a clay flooring from the waters containing that matter in suspension. Finally raised from the water, but with no mouth to the open air, it remains unintruded on for a long series of ages, during which the clay flooring receives a new calcareous covering, from the droppings of the roof. Dr. Buckland, who examined and described the Kirkdale cave, was at first of opinion that it presented a physical evidence of the Noachian deluge; but he afterwards saw reason to consider its phenomena as of a time far apart from that event, which rests on evidence of an entirely different kind.

Our attention is next drawn to the erratic blocks or boulders, which in many parts of the earth are thickly strewn over the surface, particularly in the north of Europe. Some of these blocks are many tons in weight, yet are clearly ascertained to have belonged originally to situations at a great distance. Fragments, for example, of the granite of Shap Fell are found in every direction around to the distance of fifty miles, one piece being placed high upon Criffel Mountain, on the opposite side of the Solway estuary; so also are fragments of the Alps found far up the slopes of the Jura. There are even blocks on the east coast of England, supposed to have travelled from Norway. The only rational conjecture which can be formed as to the transport of such masses from so great a distance, is one which presumes them to have been carried and dropped by icebergs, while the space between their original and final sites was under ocean. Icebergs do even now carry off such masses from the polar coasts, which falling when the retaining ice melts, must take up situations at the bottom of the sea analogous to those in which we find the erratic blocks of the present day.

As the diluvium and erratic blocks clearly suppose one last long submersion of the surface (*last*, geologically speaking), there is another set of appearances which as manifestly show the steps by which the land was made afterwards to reappear. These consist of *terraces*, which have been detected near, and at some distance inland from the coast lines of Scandinavia, Britain, America, and other regions; being evidently ancient beaches, or platforms, on which the margin of the sea at one time rested. They have been observed at different heights above the present sea-level, from twenty to above twelve hundred feet; and in many places they are seen rising above each other in succession, to the number of three, four, and even more. The smooth flatness of these terraces, with generally a slight inclination towards the sea, the sandy composition of many of them, and, in some instances, the preservation of marine shells in the ground, identify them perfectly with existing sea-beaches, notwithstanding the cuts and scoopings which have at frequent intervals been effected in them by water-courses. The irresistible inference from the phenomena is, that the highest was first the coast line: then an elevation took place, and the second highest became so, the first being now raised into the air and thrown inland. Then, upon another elevation, the sea began to form at its new point of contact with the land, the third highest beach, and so on down to the platform nearest to the present sea-beach. Phenomena of this kind become comparatively familiar to us, when we hear of evidence that the last sixty feet of the elevation of Sweden, and the last eighty-five of that of Chili, have taken place since man first dwelt in those countries; nay, that the elevation of the former country goes on at this time at the rate of about forty-five inches in a century, and that a thousand miles of Chilian coast rose four feet in one night, under the influence of a powerful earthquake, so lately as 1822. Subterranean forces, of the kind then exemplified in Chili, supply a ready explanation of the whole phenomena, though some other operating causes have been suggested. In an inquiry on this point, it becomes of consequence to learn some particulars respecting the levels. Taking a particular beach, it is generally observed that the level continues the same along a considerable number of miles, and nothing like breaks or hitches has as yet been detected in any case. A second and a third beach are also observed to be exactly parallel to the first. These facts would seem to indicate quiet elevating movements, uniform over a large tract. It must, however, be remarked that the raised beaches at one part of a coast rarely coincide with those at another part forty or fifty miles off. We might suppose this to indicate a limit in that extent of the uniformity of the elevating cause, but it would be rash to conclude positively that such is the case. In the present sea, as is well known, there are different levels at different places, owing to the operation of peculiar local causes, as currents, evaporation, and the influx of large rivers into narrow-mouthed estuaries. The differences of level in the ancient beaches might be occasioned by some such causes. But, whatever doubt may rest on this minor point, enough has been ascertained to settle the main one, that we have in these platforms indubitable monuments of the last rise of the land from the sea, and the concluding great event of the geological history.

The idea of such a wide-spread and possibly universal submersion unavoidably suggests some considerations as to the effect which it might have upon terrestrial animal life. It seems likely that this would be, on such an occasion, extensively, if not universally destroyed. Nor does the idea of its universal destruction seem the less plausible, when we remark, that none of the species of land animals heretofore discovered can be detected at a subsequent period. The whole seem to have been now changed. Some geologists incline to think that there was at this time a new development of terrestrial animal life upon the globe, and M. Agassiz, whose opinion on such a subject is eminently worthy of attention, speaks all but decidedly for such a conclusion. It must, however, be owned, that proofs for it are still scanty, beyond the bare fact of a submersion which appears to have had a very wide range. I must therefore be content to leave this point, as far as geological evidence is concerned, for future determination.

There are some other superficial deposits, of less consequence on the present occasion than the diluvium—namely, lacustrine deposits, or filled-up lakes; alluvium, or the deposits of rivers beside their margins; deltas, the deposits made by great ones at their efflux into the sea; peat mosses; and the vegetable soil. The animal remains found in these generally testify to a zoology on the verge of that which still exists, or melting into it, there being included many species which still exist. In a lacustrine deposit at Market-Weighton, in the Vale of York, there have been found bones of the elephant, rhinoceros, bison, wolf, horse, felis, deer, birds, all or nearly all belonging to extinct species; associated with thirteen species of land and fresh-water shells, "exactly identical with types now living in the vicinity." In similar deposits in North America, are remains of the mammoth, mastodon, buffalo, and other animals of extinct and living types. In short, these superficial deposits show precisely such remains as might be expected from a time at which the present system of things (to use a vague but not unexpressive phrase) obtained, but yet so far remote in chronology as to allow of the dropping of many species, through familiar causes, in the interval. Still, however, there is no authentic or satisfactory instance of human remains being found, except in deposits obviously of very moderate date; a tolerably strong proof that the creation of our own species is a comparatively recent event, and one posterior (generally speaking) to all the great natural transactions which have been here described.

GENERAL CONSIDERATIONS

RESPECTING

THE ORIGIN OF THE ANIMATED TRIBES.

Thus concludes the wondrous chapter of the earth's history which is told by geology. It takes up our globe at the period when its original incandescent state had nearly ceased; conducts it through what we have every reason to believe were vast, or at least very considerable, spaces of time, in the course of which many superficial changes took place, and vegetable and animal life was gradually developed; and drops it just at the point when man was apparently about to enter on the scene. The compilation of such a history, from materials of so extraordinary a character, and the powerful nature of the evidence which these materials afford, are calculated to excite our admiration, and the result must be allowed to exalt the dignity of science, as a product of man's industry and his reason.

If there is anything more than another impressed on our minds by the course of the geological history, it is, that the same laws and conditions of nature now apparent to us have existed throughout the whole time, though the operation of some of these laws may now be less conspicuous than in the early ages, from some of the conditions having come to a settlement and a close. That seas have flowed and ebbed, and winds disturbed their surfaces, in the time of the secondary rocks, we have proof on the yet preserved surface of the sands which constituted margins of the seas in those days. Even the fall of wind-slanted rain is evidenced on the same tables. The washing down of detached matter from elevated grounds, which we see rivers constantly engaged in at the present time, and which is daily shallowing the seas adjacent to their mouths, only proceeded on a greater scale in earlier epochs. The volcanic subterranean force, which we see belching forth lavas on the sides of mountains, and throwing up new elevations by land and sea, was only more powerfully operative in distant ages. To turn to organic nature, vegetation proceeded then exactly as now. The very alternation of the seasons has been read in unmistakable characters in sections of the trees of those days, precisely as it might be read in a section of a tree cut down yesterday. The system of prey amongst animals flourished throughout the whole of the pre-human period; and the adaptation of all plants and animals to their respective spheres of existence was as perfect in those early ages as it is still.

But, as has been observed, the operation of the laws may be modified by conditions. At one early age, if there was any dry land at all, it was perhaps enveloped in an atmosphere unfit for the existence of terrestrial animals, and which had to go through some changes before that condition was altered. In the carbonigenous era, dry land seems to have consisted only of clusters of islands, and the temperature was much above what now obtains at the same places. Volcanic forces, and perhaps also the disintegrating power, seem to have been on the decrease since the first, or we have at least long enjoyed an exemption from such paroxysms of the former, as for certain prevailed at the close of the coal formation in England and throughout the tertiary era. The surface has also undergone a gradual progress by which it has become always more and more variegated, and thereby fitted for the residence of a higher class of animals.

In pursuing the progress of the development of both plants and animals upon the globe, we have seen an advance in both cases, from simple to higher forms of organization. Amongst plants, we have first sea-weeds, afterwards land plants; and amongst these the simpler (cellular and cryptogamic) before the more complex. In the department of zoology, we see, first, traces all but certain of infusoria; then polypiaria, crinoidea, and some humble forms of the articulata and mollusca; afterwards higher forms of the mollusca; and it appears that these existed for ages before there were any higher types of being. The first step forward gives fishes, the humblest class of the vertebrata; and, moreover, the earliest fishes partake of the character of the lower sub-kingdom, the articulata. Afterwards come land animals, of which the first are reptiles, universally allowed to be the type next in advance from fishes, and to be connected with these by the links of an insensible gradation. From reptiles we advance to birds, and thence to mammalia, which are commenced by marsupialia, acknowledgedly low forms in their class.

That there is thus a progress of some kind, the most superficial glance at the geological history is sufficient to convince us. Indeed the doctrine of the gradation of animal forms has received a remarkable support from the discoveries of this science, as several types formerly wanting to a completion of the series have been found in a fossil state.*

Fossil history has no doubt still some obscure passages; and these have been partially adverted to in the preceding pages. Sea-weeds, it has been remarked, are not the lowest forms of aquatic vegetation; neither are the plants of the coal-measures the very lowest, though they are a low form, of land vegetation. But, it may be asked, could we expect to see confervæ, or land cryptogamia inferior to ferns, preserved in rocks? Is their organization such as to afford the least chance of their having been preserved? These blanks in the series are no more than blanks; and when a candid mind reflects on the nature of the missing forms, and further considers that those present are all in the order of their organic development, the whole phenomena appear exactly what might have been anticipated. It is also remarked, in objection, that the mollusca and articulata appear in the same group of rocks (the slate system) with polypiaria, crinoidea, and other specimens of the humblest subkingdom; some of the mollusca, moreover, being cephalopods, which are the highest of their division in point of organization. In strict fact, as has been shown, the

* Intervals in the series were numerous in the department of the pachydermata; many of these gaps are now filled up from the extinct genera found in the tertiary formation.

cephalopoda do not appear till the next epoch, that of the Silurian rocks. A nicer discrimination of the groups of these early strata has shown their posteriority in time to the gasteropods and other lower mollusks. A similar discrimination a few years earlier put an end to the idea that fishes appeared in the first fossiliferous rocks; they are now placed at the top of the Silurian,—ages, probably, after the origination of invertebrate animals. Seeing what discrimination of rock chronologies has done in these instances, is it unreasonable to ask that the contemporaneousness of crustacea and mollusks with radiata be held at least in suspense, until we shall have had the slate system more rigidly examined, particularly as there are appearances of infusoria in the Primaries? If this be denied, then I would say that I know to which side the charge of rash conclusions is most justly attributable. With regard to the so-called early occurrence of fishes partaking of the reptile character, I have in like manner to remark, that their occurring a full formation after the earliest and simplest fishes, is, considering how little we know of the space of time represented by a formation, not early. The subsequent rise of classes of fishes in which the saurian character does not appear, is a more startling objection; yet when we remember how curiously sub-kingdoms and classes overlap each other, and that the genetic connections are still generally so obscure, it is not insuperable. In short, all the objections which have been made to the great fact of a general progress of organic development throughout the geological ages, are merely frivolous, and, reading in the actual condemnation of some, the destiny of the rest, hardly worthy of the notice here taken of them.

It is scarcely less evident, from the geological record, that the progress of organic life has observed some correspondence with the progress of physical conditions on the surface. We do not know for certain that the sea, at the time when it supported radiated, molluscous, and articulated families, was incapable of supporting fishes; but causes for such a limitation are far from inconceivable. The huge saurians appear to have been precisely adapted to the low muddy coasts and sea margins of the time when they flourished. Marsupials appear at the time when the surface was generally in that flat, imperfectly variegated state in which we find Australia, the region where they now live in the greatest abundance, and one which has no higher native mammalian type. Finally, it was not till the land and sea had come into their present relations, and the former, in its principal continents, had acquired the irregularity of surface necessary for man, that man appeared. We have likewise seen reason for supposing that land animals could not have lived before the carbonigenous era, owing to the great charge of carbonic acid gas presumed to have been contained in the atmosphere down to that time. The surplus of this having gone, as M. Brogniart suggests, to form the vegetation whose ruins became coal, and the air being thus brought to its present state, land animals immediately appeared. So also, sea-plants were at first the only specimens of vegetation, because there appears to have been no place where other plants could be produced or supported. Land vegetation followed, at first simple, afterwards complex, probably in conformity with an advance of the conditions required by the higher class of plants. In short, we see everywhere throughout the geological history, strong traces of a parallel advance of the physical conditions of the organic forms.

In examining the fossils of the lower marine creation, with a reference to the kind of rock in connexion with which they are found, it is observed that some strata are attended by a much greater abundance of both species and individuals than others. They abound most in calcareous rocks, which is precisely what might be expected, since lime is necessary for the formation of the shells of the mollusks and articulata, and the hard substance of the crinoidea and corals; next in the carboniferous series; next in the tertiary; next in the new red sandstone; next in slates; and lastly, least of all, in the primary rocks.* This may have been the case without any regard to the origination of new species, but more probably it was otherwise; or why, for instance, should the polypiferous zoophyta be found almost exclusively in the limestones? There are, indeed, abundant appearances as if, throughout all the changes of the surface, the various kinds of organic life invariably *pressed in*, immediately on the specially suitable conditions arising, so that no place which could support any form of organic being might be left for any length of time unoccupied. Nor is it less remarkable how various species are withdrawn from the earth, when the proper conditions for their particular existence are changed. The trilobite, of which fifty species existed during the earlier formations, was extirpated before the secondary had commenced, and appeared no more. The ammonite is not found above the chalk.

* See paper by Professor Edward Forbes, read to the British Association, 1839.

The species, and even genera, of all the early radiata and mollusks, were exchanged for others long ago. Not one species of any creature which flourished before the tertiary (Ehrenberg's infusoria excepted) now exists; and of the mammalia which arose during that series, many forms are altogether gone, while of others we have now only kindred species. Thus to find not only frequent additions to the previously existing forms, but frequent withdrawals of forms which had apparently become inappropriate—a constant shifting as well as advance—is a fact calculated very forcibly to arrest attention.

A candid consideration of all these circumstances can scarcely fail to introduce into our minds a somewhat different idea of organic creation from what has hitherto been generally entertained. That God created animated beings, as well as the terraqueous theatre of their being, is a fact so powerfully evidenced, and so universally received, that I at once take it for granted. But in the particulars of this so highly supported idea, we surely here see cause for some re-consideration. It may now be inquired,—In what way was the creation of animated beings effected? The ordinary notion may, I think, be described as this,—that the Almighty Author produced the progenitors of all existing species by some sort of personal or immediate exertion. But how does this notion comport with what we have seen of the gradual advance of species, from the humblest to the highest? How can we suppose an immediate exertion of this creative power at one time to produce zoophytes, another time to add a few marine mollusks, another to bring in one or two crustacea, again to produce crustaceous fishes, again perfect fishes, and so on to the end? This would surely be to take a very mean view of the Creative Power—to, in short, anthropomorphize it, or reduce it to some such character as that borne by the ordinary proceedings of mankind. And yet this would be unavoidable; for that the organic creation was thus progressive through a long space of time, rests on evidence which nothing can overturn or gainsay. Some other idea must then be come to with regard to *the mode* in which the Divine Author proceeded in the organic creation. Let us seek in the history of the earth's formation for a new suggestion on this point. We have seen powerful evidence that the construction of this globe and its associates, and inferentially that of all the other globes of space, was the result, not of any immediate or personal exertion on the part of the Deity, but of natural laws which are expressions of his will. What is to hinder our supposing that the organic creation is also the result of natural laws, which are in like manner an expression of his will? More than this, the fact of the cosmical arrangements being an effect of natural law, is a powerful argument for the organic arrangements being so likewise, for how can we suppose that the august Being who brought all these countless worlds into form by the simple establishment of a natural principle flowing from his mind, was to interfere personally and specially on every occasion when a new shell-fish or reptile was to be ushered into existence on *one* of these worlds? Surely this idea is too ridiculous to be for a moment entertained.

It may be objected that the ordinary conceptions of Christian nations on this subject are directly derived from Scripture, or, at least, are in conformity with it; to which I would respectfully answer, that the Mosaic record appears, when perused with an awakened mind, much more in conformity with the present view than with that which has been so long entertained. All the procedure is represented primarily and pre-eminently as flowing *from commands and expressions of will, not from direct acts.* Let there be light—let there be a firmament—let the dry land appear—let the earth bring forth grass, the herb, the tree—let the waters bring forth the moving creature that hath life—let the earth bring forth the living creature after his kind—these are the terms in which the principal acts are described. The additional expressions,—God made the firmament—God made the beast of the earth, &c., occur subordinately, and only in a few instances; they do not necessarily convey a different idea of the mode of creation, and indeed only appear as alternative phrases, in the usual duplicative manner of Eastern narrative. Keeping this in view, the words used in a subsequent place, "God *formed* man in his own image," cannot well be understood as implying any more than what was implied before,—namely, that man was produced in consequence of an expression of the Divine will to that effect. Thus, the scriptural objection quickly vanishes, and the prevalent ideas about the organic creation appear only as a mistaken inference from the text, formed at the time when man's ignorance prevented him from drawing therefrom a just conclusion.

To a reasonable mind the Divine attributes must appear, not diminished or reduced in any way, by supposing a creation by law, but infinitely exalted. It is the narrowest of all views of the Deity, and characteristic of an humble class of intellects, to suppose him constantly acting in particular ways for particular occasions. It, for one thing, greatly detracts from his foresight, the most undeniable of all the attributes of Omnipotence. It lowers him towards the level of our own humble intellects. Much more worthy of him it surely is, to suppose that all things have been commissioned by him from the first, though neither is he absent from a particle of the current of natural affairs in one sense, seeing that the whole system is continually supported by his providence. Even in human affairs, if I may be allowed to adopt a familiar illustration, there is a constant progress from specific action for particular occasions, to arrangements which, once established, shall continue to answer for a great multitude of occasions. Such plans the enlightened readily form for themselves, and conceive as being adopted by all who have to attend to a multitude of affairs, while the ignorant suppose every act of the greatest public functionary to be the result of some special consideration and care on his part alone. Are we to suppose the Deity adopting plans which harmonize only with the modes of procedure of the less enlightened of our race? Those who would object to the hypothesis of a creation by the intervention of law, do not perhaps consider how powerful an argument in favor of the existence of God is lost by rejecting this doctrine. When all is seen to be the result of law, the idea of an Almighty Author becomes irresistible, for the creation of a law for an endless series of phenomena—an act of intelligence above all else that we can conceive—could have no other imaginable source, and tells, moreover, as strongly for a sustaining as for an originating power. On this point a remark of Dr. Buckland seems applicable: "If the properties adopted by the elements at the moment of their creation adapted them beforehand to the infinity of complicated useful purposes which they have already answered and may have still further to answer, under many dispensations of the material world, such an aboriginal constitution, so far from superseding an intelligent agent, would only exalt our conceptions of the consummate skill and power that could comprehend such an infinity of future uses under future systems, in the original groundwork of his creation."

A late writer, in a work embracing a vast amount of miscellaneous knowledge, but written in a dogmatic style, argues at great length for the doctrine of more immediate exertions on the part of the Deity in the works of his creation. One of the most striking of his illustrations is as follows:—"The coral polypi, united by a common animal bond, construct a defined form in stone; many kinds construct many forms. An allotted instinct may permit each polypus to construct its own cell, but there is no superintending one to direct the pattern, nor can the workers unite by consultation for such an end. There is no recipient for an instinct by which the pattern might be constructed. It is God alone, therefore, who is the architect; and for this end, consequently, he must dispose of every new polypus required to continue the pattern, in a new and peculiar position, which the animal could not have discovered by itself. Yet more, millions of these blind workers unite their works to form an island, which is almost wrought out according to a constant general pattern, and of a very peculiar nature, though the separate coral works are numerously diverse. Still less, then, here is an instinct possible. The Great Architect himself must execute what he planned, in each case equally. He uses these little and senseless animals as hands; but they are hands which he himself must direct. He must direct each one everywhere, and therefore he is ever acting."* This is a notable example of a dangerous kind of reasoning. It is now believed that corals have a general life and sensation throughout the whole mass, residing in the nervous tissue which envelopes them; consequently, there is nothing more wonderful in their determinate general forms than in those of other animals.

It may here be remarked that there is in our doctrine that harmony in all the associated phenomena which generally marks great truths. First, it agrees, as we have seen, with the idea of planet-creation by natural law. Secondly, upon this supposition, all that geology tells us of the succession of species appears natural and intelligible. Organic life *presses in*, as has been remarked, wherever there is room and encouragement for it, the forms being always such as suit the circumstances, and in a certain relation to them, as, for example, where the limestone-forming seas produce an abundance of corals, crinoidea, and shell-fish. How well the extensive changes of species which are evidenced by geology comport with our view of the details of law-creation, will be seen when these come to be explained. The more solitary commencements of species, which would have been the most inconceivably paltry exercise for an immediately creative power, are sufficiently worthy of one operating by laws.

It is also to be observed, that the thing to be accounted for is not merely the origination of organic being upon this little planet, third of a series which is but one of

* Macculloch on the Attributes of the Deity, iii., 569.

hundreds of thousands of series, the whole of which again form but one portion of an apparently infinite globe-peopled space, where all seems analogous. We have to suppose, that every one of these numberless globes is either a theatre of organic being, or in the way of becoming so. This is a conclusion which every addition to our knowledge makes only the more irresistible. Is it conceivable, as a fitting mode of exercise for creative intelligence, that it should be constantly moving from one sphere to another, to form and plant the various species which may be required in each situation at particular times? Is such an idea accordant with our general conception of the dignity, not to speak of the power, of the Great Author? Yet such is the notion which we must form, if we adhere to the doctrine of special exercise. Let us see, on the other hand, how the doctrine of a creation by law agrees with this expanded view of the organic world.

Unprepared as most men may be for such an announcement, there can be no doubt that we are able, in this limited sphere, to form some satisfactory conclusions as to the plants and animals of those other spheres which move at such immense distances from us. Suppose that the first persons of an early nation who made a ship and ventured to sea in it, observed, as they sailed along, a set of objects which they had never before seen—namely, a fleet of other ships—would they not have been justified in supposing that those ships were occupied, like their own, by human beings possessing hands to row and steer, eyes to watch the signs of the weather, intelligence to guide them from one place to another—in short, beings in all respects like themselves, or only showing such differences as they knew to be producible by difference of climate and habits of life? Precisely in this manner we can speculate on the inhabitants of remote spheres. We see that matter has originally been diffused in one mass, of which the spheres are portions. Consequently, inorganic matter must be presumed to be everywhere the same, although probably with differences in the proportions of ingredients in different globes, and also some difference of conditions. Out of a certain number of the elements of inorganic matter are composed organic bodies, both vegetable and animal; such must be the rule in Jupiter and in Sirius, as it is here. We, therefore, are all but certain that herbaceous and ligneous fibre, that flesh and blood, are the constituents of the organic beings of all those spheres which are as yet seats of life. Gravitation we see to be an all-pervading principle: therefore there must be a relation between the spheres and their respective organic occupants, by virtue of which they are fixed, as far as necessary, on the surface. Such a relation, of course, involves details as to the density and elasticity of structure, as well as size, of the organic tenants, in proportion to the gravity of the respective planets—peculiarities, however, which may quite well consist with the idea of a universality of general types, to which we are about to come. Electricity we also see to be universal; if, therefore, it be a principle concerned in life and in mental action, as science strongly suggests, life and mental action must everywhere be of one general character. We come to comparatively matter of detail, when we advert to heat and light; yet it is important to consider that these are universal agents, and that, as they bear marked relations to organic life and structure on earth, they may be presumed to do so in other spheres also. The considerations as to light are particularly interesting, for, on our globe, the structure of one important organ, almost universally distributed in the animal kingdom, is in direct and precise relation to it. Where there is light there will be eyes, and these, in other spheres, will be the same in all respects as the eyes of tellurian animals, with only such differences as may be necessary to accord with minor peculiarities of condition and of situation. It is but a small stretch of the argument to suppose that, one conspicuous organ of a large portion of our animal kingdom being thus universal, a parity in all the other organs—species for species, class for class, kingdom for kingdom—is highly likely, and that thus the inhabitants of all the other globes of space bear not only a general, but a particular resemblance to those of our own.

Assuming that organic beings are thus spread over all space, the idea of their having all come into existence by the operation of laws everywhere applicable, is only conformable to that principle, acknowledged to be so generally visible in the affairs of Providence, to have all done by the employment of the smallest possible amount of means. Thus, as one set of laws produced all orbs and their motions and geognostic arrangements, so one set of laws overspread them all with life. The whole productive or creative arrangements are therefore in perfect unity.

PARTICULAR CONSIDERATIONS

RESPECTING

THE ORIGIN OF THE ANIMATED TRIBES.

THE general likelihood of an organic creation by law having been shown, we are next to inquire if science has any facts tending to bring the assumption more nearly home to nature. Such facts there certainly are; but it cannot be surprising that they are comparatively few and scattered, when we consider that the inquiry is into one of nature's profoundest mysteries, and one which has hitherto engaged no direct attention in almost any quarter.

Crystallization is confessedly a phenomenon of inorganic matter; yet the simplest rustic observer is struck by the resemblance which the examples of it left upon a window by frost bear to vegetable forms. In some crystallizations the mimicry is beautiful and complete; for example, in the well-known one called the *Arbor Dianæ*. An amalgam of four parts of silver and two of mercury being dissolved in nitric acid, and water equal to thirty weights of the metals being added, a small piece of soft amalgam of silver, suspended in the solution, quickly gathers to itself the particles of the silver of the amalgam, which form upon it a *crystallization precisely resembling a shrub.* Vegetable figures are also presented in some of the most ordinary appearances of the electric fluid. In the marks caused by positive electricity, or which it leaves in its passage, we see the ramifications of a tree, as well as of its individual leaves; those of the negative recal the bulbous or the spreading root, according as they are clumped or divergent. These phenomena seem to say that the electric energies have had something to do in determining the forms of plants. That they are intimately connected with vegetable life is indubitable, for germination will not proceed in water charged with negative electricity, while water charged positively greatly favors it; and a garden sensibly increases in luxuriance, when a number of conducting rods are made to terminate in branches over its beds. With regard to the resemblance of the ramifications of the branches and leaves of plants to the traces of the positive electricity, and that of the roots to the negative, it is a circumstance calling for especial remark, that the atmosphere, particularly its lower strata, is generally charged positively, while the earth is always charged negatively. The correspondence here is curious. A plant thus appears as a thing formed on the basis of a natural electrical operation—*the brush* realized. We can thus suppose the various forms of plants as, immediately, the result of a law in electricity variously affecting them according to their organic character, or respective germinal constituents. In the poplar, the brush is unusually vertical, and little divergent; the reverse in the beech: in the palm, a pencil has proceeded straight up for a certain distance, radiates there, and turns outwards and downwards; and so on. We can here see at least traces of secondary means by which the Almighty Deviser might establish all the vegetable forms with which the earth is overspread.

Vegetable and animal bodies are mainly composed of the same four simple substances or elements—carbon, oxygen, hydrogen, and nitrogen. The first combinations of these in animals are into what are called proximate principles, as albumen, fibrin, &c., out of which the structure of the animal body is composed. Now it is acknowledged by Dr. Daubeny, that in the combinations forming the proximate principles there is no chemical peculiarity. "It is now certain," he says, "that the same simple laws of composition pervade the whole creation: and that, if the organic chemist only takes the requisite precautions to avoid resolving into their ultimate elements the proximate principles upon which he operates, the result of his analysis will show that they are combined precisely according to the same plan as the elements of mineral bodies are known to be."* A particular fact is here worthy of attention. "The conversion of fecula into sugar, as one of the ordinary processes of vegetable economy, is effected by the production of a secretion termed *diastase*, which occasions both the rupture of the starch vesicles, and the change of their contained gum into sugar. This diastase may be separately obtained by the chemist, and it acts as effectually in his

* Supplement to the Atomic Theory.

laboratory as in the vegetable organization. He can also imitate its effects by other chemical agents."* The writer quoted below adds, "No reasonable ground has yet been adduced for supposing that, if we had the power of bringing together the elements of any organic compound, in their requisite states and proportions, the result would be any other than that which is found in the living body."

It is much to know the elements out of which organic bodies are composed. It is something more to know their first combinations, and that these are simply chemical. How these combinations are associated in the structure of living bodies is the next inquiry, but it is one to which as yet no satisfactory answer can be given. The investigation of the minutiæ of organic structure by the microscope is of such recent origin, that its results cannot be expected to be very clear. Some facts, however, are worthy of attention with regard to the present inquiry. It is ascertained that the basis of all vegetable and animal substances consists of nucleated cells; that is, cells having granules within them. Nutriment is converted into these before being assimilated by the system. The tissues are formed from them. The ovum destined to become a new creature, is originally only a cell with a contained granule. We see it acting this reproductive part in the simplest manner in the cryptogamic plants. "The parent cell, arrived at maturity by the exercise of its organic functions, bursts, and liberates its contained granules. These, at once thrown upon their own resources, and entirely dependent for their nutrition on the surrounding elements, develope themselves into new cells,

* Carpenter on Life; Todd's Cyclopædia of Physiology.

which repeat the life of their original. Amongst the higher tribes of the cryptogamia, the reproductive cell does not burst, but the first cells of the new structure are developed within it, and these gradually extend, by a similar process of multiplication, into that primary leaf-like expansion which is the first formed structure in all plants."* *Here the little cell becomes directly a plant, the full-formed living being.* It is also worthy of remark that, in the sponges (an animal form), a gemmule detached from the body of the parent, and trusting for sustentation only to the fluid into which it has been cast, becomes, without further process, the new creature. Further, it has been recently discovered by means of the microscope, that there is, as far as can be judged, a perfect resemblance between the ovum of the mammal tribes, during that early stage when it is passing through the oviduct, and the young of the infusory animalcules. One of the most remarkable of these, the *volvex globator*, has exactly the form of the germ which, after passing through a long fœtal progress, becomes a complete mammifer, an animal of the highest class. It has even been found that both are alike provided with those *cilia*, which, producing an appearance of revolving motion, is partly the cause of the name given to this animalcule. These resemblances are the more entitled to notice, that they were made by various observers, distant from each other at the time.† It has likewise been noted that the globules of the blood

* Carpenter's Report on the results obtained by the Microscope in the study of Anatomy and Physiology, 1843.

† See Dr. Martin Barry on Fissiparous Generation; Jameson's Journal, Oct., 1843.

are reproduced by the expansion of contained granules; they are, in short, *distinct organisms multiplied by the same fissiparous generation.* So that all animated nature may be said to be based on this mode of origin; *the fundamental form of organic being is a globule, having a new globule forming within itself*, by which it is in time discharged, and which is again followed by another and another, in endless succession. It is of course obvious that, if these globules could be produced by any process from inorganic elements, we should be entitled to say that the fact of a transit from the inorganic into the organic had been witnessed in that instance; the possibility of the commencement of animated creation by the ordinary laws of nature might be considered as established. Now it was announced some years ago by the French physiologists Prevost and Dumas, that *globules could be produced in albumen by electricity.* If, therefore, these globules be identical with the cells which are now held to be reproductive, it might be said that the production of albumen by artificial means is the only step in the process wanting. This has not yet been effected; but it is known to be only a chemical process, the mode of which may be any day discovered in the laboratory.*

* The reader will please to understand that the above paragraph is only an humble attempt to bring illustration from a department of science on which at present much doubt and obscurity rest. I have followed the best lights I could find, but cannot be assured that better will not yet be evolved from the researches of the many able physiologists now engaged in the investigation of ultimate structure and of embryology. I am bound to admit, in the meantime, that the identity of the globules produced in albumen by electricity with *living cells*, and the fact of the reproduction of living globules,

In such an investigation as the present, it is not unworthy of notice, that the production of shell is a natural operation which can be precisely imitated artificially. Such an incrustation takes place on both the outside and inside of the wheel in a bleaching establishment, in which cotton cloth is rinsed free of the lime employed in its purification. From the *dressing* employed by the weaver, the cloth obtains the animal matter, *gelatin;* this and the lime form the constituents of the incrustation, exactly as in natural shell. In the wheel employed at Catrine, in Ayrshire, where the phenomenon was first observed by the eye of science, it had required ten years to produce a coating the tenth of an inch in thickness. This incrustation has all the characters of shell, displaying a highly polished surface, beautifully iridescent, and when broken, a foliated texture. The examination of it has even thrown some light on the character and mode of formation of natural shell. "The plates into which the substance is divisible have been formed in succession, and certain intervals of time have elapsed between their formation; in general, every two contiguous laminæ are separated by a thin iridescent film, varying from the three to the fifty millionth part of an inch in thickness, and producing all the various colors of thin plates which correspond to intermediate thicknesses: between some of the laminæ no such film exists, probably in consequence of the interval of time between their formation being too short; and

are both doubted by physiologists of high character. In this, as in other instances, I believe that particular illustrations may be held in doubt, or may altogether fail, without necessary injury to my general argument.

between others the film has been formed of an unequal thickness. There can be no doubt that these iridescent films are formed when the dash wheel is at rest during the night, and that when no film exists between two laminæ, an interval too short for its formation (arising, perhaps, from the stopping of the work during the day), has elapsed during the drying or induration of one lamina and the deposition of another."* From this it has been deduced, by a patient investigation, that those colors of mother-of-pearl, which are incommunicable to wax, arise from iridescent films deposited between the laminæ of its structure, and it is hence inferred that *the animal*, like the wheel, *rests periodically from its labors in forming the natural substance.*

These, it will be owned, are curious and not irrelevant facts; but it will be asked what actual experience says respecting origination of life. Are there, it will be said, any authentic instances of either plants or animals, of however humble and simple a kind, having come into existence otherwise than in the ordinary way of generation, since the time of which geology forms the record? To this it may be answered, in the first place, that the negative of the question could not be by any means formidable to the doctrine of law-creation, seeing that the conditions necessary for the operation of the supposed life-creating laws may not have existed within record to any great extent. There may have never been an instance of the organization of life, otherwise than by generation, since the commencement of the human species, and nevertheless the

* Mr. Leonard Horner and Sir David Brewster, on a substance resembling shell.—*Philosophical Transactions*, 1836.

doctrine in question may be shown upon grounds altogether apart to have strong probability on its side. On the other hand, as we see the physical laws of early times still acting with more or less force, it might not be unreasonable to expect that we should still see some remnants, or partial and occasional workings of the life-creating energy amidst a system of things generally stable and at rest. Are there, then, any such remnants to be traced in our own day, or during man's existence upon earth? If there be, it clearly would form a strong evidence in favor of the doctrine, as what now takes place upon a confined scale, and in a comparatively casual manner, may have formerly taken place on a great scale, and as the proper and eternity-destined means of supplying a vacant globe with suitable tenants. It will at the same time be observed that, the earth being now supplied with both kinds of tenants in great abundance, we only could expect to find the life-originating power at work in some very special and extraordinary circumstances, and probably only in the inferior and obscurer departments of the vegetable and animal kingdoms.

Perhaps, if the question were asked of ten men of approved reputation in science, nine out of the number would answer in the negative. This is because, in a great number of instances where the superficial observers of former times assumed a non-generative origin for life (as in the celebrated case in Virgil's fourth Georgic), either the direct contrary has been ascertained, or exhaustive experiments have left no alternative from the conclusion that ordinary generation did take place, albeit in a manner which escapes observation. Finding that an erroneous assumption has been formed in many cases, modern inquirers have not hesitated to assume that there can be no case in which generation is not concerned. Now their conclusion may be right, but it clearly is not one beyond question; and it is equally true that the explanations suggested in difficult cases are often far from being satisfactory. When, for instance, lime is laid down upon a piece of waste moss ground, and a crop of white clover for which no seeds were sown is the consequence, the common explanation is, that the seeds have been dormant there for an unknown time, and were stimulated into germination when the lime produced the appropriate circumstances. How is it possible to be satisfied with this hypothesis, when we know (as in an authentic case under my notice) that the spot is many miles from where clover is cultivated, and that there is nothing for six feet below but pure peat moss, clover seeds being, moreover, known to be too heavy to be transported, as many other seeds are, by the winds?

There are several persons eminent in science who profess at least to find great difficulty in accepting the doctrine of invariable generation. One of these* has stated several considerations arising from analogical reasoning, which appear to him to throw the balance of evidence in favor of the primitive production of infusoria, the vegetation called mould, and the like. One seems to be of great force; namely, that the animalcules, which are supposed (altogether hypothetically) to be produced by ova, are afterwards found increasing their numbers, not by that mode at all, but by division of their bodies. If it be the

* Dr. Allen Thomson, in the article *Generation*, in Todd's Cyclopædia of Anatomy and Physiology.

nature of these creatures to propagate in this splitting or fissiparous manner, how could they be communicated to a vegetable infusion? It has been shown by the opponents of this theory, that when a vegetable infusion is debarred from the contact of the atmosphere, by being closely sealed up or covered with a layer of oil, no animalcules are produced; but it has been said, on the other hand, that the exclusion of the air may prevent some simple condition necessary for the aboriginal development of life—and nothing is more likely. Perhaps the prevailing doctrine is in nothing placed in greater difficulties than it is with regard to the entozoa, or creatures which live within the bodies of others. These creatures do, and apparently can, live nowhere else than in the interior of other living bodies, where they generally take up their abode in the viscera, but also sometimes in the chambers of the eye, the interior of the brain, the serous sacs, and other places having no communication from without. Some are viviparous, others oviparous. Of the latter it cannot be reasonably supposed that the ova ever pass through the medium of the air, or through the blood-vessels, for they are too heavy for the one transit, and too large for the other. Of the former, it cannot be conceived how they pass into young animals—certainly not by communication from the parent, for it has often been found that entozoa do not appear in certain generations of a human family, and some of peculiar and noted character have only appeared at rare intervals, and in very extraordinary circumstances. A candid view of the less popular doctrine, as to the origin of this humble form of life, is taken by a distinguished living naturalist. "To explain the beginning of these worms within the human body, and the common doctrine that all created beings proceed from their likes, or a primordial egg, is so difficult, that the moderns have been driven to speculate, as our fathers did, on their spontaneous birth; but they have received the hypothesis with some modification. Thus it is not from putrefaction or fermentation that the entozoa are born, for both of these processes are rather fatal to their existence, but from the aggregation and fit apposition of matter which is already organized, or has been thrown from organized surfaces. * * Their origin in this manner is not more wonderful or more inexplicable than that of many of the inferior animals from sections of themselves. * * Particles of matter fitted by digestion, and their transmission through a living body, for immediate assimilation with it, or flakes of lymph detached from surfaces already organized, seem neither to exceed nor fall below that simplicity of structure which favors this wonderful development; and the supposition that, like morsels of a planaria, they may also, when retained in contact with living parts, and in other favorable circumstances, continue to live and be gradually changed into creatures of analogous conformation, is surely not so absurd as to be brought into comparison with the Metamorphoses of Ovid. * * We think the hypothesis is also supported in some degree by the fact, that the origin of the entozoa is favored by all causes which tend to disturb the equality between the secerning and absorbent system."* Here particles of organized matter are suggested as the germinal original of distinct and fully organized animals, many of which have a highly developed

* Article "Zoophytes," Encyclopædia Britannica, 7th edition.

reproductive system. How near such particles must be to the inorganic form of matter may be judged from what has been said within the last few pages. If, then, this view of the production of entozoa be received, it must be held as in no small degree favorable to the general doctrine of an organic creation by law.*

There is another series of facts, akin to the above, and

* A more general, but more arresting argument in favor of primitive production, though not conclusively so, has been presented in the following terms:—

"We see a simple germ—the nucleus of a cell—develope itself into a feeling, moving, thinking man, by drawing into itself, and combining into new forms, the particles of what we are accustomed to call inorganic matter. These new forms are caused, by the very act of combination, to manifest properties of a new and peculiar kind; and their actions constitute the life of the being. Hence we must attribute to all those substances, which are thus drawn from the inorganic mode of existence, *a latent capacity* for the latter;—just as we say that the oxygen, hydrogen, carbon, and nitrogen, which make up the organic substance termed muscular fibre, and which, in *that* state or mode of combination, possess certain vital properties, possess also *a latent capacity* for combining in that mode of aggregation termed crystalline, and for exhibiting the solubility, translucency, and other qualities of a salt (all of which are totally opposed to its vital properties, and cannot coexist with them), when united into the form of cyanate of ammonia. If we were only acquainted with those elements as they exist in organic compounds, their transposition into a crystalline salt would be almost as marvellous to us as the opposite change is now. If this *latent organizability or vitality* be admitted (as we conceive logical proof to have been given that it must), as a property of a large proportion of what we call inorganic matter, is there any such wonderful difficulty in imagining that it may be brought into play in some other manner than by the agency of a pre-existing germ? We think not. But let further investigation and more extended experience decide."—*British and Foreign Medical Review*, January, 1845.

which deserve not less attention. The pig, in its domestic state, is subject to the attacks of a hydatid, from which the wild animal is free; hence the disease called measles in pork. The domestication of the pig is of course an event subsequent to the origin of man; indeed, comparatively speaking, a recent event. Whence, then, the first progenitor of this hydatid? So also there is a tinea which attacks dressed wool, but never touches it in its unwashed state. A particular insect disdains all food but chocolate, and the larva of the *oinopota cellaris* lives nowhere but in wine and beer, all of these being articles manufactured by man. There is likewise a creature called the *pymelodes cyclopum* which is only found in subterranean cavities connected with certain specimens of the volcanic formation in South America, dating from a time posterior to the arrangements of the earth for our species. Whence the first pymelodes cyclopum? Will it, to a geologist, appear irrational to suppose that, just as the pterodactyle was added as a new offshoot from the animal stock, in the era of the new red sandstone, when the earth had become suited for such a creature, so may these creatures have been added when media suitable for their existence arose, and that such phenomena may take place any day, the only cause for their taking place seldom being the rarity of the rise of new physical conditions on a globe which seems to have already undergone the principal part of its destined mutations?

Between such isolated facts and the greater changes which attended various geological eras, it is not easy to see any difference, besides simply that of the scale on which the respective phenomena took place, as the throwing off of one copy from an engraved plate is exactly the same process as that by which a thousand are thrown off. To Creative Providence, we may well conceive, the numbers of such phenomena, the time when, and the circumstances under which they take place, are indifferent matters. The Eternal One has arranged for everything beforehand, and trusted all to the operation of the laws of his appointment, himself being ever present in all things. We can even conceive that man, in his many doings upon the surface of the earth, may occasionally, without his being aware of it, or otherwise, act as an instrument in preparing the association of conditions under which the creative laws work; and perhaps some instances of his having acted as such an instrument have actually occurred in our own time.

I allude, of course, to the experiments conducted a few years ago by Mr. Crosse, which seemed to result in the production of a heretofore unknown species of insect in considerable numbers. Various causes have prevented these experiments and their results from receiving candid treatment, but they may perhaps be yet found to have opened up a new and most interesting chapter of nature's mysteries. Mr. Crosse was pursuing some experiments in crystallization, causing a powerful voltaic battery to operate upon a saturated solution of silicate of potash, when the insects unexpectedly made their appearance. He afterwards tried nitrate of copper, which is a deadly poison, and from that fluid also did live insects emerge. Discouraged by the reception of his experiments, Mr. Crosse soon discontinued them; but they were some years after pursued by Mr. Weekes, of Sandwich, with precisely the same results. This gentleman, besides trying the first of the above substances, employed ferrocyanuret of potassium on account of its containing a larger proportion of carbon, the principal element of organic bodies; and from this substance the insects were produced *in increased numbers*. A few weeks sufficed for this experiment, with the powerful battery of Mr. Crosse; but the first attempts of Mr. Weekes required about eleven months, a ground of presumption in itself that the electricity was chiefly concerned in the phenomenon. The changes undergone by the fluid operated upon, were in both cases remarkable, and nearly alike. In Mr. Weekes's apparatus, the silicate of potash became first turbid, then of a milky appearance; round the negative wire of the battery, dipped into the fluid, there gathered a quantity of *gelatinous matter*, a part of the process which is very striking, when we remember that gelatin is one of the *proximate principles*, or first compounds, out of which animal bodies are formed, though, of course, we should require further proofs to satisfy us that the matter here concerned was actually gelatin. From the matter, whatever was its nature, Mr. Weekes observed one of the insects in the very act of emerging, immediately after which it ascended to the surface of the fluid, and sought concealment in an obscure corner of the apparatus. The insects produced by both experimentalists seem to have been the same, a species of acarus, minute and semi-transparent, and furnished with long bristles, which can only be seen by the aid of the microscope. It is worthy of remark, that some of these insects, soon after their existence had commenced, were found to be likely to extend their species. They were sometimes observed to go back to the fluid to feed, and occasionally they devoured each other.*

* See a Pamphlet circulated by Mr. Weekes, in 1842.

The reception of novelties in science must ever be regulated very much by the amount of kindred or relative phenomena which the public mind already possesses and acknowledges, to which the new can be assimilated. A novelty, however true, if there be no received truths with which it can be shown in harmonious relation, has little chance of a favorable hearing. In fact, as has been often observed, there is a measure of incredulity from our ignorance as well as from our knowledge, and if the most distinguished philosopher three hundred years ago had ventured to develope any striking new fact which only could harmonize with the as yet unknown Copernican solar system, we cannot doubt that it would have been universally scoffed at in the scientific world, such as it then was, or, at the best, interpreted in a thousand wrong ways in conformity with ideas already familiar. The experiments above described, finding a public mind which had never discovered a fact or conceived an idea at all analogous, were of course ungraciously received. It was held to be impious, even to surmise that animals could have been formed through any instrumentality of an apparatus devised by human skill. The more likely account of the phenomena was said to be, that the insects were only developed from ova, resting either in the fluid, or in the wooden frame on which the experiments took place. On these objections the following remarks may be made. The supposition of impiety arises from an entire misconception of what is implied by an aboriginal creation of insects. The experimentalist could never be considered as the author of the existence of these creatures, except by the most unreasoning ignorance. The utmost that can be claimed for, or imputed to him, is, that he arranged the natural conditions under which the true creative energy—that flowing from the primordial appointment of the Divine Author of all things—was pleased to work in that instance. On the hypothesis here brought forward, the *acarus Crossii* was a type of being ordained from the beginning, and destined to be realized under certain physical conditions. When a human hand brought these conditions into the proper arrangement, it did an act akin to hundreds of familiar ones which we execute every day, and which are followed by natural results; but it did nothing more. The production of the insect, if it did take place as assumed, was as clearly an act of the Almighty himself, as if he had fashioned it with hands. For the presumption that an act of aboriginal creation did take place, there is this to be said, that, in Mr. Weekes's experiment, every care that ingenuity could devise was taken to exclude the possibility of a development of the insects from ova. The wood of the frame was baked in a powerful heat; a bell-shaped glass covered the apparatus, and from this the atmosphere was excluded by the fumes constantly rising from the liquid, for the emission of which there was an aperture so arranged at the top of the glass, that only these fumes could pass. The water was distilled, and the substance of the silicate had been subjected to white heat. Thus every source of fallacy seemed to be shut up. In such circumstances, a candid mind, which sees nothing either impious or unphilosophical in the idea of a new creation, will be disposed to think that there is less difficulty in believing in such a creation having actually taken place, than in believing that, in two instances, separated in place and time, exactly the same insects should have chanced to arise from concealed ova, and these of a species heretofore unknown.*

* The writer of the critique upon this work in the *British and Foreign Medical Review*, after saying that "none of the easy solutions which have been offered of the difficult problem presented by the appearance of this acarus can be admitted," proceeds to make a few remarks much to the above purpose; and adds—"Not the least curious part of its (the acarus's) history is the series of metamorphoses which it undergoes before quitting the solution; these being *entirely different from the very slight changes which other acari undergo after their emersion from the egg.* Further, we believe it may be positively asserted, that, in whatever mode these acari are first generated, *it is not from eggs;* since, after they have escaped from the solution, they live in the neighborhood, and readily breed; and their eggs, which we have ourselves seen, are quite large enough to have been readily visible in the solution, had they existed there."

The metamorphoses here adverted to will perhaps go some way to satisfy those who have objected that the acarus, belonging as it does to the articulata, is too high an animal to have been produced otherwise than from ova.

I would, nevertheless, remark that the Acarus Crossii is only brought forward as one illustration, and in order that a hypothesis which I think has strong probabilities on its side may have the benefit of any doubts that can be instituted with regard to the production of this creature. The decision of the question against the conclusion here leant to, would still leave much sound illustration, and not in the least affect the general argument.

HYPOTHESIS OF THE DEVELOPMENT

OF THE

VEGETABLE AND ANIMAL KINGDOMS.

It has been already intimated, as a general fact, that there is an obvious gradation amongst the families of both the vegetable and animal kingdoms, from the simple lichen and animalcule respectively up to the highest order of dicotyledonous trees and mammalia. Confining our attention, on this occasion, to the animal kingdom—it is to be observed that the gradation is much less simple and direct than is generally supposed. It certainly does not proceed, at all parts of its course at least, upon one line; for the two sub-kingdoms of middle rank, mollusca and articulata, form unquestionably two distinct approaches to the highest, the vertebrata. It may even be admitted that there are appearances of more than two lines at various parts of the animal scale. Another circumstance of a perplexing nature, which has already been touched upon, may be thus instanced:—the vertebrate division, though generally possessing the highest organization, sinks down in its lower forms (the cyclostomous fishes) into such a humility—the vertebrate structure being highly recognizable—that these animals must be held as, generally speaking, far inferior to the upper forms of both the articulata and mollusca (crustacea and cephalopoda), and rather approaching to the lower families, at least of the articulata. There is, in short, an appearance, either of an overlapping of parts of the animal scale, or of a loop-like divergence at various parts of it, the line of the loop going on into highly organized forms, but becoming humble again at the further extremity, where it returns to the general scale. Still, notwithstanding all difficulties, there is no room to doubt of a general advance of organization from the radiate, into both the molluscous and articulate forms, and from these again into the vertebrate ; as also along the classes of (for example) the vertebrata, in this sequence—fishes, reptiles, birds, mammals.

While the external forms of all these various animals are so different, it is very remarkable that the whole are, after all, variations of a fundamental plan, which can be traced as a basis throughout the whole, the variations being merely modifications of that plan to suit the particular conditions in which each particular animal has been designed to live. Starting from the primeval germ, which, as we have seen, is the representative of a particular order of full-grown animals, we find all others to be merely advances from that type, with the extension of endowments and modification of forms which are required in each particular case ; each form, also, retaining a strong affinity to that which precedes it, and tending to impress its own features on that which succeeds. This unity of structure, as it is called, becomes the more remarkable, when we observe that the organs, while preserving a resemblance, are often put to different uses. For example; the ribs become, in the serpent, organs of locomotion, and the snout is extended, in the elephant, into a prehensile instrument.

It is equally remarkable that analogous purposes are served in different animals by organs essentially different. Thus the mammalia breathe by lungs; the fishes, by gills. These are not modifications of one organ, but distinct organs. In mammifers, the gills exist and act at an early stage of the fœtal state, but afterwards go back and appear no more; while the lungs are developed. In fishes, again, the gills only are fully developed; while the lung structure either makes no advance at all, or only appears in the rudimentary form of an air-bladder. So, also, the baleen of the whale and the teeth of the land mammalia are different organs. The whale, in embryo, shows the rudiments of teeth; but these, not being wanted, are not developed, and the baleen is brought forward instead. The land animals, we may also be sure, have the rudiments of baleen in their organization. In many instances, a particular structure is found advanced to a certain point in a particular set of animals (for instance, feet in the serpent tribe), although it is not there required in any degree; but the peculiarity, being carried a little farther forward, is perhaps useful in the next set of animals in the scale. In other instances, a portion of organization necessary in one sex is also presented in the other, where it is not necessary. For example, the mammæ of the human female, by whom these organs are obviously required, also exist in the male, who has no occasion for them. It might be supposed that in this case there was a regard to uniformity for mere appearance sake; but that no such principle is concerned, appears from a much more remarkable instance connected with the marsupial animals. The female of that tribe has a process of bone advancing from the pubes for the support of her pouch; and this also appears in the male marsupial, who has no pouch, and requires none. The rudimentary organs, as those not fully developed for use are called, appear most conspicuously in animals which form links between various classes.

As formerly stated, the marsupials, standing at the bottom of the mammalia, show their affinity to the oviparous vertebrata, by the rudiments of two canals passing from near the anus to the external surfaces of the viscera, which are fully developed in fishes, being required by them for the respiration of aerated waters, but which are not needed by the atmosphere-breathing marsupials. We have also the peculiar form of the sternum and rib-bones of the lizards *represented* in the mammalia in certain white cartilaginous lines traceable among their abdominal muscles. The struthionidæ (birds of the ostrich tribe) form a link between birds and mammalia, and in them we find the wings imperfectly or not at all developed, a diaphragm and urinary sac (organs wanting in other birds), and feathers approaching the nature of hair. Again, the ornithorhynchus belongs to a class at the bottom of the mammalia, and approximating to birds, and in it behold the bill and web-feet of that order!

For further illustration, it is obvious that, various as may be the lengths of the upper part of the vertebral column in the mammalia, it always consists of the same parts. The giraffe has in its tall neck the same number of bones with the pig, which scarcely appears to have a neck at all.* Man, again, has no tail; but the notion of a much-ridiculed philosopher of the last century is not altogether, as it happens, without foundation, for between the fifth and seventh week of the embryo a tail does exist, and in the mature subject the bones of this caudal appendage are found in an undeveloped state in the *os coccygis*. The limbs of all the vertebrate animals are, in like manner, on one plan, however various they may appear. In the hind-leg of a horse, for example, the angle called the hock is the same part which in us forms the heel: and the horse and other quadrupeds, with certain exceptions, walk, in reality, upon what answers to the toes of a human being. In this and many other quadrupeds the fore part of the extremities is shrunk up in a hoof, as the tail of the human being is shrunk up in the bony mass at the bottom of the back. The bat, on the other hand, has these parts largely developed. The membrane, commonly called its wing, is framed chiefly upon bones answering precisely to those of the human hand; its extinct congener, the ptero-dactyle, had the same membrane extended upon the fore-finger only, which in that animal was prolonged to an extraordinary extent. In the paddles of the whale and other animals of its order, we see the same bones as in the more highly developed extremities of the land mammifers; and even the serpent tribes, which present no external appearance of such extremities, possess them in reality, but in an undeveloped or rudimental state.

* D'Aubenton established the rule, that all the viviparous quadrupeds have seven vertebræ in the neck.

The same law of development presides over the vegetable kingdom. Amongst phanerogamous plants, a certain number of organs appear to be always present, either in a developed or rudimentary state; and those which are rudimentary can be developed by cultivation. The flowers which bear stamens on one stalk and pistils on another, can be caused to produce both, or to become perfect flowers, by having a sufficiency of nourishment supplied to them. So, also, where a special function is required for particular circumstances, nature provided for it, not by a new organ, but by a modification of a common one, which she has effected in development. Thus, for instance, some plants destined to live in arid situations, require to have a store of water which they may slowly absorb. The need is arranged for by a cup-like expansion round the stalk, in which water remains after a shower. Now the *pitcher*, as this is called, is not a new organ, but simply the metamorphosis of a leaf.

These facts clearly show how all the various organic forms of our world are bound up in one—how a fundamental unity pervades and embraces them all, collecting them, from the humblest lichen up to the highest mammifer, in one system, the whole creation of which must have depended upon one law or decree of the Almighty, though it did not all come forth at one time. After what we have seen, the idea of a separate exertion for each must appear totally inadmissible. The single fact of abortive or rudimentary organs condemns it; for these, on such a supposition, could be regarded in no other light than as blemishes or blunders—the thing of all others most irreconcileable with that idea of Almighty Perfection which a general view of nature so irresistibly conveys. On the other hand, when the organic creation is admitted to have been effected by a general law, we see nothing in these abortive parts but harmless peculiarities of development, and interesting evidences of the manner in which the divine Author has been pleased to work.

We have yet to advert to the most interesting class of facts connected with our subject. First surmised by the illustrious Harvey, afterwards illustrated by Hunter in his wondrous collection at the Royal College of Surgeons, finally advanced to mature conclusions by Tiedemann, St. Hilaire, and Serres, embryotic development is now a science. Its primary positions are—1. that the embryos of all animals are not distinguishably different from each other; and, 2. that those of all animals pass through a series of phases of development, each of which is the type or analogue of the permanent configuration of tribes inferior to it in the scale. With regard to the latter proposition, it is to be remarked that, while it is generally true of the whole forms of animal being, it is more particularly true of departments of the organization, as the nutritive system, the vascular system, the nervous system, &c., each of which is destined for a peculiar degree of development in different groups of animals, according to their needs; and this, I may observe, is so far an explanation of such phenomena as the superiority of the highest mollusks to the lowest vertebrates. Even in man there are some particulars of organization less developed than in certain animals which generally are far inferior. Speaking, however, roundly, it is undoubted that all animals pass in embryo through phases resembling the general as well as the particular characters of those of lower grade. For example, the comatula, a free-swimming star-fish, is, at one stage of its early progress, a crinoid—that is, a star-fish fixed upon a stalk to the bottom of the sea. It advances from the form of one of the lower to that of one of the higher echinodermata. The animals of its first form were, as we have seen, among the most abundant in the earliest fossiliferous rocks; they began to decline in the new red sandstone era, and they were succeeded in the oolitic age by animals *of the form of the mature comatula.* Thus, too, the insect, standing near the head of the articulated animals, is, in the larva state, an annelid or worm, the annelida being the lowest in the same class. Of the worm, again, it has been observed that it passes through the forms of the polype, helianthois, and arenicola, before attaining its permanent character as an annelid. The higher crustacea, as the crab or lobster, at their escape from the ovum, resemble the perfect animal of the inferior order entomostraca, and pass through all the forms of transition which characterize the intermediate tribes of crustacea. The salmon, a highly organized fish, exhibits, in its early stages, as has been remarked, the gelatinous dorsal cord, the heterocercal tail, and inferior position of the mouth, which mark the mature example of the lower tribes of fishes, the placoids and ganoids. The frog, again, for some time after its birth, is a fish with external gills, and other organs fitting it for an aquatic life, all of which are changed as it advances to maturity, and becomes a land animal. The mammifer only passes through still more stages, according to its higher place in the scale. Nor is man himself exempt from this law. His first form is that which is permanent in the animalcule. His organization gradually passes through conditions generally resembling a fish, a reptile, a bird, and the lower mammalia, before it attains its specific maturity. At one of the last stages of his fœtal career, he exhibits an intermaxillary bone, which is characteristic of the perfect ape; this is suppressed, and he may then be said to take leave of the simial type, and become a true human creature. Even, as we shall see, the varieties of his race are represented in the progressive development of an individual of the highest, before we see the adult Caucasian, the highest point yet attained in the animal scale.

To come to particular points of the organization. The brain of man, which exceeds that of all other animals in complexity of organization and fulness of development, is, at one early period, only "a simple fold of nervous matter, with difficulty distinguishable into three parts, while a little tail-like prolongation towards the hinder parts, and which had been the first to appear, is the only representation of a spinal marrow. Now, in this state it perfectly resembles the brain of an adult fish, thus assuming *in transitu* the form that in the fish is permanent. In a short time, however, the structure is become more complex, the parts more distinct, and the spinal marrow better marked; it is now the brain of a reptile. The change continues; by a singular motion, certain parts (*corpora quadrigemina*) which had hitherto appeared on the upper surface, now pass towards the lower; the former is their permanent situation in fishes and reptiles, the latter in birds and mammalia. This is another advance in the scale, but more remains yet to be done. The complication of the organ increases; cavities termed *ventricles* are formed, which do not exist in fishes, reptiles, or birds; curiously organized parts, such as the corpora striata, are added; it is now the brain of the mammalia. Its last and final change alone seems wanting, that which shall render it the brain of MAN."* And this change in time takes place.

So also with the heart. This organ, in the mammalia, consists of four cavities, but in the reptiles of only three, and in fishes of two only, while in the articulated animals it is merely a prolonged tube. Now in the mammal fœtus, at a certain early stage, the organ has the form of a prolonged tube; and a human being may be said to have then the heart of an insect. Subsequently it is shortened and widened, and becomes divided by a contraction into two parts, a ventricle and an auricle; it is now the heart of a fish. A subdivision of the auricle afterwards makes a triple-chambered form, as in the heart of the reptile tribes; lastly, the ventricle being also subdivided, it becomes a full mammal heart.†

* Lord's Popular Physiology.

† M. Serres has shown that there is a similar gradation in the tissues. The elementary tissue in the lower infusoria is mere cellular substance, with functions limited to exhalation and absorption. To this, in the echinodermata, is added a peripheral system of blood-vessels. In the rotifera a muscular system is added; and these are united in the helianthoidea. Nervous apparatus becomes distinct in the muscular system in the annelida and mollusca. Compare this with the progress of the embryo. A mere vesicle of cellular membrane before impregnation, it becomes after that process a double membrane. Between the two membranes appears in a short time a vascular tissue, and to this a nervous tissue is subsequently added.

Our physiologist obtained a curious confirmation of his views on this subject by some experiments on the common earth-worm. This animal, in its fœtal evolution, passes through stages represent-

It is certainly very remarkable that, corresponding generally to these progressive forms in the development of individuals, has been the succession of animal forms in the course of time. Our earth, as we have seen, bore crinoidea before it bore the higher echinodermata. It presented crustacea before it bore fishes, and when fishes came, the first forms were those ganoidal and placoidal types which correspond with the early fœtal condition of higher orders. Afterwards there were reptiles, then mammifers, and finally, as we know, came man. The tendency of all these illustrations is to make us look to *development* as the principle which has been immediately concerned in the peopling of this globe, a process extending over a vast space of time, but which is nevertheless connected in character with the briefer process by which an individual being is evoked from a simple germ. What mystery is there here—and how shall I proceed to enunciate the conception which I have ventured to form of what may prove to be its proper solution! It is an idea by no means calculated to impress by its greatness, or to puzzle by its profoundness. It is an idea more marked by simplicity than perhaps any other of those which have explained the great secrets of nature. But in this lies, perhaps, one of its strongest claims to our faith.

The whole train of animated beings, from the simplest

ing the permanent forms of the polype, tænia, helianthois, and arenicola. A piece of its skin having been destroyed, the regenerated part was found to be the same in structure as that of the arenicola. A second reproduction of the same part gave the structure of the helianthois. A third brought it down to the merely cellular membrane of the polype.

and oldest, up to the highest and most recent, are, then, to be regarded as a series of *advances of the principle of development*, which have depended upon external physical circumstances, to which the resulting animals are appropriate. I contemplate the whole phenomena as having been in the first place arranged in the counsels of Divine Wisdom, to take place, not only upon this sphere, but upon all the others in space, under necessary modifications, and as being carried on, from first to last, here and elsewhere, under immediate favor of the creative will or energy.* The nucleated vesicle, the fundamental form of all organization, we must regard as the meeting-point between the inorganic and the organic—the end of the mineral and beginning of the vegetable and animal kingdoms, which thence start in different directions, but in a general parallelism and analogy. We have already seen that this nucleated vesicle is itself a type of mature and independent being in the infusory animalcules, as well as the starting-point of the fœtal progress of every higher individual in creation, both animal and vegetable. We have seen that it is a form of being which there is some reason to believe electric agency will produce—though not perhaps usher into full life—in albumen, one of those component materials of animal bodies, in whose combinations it is believed there is no chemical peculiarity forbidding

* When I formed this idea, I was not aware of one which seems faintly to foreshadow it—namely, Socrates's doctrine, afterwards dilated on by Plato, that "previous to the existence of the world, and beyond its present limits, there existed certain archerypes, the embodiment (if we may use such a word) of general ideas; and that these archetypes were models, in imitation of which all particular beings were created."

their being any day realized in the laboratory. Remembering these things, we are drawn on to the supposition, that the first step in the creation of life upon this planet was *a chemico-electric operation, by which simple germinal vesicles were produced.* This is so much, but what were the next steps? I suggest, as an hypothesis countenanced by much that is ascertained, and likely to be further sanctioned by much that remains to be known, that the first step was *an advance under favor of peculiar conditions, from the simplest forms of being, to the next more complicated, and this through the medium of the ordinary process of generation.*

Unquestionably, what we ordinarily see of nature is calculated to impress a conviction that each species invariably produces its like. But I would here call attention to a remarkable illustration of natural law which has been brought forward by Mr. Babbage, in his *Ninth Bridgewater Treatise.* The reader is requested to suppose himself seated before the calculating machine, and observing it. It is moved by a weight, and there is a wheel which revolves through a small angle round its axis, at short intervals, presenting to his eye successively, a series of numbers engraved on its divided circumference.

Let the figures thus seen be the series, 1, 2, 3, 4, 5, &c., of natural numbers, each of which exceeds its immediate antecedent by unity.

"Now, reader," says Mr. Babbage, "let me ask you how long you will have counted before you are firmly convinced that the engine has been so adjusted, that it will continue, while its motion is maintained, to produce the same series of natural numbers? Some minds are so constituted, that after passing the first hundred terms, they will be satisfied that they are acquainted with the law. After seeing five hundred terms few will doubt, and after the fifty thousandth term the propensity to believe that the succeeding term will be fifty thousand and one, will be almost irresistible. That term *will* be fifty thousand and one; and the same regular succession will continue; the five millionth and the fifty millionth term will still appear in their expected order, and one unbroken chain of natural numbers will pass before your eyes, from *one* up to *one hundred million.*

"True to the vast induction which has been made, the next succeeding term will be one hundred million and one; but the next number presented by the rim of the wheel, instead of being one hundred million and two, is one hundred million *ten thousand* and two. The whole series from the commencement being thus,—

1
2
3
4
5
. . .
. . . .
. . . . .
. . . . . .
99,999,999
100,000,000
regularly as far as 100,000,001
100,010,002 the law changes.
100,030,003
100,060,004
100,100,005

100,150,006
100,210,007
100,280,008
. . . .
. . . .

"The law which seemed at first to govern this series failed at the hundred million and second term. This term is larger than we expected by 10,000. The next term is larger than was anticipated by 30,000, and the excess of each term above what we had expected forms the following table:—

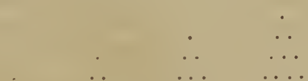
10,000
30,000
60,000
100,000
150,000
. . . . . .
. . . . . .

being, in fact, the series of *triangular numbers*,* each multiplied by 10,000.

* The numbers 1, 3, 6, 10, 15, 21, 28, &c., are formed by adding the successive terms of the series of natural numbers thus:

$$1 = 1$$
$$1+2 = 3$$
$$1+2+3 = 6$$
$$1+2+3+4 = 10, \text{ \&c.}$$

They are called triangular numbers, because a number of points corresponding to any term can always be placed in the form of a triangle; for instance—



1 3 6 10

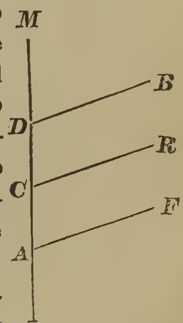
"If we now continue to observe the numbers presented by the wheel, we shall find, that for a hundred, or even for a thousand terms, they continue to follow the new law relating to the triangular numbers; but after watching them for 2761 terms, we find that this law fails in the case of the 2762d term.

"If we continue to observe, we shall discover another law then coming into action, which also is dependent, but in a different manner, on triangular numbers. This will continue through about 1430 terms, when a new law is again introduced which extends over about 950 terms, and this, too, like all its predecessors, fails, and gives place to other laws, which appear at different intervals.

"Now it must be observed that *the law that each number presented by the engine is greater by unity than the preceding number*, which law the observer had deduced from an induction of a hundred million instances, *was not the true law that regulated its action*, and that the occurrence of the number 100,010,002 at the 100,000,002d term was *as necessary a consequence of the original adjustment, and might have been as fully foreknown at the commencement*, *as was the regular succession of any one of the intermediate numbers to its immediate antecedent*. The same remark applies to the next apparent deviation from the new law, which was founded on an induction of 2761 terms, and also to the succeeding law, with this limitation only—that, whilst their consecutive introduction at various definite intervals, is a necessary consequence of the mechanical structure of the engine, our knowledge of analysis does not enable us to predict the periods themselves at which the more distant laws will be introduced."

It is not difficult to apply the philosophy of this passage to the question under consideration. It must be borne in mind that the gestation of a single organism is the work of but a few days, weeks, or months; but the gestation (so to speak) of a whole creation is a matter probably involving enormous spaces of time. Suppose that an ephemeron, hovering over a pool for its one April day of life, were capable of observing the fry of the frog in the water below. In its aged afternoon, having seen no change upon them for such a long time, it would be little qualified to conceive that the external branchiæ of these creatures were to decay, and be replaced by internal lungs, that feet were to be developed, the tail erased, and the animal then to become a denizen of the land. Precisely such may be our difficulty in conceiving that any of the species which people our earth is capable of advancing by generation to a higher type of being. During the whole time which we call the historical era, the limits of species have been, to ordinary observation, rigidly adhered to. But the historical era is, we know, only a small portion of the entire age of our globe. We do not know what may have happened during the ages which preceded its commencement, as we do not know what may happen in ages yet in the distant future. All, therefore, that we can properly infer from the apparently invariable production of like by like is, that such is the ordinary procedure of nature in the time immediately passing before our eyes. Mr. Babbage's illustration powerfully suggests that this ordinary procedure may be subordinate to a higher law which only *permits* it for a time, and in proper season interrupts and changes it. We shall soon see some philosophical evidence for this very conclusion.

It has been seen that, in the reproduction of the higher animals, the new being passes through stages in which it is successively fish-like and reptile-like. But the resemblance is not to the adult fish or the adult reptile, but to the fish and reptile at a certain point in their fœtal progress; this holds true with regard to the vascular, nervous, and other systems alike. It seems as if gestation consisted of two distinct and independent stages—one devoted to the development of the new being through the conditions of the inferior types, or rather through the corresponding *first stages of their development;* another perfecting and bringing the new being to a healthy maturity, on the basis of the point of development reached. This may be illustrated by a simple diagram. The fœtus of all the four classes may be supposed to advance in an identical condition to the point A. The fish there diverges and passes along a line apart, and peculiar to itself, to its mature state at F. The reptile, bird, and mammal, go on together to C, where the reptile diverges in like manner, and advances by itself to R. The bird diverges at D, and goes on to B. The mammal then goes forward in a straight line to the highest point of organization at M.



This diagram shows only the main ramifications; but the reader must suppose minor ones, representing the subordinate differences of orders, tribes, families, genera, &c., if he wishes to extend his views to the whole varieties of being in the animal kingdom. Limiting ourselves at present to the outline afforded by this diagram, it is apparent that the only thing required for an advance from one type to another in the generative process is that, for example, the fish embryo should not diverge at A, but go on to C before it diverges, in which case the progeny will be, not a fish, but a reptile. To protract the *straight-forward part of the gestation over a small space*—and from species to species the space would be small indeed—is all that is necessary.

This might be done by the force of certain external conditions operating upon the parturient system. The nature of these conditions we can only conjecture, for their operation, which in the geological eras was so powerful, has in its main strength been long interrupted, and is now perhaps only allowed to work in some of the lowest departments of the organic world, or under extraordinary casualties in some of the higher, and to these points the attention of science has as yet been little directed. But though this knowledge were never to be clearly attained, it need not much affect the present argument, provided it be satisfactorily shown that there must be some such influence within the range of natural things.

To this conclusion it is greatly conducive that the law of organic development is still daily seen at work to certain effects, short, indeed, of a transition from species to species, but evidently of the same character. Sex is fully ascertained to be a matter of development. All beings are, at one stage of the embryotic progress, female; a certain number of them are afterwards *advanced* to be male. From this it will be understood that no absolute distinction exists; all such are merely apparent. The ingenious Huber first made us aware of an instance, in an humble department of the animal world, of arrangements being made by the animals themselves for adjusting the law of development to the production of a particular sex. Amongst bees, as amongst several other insect tribes, there is in each community but one true female, the queen bee, the workers being false females or neuters; that is to say, sex is carried on in them to a point intermediate between the female and male, where it is attended by sterility. The preparatory states of the queen bee occupy sixteen days; those of the neuters, twenty; and those of males, twenty-four. Now it is a fact, settled by innumerable observations and experiments, that the bees can so modify a larva, which otherwise would result in a worker, that, when the perfect insect emerges from the pupa, it is found to be a queen or true female. For this purpose they enlarge its cell, make a pyramidal hollow to allow of its assuming a vertical instead of a horizontal position, keep it warmer than other larvæ are kept, and feed it with a peculiar kind of food. From these simple circumstances, leading to a *shortening* of the embryotic condition, results a creature different in form, and also in dispositions, from what would have otherwise been produced. Some of the organs possessed by the worker are here wanting. We have a creature "destined to enjoy love, to burn with jealousy and anger, to be incited to vengeance, and to pass her time without labor," instead of one "zealous for the good of the community, a defender of the public rights, enjoying an immunity from the stimulus of sexual appetite and the pains of parturition; laborious, industrious, patient, ingenious, skilful; incessantly engaged in the nurture of the young, in collecting honey and pollen, in elaborating wax, in constructing cells and the like!—paying the most respectful and assiduous attention to objects which, had its ovaries been developed, it would have hated and pursued with the most vindictive fury till it had destroyed them!"* All these changes may be produced by a mere modification of the embryotic progress, which it is within the power of the adult animals to effect. But it is important to observe that this modification is different from working a direct change upon the embryo. It is not the different food which effects a metamorphosis. All that is done is merely to accelerate the period of the insect's perfection. By the arrangements made and the food given, the embryo becomes sooner fit for being ushered forth in its image or perfect state. Development may be said to be thus arrested at a particular stage—that early one at which the female sex is complete. In the other circumstances, it is allowed to go on four days longer, and a stage is then reached between the two sexes, which in this species is designed to be the perfect condition of a large portion of the community. Four days more make it a perfect male. It may be observed that there is, from the period of oviposition, a destined distinction between the sexes of the young bees. The queen lays the whole of the eggs which are designed to become workers, before she begins to lay those which become males. But probably the condition of her reproductive system governs the matter of sex, for it is remarked that when her impregnation is delayed beyond the twenty-eighth day of her entire existence, she lays only eggs which become males.

We have here, it will be admitted, a most remarkable illustration of the principle of development, although in an operation limited to the production of sex only. Let it not be said that the phenomena concerned in the generation of bees may be very different from those concerned in

* Kirby and Spence.

the reproduction of the higher animals. There is a unity throughout nature which makes the one case an instructive reflection of the other.

We shall now see an instance of development operating within the production of what approaches to the character of variety of species. It is fully established that a human family, tribe, or nation, is liable, in the course of generations, to be either advanced from a mean form to a higher one, or degraded from a higher to a lower, by the influence of the physical conditions in which it lives. The coarse features and other structural peculiarities of the negro race only continue while these people live amidst the circumstances usually associated with barbarism. In a more temperate clime, and higher social state, the face and figure become greatly refined. The few African nations which possess any civilisation exhibit forms approaching the European; and when the same people in the United States of America have enjoyed a within-door life for several generations, they assimilate to the whites amongst whom they live. On the other hand, there are authentic instances of a people originally well-formed and good-looking, being brought by imperfect diet and a variety of physical hardships, to a meaner form. It is remarkable that prominence of the jaws, a recession and diminution of the cranium, and an elongation and attenuation of the limbs, are peculiarities always produced by these miserable conditions, for they indicate an unequivocal retrogression towards the type of the lower animals. Thus we see nature alike willing to go back and to go forward. Both effects are simply the result of the operation of the law of development in the generative system. Give good conditions, it advances; bad ones, it recedes. Now, perhaps, it is only because there is no longer a possibility, in the higher types of being, of giving sufficiently favorable conditions to carry on species to species, that we see the operation of the law so far limited.

Let us trace this law also in the production of certain classes of monstrosities. A human fœtus is often left with one of the most important parts of its frame imperfectly developed: the heart, for instance, goes no farther than the three-chambered form, so that it is the heart of a reptile. There are even instances of this organ being left in the two-chambered or fish-form. Such defects are the result of nothing more than a failure of the power of development in the system of the mother, occasioned by weak health or misery, and bearing with force upon that sub-stage of the gestation at which the perfecting of the heart to its right form ought properly to have taken place. Here we have apparently a realization of the converse of those conditions which carry on species to species, so far, at least, as one organ is concerned. Seeing a complete specific retrogression in this one point, how easy it is to suppose an access of favorable conditions sufficient to reverse the phenomena, and make a fish mother develope a reptile heart, or a reptile mother develope a mammal one. It is no great boldness to surmise that a super-adequacy in the measure of this under-adequacy (and the one thing seems as natural an occurrence as the other) would suffice in a goose to give its progeny the body of a rat, and produce the ornithorhynchus, or might give the progeny of an ornithorhynchus the mouth and feet of a true rodent, and thus complete at two stages the passage from the aves to the mammalia.

Perhaps even the transition from species to species does still take place in some of the obscurer fields of creation, or under extraordinary casualties, though science professes to have no such facts on record. It is here to be remarked, that such facts might often happen, and yet no record be taken of them, for so strong is the prepossession for the doctrine of invariable like-production, that such circumstances, on occurring, would be almost sure to be explained away on some other supposition, or, if presented, would be disbelieved and neglected. Science, therefore, has no such facts, for the very same reason that some small sects are said to have no discreditable members—namely, that they do not receive such persons, and extrude all who begin to verge upon the character. There is, however, one direct case of a translation of species, which has been presented with a respectable amount of authority.* It appears that, whenever oats sown at the usual time are kept cropped down during summer and autumn, and allowed to remain over the winter, a thin crop of rye is the harvest presented at the close of the ensuing summer. This experiment has been tried repeatedly, with but one result ; invariably the *secale cereale* is the crop reaped where the *avena sativa*, a recognized different species, was sown. Now it will not satisfy a strict inquirer to be told that the seeds of the rye were latent in the ground, and only superseded the dead product of the oats ; for if any such fact were in the case, why should the usurping grain be always rye ? Perhaps those curious facts which have been stated with regard to forests of one kind of trees,

* See an article by Dr. Weissenborn, in the New Series of "Magazine of Natural History," vol i., p. 574. See also the Gardener's Chronicle, August and November, 1844.

when burnt down, being succeeded (without planting) by other kinds, may yet be found most explicable, as this is, upon the hypothesis of a transmutation of species which takes place under certain favoring conditions, now apparently of comparatively rare occurrence. The case of the oats is the more valuable, as bearing upon the suggestion as to a protraction of the gestation at a particular part of its course. Here, the generative process is, by the simple mode of cropping down, kept up for a whole year beyond its usual term. The type is thus allowed to advance, and what was oats becomes rye.

It may here be said that perhaps the oats and rye are not of different species, as heretofore supposed, but only varieties of one, liable to return to, or melt into, each other in proper circumstances. And for this some arguments may be adduced. It is, in the first place, to be remarked, that the distinction called *species*, is applied by naturalists to any group of organized beings, which do not show any variation beyond what can be proved to have been the result of external conditions. Thus, the various families of dogs, although so different in external form and even in psychical character, are all held as of one species, because, under certain changed conditions, the peculiarities of form and of instinct will all disappear, and a tendency will be shown to go back to a common and apparently original type. So, also, it has been shown that the primrose, cowslip, oxslip, and polyanthus, are varieties of one species, produced by peculiar conditions. When we descend into the lower fields of animal and vegetable existence, we find even more curious evidence as to this lubricity of specific distinctions. It is fully admitted that many lichens, mosses, and other humble families of plants, present a considerable number of forms, hitherto supposed to be independent species, yet proceeding, in each instance, from a germ of one kind, the variation being in each case simply accordant with the circumstances of the infant organism. The infusory animalcules are liable to appear in the same multiplicity of forms, so that it is hardly possible to determine species in that department of nature, and many thought at one time to be distinct, are now regarded as only variations of one. Now, if we except the infusory animalcules, all the varieties thus produced are liable to become permanent when the affecting conditions are persevered in; and it requires a subsequent alteration of circumstances to effect a new change of forms in the course of reproduction. A variability so great undoubtedly says something for the possibility of the cerealia being of one species. It may be observed, indeed, that the circumstances leading to a change from oats to rye are of a peculiar character. They do not consist merely of such elements as heat, soil, manure, or climate, but apparently resemble that process by which the bees work a modification of embryotic development in their larvæ. There is, as has been remarked, a prolongation of the ordinary term of gestation. The new organism may be supposed to be effected at a stage where fundamental, not superficial, changes take place. The change certainly looks much more, both in its causes and its effects, like a change from species to species than any of the other cases mentioned; for, if I mistake not, the difference between the two plants is so great as to have caused their being ranked by botanists, not only as different species, but even as belonging to different genera. Notwithstanding all this, supposing the change to be one of variety only, it would surely speak powerfully regarding this phenomenon called variability. We surely see, in this and other instances, at the very least, striking proofs of the effect of conditions upon organic development. Who is to say where this power of conditions has its limit? Or, admitting that it has a limit short of species-transition in the present state of the physical world, who is to say that it had not a little more power in the geological ages, and did then move the animated families on from one specific type to another? It will be said no one pretends to deny the possibility of such power; we only require proof. See proof, then, in the facts of geology, for species did in those ages follow each other in an order at once of development and of time. This, indeed, is not a demonstration; but take it for what it is—ground of a strong probability; and say, if, when we see that conditions will advance a sea-side weed into some of our best pot-herbs, they might not advance a sauroid fish into an ichthyosaur, and if there be more rationality in assuming supernatural interference in the one case than the other, especially when we have so many other facts telling us that the age of the coal and oolite was an age of natural conditions in other respects, exactly as is the present. The change of external conditions between these two periods, in proportion to the advance from the megalichthys to the ichthyosaur, was not less, to all appearance, than is the change from the conditions which produced the sea-side weeds to those which produced the pot-herbs, in proportion to the distance between the characters of those plants. The lengthening of the legs of our common pig, when left to breed in the wilderness; the change from the lean, bare dog of Turkey, to the short, thick, well-furred dog of Siberia; the metamorphosis of the round, plump form of the Englishman in a second generation, into the raw, wiry New Englander, are all transitions not less wonderful, in our age of comparatively (time-) uniform conditions, than was one of the passages between the cetacean and the pachyderm, at a time when, probably, the part of the globe where the phenomenon took place was for the first time the scene of a physical fact of no less importance than the formation of rivers! These phenomena are of one character in their effects, the difference being only in degree. The causes must be one in character also; that is, simply natural. We only do not now ordinarily see these causes in sufficient force to transmute family into family.

The idea, then, which I form of the progress of organic life upon our earth—and the hypothesis is applicable to all similar theatres of vital being—is, *that the simplest and most primitive type, under a law to which that of like-production is subordinate, gave birth to the type next above it, that this again produced the next higher, and so on to the very highest*, the stages of advance being in all cases very small—namely, from one species only to another; so that the phenomenon has always been of a simple and modest character. Thus, the production of new forms, as shown in the pages of the geological record, has never been anything more than a new stage of progress in gestation, an event as simply natural, and attended as little by any circumstances of a wonderful or startling kind, as the silent advance of an ordinary mother from one week to another of her pregnancy. Yet, be it remembered, the whole phenomena are, in another point of view, wonders of the highest kind, in as far as they are direct effects of an Almighty will, which had provided beforehand that everything should be very good.

This may be the proper place at which to introduce the preceding illustrations in a form calculated to bring them more forcibly before the mind of the reader. The following table was suggested to me, in consequence of seeing the scale of animated nature presented in Dr. Fletcher's Rudiments of Physiology. Taking that scale as its basis, it shows the wonderful parity observed in the progress of creation, as presented to our observation in the succession of fossils, and also in the fœtal progress of one of the principal human organs.* Dr. Fletcher's scale, it may be remarked, was not made up with a view to support such an hypothesis as the present, nor with any ap-

* "It is a fact of the highest interest and moment that, as the brain of every tribe of animals appears to pass, during its development, in succession through the types of all those below it, so the brain of man passes through the types of those of every tribe in the creation. It represents, accordingly, before the second month of utero-gestation, that of an avertebrated animal; at the second month, that of an osseous fish: at the third, that of a turtle; at the fourth, that of a bird; at the fifth, that of one of the rodentia; at the sixth, that of one of the ruminantia; at the seventh, that of one of the digitigrada; at the eighth, that of one of the quadrumana; till, at length, at the ninth, it compasses the brain of Man! It is hardly necessary to say, that all this is only an approximation to the truth; since neither is the brain of all osseous fishes, of all turtles, of all birds, nor of all the species of any one of the above order of mammals, by any means precisely the same, nor does the brain of the human fœtus at any time precisely resemble, perhaps, that of any individual whatever among the lower animals. Nevertheless, it may be said to represent, at each of the above-mentioned periods, the aggregate, as it were, of the brains of each of the tribes stated."—*Fletcher's Rudiments of Physiology.*

	SCALE OF ANIMAL KINGDOM. (The numbers indicate orders.)	ORDER OF ANIMALS IN
RADIATA	(1, 2, 3, 4, 5)	Infusoria
		Polypiaria
		Crinoidea
		(Crustacea)
MOLLUSCA	(6, 7, 8, 9, 10, 11)	Conchifera
		Cephalopeda
ARTICULATA.	*Annelida* (12, 13, 14)	Annelida
	Crustacea (15—20)	Crustaceous Fishes
	Arachnida & Insecta (21—31)	
VERTEBRATA.	*Pisces* (32, 33, 34, 35, 36)	True Fishes
	Reptilia (37, 38, 39, 40)	Piscine Saurians (ichthyosaurus, &c.)
		Pterodactyles
		Crocodiles
		Tortoises
		Batrachians
	Aves (41, 42, 43, 44, 45, 46	Birds
	Mammalia 47 Cetacea	Bones of a cetaceous animal
		Bones of a marsupial
	48 Ruminantia	
	49 Pachydermata	Pachydermata (tapirs, &c.)
	50 Edentata	
	51 Rodentia	Rodentia (dormouse, squirrel, &c.)
	52 Marsupialia	Marsupialia (raccoon, opossum, &c.)
	53 Amphibia	
	54 Digitigrada	Digitigrada (genette, fox, wolf, &c.)
	55 Plantigrada	Plantigrada (bear)
	56 Insectivora	
		Edentata (sloths, &c.)
		Ruminantia (oxen, deer, &c.)
	57 Cheiroptera	
	58 Quadrumana	Quadrumana
	59 Bimana	Bimana (man)

ASCENDING SERIES OF ROCKS.	FŒTAL HUMAN BRAIN. RESEMBLES, IN
1 Gneiss and Mica Slate System	
2 Clay Slate and Grauwacké system	1st month, that of an avertebrated animal ;
3 Silurian system	
4 Old Red Sandstone	
5 Carboniferous formation	2nd month, that of a fish ;
6 New Red Sandstone	3rd month, that of a turtle ;
	4th month, that of a bird ;
7 Oolite	
8 Cretaceous formation	
9 Lower Eocene	5th month, that of a rodent ; 6th month, that of a ruminant ;
10 Miocene	7th month, that of a digitigrade animal ;
11 Pliocene	
21 Superficial deposits	8th month, that of the quadrumana ; 9th month, attains full human character.

parent regard to the history of fossils, but merely to express the appearance of advancement in the orders of the Cuvierian system, assuming, as the criterion of that advancement, "an increase in the number and extent of the manifestations of life, or of the relations which an organized being bears to the external world." Excepting in the relative situation of the annelida and a few of the mammal orders, the parity is perfect; nor may even these small discrepancies appear when the order of fossils shall have been further investigated, or a more correct scale shall have been formed. Meanwhile, it is a wonderful evidence in favor of our hypothesis, that a scale formed so arbitrarily should coincide to such a nearness with our present knowledge of the succession of animal forms upon earth, and also that both of these series should harmonize so well with the view given by modern physiologists of the embryotic progress of one of the organs of the highest order of animals.

The reader has seen physical conditions referred to, as to be presumed to have in some way governed the progress of the development of the zoological series. This language may seem vague, and, it may be asked,—can any particular physical condition be adduced as likely to have affected development? To this it may be answered, that air and light are possibly amongst the principal agencies of this kind which operated in educing the various forms of being. Light is found to be essential to the development of the individual embryo. When tadpoles were placed by Dr. Milne Edwards in a perforated box, and that box sunk in the Seine, light being the only condition thus abstracted, they grew to a great size in their original form, but did not pass through the usual metamorphose which brings them to their mature state as frogs. The proteus, an animal of the frog kind, which lives in subterranean waters where there is no light, and which never changes the branchiæ for lungs, looks as if the development of that part of its organization had been arrested from a similar cause. When, in connexion with these facts, we learn that human mothers living in dark and close cells under ground,—that is to say, with an inadequate provision of air and light,—are found to produce an unusual proportion of defective children,* we can appreciate the important effects of both these physical conditions in ordinary reproduction. Now there is nothing to forbid the supposition that the earth has been at different stages of its career under different conditions, as to both air and light. On the contrary, we have seen reason for supposing that the proportion of carbonic acid gas (the element fatal to animal life) was larger at the time of the carboniferous formation than it afterwards became. We have also seen that astronomers regard the zodiacal light as a residuum of matter enveloping the sun, and which was probably at one time denser than it is now. Here we have the indications of causes for a progress in the purification of the atmosphere and in the diffusion of light during the earlier ages of the earth's history, with which the progress of organic life may have been conformable. An accession to the proportion of oxygen, and the effulgence of the central luminary, may have been the immediate prompting cause of all those advances from species to species which we have seen,

* Some poor people having taken up their abode in the cells under the fortifications of Lisle, the proportion of defective infants produced by them became so great, that it was deemed necessary to issue an order commanding these cells to be shut up.

upon other grounds, to be necessarily supposed as having taken place. And causes of the like nature may well be supposed to operate on other spheres of being, as well as on this. I do not indeed present these ideas as furnishing the true explanation of the progress of organic creation; they are merely thrown out as hints towards the formation of a just hypothesis, the complexion of which is only to be looked for when some considerable advances shall have been made in the amount and character of our stock of knowledge.

Early in this century, M. Lamarck, a naturalist of the highest character, suggested a hypothesis of organic progress which has incurred much ridicule, and scarcely ever had a single defender. He surmised, and endeavored, with a great deal of ingenuity, to prove, that one being advanced in the course of generation to another, in consequence merely of its experience of wants calling for the exercise of its faculties in a particular direction, by which exercise new developments of organs took place, ending in variations sufficient to constitute a new species. Thus he thought that a bird would be driven by necessity to seek its food in the water, and that in its efforts to swim, the outstretching of its claws would lead to the expansion of the intermediate membranes, and it would thus become web-footed. Now it is possible that wants and the exercise of faculties have entered in some manner into the production of the phenomena which we have been considering; but certainly not in the way suggested by Lamarck, whose whole notion is obviously inadequate to account for the rise of the organic kingdoms. Had the laws of organic development been known in his time, his theory might have been of a more imposing kind. It is upon these that the present hypothesis is mainly founded. I take existing natural means, and show them to have been capable of producing all the existing organisms, with the simple and easily conceivable aid of a higher generative law, which we perhaps still see operating upon a limited scale. I also go beyond the French philosopher to a very important point, the original Divine conception of all the forms of being which these natural laws were only instruments in working out and realizing. And what a preconception or forethought have we here! For let us only for a moment consider how various are the external physical conditions in which animals live—climate, soil, temperature, land, water, air: the peculiarities of food, and the various ways in which it is to be sought: the peculiar circumstances in which the business of reproduction and the care-taking of the young are to be attended to: all these requiring to be taken into account, and thousands of animals to be formed suitable in organization and mental character for the concerns they were to have with these various conditions and circumstances—here a tooth fitted for crushing nuts; there a claw fitted to serve as a hook for suspension; here to repress teeth and develope a bony net-work instead; there to arrange for a branchial apparatus, to last only for a certain brief time: let us, I say, only consider these things, and we shall see that the decreeing of laws to bring the whole about was an act involving such a degree of wisdom and device as we only can attribute, adoringly, to the one Eternal and Unchangeable. It may be asked, how does this reflection comport with that timid philosophy which would have us to draw back from the investigation of God's works, lest the knowledge of them should make us undervalue his greatness and forget his paternal character? Does it not rather appear that our ideas of the Deity can only be worthy of him in the ratio in which we advance in a knowledge of his works and ways; and that the acquisition of this knowledge is consequently an available means of our growing in a genuine reverence for him!

But the idea that any of the lower animals have been concerned in any way with the origin of man—is not this degrading? Degrading is a term expressive of a notion of the human mind, and the human mind is liable to prejudices which prevent its notions from being invariably correct. Were we acquainted for the first time with the circumstances attending the production of an individual of our race, we might equally think them degrading, and be eager to deny them, and exclude them from the admitted truths of nature. Knowing this fact familiarly and beyond contradiction, a healthy and natural mind finds no difficulty in regarding it complacently. Creative Providence has been pleased to order that it should be so, and it must therefore be submitted to. The present hypothesis as to the progress of organic creation, if we become satisfied that it is in the main the reflection of a great truth, ought to be received precisely in this spirit. Say it has pleased Providence to arrange that one species should give birth to another, until the second highest gave birth to man, who is the very highest: be it so; it is our part to admire and to submit. The very faintest notion of there being anything ridiculous or degrading in the theory—how absurd does it appear when we remember that every individual amongst us actually passes through the characters of the insect, the fish, and reptile (to speak nothing of others); before he is permitted to breathe the breath of life! But such notions are mere emanations of false pride and ignorant prejudice. He who conceives them little reflects that they, in reality, involve a contempt for the works and ways of God. For it may be asked, if He, as appears, has chosen to employ inferior organisms as a generative medium for the production of higher ones, even including ourselves, what right have we, his humble creatures, to find fault? There is, also, in this prejudice, an element of unkindliness towards the lower animals, which is utterly out of place. These creatures are all of them part products of the Divine Conception, as well as ourselves. All of them display wondrous evidences of his wisdom and benevolence. All of them have had assigned to them by their Great Father a part in the drama of the organic world, as well as ourselves. Why should they be held in such contempt? It is much to be feared that with this proud prejudice is connected much of that inhumanity which is shown to the inferior animals, and which tends to degrade man himself below them. Let us regard them in a right spirit, as parts of a grand plan which only approaches its perfection in ourselves, and we shall see no degradation in the idea of our genetic connexion with them, but, on the contrary, reason incontestable for treating them in the manner which we already feel that a high morality demands.

THE HYPOTHESIS CONSIDERED

IN CONNEXION WITH THE CLASSIFICATION AND GEOGRAPHICAL DISTRIBUTION OF ORGANISMS.

The vegetable and animal kingdoms are arranged upon a scale, starting from simply organized forms, and going on to the more complex, each of these forms being but slightly different from those next to it on both sides. The lowest and most slightly developed forms in the two kingdoms are so closely connected, that it is impossible to say where vegetable ends and animal begins. United at what may be called their bases, they start away in different directions, but not altogether to lose sight of each other. On the contrary, they maintain a strict analogy throughout the whole of their subsequent courses, sub-kingdom for sub-kingdom, class for class; showing a beautiful, though as yet obscure relation between the two grand forms of being, and consequently a unity in the laws which brought them both into existence.

It is as yet but a few years since a system of subordinate analogies not less remarkable began to be speculated upon as within the range of the animal kingdom. Probably it also exists in the vegetable kingdom; but to this point no direct attention has been given; so we are left to infer that such is the case from theoretical considerations only.

The Macleay system, as it may be called in honor of its principal author, announces that, whether we take the whole animal kingdom, or any definite division of it, we shall find that we are examining a group of beings which is capable of being arranged along a series of close affinities, *in a circular form*,—that is to say, starting from any one portion of the group, when it is properly arranged, we can proceed from one to another by minute gradations, till at length, having run through the whole, we return to the point whence we set out. All natural groups of animals are, therefore, in the language of Mr. Macleay, *circular;* and the possibility of throwing any supposed group into a circular arrangement is held as a decisive test of its being a real or natural one. It is of course to be understood that each circle is composed of a set of inferior circles; for example, a set of *tribe* circles composes an *order;* a set of *order* circles, again, forms a *class;* and so on. Mr. Macleay and his associates have advanced from this doctrine, which has much evidence in its favor, to another which certainly is not and cannot be proved, and which has given a fanciful air to their other views; namely, that of each group, the component circles are invariably five in number.

Overlooking the quinarian part of the theory, we may take a passing glace at the system of analogies, or adopting their own term, of *representation* which these naturalists claim to have discovered in the animal kingdom. It is founded upon the characters of the five orders into which they divided the class Aves ; namely, *insessores* (perching birds), *raptores* (birds of prey), *natatores* (swimming birds), *grallatores* (waders), *rasores* (scrapers). In these orders our naturalists believed they found distinct organic characters, of different degrees of perfectness, the first being the most perfect with regard to the general character of the class, and therefore the best representative of that class ; whence it was called the *typical* order. The second was found to be inferior, or rather to have a less perfect balance of qualities ; hence it was designated the *sub-typical*. In this are comprehended the chief noxious and destructive animals of the circle to which it belongs. The other three groups were called aberrant, as exhibiting a much wider departure from the typical standard, although the last of the three makes a certain recovery, and joins on to the typical group, so as to complete the circle. The first of the aberrant groups (natatores) is remarkable for making the water the theatre of its existence, and the birds composing it are in general of comparatively large bulk. The second (grallatores) are long-limbed and long-billed, that they may wade and pick up their subsistence in the shallows and marshes in which they chiefly live. The third (rasores) are distinguished by strong feet, for walking or running on the ground, and for scraping in it for their food ; also by wings designed to scarcely raise them off the earth ; and, further, by a general domesticity of character, and usefulness to man.

According to our naturalists, these organic characters, habits, and moral properties are traceable more or less distinctly in the corresponding portions of every other group, even of those belonging to distant subdivisions of the animal kingdom, as, for instance, the insects. The insessores (typical order of Aves) being reduced to its constituent circles or tribes, they found that these strictly represented the five orders. In the *conirostres* are the perfections which belong to the insessores as an order, with the conspicuous external feature of a comparatively small notch in their bills; in the *dentirostres*, the notch is strong and tooth-like (hence the name of the tribe), assimilating them to the raptores; the *fissirostres* come into analogy with the natatores in the slight development of their feet and their great powers of flight; the *tenuirostres* have the small mouths and long soft bills of the grallatores. Finally, the *scansores* resemble the rasores in their superior intelligence and docility, and in their having strong limbs and a bill entire at the tip. This parity of qualities becomes clearer when placed in a tabular form:

Orders of Birds.	*Characters.*	*Tribes of Insessores.*
Insessores - -	Most perfect of their circle: notch of bill small - - - - - - - - - -	Conirostres.
Raptores - -	Notch of bill like a tooth - - - - -	Dentirostres.
Natatores - -	Slightly developed feet; strong flight - - - - - - - - - - - - - -	Fissirostres.
Grallatores -	Small mouths; long soft bills- - - -	Tenuirostres.
Rasores - - -	Strong feet, short wings; docile and domestic - - - - - - - - - - -	Scansores.

Such is the doctrine of representation; it presumes that every group or circle of beings, being in five parts, exhibits in these various parts more or less strong traces of those physical and mental characters. This is certainly claiming too much; but undoubtedly there are repetitions of some such characters in certain parts of the animal kingdom. When we consult geology and zoology in union, we discover that the first animals of every broadly marked type are aquatic, and that these are less perfectly organized than their successors. The radiate sub-kingdom, which Mr. Swainson considers natatorial in its circle, is entirely aquatic. The mollusca and articulata respectively send off land or air-breathing families, which are (I speak with certainty only of the latter case) more highly organized than their predecessors. The first reptiles (ichthyosauri) were natatorial, and of comparatively mean organization. In reptiles, in the lower sub-kingdoms, in birds, in mammalia, there are alike appearances of lines of development, giving, first, aquatic animals; next, creatures which could live partly in water and partly on land, frequenting shores or shallows. To this second type belong the plesiosaur, the wading birds, the cetacean amphibia. *It is an order following the sequence of conditions which geology shows us in the history of our globe.* Purely land animals follow, as, for instance, where we see the pachyderms come in immediate descent from the amphibia. And there is much to make us believe that types, not greatly different from those described by the Macleay school, do form a succession in the terrestrial tribes, each bearing a reference, in respect of general habits and character, to appropriate circumstances in the external world. For example, the rasorial birds and ruminant quadrupeds seem respectively to have arisen from the preceding type, as creatures qualified to subsist by immediate connection with the ground; and it is curious to find that many such birds have a regurgitating power like the ruminant quadrupeds, as if common circumstances had led to common organization.

There is equally good reason to regard the obviously analogous raptores and felinæ as a further development of their respective classes, necessary for the regulation of the numbers of those animals which previously existed. To me, however, these representations appear, primarily at least, as a result of physical conditions for animal existence operating in various departments of the kingdom alike. To illustrate this, let us take another instance. It is clear that woods, when these came to exist, gave occasion at once to certain families of both birds and mammalia; and such families must have been all alike adapted, by some peculiar modifications of type formation, to the nature of a sylvan life, or they could not have existed. Hence it is not surprising to find the perching birds and squirrels have claws, and the quadrumana hands and feet, suitable for grasping branches and climbing along them, and presenting in these features certain analogies apt to strike an observant mind. But this does not imply such a representation as the quinarian school have endeavored to establish, though, in another point of view, it is a fact highly worthy of notice.

If, as alleged, representation goes down into every section of the animal kingdom; if, as has been pointed out, the acrita are a prophecy of the four other types, and the fishes have a family prefiguring the scraping birds, it would imply a curious artificiality of arrangement in the creative design; but it would present no objection to our hypothesis of organic development; and this is all that I am at present concerned to show.

Let us now consider the facts known regarding the geographical distribution of plants and animals in connexion with the same hypothesis.

Plants, as is well known, require various kinds of soil, forms of geographical surface, climate, and other conditions, for their existence. And it is everywhere found that, however isolated a particular spot may be with regard to these conditions,—as a mountain top in a torrid country, the marsh round a salt spring far inland, or an island placed far apart in the ocean,—appropriate plants have there taken up their abode. But the torrid zone divides the two temperate regions from each other by the space of more than forty-six degrees, and the torrid and temperate zones together form a much broader line of division between the two arctic regions. The Atlantic and Pacific Oceans, and the Persian Gulf, also divide the various portions of continent in the torrid and temperate zones from each other. Australia is also divided by a broad sea from the continent of Asia. Thus there are various portions of the earth separated from each other in such a way as to preclude anything like a general communication of the seeds of their respective plants towards each other. Hence arises an interesting question—Are the plants of the various isolated regions which enjoy a parity of climate and other conditions, identical or the reverse? The answer is—that in such regions the vegetation bears a general resemblance, but the *species* are nearly all different, and there is even, in a considerable measure, a diversity of *families*.

The general facts have been thus stated: In the arctic and antarctic regions, and in those parts of lower latitudes, which, from their elevation, possess the same cold climate, there is always a similar or analogous vegetation, but few species are common to the various situations. In like manner, the intertropical vegetation of Asia, Africa, and America, are specifically different, though generally similar. The southern region of America is equally diverse from that of Africa, a country similar in clime, but separated by a vast extent of ocean. The vegetation of Australia, another region similarly placed in respect of clime, is even more peculiar. These facts are the more remarkable when we discover that, in most instances, the plants of one region have thriven when transplanted to another of parallel clime. This would show that parity of conditions does not lead to a parity of productions so exact as to include identity of species, or even genera. Besides the various isolated regions here enumerated, there are some others indicated by naturalists as exhibiting a vegetation equally peculiar. Some of these are isolated by mountains, or the interposition of sandy wastes. For example, the temperate region of the elder continent is divided about the centre of Asia, and the east of that line is different from the west. So also is the same region divided in North America by the Rocky Mountains. Abyssinia and Nubia constitute another distinct botanical region. De Candolle enumerates in all twenty well-marked portions of the earth's surface which are peculiar with respect to vegetation; a number which would be greatly increased if remote islands and isolated mountain ranges were to be included.

When we come to the zoology, we find precisely similar results; excepting that man (with, perhaps, some of the less conspicuous forms of being) is universal, and that several tribes, as the bear and dog, appear to have passed by the land connexion from the arctic regions of the eastern to those of the western hemisphere. "With these exceptions," says Dr. Prichard, "and without any others, as far as zoological researches have yet gone, it may be asserted that no individual species are common to distant regions. In parallel climates, analogous species replace each other; sometimes, but not frequently, the same genus is found in two separate continents; but the species which are natives of one region are not identical with corresponding races indigenous in the opposite hemisphere.

"A similar result arises when we compare the three great intertropical regions, as well as the extreme spaces of the three great continents, which advance into the temperate climates of the southern hemisphere.

"Thus, the tribes of simiæ (monkeys), of the dog and cat kinds, of pachyderms, including elephants, tapirs, rhinoceroses, hogs, of bats, of saurian and ophidian reptiles, as well as of birds and other terrene animals, are all different in the three great continents. In the lower departments of the mammiferous family, we find that the bruta, or edentata (sloths, armadillos, &c.), of Africa, are differently organized from those of America, and these again from the tribes found in the Malayan archipelago and Terra Australis."*

It does not appear that the diversity between the similar regions of Africa, Asia, and America, is occasioned in all instances by any disqualification of these countries to support precisely the same genera or species. The ox, horse, goat, &c., of the elder continent have thriven and extended themselves in the new, and many of the indigenous tribes of America would no doubt flourish in corresponding climates in Europe, Asia, and Africa. It has, however, been remarked that the larger and more powerful animals of their respective orders belong to the elder

* Researches in the Physical History of Man, 4th edition, i., 95.

continent, and that thus the animals of America, unlike the features of inanimate nature, appear to be upon a small scale. The swiftest and most agile animals, and a large proportion of those most useful to man, are also natives of the elder continent. On the other hand, the bulk of the edentata, a group remarkable for defects and meanness of organization, are American. The zoology of America may be said, upon the whole, to recede from that of Asia, "and perhaps in a greater degree," adds Dr. Prichard, "from that of Africa." A much greater recession is, however, observed in both the botany and zoology of Australia.

There, "we do not find, in the great masses of vegetation, either the majesty of the virgin forests of America, or the variety and elegance of those of Asia, or the delicacy and freshness of the woods of our temperate countries of Europe. The vegetation is generally gloomy and sad; it has the aspect of our evergreens or heaths; the plants are for the most part woody; the leaves of nearly all the plants are linear, lanceolated, small, coriaceons, and spinescent. The grasses, which elsewhere are generally soft and flexible, participate in the stiffness of the other vegetables. The greater part of the plants of New Holland belong to new genera; and those included in the genera already known are of new species. The natural families which prevail are those of the heaths, the proteæ, compositæ, leguminosæ, and myrtaceæ; the larger trees all belong to the last family." *

The prevalent animals of Australia are not less peculiar. It is well known that none above the marsupialia, or pouched animals, are native to it.

* Prichard.

The most conspicuous are these marsupials, which exist in great varieties here, though unknown in the elder continent, and only found in a few mean forms in America. Next to them are the monotremata, which are entirely peculiar to this portion of the earth. Now these are animals at the bottom of the mammiferous class, adjoining to that of birds, of whose character and organization the monotremata largely partake, the ornithorhynchus presenting the bill and feet of a duck, producing its young in eggs, and having, like birds, a clavicle between the two shoulders. The birds of Australia vary in structure and plumage, but all have some singularity about them—the swan, for instance, is black. The country abounds in reptiles, and the prevalent fishes are of the early kinds, having a cartilaginous structure.

Altogether, the plants and animals of this minor continent convey the impression of an early system of things, such as might be displayed in other parts of the earth about the time of the oolite. In connexion with this circumstance, it is a fact of some importance, that the geognostic character of Australia, its vast arid plains, its little diversified surface and consequent paucity of streams, and the very slight development of volcanic rock on its surface, seem to indicate a system of physical conditions, such as we may suppose to have existed elsewhere in the oolitic era: perhaps we see the chalk formation preparing there in the vast coral beds frontiering the coast. Australia thus appears as a portion of the earth which has, from some unknown causes, been belated in its physical and organic development.

The general conclusions regarding the geography of organic nature may be thus stated, (1.) There are numerous distinct foci of organic production throughout the earth. (2.) These have everywhere advanced in accordance with the local conditions of climate, &c., as far as at least the class and order are concerned, a diversity taking place in the lower gradations. No physical or geographical reason appearing for this diversity, we are led to infer that, (3.) it is the result of minute and inappreciable causes giving the law of organic development a particular direction in the lower sub-divisions of the two kingdoms. (4.) Development has not gone on to equal results in the various continents, being most advanced in the eastern continent, next in the western, and least in Australia, this inequality being perhaps the result of the comparative antiquity of the various regions, geologically and geographically.

It must also be evident that the line of organic development can have nowhere required for its advance the whole of the families comprehended in the two kingdoms, seeing that some of these are confined to one continent, and some to another, without a conceivable possibility of one having been connected with the other in the way of ancestry. The two great families of quadrumana, cebidæ, and simiadæ, are a noted instance, the one being exclusively American, while the other belongs entirely to the old world. It rather appears that the entire system has been produced in lines geographically detached, and accordingly in separate genealogies, the general types being everywhere regular in succession, by virtue, we may suppose, of conditions so far uniform, but afterwards branching out in ramifications of a diverse character, under the influence of circumstances the nature of which we can imagine, but of which we might vainly endeavor to ascertain the particulars.

We must now call to mind that the geographical distribution of plants and animals was very different in the geological ages from what it is now. Down to a time not long antecedent to man, the same vegetation overspread every clime, and a similar uniformity marked the zoology. This is conceived by M. Brogniart, with great plausibility, to have been the result of a uniformity of climate, produced by the as yet unexhausted effect of the internal heat of the earth upon its surface; whereas climate has since depended chiefly on external sources of heat, as modified by the various meteorological influences. However the early uniform climate was produced, certain it is that, from about the close of the geological epoch, plants and animals have been dispersed over the globe with a regard to their particular characters, and specimens of both are found so isolated in particular situations, as utterly to exclude the idea that they came thither from any common centre. It may be asked,—Considering that, in the geological epoch, species are not limited to particular regions, and that since the close of that epoch, they are very peculiarly limited, are we to presume the present organisms of the world to have been created *ab initio* after that time? To this it may be answered,—Not necessarily, as it so happens that animals begin to be much varied, or to appear in a considerable variety of species, pretty early in the tertiary formation. It may have been that the multitudes of locally peculiar species only came into being after the uniform climate had passed away. It may have only been when a varied climate arose, that the originally few species branched off into the present extensive variety.

EARLY HISTORY OF MANKIND.

The human race is known to consist of numerous nations, displaying considerable differences of external form and color, and speaking in general different languages. This has been the case since the commencement of written record. It is also ascertained that the external peculiarities of particular nations do not rapidly change. While a people remain upon one geographical area, and under the influence of one set of conditions, they always exhibit a tendency to persistency of type, insomuch that a subordinate admixture of various type is usually obliterated in a few generations. Numerous as the varieties are, they have all been found classifiable under five leading ones:—1. The Caucasian, or Indo-European, which extends from India into Europe and Northern Africa; 2. The Mongolian, which occupies Northern and Eastern Asia; 3. The Malayan, which extends from the Ultra-Gangetic Peninsula into the numerous islands of the South Seas and Pacific; 4. The Negro, chiefly confined to Africa; 5. The aboriginal American. Each of these is distinguished by certain general features of so marked a kind, as to suggest to many inquirers, that they have had distinct or independent origins. Of these peculiarities, color is the most conspicuous: the Caucasians are generally white, the Mongolians yellow, the Negroes black, and the Americans red. The opposition of two of these in particular, white and black, is so striking, that of them, at least, it seems almost necessary to suppose separate origins. Of late years, however, the whole of this question has been subjected to a rigorous investigation by a British philosopher, who has successfully shown that the human race might have had one origin, for anything that can be inferred from external peculiarities.

It appears from this inquiry,* that color and other physiological characters are of a more superficial and accidental nature than was at one time supposed. One fact is at the very first extremely startling, that there are nations, such as the inhabitants of Hindostan, apparently one in descent, which nevertheless contain groups of people of almost all shades of color, and likewise discrepant in other of those important features on which much stress has been laid. Some other facts, which I may state in brief terms, are scarcely less remarkable. In Africa, there are Negro nations—that is, nations of intensely black complexion, as the Jolofs, Mandingoes, and Kafirs, whose features and limbs are as elegant as those of the best European nations. While we have no proof of Negro races becoming white in the course of generations, the converse may be held as established, for there are Arab and Jewish families of ancient settlement in Northern Africa, who have become as black as the other inhabitants. There are also facts

* See Dr. Prichard's Researches into the Physical History of Man.

which seem to show the possibility of a natural transition by generation from the black to the white complexion, and from the white to the black. True whites (apart from Albinoes), are not unfrequently born among the Negroes, and the tendency to this singularity is transmitted in families. There is, at least, one authentic instance of a set of perfectly black children being born to an Arab couple, in whose ancestry no such blood had intermingled. This occurred in the valley of the Jordan, where it is remarkable that the Arab population in general have flatter features, darker skins, and coarser hair, than any other tribes of the same nntion.*

The style of living is ascertained to have a powerful effect in modifying the human figure in the course of generations, and this even in its osseous structure. About two hundred years ago, a number of people were driven by a barbarous policy from the counties of Antrim and Down, in Ireland, towards the sea-coast, where they have ever since been settled, but in unusually miserable circumstances, even for Ireland; and the consequence is, that they exhibit peculiar features of the most repulsive kind, projecting jaws with large open mouths, depressed noses, high cheek bones, and bow legs, together with an extremely diminutive stature. These, with an abnormal slenderness of the limbs, are the outward marks of a low and barbarous condition all over the world; it is particularly seen in the Australian aborigines. On the other hand, the beauty of the higher ranks in England is very remarkable, being, in the main, as clearly a result of

* Buckingham's Travels among the Arabs. This fact is the more valuable to the argument, as having been set down with no regard to any kind of hypothesis.

good external conditions. "Coarse, unwholesome, and ill-prepared food," says Buffon, "makes the human race degenerate. All those people who live miserably are ugly and ill-made. Even in France, the country people are not so beautiful as those who live in towns; and I have often remarked that in those villages where the people are richer and better fed than in others, the men are likewise more handsome, and have better countenances." He might have added, that elegant and commodious dwellings, cleanly habits, comfortable clothing, and being exposed to the open air only as much as health requires, co-operate with food in increasing the elegance of a race of human beings.

Subject to these modifying agencies, and perhaps to some others of a less appreciable nature, connected with physical geography, there is, as has been said, a remarkable persistency in national features and forms, insomuch that a single individual thrown into a family different from himself is absorbed in it, and all trace of him lost after a few generations. Such permanency may, like that of species, be the rule, but the exceptive variations, which result from causes obvious or obscure, are also of a prominent character. They seem to tend most to occur among the humbler families of plants and animals, but also frequently take place in the very highest. A notable instance of variety-production in an animal family by no means low, is often referred to, as having occurred under the observation of persons still alive to attest it. On a New England farm there originated, in the latter part of the last century, a variety of sheep with unusually short legs, which was kept up by breeding, on account of the convenience in that country of having sheep which are unable to jump over low fences. The starting and maintaining a *breed* of cattle, that is, a variety marked by some desirable peculiarity, are familiar to a large class of persons. It appears only necessary, when a variety has been thus produced, that a union should take place between individuals similarly characterized, and that the conditions under which it has been produced should be persisted in, in order to establish it. Early in the last century, a man named Lambert was born in Suffolk, with semi-horny excrescences of about half an inch long, thickly growing all over his body. The peculiarity was transmitted to his children, and was last heard of in a third generation. The peculiarity of six fingers on the hand, and six toes on the feet, appears in like manner in families which have no record or tradition of such a peculiarity having affected them at any former period, and it is then sometimes seen to descend through several generations. It was Mr. Lawrence's opinion, that a pair, in which both parties were so distinguished, might be the progenitors of a new variety of the race who would be thus marked in all future time. We have but obscure notions of the laws which regulate this variability within specific limits; but we see them continually operating, and they are obviously favorable to the supposition that all the great families of men are of one stock.

The tendency of the modern study of the languages of nations is to the same point. The last fifty years have seen this study elevated to the character of a science, and the light which is thrown upon the history of mankind is of a most remarkable nature.

Following a natural analogy, philologists have thrown the earth's language into a kind of classification: a number bearing a considerable resemblance to each other, and in general geographically near, are styled a *group* or *sub-family;* several groups, again, are associated as a *family*, with regard to more general features of resemblance. Six families are spoken of.

The Indo-European family nearly coincides in geographical limits with these which have been assigned to that variety of mankind which generally shows a fair complexion, called the Caucasian variety. It may be said to commence in India, and thence to stretch through Persia into Europe, the whole of which it occupies, excepting Hungary, the Basque provinces of Spain, and Finland. Its sub-families are the Sanskrit or ancient language of India, the Persian, the Slavonic, Celtic, Gothic, and Pelasgian. The Slavonic includes the modern languages of Russia and Poland. Under the Gothic, are (1) the Scandinavian tongues, the Norske, Swedish, and Danish; and (2) the Teutonic, to which belong the modern German, the Dutch, and our own Anglo-Saxon. I give the name of Pelasgian to the group scattered along the north shores of the Mediterranean, the Greek and Latin, including the modifications of the latter under the names of Italian, Spanish, &c. The Celtic was, from two to three thousand years ago, the speech of a considerable tribe dwelling in Western Europe; but these have since been driven before superior nations into a few corners, and are now only to be found in the highlands of Scotland, Ireland, Wales, Cornwall, and certain parts of France. The Gaelic of Scotland, Erse of Ireland, and the Welsh, are the only living branches of this sub-family of languages.

The resemblances amongst languages are of two kinds,—identity of words, and identity of grammatical forms; the latter being now generally considered as the most important towards the argument. When we inquire into the first kind of affinity among the languages of the Indo-European family, we are surprised at the great number of common terms which exist amongst them, and these referring to such primary ideas, as to leave no doubt of their having all been derived from a common source. Colonel Vans Kennedy presents nine hundred words common to the Sanskrit and other languages of the same family. In the Sanskrit and Persian, we find several which require no sort of translation to an English reader, as *pader*, *mader*, *sunu*, *dokhter*, *brader*, *mand*, *vidhava;* likewise *asthi*, a bone (Greek, *ostoun*); *denta*, a tooth (Latin, *dens*, *dentis*); *eycumen*, the eye; *brouwa*, the eyebrow (German, *braue*): *nasa*, the nose; *karu*, the hand (Gr. *cheir*); *genu*, the knee (Lat. *genu*,); *ped*, the foot (Lat. *pes*, *pedis*); *hrti*, the heart; *jecur*, the liver (Lat. *jecur*); *stara*, a star; *gela*, cold (Lat. *gelu*, ice); *aghni*, fire (Lat. *ignis*); *dhara*, the earth (Lat. *terra*, Gaelic, *tir*); *arrivi*, a river; *nau*, a ship (Gr. *naus*, Lat. *navis*); *ghau*, a cow; *sarpam*, a serpent.

The inferences from these verbal coincidences were confirmed in a striking manner when Bopp and others investigated the grammatical structure of this family of languages. Dr. Wiseman pronounces that the great philologist just named, "by a minute and sagacious analysis of the Sanskrit verb, compared with the conjugational system of the other members of this family, left no doubt of their intimate and positive affinity." It was now discovered that the peculiar terminations or inflections by which persons are expressed throughout the verbs of nearly the whole of these languages, have their foundation in pronouns; the pronoun was simply placed at the end, and thus became an inflection. "By an analysis of the Sanskrit pronouns, the elements of those existing in all the other languages were cleared of their anomalies; the verb substantive, which in Latin is composed of fragments referable to two distinct roots, here found both existing in regular form; the Greek conjugations, with all their complicated machinery of middle voice, augments and reduplications, were here found and illustrated in a variety of ways, which a few years ago would have appeared chimerical. Even our own language may sometimes receive light from the study of distant members of our family. Where, for instance, are we to seek for the root of our comparative *better?* Certainly not in its positive, good, nor in the Teutonic dialects in which the same anomaly exists. But in the Persian we have precisely the same comparative, *behter*, with exactly the same signification, regularly formed from its positive *beh*, good."*

* Wiseman's Lectures on the Connexion between Science and Revealed Religion, i., 44. The Celtic has been established as a member or group of the Indo-European family, by the work of Dr. Prichard, *on the Eastern Origin of the Celtic Nations*. "First," says Dr. Wiseman, "he has examined the lexicon resemblances, and shown that the primary and most simple words are the same in both, as well as in the numerals and elementary verbal roots. Then follows a minute analysis of the verb, directed to show its analogies with other languages, and they are such as manifest no casual coincidence, but an internal structure radically the same. The verb substantive, which is minutely analysed, presents more striking analogies to the Persian verb than perhaps any other language of the family. But Celtic is not thus become a mere member of this confederacy, but has brought to it most important

The second great family of languages is the *Syro-Phœnician*, comprising the Hebrew, Syro-Chaldaic, Arabic, and Gheez or Abyssinian, being localized principally in the countries to the west and south of the Mediterranean. Beyond them, again, is the African family, which, as far as research has gone, seems to be in like manner marked by common features, both verbal and grammatical. The fourth is the Polynesian family, extending from Madagascar on the west, through the Indian Archipelago, besides taking in the Malayan dialect from the continent of India, and comprehending Australia and the islands of the western portion of the Pacific. This family, however, bears such an affinity to that next to be described, that Dr. Leyden and some others do not give it a distinct place as a family of languages.

The fifth family is the Chinese, embracing a large part of China, and most of the regions of Central and Northern Asia. The leading features of the Chinese language are, in consisting altogether of monosyllables, and being destitute of all grammatical forms, except certain arrangements and accentuations, which vary the sense of particular words. It is also deficient in some of the consonants most conspicuous in other languages, b, d, r, v,

aid; for, from it alone can be satisfactorily explained some of the conjugational endings in the other languages. For instance, the third person plural of the Latin, Persian, Greek, and Sanscrit, ends in nt, nd, ντι, ντο, nti, or nt. Now, supposing, with most grammarians, that the inflections arose from the pronouns of the respective persons, it is only in Celtic that we find a pronoun that can explain this termination; for there, too, the same person ends in nt, and thus corresponds exactly, as do the others, with its pronoun, *hwynt*, or *ynt*."

and z; so that this people can scarcely pronounce our speech in such a way as to be intelligible: for example, the word Christus they call *Kuliss-ut-oo-suh*. The Chinese, strange to say, though they early attained to a remarkable degree of civilisation, and have preceded the Europeans in many of the most important inventions, have a language which resembles that of children, or deaf and dumb people. The sentence of short, simple, unconnected words, in which an infant amongst us attempts to express some of its wants and its ideas—the equally broken and difficult terms which the deaf and dumb express by signs, as the following passage of the Lord's Prayer:—"Our Father, heaven in, wish your name respect, wish your soul's kingdom providence arrive, wish your will do heaven and earth equality," &c.—these are like the discourse of the refined people of the so-called Celestial Empire. An attempt was made by the Abbé Sicard to teach the deaf and dumb grammatical signs; but they persisted in restricting themselves to the simple signs of ideas, leaving the structure undetermined by any but the natural order of connexion. Such is exactly the condition of the Chinese language.

Crossing the Pacific, we come to the last great family in the languages of the aboriginal Americans, which have all of them features in common, proving them to constitute a group by themselves, without any regard to the very different degrees of civilisation which these nations had attained at the time of the discovery. The common resemblance is in the grammatical structure as well as in words, and the grammatical structure of this family is of a very peculiar and complicated kind. The general character in this respect has caused the term Polysynthetic to be applied to the American languages. A long many-syllabled word is used by the rude Algonquins and Delawares to express a whole sentence: for example, a woman of the latter nation, playing with a little dog or cat, would perhaps be heard saying, "*kuligatschis*," meaning, "give me your pretty little paw;" the word, on examination, is found to be made up in this manner: *k*, the second personal pronoun; *uli*, part of the word wulet, pretty; *gat*, part of the word wiehgat, signifying a leg or paw; *schis*, conveying the idea of littleness. In this same tongue, a youth is called pilape, a word compounded from the first part of pilsit, innocent, and the latter part of lenape, a man. Thus, it will be observed, a number of parts of words are taken and thrown together, by a process which has been happily termed *agglutination*, so as to form one word, conveying a complicated idea. There is also an elaborate system of inflection; in nouns, for instance, there is one kind of inflection to express the presence or absence of vitality, and another to express number. The genius of the language has been described as accumulative; it "tends rather to add syllables or letters, making farther distinctions in objects already before the mind, than to introduce new words."* Yet it has also been shown very distinctly, that these languages are based in words of one syllable, like those of the Chinese and Polynesian families; all the primary ideas are thus expressed: the elaborate system of inflection and agglutination is shown to be simply a further development of the language-forming principle, as it may be called—or the Chinese system may be described as an

* Schoolcraft.

arrestment of this principle at a particular early point. It has been fully shown, that between the structure of the American and other families, sufficient affinities exist to make a common origin or early connexion extremely likely. The verbal affinities are also very considerable. Humboldt says, "In eighty-three American languages examined by Messrs. Barton and Vater, one hundred and seventy words have been found, the roots of which appear to be the same; and it is easy to perceive that this analogy is not accidental, since it does not rest merely upon imitative harmony, or on that conformity of organs which produces almost a perfect identity in the first sounds articulated by children. Of these one hundred and seventy words which have this connexion, three-fifths resemble the Manchou, the Tongouse, the Mongol, and the Samoyed; and two-fifths, the Celtic and Tchoud, the Biscayan, the Coptic, and Congo languages. These words have been found by comparing the whole of the American languages with the whole of those of the Old World; for hitherto we are acquainted with no American idiom which seems to have an exclusive correspondence with any of the Asiatic, African, or European tongues."* Humboldt and others considered these words as brought into America by recent immigrants; an idea resting on no proof, and which seems at once refuted by the common words being chiefly those which represent primary ideas; besides, we now know, what was not formerly perceived or admitted, that there are great affinities of structure also. I may here refer to a curious mathematical calculation by Dr. Thomas Young, to the effect,

* Views of the Cordilleras.

that if three words coincide in two different languages, it is ten to one they must be derived in both cases from some parent language, or introduced in some other manner. "Six words would give more," he says, "than seventeen hundred to one, and eight near 100,000, so that in these cases the evidence would be little short of absolute certainty." He instances the following words to show a connexion between the ancient Egyptian and the Biscayan :—

	Biscayan.	Egyptian.
New - - - - -	Beria - - - -	Beri.
A dog - - - - -	Ora - - - -	Whor.
Little - - - - -	Gutchi - - - -	Kudchi.
Bread - - - - -	Ognia - - - -	Oik.
A wolf - - - - -	Otgsa - - - -	Ounsh.
Seven - - - - -	Shashpi - - - -	Shashf.

Now, as there are, according to Humboldt, one hundred and seventy words in common between the languages of the new and old continents, and many of these are expressive of the most primitive ideas, there is, by Dr. Young's calculation, overpowering proof of the original connexion of the American and other human families.

This completes the slight outline which I have been able to give, of the evidence for the various races of men being descended from one stock. It cannot be considered as conclusive, and there are many eminent persons who deem the opposite idea the more probable ; but I must say that, without the least regard to any other kind of evidence, that which physiology and philology present seems to me decidedly favorable to the idea of one local origin.

Supposing the human race to be *one*, we are next called upon to inquire in what part of the earth it may most probably be supposed to have originated. One obvious mode of approximating to a solution of this question is to trace backward the lines in which the principal tribes appear to have migrated, and to see if these converge nearly to a point. It is very remarkable that the lines do converge, and are concentrated about the region of Hindostan. The language, religion, modes of reckoning time, and some other peculiar ideas of the Americans, are now believed to refer their origin to North-Eastern Asia. Trace them further back in the same direction, and we come to the north of India. The history of the Celts and Teutones represents them as coming from the east, the one after the other, successive waves of a tide of population flowing towards the north-west of Europe: this line being also traced back, rests finally at the same place. So does the line of Iranian population, which has peopled the east and south shores of the Mediterranean, Syria, Arabia, and Egypt. The Malay variety, again, rests its limit in one direction on the borders of India. Standing on that point, it is easy to see how the human family, originating there, might spread out in different directions, passing into varieties of aspect and of language as they spread, the Malay variety proceeding towards the Oceanic region, the Mongolians to the east and north, and sending off the red men as a sub-variety, the European population going off to the north-westward, and the Syrian, Arabian and Egyptian, towards the countries which they are known to have so long occupied. The negro alone is here unaccounted for; and of that race it may fairly be said, that it is the one most likely to have had an independent origin, seeing that it is a type so peculiar in an inveterate black color, and so humble in development. The ancient traditions of the human race exhibit an agreement with this view of its origin. There is one among the Hindoos which places the cradle of the human family in Thibet; another makes Ceylon the residence of the first man. The development hypothesis would demand, of course, that the original seat of the human race should be in a region where the quadrumana are rife. Now these are most abundant, both in species and individuals, in the Indian archipelago, although it now appears, from the investigations of Professor Owen, that the chimpanzee of Western Africa approaches nearer to man than any known species of Indian simiæ.

After all it may be regarded as still an open question, whether mankind is of one or more origins. The first human generation may have consisted of many pairs, though situated at one place, and these may have been considerably different from each other in external characters. And we are equally bound to admit, though this does not as yet seem to have occurred to any other speculator, that, barring any objection of a philological nature, there may have been at least one other line or source of origination—shall we say in Africa, which resulted in the production of a being identical in species, although variously marked.

It has of late years been a favorite notion with several writers, that the human race was at first in a highly civilized state, and that barbarism was a second condition. The principal argument for it is, that we see many examples of nations falling away from civilisation into barbarism, while, in some regions of the earth, the history of which we do not clearly know, there are remains of works of art far superior to any which the present unenlightened inhabitants could have produced. It is to be readily admitted that such decadences are common; but do they necessarily prove that there has been anything like a regular and constant decline into the present state, from a state more generally refined? May not these be only instances of local failures and suppressions of the principle of civilisation, where it had begun to take root amongst a people generally barbarous? This, at least, was as legitimate an inference from the facts which are known. But it is also alleged that we know of no such thing as civilisation being ever self-originated. It is also seen to be imparted from one people to another. Hence, of course, we must infer that civilisation at the first could only have been of supernatural origin. This argument appears to be founded on false premises, for civilisation does sometimes rise in a manner clearly independent amongst a horde of people generally barbarous. A striking instance is described in the laborious work of Mr. Catlin on the North-American tribes. Far placed among those which inhabit the vast region of the northwest, and quite beyond the reach of any influence from the whites, he found a small tribe living in a fortified village, where they cultivated the arts of manufacture, realized comforts and luxuries, and had attained to a remarkable refinement of manners, insomuch as to be generally called "polite and friendly Mandans." They were also more than usually elegant in their persons, and of every variety of complexion between that of their compatriots and a pure white. Up to the time of Mr. Catlin's visit, these people had been able to defend themselves and their possessions against the roving bands which surrounded them on all sides; but, soon after, they were attacked by small-pox, which cut them all off except a small party, whom their enemies rushed in upon and destroyed to a man. What is this but a repetition on a small scale of phenomena with which ancient history familiarizes us—a nation rising in arts and elegances amidst barbarous neighbors, but at length overpowered by the rude majority, leaving only a Tadmor or a Luxor as a monument of itself to beautify the waste? What can we suppose the nation which built Palenque and Copan to have been but only a kind of Mandan tribe, which chanced to have made its way further along the path of civilisation and the arts, before the barbarians broke in upon it? The flame essayed to rise in many parts of the earth; but there were considerable agencies working against it, and down it accordingly went, times without number; yet there was always a vitality in it, nevertheless, and a tendency to progress, and at length it seems to have atttained a strength against which the powers of barbarism can never more prevail. The state of our knowledge of uncivilized nations is very apt to make us fall into error on this subject. They are generally supposed to be all at one point in barbarism, which is far from being the case, for in the midst of every great region of uncivilized men, such as North America, there are nations partially refined. The Jolofs, Mandingoes, and Kafirs, are African examples, where a natural and independent origin for the improvement which exists is as unavoidably to be presumed as in the case of the Mandans.

The most conclusive argument against the original civilisation of mankind is to be found in the fact that we do not now see civilisation existing anywhere except in certain conditions altogether different from any we can suppose to have existed at the commencement of our race. To have civilisation, it is necessary that a people should be numerous and closely placed; that they should be fixed in their habitations, and safe from violent external and internal disturbance; that a considerable number of them should be exempt from the necessity of drudging for immediate subsistence. Feeling themselves at ease about the first necessities of their nature, including self-preservation, and daily subjected to that intellectual excitement which society produces, men begin to manifest what is called civilisation; but never in rude and shelterless circumstances, or when widely scattered. Even men who have been civilized, when transferred to a wide wilderness, where each has to work hard and isolatedly for the first requisites of life, soon show a retrogression to barbarism; witness the plains of Australia, as well as the backwoods of Canada and the prairies of Texas. Fixity of residence and thickening of population are perhaps the prime requisites for civilisation, and hence it will be found that all civilisations as yet known have taken place in regions physically limited. That of Egypt arose in a narrow valley hemmed in by deserts on both sides. That of Greece took its rise in a small peninsula bounded on the only land side by mountains. Etruria and Rome were naturally limited regions. Civilisations have taken place at both the eastern and western extremities of the elder continent—China and Japan, on the one hand: Germany, Holland, Britain, France, on the other—while the great unmarked tract between contains nations decidedly less advanced. Why is this, but because the sea, in both cases, has imposed limits to further migration, and caused the population to settle and condense—the conditions most necessary for social improvement.* Even the simple case of the Mandans affords an illustration of this principle, for Mr. Catlin expressly, though without the least regard to theory, attributes their improvement to the fact of their being a small tribe, obliged, by fear of their more numerous enemies, to *settle in a permanent village*, so fortified as to ensure their preservation. "By this means," says he, "they have advanced further in the arts of manufacture, and have supplied their lodges more abundantly with the comforts and even luxuries of life than any Indian nation I know of. The consequence of this," he adds, "is, that the tribe has taken many steps ahead of other tribes in *manners and refinements*." These conditions can only be regarded as natural laws affecting civilisation, and it might not be difficult, taking them into account, to predict of any newly settled country its social destiny. An island like Van Dieman's land might fairly be expected to go on more rapidly to good manners and sound institutions than a wide region like Australia. The United States might be expected to make no great way in civilisation till they be fully peopled to the Pacific ; and it might not be unreasonable to expect that, when that event has occurred, the greatest civilisations of that vast territory will be found in the peninsula of California and the narrow stripe of country beyond the Rocky Mountains. This, however, is a digression. To return : it is also ne-

* The problem of Chinese civilisation, such as it is—so puzzling when we consider that they are only, as will be presently seen, the child race of mankind—is solved when we look to geographical position producing fixity of residence and density of population.

cessary for a civilisation that at least a portion of the community should be placed above mean and engrossing toils. Man's mind is subdued, like the dyer's hand, to that it works in. In rude and difficult circumstances, we unavoidably become rude, because then only the inferior and harsher faculties of our nature are called into exercise. When, on the contrary, there is leisure and abundance, the self-seeking and self-preserving instincts are allowed to rest, the gentler and more generous sentiments are evoked, and man becomes that courteous and chivalric being which he is found to be amongst the upper classes of almost all civilized countries. These, then, may be said to be the chief natural laws concerned in the moral phenomenon of civilisation. If I am right in so considering them, it will of course be readily admitted that the earliest families of the human race, although they might be simple and innocent, could not have been in anything like a civilized state, seeing that the conditions necessary for that state could not have then existed. Let us only for a moment consider some of the things requisite for their being civilized,—namely, a set of elegant homes ready furnished for their reception, fields ready cultivated to yield them food without labor, stores of luxurious appliances of all kinds, a complete social enginery for the securing of life and property,—and we shall turn from the whole conceit as one worthy only of the philosophers of Utopia.

Yet, as has been remarked, the earliest families might be simple and innocent, while at the same time unskilled and ignorant, and obliged to live merely upon such substances as they could readily procure. The traditions of all nations refer to such a state as that in which mankind were at first: perhaps it is not so much a tradition as an idea which the human mind naturally inclines to form respecting the fathers of the race; but nothing that we see of mankind absolutely forbids our entertaining this idea, while there are some considerations rather favorable to it. A few families, in a state of nature, living near each other, in a country supplying the means of livelihood abundantly, are generally simple and innocent; their instinctive and perceptive faculties are also apt to be very active, although the higher intellect may be dormant. If we therefore presume India to have been the cradle of our race, they might at first exemplify a sort of golden age; but it could not be of long continuance. The very first movements from the primal seat would be attended with deterioration, nor could there be any tendency to true civilisation till groups had settled and thickened in particular seats physically limited.

The causes of the various external peculiarities of mankind now require some attention. Why, it is asked, are the Africans black, and generally marked by ungainly forms; why the flat features of the Chinese, and the comparatively well-formed figures of the Caucasians? Why the Mongolians generally yellow, the Americans red, and the Caucasians white? These questions were complete puzzles to all early writers; but physiology has lately thrown a great light upon them. It is now shown that the brain, after completing the series of animal transformations, passes through the characters in which it appears in the Negro, Malay, American, and Mongolian nations, and finally becomes Caucasian. The face partakes of these alterations. "One of the earliest points in which ossification commences is the lower jaw. This bone is consequently sooner completed than the other bones of the head, and acquires a predominance, which, as is well known, it never loses in the Negro. During the soft pliant state of the bones of the scull, the oblong form which they naturally assume, approaches nearly the permanent shape of the Americans. At birth, the flattened face and broad smooth forehead of the infant, the position of the eyes rather towards the side of the head, and the widened space between, represent the Mongolian form; while it is only as the child advances to maturity, that the oval face, the arched forehead, and the marked features of the true Caucasian, become perfectly developed."*

The leading characters, in short, of the various races of mankind, are simply representations of particular stages in the development of the highest or Caucasian type. The Negro exhibits permanently the imperfect brain, projecting lower jaw, and slender bent limbs, of a Caucasian child, some considerable time before the period of its birth. The Aboriginal American represents the same child nearer birth. The Mongolian is an arrested infant newly born. And so forth. All this is as respects form;† but whence color? This might be supposed to have depended on climatal agencies only; but it has been shown by overpowering evidence to be independent of these. In further considering the matter, we are met by the very remarkable fact that color is deepest in the least perfectly developed type, next in the Malay, next in the American,

* Lord's Popular Physiology, explaining observations by M. Serres.

† Conformably to this view, the beard, that peculiar attribute of maturity, is scanty in the Mongolian, and scarcely exists in the Americans and Negroes.

next in the Mongolian, the very order in which the degrees of development are ranged. *May not color, then, depend upon development also?* We do not, indeed, see that a Caucasian fœtus at the stage which the African represents is anything like black; neither is a Caucasian child yellow, like the Mongolian. But the case of a Caucasian fœtus, or child, at any of its stages of development, is different from that of a being whose *mature form* only comes up to the same point. When a being is presented, who at full time has only attained a point of formation such as the Caucasian passed at a comparatively early stage of his embryotic history, there may be a character of skin liable to a certain tinting on being exposed. Development being arrested at so immature a stage in the case of the Negro, the skin may take on the color as an unavoidable consequence of its imperfect organization. It is favorable to this view, that Negro infants are not deeply black, at first, but only acquire the full color tint after exposure for some time to the atmosphere; also that the parts of the body concealed by clothing are not generally of so deep a hue as the face and hands. The phenomenon, in short, appears identical in character with the photographic process; not a result of the action of heat, as has been so long blunderingly supposed, but of light! It takes its place under the infant science of actino-chemistry, to which, perhaps, many other remarkable phenomena connected with the natural history of our race will yet be referred. This view, it must be admitted, is favorable to the doctrine of one origin for the human family. It seems to account for all the varieties as only the result of so many advances and retrogressions, or the one or the other exclusively, in the developing power of the human mothers.

We have seen that the traces of a common origin in all languages afford a ground of presumption for the unity of the human race. They establish a still stronger probability that mankind had not yet begun to disperse before they were possessed of a means of communicating their ideas by conventional sounds—in short, speech. This is a gift so peculiar to man, and in itself so remarkable, that there is a great inclination to surmise a miraculous origin for it, although there is no proper ground, or even support, for such an idea in Scripture, while it is clearly opposed to everything else we know with regard to the providential arrangements for the creation of our race. Here, as in many other cases, a little observation of nature might have saved much vain discussion. The real character of language itself has not been thoroughly understood. Language, in its most comprehensive sense, is the communication of ideas by whatever means. Ideas can be communicated by looks, gestures, and signs of various other kinds, as well as by speech. The inferior animals possess some of those means of communicating ideas, and they have likewise a silent and unobservable mode of their own, the nature of which is a complete mystery to us, though we are assured of its reality by its effects. Now, as the inferior animals were all in being before man, there was language upon earth long ere the history of our race commenced. The only additional fact in the history of language, which was produced by our creation, was the rise of a new mode of expression—namely, that by *sound-signs* produced by the vocal organs. In other words, speech was the only novelty in this respect attending the creation of the human race. No doubt it was an addition of great importance, for, in comparison with it, the other natural modes of communicating ideas are insignificant. Still, the main and fundamental phenomenon, language, as the communication of ideas, was no new gift of the Creator to man; and in speech itself, when we judge of it as a natural fact, we see only a result of some of those superior endowments of which so many others have fallen to our lot through the medium of a superior organization.

The first and most obvious natural endowment concerned in speech is that peculiar organization of the larynx, trachea, and mouth, which enables us to produce the various sounds required. Man started at first with this organization ready for use, a constitution of the atmosphere adapted for the sounds which that organization was calculated to produce, and, lastly, but not leastly, as will afterwards be more particularly shown, a mental power within, prompting to, and giving directions for, the expression of ideas. Such an arrangement of mutually adapted things was as likely to produce sounds as an Eolian harp placed in a draught is to produce tones. It was unavoidable that human beings so organized, and in such a relation to external nature, should utter sounds, and also come to attach to these conventional meanings, thus forming the elements of spoken language. The great difficulty which has been felt was to account for man going in this respect beyond the inferior animals. There could have been no such difficulty if speculators in this class of subjects had looked into physiology for an account of the superior vocal organization of man, and had they possessed a true science of mind to show man possessing a faculty for the expression of ideas which is only rudimental in the lower animals. Another difficulty has been in the consideration that, if men were at first utterly untutored and barbarous, they could scarcely be in a condition to form or employ language—an instrument which it requires the fullest powers of thought to analyze and speculate upon. But this difficulty also vanishes upon reflection—for, in the first place, we are not bound to suppose the fathers of our race early attaining to great proficiency in language, and, in the second, language itself seems to be amongst the things least difficult to be acquired, if we can form any judgment from what we see in children, most of whom have, by three years of age, while their information and judgment are still as nothing, mastered and familiarized themselves with a quantity of words, infinitely exceeding in proportion what they acquire in the course of any subsequent similar portion of time.

Discussions as to which parts of speech were first formed, and the processes by which grammatical structure and inflections took their rise, appear in a great measure needless, after the matter has been placed in this light. The mental powers could readily connect particular arbitrary sounds with particular ideas, whether those ideas were nouns, verbs, or interjections. As the words of all languages can be traced back into roots which are monosyllables, we may presume these sounds to have all been monosyllabic accordingly. The clustering of two or more together to express a compound idea, and the formation of inflections by additional syllables expressive of pronouns and such prepositions as of, by, and to, are processes which would or might occur as matters of course, being simple results of a mental power called into action, and partly directed, by external necessities. This power.

however, as we find it in very different degrees of endowment in individuals, so would it be in different degrees of endowment in nations, or branches of the human family. Hence we find the formation of words and the process of their composition and grammatical arrangement, in very different stages of development in different races. The Chinese have a language composed of a limited number of monosyllables, which they multiply in use by mere variations of accent, and which they have never yet attained the power of clustering or inflecting; the language of this immense nation—the third part of the human race—may be said to be in the condition of infancy.

The aboriginal Americans, so inferior in civilisation, have, on the other hand, a language of the most elaborately composite kind, perhaps even exceeding, in this respect, the languages of the most refined European nations. These are but a few out of many facts tending to show that language is in a great measure independent of civilisation, as far as its advance and development are concerned. Do they not also help to prove that cultivated intellect is not necessary for the origination of language?

Facts daily presented to our observation afford equally simple reasons for the almost infinite diversification of language. It is invariably found that, wherever society is at once dense and refined, language tends to be uniform throughout the whole population, and to undergo few changes in the course of time. Wherever, on the contrary, we have a scattered and barbarous people, we have great diversities, and comparatively rapid alterations of language. Insomuch that, while English, French, and German are each spoken with little variation by many millions, there are islands in the Indian archipelago, probably not inhabited by one million, but in which there are hundreds of languages, as diverse as are English, French, and German. It is easy to see how this should be. There are peculiarities in the vocal organization of every person, tending to produce peculiarities of pronunciation; for example, it has been stated that each child in a family of six gave the monosyllable, fly, in a different manner (eye, fy, ly, &c.), until, when the organs were more advanced, correct example induced the proper pronunciation of this and similar words. Such departures from orthoepy are only to be checked by the power of such example; but this is a power not always present, or not always of sufficient strength. The self-devoted Robert Moffat, in his work on South Africa, states, without the least regard to hypothesis, that amongst the people of the towns of that great region, "the purity and harmony of language is kept up by their pitchos or public meetings, by their festivals and ceremonies, as well as by their songs and their constant intercourse. With the isolated villages of the desert, it is far otherwise. They have no such meetings; they are compelled to traverse the wilds, often to a great distance from their native village. On such occasions, fathers and mothers, and all who can bear a burden, often set out for weeks at a time, and leave their children to the care of two or three infirm old people. The infant progeny, some of whom are beginning to lisp, while others can just master a whole sentence, and those still further advanced, romping and playing together, the children of nature, through the livelong day, *become habituated to a language of their own.* The more voluble condescend to the less precocious, and thus, from this infant Babel, proceeds a dialect composed of a host of mongrel words and phrases, joined together without rule, and *in the course of a generation the entire character of the language is changed*."* I have been told, that in like manner the children of the Manchester factory workers, left for a great part of the day, in large assemblages, under the care of perhaps a single elderly person, and spending the time in amusements, are found to make a great deal of new language. I have seen children in other circumstances amuse themselves by concocting and throwing into the family circulation entirely new words; and I believe I am running little risk of contradiction when I say that there is scarcely a family, even amongst the middle classes of this country, who have not some peculiarities of pronunciation and syntax, which have originated amongst themselves, it is hardly possible to say how. All these things being considered, it is easy to understand how mankind have come at length to possess between three and four thousand languages, all different at least as much as French, German, and English, though, as has been shown, the traces of a common origin are observable in them all.

What has been said on the question whether mankind were originally barbarous or civilized, will have prepared the reader for understanding how the arts and sciences, and the rudiments of civilisation itself, took their rise amongst men. The only source of fallacious views on this subject is the so frequent observation of arts, sciences, and social modes, forms, and ideas, being not indigenous where we see them now flourishing, but known to have been derived elsewhere: thus Rome borrowed from Greece,

* Missionary Scenes and Labors in South Africa.

Greece from Egypt, and Egypt itself, lost in the mists of historic antiquity, is now supposed to have obtained the light of knowledge from some still earlier scene of intellectual culture. This has caused to many a great difficulty in supposing a natural or spontaneous origin for civilisation and the attendant arts. But, in the first place, several stages of derivation are no conclusive argument against there having been an originality at some earlier stage. In the second, such observers have not looked far enough, for, if they had, they could have seen various instances of civilisations which it is impossible, with any plausibility, to trace back to a common origin with others; such as those of China and America. They would also have seen civilisation springing up, as it were, like oases amongst the arid plains of barbarism, as in the case of the Mandans. A still more attentive study of the subject would have shown, amongst living men, the very psychological procedure on which the origination of civilisation and the arts and sciences depended.

These things, like language, are simply the effects of the spontaneous working of certain mental faculties, each in relation to the things of the external world on which it was intended by creative Providence to be exercised. The monkeys themselves, without instruction from any quarter, learn to use sticks in fighting, and some build houses—an act which cannot in their case be considered as one of instinct, but of intelligence. Such being the case, there is no necessary difficulty in supposing how man, with his superior mental organization (a brain five times heavier), was able, in his primitive state, without instruction, to turn many things in nature to his use, and commence, in short, the circle of the domestic arts. He appears, in the most unfavorable circumstances, to be able to provide himself with some sort of dwelling, to make weapons, and to practise some simple kind of cookery. But, granting, it will be said, that he can go thus far, how does he ever proceed further unprompted, seeing that many nations remain fixed for ever at this point, and seem unable to take one step in advance? It is perfectly true that there is such a fixation in many nations; but, on the other hand, all nations are not alike in mental organization, and another point has been established, that only when some favorable circumstances have settled a people in one place, do arts and social arrangements get leave to flourish. If we were to limit our view to humbly endowed nations, or the common class of minds in those called civilized, we should see absolutely no conceivable power for the origination of new ideas and devices. But let us look at the inventive class of minds which stand out amongst their fellows—the men who, with little prompting or none, conceive new ideas in science, arts, morals—and we can be at no loss to understand how and whence have arisen the elements of that civilisation which history traces from country to country throughout the course of centuries. See a Pascal, reproducing the Alexandrian's problems at fifteen; a Ferguson, making clocks from the suggestions of his own brain, while tending cattle on a Morayshire heath; a boy Lawrence, in an inn on the Bath road, producing, without a master, drawings which the educated could not but admire; or look at Solon and Confucius, devising sage laws, and breathing the accents of all but divine wisdom, for their barbarous fellow-countrymen, three thousand years ago—and the whole mystery is solved at once. Amongst the arrangements of Providence is one for the production of original, inventive, and aspiring minds, which, when circnmstances are not decidedly unfavorable, strike out new ideas for the benefit of their fellow-creatures, or put upon them a lasting impress of their own superior sentiments. Nations, improved by these means, become in turn *foci* for the diffusion of light over the adjacent regions of barbarism—their very passions helping to this end, for nothing can be more clear than that ambitious aggression has led to the civilisation of many countries. Such is the process which seems to form the destined means for bringing mankind from the darkness of barbarism to the day of knowledge and mechanical and social improvement. Even the noble art of letters is but, as Dr. Adam Fergussòn has remarked, "a natural produce of the human mind, which will rise spontaneously, wherever men are happily placed;" original alike amongst the ancient Egyptians and the dimly monumented Toltecans of Yucatan. "Banish," says Dr. Gall, "music, poetry, painting, sculpture, architecture, all the arts and sciences, and let your Homers, Raphaels, Michael Angelos, Glucks, and Canovas, be forgotten, yet let men of genius of every description spring up, and poetry, music, painting, architecture, sculpture, and all the arts and sciences, will again shine out in all their glory. Twice within the records of history has the human race traversed the great circle of its entire destiny, and twice has the rudeness of barbarism been followed by a higher degree of refinement. It is a great mistake to suppose one people to have proceeded from another on account of their conformity of manners, customs, and arts. The swallow of Paris builds its nest like the swallow of Vienna, but does it thence follow that the former sprung from the latter? With the same causes we have the same effects; with the same organization we have the manifestation of the same powers."

MENTAL CONSTITUTION OF ANIMALS.

It has been one of the most agreeable tasks of modern science to trace the wonderfully exact adaptations of the organization of animals to the physical circumstances amidst which they are destined to live. From the mandibles of insects to the hand of man, all is seen to be in the most harmonious relation to the things of the outward world, thus clearly proving that *design* presided in the creation of the world—design again implying a designer, another word for a CREATOR.

It would be tiresome to present in this place even a selection of the proofs which have been adduced on this point. The Natural Theology of Paley, and the Bridgewater Treatises, place the subject in so clear a light, that the general postulate may be taken for granted. The physical constitution of animals is, then, to be regarded as in the nicest congruity and adaptation to the external world.

Less clear ideas have hitherto been entertained on the mental constitution of animals. The very nature of this constitution is not as yet generally known or held as ascertained. There is, indeed, a notion of old standing, that the mind is in some way connected with the brain; but the metaphysicians insist that it is, in reality, known only by its acts or effects, and they accordingly present the subject in a form which is unlike any other kind of science, for it does not so much as pretend to have nature for its basis. There is a general disinclination to regard mind in connexion with organization, from a fear that this must needs interfere with the cherished religious doctrine of the spirit of man, and lower him to the level of the brutes. A distinction is therefore drawn between our mental manifestations and those of the lower animals, the latter being comprehended under the term instinct, while ours are collectively described as mind, mind being again a received synonyme with soul, the immortal part of man. There is here a strange system of confusion and error, which it is most imprudent to regard as essential to religion, since candid investigations of nature tend to show its untenableness. There is, in reality, nothing to prevent our regarding man as specially endowed with an immortal spirit, at the same time that his ordinary mental manifestations are looked upon as simple phenomena resulting from organization, those of the lower animals being phenomena absolutely the same in character, though developed within narrower limits.*

* "Is not God the first cause of matter as well as of mind? Do not the first attributes of matter lie as inscrutably in the bosom of God—of its first author—as those of mind? Has not even matter confessedly received from God the power of experiencing, in consequence of impressions from the earlier modifications of matter, certain consciousnesses called sensations of the same? Is not, therefore, the wonder of matter also receiving the consciousnesses of other mat-

What has chiefly tended to take mind, in the eyes of learned and unlearned, out of the range of nature, is its apparently irregular and wayward character. How different the manifestations in different beings! how unstable in all!—at one time so calm, at another so wild and impulsive! It seemed impossible that anything so subtle and aberrant could be part of a system, the main features

ter called ideas of the mind a wonder more flowing out of and in analogy with all former wonders, than would be, on the contrary, the wonder of this faculty of the mind not flowing out of any faculties of matter? Is it not a wonder which, so far from destroying our hopes of immortality, can establish that doctrine on a train of inferences and inductions more firmly established and more connected with each other than the former belief can be, as soon as we have proved that matter is not perishable, but is only liable to successive combinations and decombinations?

"Can we look further back one way into the first origin of matter than we can look forward the other way into the last developments of mind? Can we say that God has not in matter itself laid the seeds of every faculty of mind, rather than that he has made the first principle of mind entirely distinct from that of matter? Cannot the first cause of all we see and know have *fraught matter itself, from its very beginning, with all the attributes necessary to develope into mind*, as well as he can have from the first made the attributes of mind wholly different from those of matter, only in order afterwards, by an imperceptible and incomprehensible link, to join the two together?

" * * [The decombination of the matter on which mind rests] is this a reason why mind must be annihilated? Is the temporary reverting of the mind, and of the sense out of which that mind developes, to their original component elements, a reason for thinking that they cannot again at another later period and in another higher globe, be again recombined, and with more splendor than before? * * The New Testament does not after death here promise us a soul hereafter unconnected with matter, and which has of which are regularity and precision. But the irregularity of mental phenomena is only in appearance. When we give up the individual, and take the mass, we find as much uniformity of result as in any other class of natural phenomena. The irregularity is exactly of the same kind as that of the weather. No man can say what may be the weather of to-morrow; but the quantity of rain which falls in any particular place in any five years is precisely the same as the quantity which falls in any other five years at the same place. Thus, while it is absolutely impossible to predict of any one Frenchman that during next year he will commit a crime, it is quite certain that about one in every six hundred and fifty of the French people will do so, because in past years the proportion has generally been about that amount, the tendencies to crime

no connexion with our present mind—a soul independent of time and space. That is a fanciful idea, not founded on its expressions, when taken in their just and real meaning. On the contrary, it promises us a mind like the present, founded on time and space; since it is, like the present, to hold a certain situation in time, and a certain locality in space: but it promises a mind situated in portions of time and of space different from the present: a mind composed of elements of matter more extended, more perfect, and more glorious: a mind which, formed of materials supplied by different globes, is consequently able to see further into the past, and to think further into the future, than any mind here existing: a mind which, freed from the partial and uneven combination incidental to it on this globe, will be exempt from the changes for evil to which, on the present globe, mind as well as matter is liable, and will only thenceforth experience the changes for the better which matter, more justly poised, will alone continue to experience: a mind which, no longer fearing the death, the total decomposition, to which it is subject on this globe, will thenceforth continue last and immortal."—Hope, *on the Origin and Prospects of Man*, 1831.

in relation to the temptations being everywhere invariable over a sufficiently wide range of time. So also, the number of persons taken in charge by the police in London for being drunk and disorderly in the streets, is, week by week, a nearly uniform quantity, showing that the inclination to drink to excess is always in the mass about the same, regard being had to the existing temptations or stimulations to this vice. Even mistakes and oversights are of regular recurrence, for it is found in the post-offices of large cities, that the number of letters put in without addresses is year by year the same. Statistics has made out an equally distinct regularity in a wide range, with regard to many other things concerning the mind, and the doctrine founded upon it has lately produced a scheme which may well strike the ignorant with surprise. It was proposed to establish in London a society for ensuring the integrity of clerks, secretaries, collectors, and all such functionaries as are usually obliged to find security for money passing through their hands in the course of business. A gentleman of the highest character as an actuary spoke of the plan in the following terms:—"If a thousand bankers' clerks were to club together to indemnify their securities, by the payment of one pound a year each, and if each had given security for 500*l.*, it is obvious that two in each year might become defaulters to that amount, four to half the amount, and so on, without rendering the guarantee fund insolvent. If it be tolerably well ascertained that the instances of dishonesty (yearly) among such persons amount to one in five hundred, this club would continue to exist, subject to being in debt in a bad year, to an amount which it would be able to discharge in good ones. The only question necessary to be asked previous to the formation of such a club would be,—may it not be feared that the motive to resist dishonesty would be lessened by the existence of the club, or that ready-made rogues, by belonging to it, might find the means of obtaining situations which they would otherwise have been kept out of by the impossibility of obtaining security among those who know them? Suppose this be sufficiently answered by saying, that none but those who could bring satisfactory testimony to their previous good character should be allowed to join the club; that persons who may now hope that a deficiency on their parts will be made up and hushed up by the relative or friend who is security, will know very well that the club will have no motive to decline a prosecution, or to keep the secret, and so on. It then only remains to ask, whether the sum demanded for the guarantee is sufficient?"* The philosophical principle on which the scheme proceeds, seems to be simply this, that amongst a given (large) number of persons of good character, there will be, within a year or other considerable space of time, a determinate number of instances in which moral principle and the terror of the consequences of guilt will be overcome by temptations of a determinate kind and amount, and thus occasion a certain periodical amount of loss which the association must make up.

This statistical regularity in moral affairs fully establishes their being under the presidency of law. Man is now seen to be an enigma only as an individual; in the

* Dublin Review, Aug., 1840. The Guarantee Society has since been established, and is likely to become a useful and prosperous institution.

mass he is a mathematical problem. It is hardly necessary to say, much less to argue, that mental action, being proved to be under law, passes at once into the category of natural things. Its old metaphysical character vanishes in a moment, and the distinction usually taken between physical and moral is annulled. This view agrees with what all observation teaches, that mental phenomena flow directly from the brain. They are seen to be dependent on naturally constituted and naturally conditioned organs, and thus obedient, like all other organic phenomena, to law. And how wondrous must the constitution of this apparatus be, which gives us consciousness of thought and of affection, which makes us familiar with the numberless things of earth, and enables us to rise in conception and communion to the councils of God himself! It is matter which forms the medium or instrument—a little mass which, decomposed, is but so much common dust; yet in its living constitution, designed, formed and sustained by Almighty Wisdom, how admirable its character! how reflective of the unutterable depths of that Power by which it was so formed, and is so sustained!

In the mundane economy, mental action takes its place as a means of providing for the independent existence and the various relations of animals, each species being furnished according to its special necessities and the demands of its various relations. The nervous system—the more comprehensive term for its organic apparatus—is variously developed in different classes and species, and also in different individuals, the volume or mass bearing a general relation to the amount of power. Passing over the humblest orders, where nervous apparatus is so obscure as hardly to be traceable, we see it in the nematoneura of Owen* in filaments and nuclei, the mere rudiments of the system. In the articulata, it is advanced to a double nervous cord, with ganglia or little masses of nervous matter at frequent intervals, and filaments branching out towards each side; the ganglia near the head being apparently those which send out nerves to the organs of the senses; and this arrangement is only less symmetrical in the mollusca. Ascending to the vertebrata, we find a spinal cord, with a brain at the upper extremity, and numerous branching lines of nervous tissue,† an organization strikingly superior; yet here, as in the general structure of animals, the great principle of unity is observed. The brain of the vertebrata is merely an expansion of the anterior pair of the ganglia of the articulata, or these ganglia may be regarded as the rudiment of a brain, the superior organ thus appearing as only a further development of the inferior. There are many facts which tend to prove that the action of this apparatus is of an electric nature, a modification of that surprising agent, which takes magnetism, heat, and light, as other subordinate forms, and of whose general scope in this great system of things we are only beginning to have a right conception. It has been found that simple electricity, artificially produced, and sent along the nerves of a dead body, excites muscular action. The brain of a newly-killed animal being taken out, and replaced by a substance which produces electric action, the operation of

* Including rotifera, entozoa, echinodermata, &c.

† The ray, which is considered as low in the scale of fishes, and near to the crustaceans, gives the first faint representation of a brain in certain scanty and medullary masses, which appear as merely composed of enlarged origins of the nerves.

digestion, which had been interrupted by the death of the animal, was resumed, showing the absolute identity of the brain with a galvanic battery. Nor is this a very startling idea, when we reflect that electricity is almost as metaphysical as ever mind was supposed to be. It is a thing perfectly intangible, weightless. A mass of metal may be magnetized, or heated to seven hundred of Fahrenheit, without becoming the hundredth part of a grain heavier. And yet electricity is a real thing, an actual existence in nature, as witness the effects of heat and light in vegetation—the power of the galvanic current to re-assemble the particles of copper from a solution, and make them again into a solid plate—the rending force of the thunderbolt as it strikes the oak. See also how both heat and light observe the angle of incidence in reflection, as exactly as does the grossest stone thrown obliquely against a wall. So mental action may be imponderable, intangible, and yet a real existence, and ruled by the Eternal through his laws.*

Common observation shows a great general superiority

* If mental action is electric, the proverbial quickness of thought—that is, the quickness of the transmission of sensation and will—may be presumed to have been brought to an exact measurement. The speed of light has long been known to be about 192,000 miles per second, and the experiments of Wheatstone have shown that the electric agent travels (if I may so speak) at the same rate, thus showing a likelihood that one law rules the movements of all the "imponderable bodies." Mental action may accordingly be presumed to have a rapidity equal to one hundred and ninety-two thousand miles in the second—a rate evidently far beyond what is necessary to make the design and execution of any of our ordinary muscular movements apparently identical in point of time, which they are.

of the human mind over that of the inferior animals. Man's mind is almost infinite in device; it ranges over all the world; it forms the most wonderful combinations; it seeks back into the past, and stretches forward into the future; while the animals generally appear to have a narrow range of thought and action. But so also has an infant but a limited range, and yet it is mind which works there, as well as in the most accomplished adults. The difference between mind in the lower animals and in man is a difference in degree only; it is not a specific difference. All who have studied animals by actual observation, and even those who have given a candid attention to the subject in books, must attain more or less clear convictions of this truth, notwithstanding all the obscurity which prejudice may have engendered. We see animals capable of affection, jealousy, envy; we see them quarrel, and conduct quarrels in the very manner pursued by the ruder and less educated of our own race. We see them liable to flattery, inflated with pride, and dejected by shame. We see them as tender to their young as human parents are, and as faithful to a trust as the most conscientious of human servants. The horse is startled by marvellous objects, as a man is. The dog and many others show tenacious memory. The dog also proves himself possessed of imagination, by the act of dreaming. Horses finding themselves in want of a shoe, have of their own accord gone to a farrier's shop where they were shod before. Cats, closed up in rooms, will endeavor to obtain their liberation by pulling a latch or ringing a bell. It has several times been observed that in a field of cattle, when one or two were mischievous, and persisted long in annoying or tyrannizing over the rest, the herd, to all appearance, consulted, and then, making a united effort, drove the troublers off the ground. The members of a rookery have also been observed to take turns in supplying the needs of a family reduced to orphanhood. All of these are acts of reason, in no respect different from similar acts of men. Moreover, although there is no heritage of accumulated knowledge amongst the lower animals as there is amongst us, they are in some degree susceptible of those modifications of natural character, and capable of those accomplishments, which we call education. The taming and domestication of animals, and the changes thus produced upon their nature in the course of generations, are results identical with civilisation amongst ourselves; and the quiet, servile steer is probably as unlike the original wild cattle of this country, as the English gentleman of the present day is unlike the rude baron of the age of King John. Between a young, unbroken horse, and a trained one, there is, again, all the difference which exists between a wild youth reared at his own discretion in the country, and the same person when he has been toned down by long exposure to the influences of refined society. On the accomplishments acquired by animals it were superfluous to enter at any length; but I may advert to the dogs of M. Leonard, as remarkable examples of what the animal intellect may be trained to. When four pieces of card are laid down before them, each having a number pronounced *once* in connexion with it, they will, after a re-arrangement of the pieces, select any one named by its number. They also play at dominoes, and with so much skill as to triumph over biped opponents, whining if the adversary plays a wrong piece, or if they themselves be deficient in a right one. Of extensive combinations of thought we have no reason to believe that any animal is capable—and yet most of us must feel the force of Walter Scott's remark, that there was scarcely anything which he would not believe of a dog. There is a curious result of education in certain animals, namely, that habits to which they have been trained in some instances become hereditary. For example, the accomplishment of pointing at game, although a pure result of education, appears in the young pups brought up apart from their parents and kind. The peculiar leap of the Irish horse, acquired in the course of traversing a boggy country, is continued in the progeny brought up in England. This hereditariness of specific habits suggests a relation to that form of psychological demonstration usually called instinct; but instinct is only another term for mind, or is mind in a peculiar stage of development; and though the fact were otherwise, it could not affect the postulate, that demonstrations such as have been enumerated are mainly intellectual demonstrations, not to be distinguished as such from those of human beings.

More than this, the lower animals manifested mental phenomena long before man existed. While as yet there was no brain capable of working out a mathematical problem, the economy of the six-sided figure was exemplified by the instinct of the bee. The dog and the elephant prefigured the sagacity of the human mind. The love of a human mother for her babe was anticipated by nearly every humbler mammal, the carnaria not excepted. The peacock strutted, the turkey blustered, and the cock fought for victory, just as human beings afterwards did, and still do. Our faculty of imitation, on which so much of our amusement depends, was exercised by the mocking-bird; and the whole tribe of monkeys must have walked about the pre-human world, playing off those tricks in which we see the comicality and mischief-making of our character so curiously exaggerated.

The unity and simplicity which characterize nature give great antecedent probability to what observation seems about to establish, that, as the brain of the vertebrata generally is just an advanced condition of a particular ganglion in the mollusca and crustacea, so are the brains of the higher and more intelligent mammalia only further developments of the brains of the inferior orders of the same class. Or, to the same purpose, it may be said, that each species has certain superior developments, according to its needs, while others are in a rudimental or repressed state. This will more clearly appear after some inquiry has been made into the various powers comprehended under the term mind.

One of the first and simplest functions of mind is to give *consciousness*—consciousness of our identity and of our existence. This, apparently, is independent of the *senses*, which are simply media, and, as Locke has shown, the only media, through which ideas respecting the external world reach the brain. The access of such ideas to the brain is the act to which the metaphysicians have given the name of perception. Gall, however, has shown, by induction from a vast number of actual cases, that there is a part of the brain devoted to perception, and that even this is subdivided into portions which are respectively dedicated to the reception of different sets of ideas, as those of form, size, color, weight, objects in their totality, events in their progress or occurrence, time, musical sounds, &c. The system of mind invented by this philosopher—the only one founded upon nature, or which even pretends to or admits of that necessary basis—shows a portion of the brain acting as a faculty of comic ideas, another of imitation, another of wonder, one for discriminating or observing differences, and another in which resides the power of tracing effects to causes. There are also parts of the brain for the sentimental part of our nature, or the affections, at the head of which stand the moral feelings of benevolence, conscientiousness, and veneration. Through these, man stands in relation to himself, his fellow men, the external world, and his God; and through these comes most of the happiness of man's life, as well as that which he derives from the contemplation of the world to come, and the cultivation of his relation to it (pure religion). The other sentiments may be briefly enumerated, their names being sufficient in general to denote their functions—firmness, hope, cautiousness, self-esteem, love of approbation, secretiveness, marvellousness, constructiveness, imitation, combativeness, destructiveness, concentrativeness, adhesiveness, love of the opposite sex, love of offspring, alimentiveness, and love of life. Through these faculties man is connected with the external world, and supplied with active impulses to maintain his place in it as an individual and as a species. There is also a faculty (language), for expressing, by whatever means (signs, gestures, looks, conventional terms in speech), the ideas which arise in the mind. There is a particular state of each of these faculties, when the ideas of objects once formed by it are revived or reproduced, a process which seems to be intimately allied with some of the phenomena of the new science of photography, when images impressed by reflection of the sun's rays upon sensitive paper are, after a temporary obliteration, resuscitated on the sheet being exposed to the fumes of mercury. Such are the phenomena of memory, that handmaid of intellect, without which there could be no accumulation of mental capital, but an universal and continual infancy. Conception and imagination appear to be only intensities, so to speak, of the state of brain in which memory is produced. On their promptness and power depend most of the exertions which distinguish the man of arts and letters, and even in no small measure the cultivator of science.

The faculties above described—the actual elements of the mental constitution—are seen in mature man in an indefinite potentiality and range of action. It is different with the lower animals. They are there comparatively definite in their power and restricted in their application. The reader is familiar with what are called instincts in some of the humbler species, that is, an uniform and unprompted tendency towards certain particular acts, as the building of cells by the bee, the storing of provisions by that insect and several others, and the construction of nests for a coming progeny by birds. This quality is nothing more than a mode of operation peculiar to the faculties in an humble state of endowment, or early stage of development. The cell formation of the bee, the house-building of ants and beavers, the web-spinning of spiders, are but primitive exercises of constructiveness, the faculty which, indefinite with us, leads to the arts of the weaver, upholsterer, architect, and mechanist, and makes us often work delightedly where our labors are in vain, or nearly so. The storing of provision by the bees is an exercise of acquisitiveness,—a faculty which with us makes rich men and misers. A vast number of curious devices, by which insects provide for the protection and subsistence of their young, whom they are perhaps never to see, are most probably a peculiar restricted effort of philoprogenitiveness. The common source of this class of acts, and of common mental operations, is shown very convincingly by the melting of the one set into the other. Thus, for example, the bee and bird will make modifications in the ordinary form of their cells and nests when necessity compels them. Thus, the alimentiveness of such animals as the dog, usually definite with regard to quantity and quality, can be pampered or educated up to a kind of epicurism, that is, an indefiniteness of object and action. The same faculty acts limitedly in ourselves at first, dictating the special act of sucking; afterwards it acquires indefiniteness. Such is the real nature of the distinction between what are called instincts and reason, upon which so many volumes have been written without profit to the world. All faculties are instinctive, that is, dependent on internal and inherent impulses. This term is therefore not specially applicable to either of the recognized modes of the operation of the faculties. We only, in the one case, see the faculty in an immature and slightly developed state; in the other, in its most advanced condition. In the one case it is *definite*, in the other, *indefinite*, in its range of action. These terms would perhaps be the most suitable for expressing the distinction.

In the humblest forms of being we can trace scarcely anything besides a definite action in a few of the faculties. Generally speaking, as we ascend in the scale, we see more and more of the faculties in exercise, and these tending more to the indefinite mode of manifestation. And for this there is the obvious reason in providence, that the lowest animals have all of them a very limited sphere of existence, born only to perform a few functions, and enjoy a brief term of life, and then give way to another generation, so that they do not need much mental guidance. At higher points in the scale, the sphere of existence is considerably extended, and the mental operations are less definite accordingly. The horse, dog, and a few other animals, noted for their serviceableness to our race, have the indefinite powers in no small endowment. Man, again, shows very little of the definite mode of operation, and that little chiefly in childhood, or in barbarism, or idiocy. Destined for a wide field of action, and to be applicable to infinitely varied contingencies, he has all the faculties developed to a high pitch of indefiniteness, that he may be ready to act well in all imaginable cases. His commission, it may be said, gives large discretionary powers, while that of the inferior animals is limited to a few precise directions. But when the human brain is congenitally imperfect or diseased, or when it is in the state of infancy, we see in it an approach towards the character of the brains of some of the inferior animals. Dr. J. G. Davey states that he has frequently witnessed, among his patients at the Hanwell Lunatic Asylum, indications of a particular abnormal cerebration which forcibly reminded him of the specific healthy characteristics of animals lower in the scale of organization;* and every one must have observed how often the actions of children, especially in their moments of play, and where their sel-

* Phrenological Journal, xv., 338.

fish feelings are concerned, bear a resemblance to those of certain familiar animals.* Behold, then, the wonderful unity of the whole system. The grades of mind, like the forms of being, are mere stages of development. In the humbler forms, but a few of the mental faculties are traceable, just as we see in them but a few of the lineaments of universal structure. In man the system has arrived at its highest condition. The few gleams of reason, then, which we see in the lower animals, are precisely analogous to such a development of the fore-arm as we find in the paddle of the whale. Causality, comparison, and other of the nobler faculties, are in them *rudimental.*

Bound up as we thus are by an identity in the character of our mental organization with the lower animals, we are yet, it will be observed, strikingly distinguished from them by this great advance in development. We have faculties in full force and activity which the animals either possess not at all, or in so low and obscure a form as to be equivalent to non-existence. Now these parts of mind are those which connect us with the things that are not of this world. We have veneration, prompting us to the worship of the Deity, which the animals lack. We have hope, to carry us on in thought beyond the bounds of time. We have reason, to enable us to inquire into the character of the Great Father, and the relation of us, his humble creatures, towards him. We have conscientiousness and benevolence, by which we can in a faint

* A pampered lap-dog, living where there is another of its own species, will hide any nice morsel which it cannot eat, under a rug, or in some other by-place, designing to enjoy it afterwards. I have seen children do the same thing.

and humble measure imitate, in our conduct, that which he exemplifies in the whole of his wondrous doings. Beyond this, mental science does not carry us in support of religion ; the rest depends on evidence of a different kind. But it is surely much that we thus discover in nature a provision for things so important. The existence of faculties having a regard to such things is a good evidence that such things exist. The face of God is reflected in the organization of man, as a little pool reflects the glorious sun.

The affective or sentimental faculties are all of them liable to operate whenever appropriate objects or stimuli are presented, and this they do as irresistibly and unerringly as the tree sucks up moisture which it requires, with only this exception, that one faculty often interferes with the action of another, and operates instead by force of superior inherent strength or temporary activity. For example, alimentiveness may be in powerful operation with regard to its appropriate object, producing a keen appetite, and yet it may not act, in consequence of the more powerful operation of cautiousness, warning against evil consequences likely to ensue from the desired indulgence. This liability to flit from under the control of one feeling to the control of another, constitutes what is recognized as free will in man, being nothing more than a vicissitude in the supremacy of the faculties over each other.

It is a common mistake to suppose that the individuals of our own species are all of them formed with similar faculties—similar in power and tendency—and that education and the influence of circumstances produce all the differences which we observe. There is not, in the old systems of mental philosophy, any doctrine more opposite to the truth than this. It is refuted at once by the great differences of intellectual tendency and moral disposition to be observed amongst a group of young children who have been all brought up in circumstances perfectly identical—even in twins, who have never been but in one place, under the charge of one nurse, attended to alike in all respects. The mental characters of individuals are inherently various, as the forms of their persons and the features of their faces are; and education and circumstances, though their influence is not to be despised, are incapable of entirely altering these characters, where they are strongly developed. That the original characters of mind are dependent on the volume of particular parts of the brain and the general quality of that viscus, is proved by induction from an extensive range of observations, the force of which must have been long since universally acknowledged but for the unpreparedness of mankind to admit a functional connexion between mind and body. The different mental characters of individuals may be presumed from analogy to depend on the same law of development which we have seen determining forms of being and the mental characters of particular species. This we may conceive as carrying forward the intellectual powers and moral dispositions of some to a high pitch, repressing those of others at a moderate amount, and thus producing all the varieties which we see in our fellow-creatures. Thus a Cuvier and a Newton are but expansions of a clown, and the person emphatically called the wicked man, is one whose highest moral feelings are rudimental. Such differences are not confined to our species; they are only less strongly marked in many of the inferior animals. There are clever dogs and wicked horses, as well as clever men and wicked men; and education sharpens the talents, and in some degree regulates the dispositions of animals, as it does our own.

There is, nevertheless, a general adaptation of the mental constitution of man to the circumstances in which he lives, as there is between all the parts of nature to each other. The goods of the physical world are only to be realized by ingenuity and industrious exertion; behold, accordingly, an intellect full of device, and a fabric of the faculties which would go to pieces or destroy itself if it were not kept in constant occupation. Nature presents to us much that is sublime and beautiful: behold faculties which delight in contemplating these properties of hers, and in rising upon them, as upon wings, to the presence of the Eternal. It is also a world of difficulties and perils, and see how a large portion of our species are endowed with vigorous powers which take a pleasure in meeting and overcoming difficulty and danger. Even that principle on which our faculties are constituted—a wide range of freedom in which to act for all various occasions—necessitates a resentful faculty, by which individuals may protect themselves from the undue and capricious exercise of each other's faculties, and thus preserve their individual rights. So also there is cautiousness, to give us a tendency to provide against the evils by which we may be assailed; and secretiveness, to enable us to conceal whatever, being divulged, would be offensive to others or injurious to ourselves,—a function which obviously has a certain legitimate range of action, however liable to be abused. The constitution of the mind generally points to a state of intimate relation of individuals towards society, towards the external world, and towards things above this world. No individual being is integral or independent; he is only part of an extensive piece of social mechanism. The inferior mind, full of rude energy and unregulated impulse, does not more require a superior nature to act as its master and its mentor, than does the superior nature require to be surrounded by such rough elements on which to exercise its high endowments as a ruling and tutelary power. This relation of each to each produces a vast portion of the active business of life. It is easy to see that, if we were all alike in our moral tendencies, and all placed on a medium of perfect moderation in this respect, the world would be a scene of everlasting dulness and apathy. It requires the variety of individual constitution to give moral life to the scene.

The indefiniteness of the potentiality of the human faculties, and the complexity which thus attends their relations, lead unavoidably to occasional error. If we consider for a moment that there are not less than thirty such faculties, that they are each given in different proportions to different persons, that each is at the same time endowed with a wide discretion as to the force and frequency of its action, and that our neighbors, the world, and our connexions with something beyond it, are all exercising an ever-varying influence over us, we cannot be surprised at the irregularities attending human conduct. It is simply the penalty paid for the superior endowment. It is here that the imperfection of our nature resides. Causality and conscientiousness are, it is true, guides over all; but even these are only faculties of the same indeterminate constitution as the rest, and partake accordingly of the same inequality of action. Man is therefore a piece of mechanism, which never can act so as to satisfy his own ideas of what he might be—for he can imagine a state of moral perfection (as he can imagine a globe formed of diamonds, pearls, and rubies), though his constitution forbids him to realize it. There ever will, in the best disposed and most disciplined minds, be occasional discrepancies between the amount of temptation and the power summoned for regulation or resistance, or between the stimulus and the mobility of the faculty; and hence those errors, and shortcomings, and excesses, without end, with which the good are constantly finding cause to charge themselves. There is at the same time even here a possibility of improvement. In infancy, the impulses are all of them irregular; a child is cruel, cunning, and false, under the slightest temptation, but in time learns to control these inclinations, and to be habitually humane, frank, and truthful. So is human society, in its earlier stages, sanguinary, aggressive, and deceitful, but in time becomes just, faithful and benevolent. To such improvements there is a natural tendency which will operate in all fair circumstances, though it is not to be expected that irregular and undue impulses will ever be altogether banished from the system.

It may still be a puzzle to many, how beings should be born into the world whose organization is such that they unavoidab , even in a civilized country, become malefactors. Does God, it may be asked, make criminals? Does .ie fashion certain beings with a predestination to evil? He does not do so; and yet the criminal type of brain, as it is called, comes into existence in accordance with laws which the Deity has established. It is not, however, as the result of the first or general intention of those laws, but as an exception from their ordinary and proper action. The production of those evilly disposed beings is in this manner. The moral character of the progeny depends in a general way (as does the physical character also), upon conditions of the parents,—both general conditions, and conditions at the particular time of the commencement of the existence of the new being, and likewise external conditions affecting the fœtus through the mother. Now the amount of these conditions is indefinite. The faculties of the parents, as far as these are concerned, may have oscillated for the time towards the extreme of tensibility in one direction. The influences upon the fœtus may have also been of an extreme and unusual kind. Let us suppose that the conditions upon the whole have been favorable for the development, not of the higher, but of the lower sentiments, and of the propensities of the new being, the result will necessarily be a mean type of brain. Here, it will be observed, God no more decreed an immoral being, than he decreed an immoral paroxysm of the sentiments. Our perplexity is in considering the ill-disposed being by himself. He is only a part of a series of phenomena, traceable to a principle good in the main, but which admits of evil as an exception. We have seen that it is for wise ends that God leaves our moral faculties to an indefinite range of action: the general good results of this arrangement are obvious; but exceptions of evil are inseparable from such a system, and this is one of them. To come to particular illustration—when a people are oppressed, or kept in a state of slavery, they invariably contract habits of lying, for the purpose of deceiving and outwitting their superiors, falsehood being a refuge of the weak under difficulties. What is a habit in parents becomes an inherent quality in children. We are not, therefore, to be surprised when a traveller tells us that black children in the West Indies appear to lie by instinct, and never answer a white person truly, even in the simplest matter. Here we have secretiveness roused in a people to a state of constant and exalted exercise ; an over tendency of the nervous energy in that direction is the consequence, and a new organic condition is established. This tells upon the progeny, which comes into the world with secretiveness excessive in strength and activity. All other evil characteristics may be readily conceived as being implanted in a new generation in the same way. And sometimes not one, but several generations, may be concerned in bringing up the result to a pitch which produces crime. It is, however, to be observed, that the general tendency of things is to a limitation, not the extension of such abnormally constituted beings. The criminal brain finds itself in a social scene where all is against it. It may struggle on for a time, but the medium and superior natures are never long at a loss in getting the better of it. The disposal of such beings will always depend much on the moral state of a community, the degree in which just views prevail with regard to human nature, and the feelings which accident may have caused to predominate at a particular time. Where the mass was little enlightened or refined, and terrors for life or property were highly excited, malefactors have ever been treated severely. But when order is generally triumphant, and reason allowed sway, men begin to see the true case of criminals—namely, that while one large department are victims of erroneous social conditions, another are brought to error by tendencies which they are only unfortunate in having inherited from nature. Criminal jurisprudence, then, addresses itself less to the direct punishment than to the reformation and care-taking of those liable to its attention. And such a treatment of criminals, it may be further remarked, so that it stop short of affording any encouragement to crime (a point which experience will determine), is evidently no more than justice, seeing how accidentally all forms of the moral constitution are distributed, and how thoroughly mutual obligation shines throughout the whole frame of society—the strong to help the weak, the good to redeem and restrain the bad.

The sum of all we have seen of the psychical constitution of man is, that its Almighty Author has destined it, like everything else, to be developed from inherent qualities, and to have a mode of action depending solely on its own organization. Thus the whole is complete on one principle. The masses of space are formed by law; law makes them in due time theatres of existence for plants and animals; sensation, disposition, intellect, are all in like manner developed and sustained in action by law. It is most interesting to observe into how small a field the whole of the mysteries of nature thus ultimately resolve themselves. The inorganic has been thought to have one final comprehensive law, GRAVITATION. The organic, the other great department of mundane things, rests in like manner, on one law, and that is DEVELOPMENT. Nor may even these be after all twain, but only branches of one still more comprehensive law, the expression of a unity, flowing immediately from the One who is First and Last.

PURPOSE AND GENERAL CONDITION OF THE ANIMATED CREATION.

We have now to inquire how this view of the constitution and origin of nature bears upon the condition of man upon the earth, and his relation to supra-mundane things.

That enjoyment is the proper attendant of animal existence is pressed upon us by all that we see and all we experience. Everywhere we perceive in the lower creatures, in their ordinary condition, symptoms of enjoyment. Their whole being is a system of needs, the supplying of which is gratification, and of faculties, the exercise of which is pleasurable. When we consult our own sensations we find that, even in a sense of a healthy performance of all the functions of the animal economy, God has furnished us with an innocent and very high enjoyment. The mere quiet consciousness of a healthy play of the mental functions—a mind at ease with itself and all around it—is in like manner extremely agreeable. This negative class of enjoyments, it may be remarked, is likely to be even more extensively experienced by the lower animals than by man, at least in the proportion of their absolute endowments, as their mental and bodily functions are much less liable to derangement than ours. To find the world constituted on this principle is only what in reason we would expect. We cannot conceive that so vast a system could have been created for a contrary purpose. No averagely constituted human being would, in his own limited sphere of action, think of producing a similar system upon an opposite principle. But to form so vast a range of being, and to make being everywhere a source of gratification, is conformable to our ideas of a Creator, in whom we are constantly discovering traits of a nature, of which our own is but a faint and far-cast shadow at the best.

It appears at first difficult to reconcile with this idea the many miseries which we see all sentient beings, ourselves included, occasionally enduring. How, the sage has asked in every age, should a Being so transcendently kind, have allowed of so large an admixture of evil in the condition of his creatures? Do we not at length find an answer to a certain extent satisfactory, in the view which has now been given of the constitution of nature? We there see the Deity operating in the most august of his works by fixed laws, an arrangement which, it is clear, only admits of the main and primary results being good, but disregards exceptions. Now the mechanical laws are so definite in their purposes, that no exceptions ever take place in that department; if there is a certain quantity of nebulous matter to be agglomerated and divided and set in motion as a planetary system, it will be so with hair's-breadth accuracy, and cannot be otherwise. But the laws presiding over meteorology, life, and mind, are necessarily less definite, as they have to produce a great variety of mutually related results. Left to act independently of each other, each according to its separate commission, and each with a wide range of potentiality to be modified by associated conditions, they can only have effects generally beneficial. Often there must be an interference of one law with another; often a law will chance to operate in excess, or upon a wrong object, and thus evil will be produced. Thus, winds are generally useful in many ways, and the sea is useful as a means of communication between one country and another; but the natural laws which produce winds are of indefinite range of action, and sometimes are unusually concentrated in space or in time, so as to produce storms and hurricanes, by which much damage is done; the sea may be by these causes violently agitated, so that many barks and many lives perish. Here, it is evident, the evil is only exceptive. Suppose, again, that a boy, in the course of the lively sports proper to his age, suffers a fall which injures his spine, and renders him a cripple for life. Two things have been concerned in the case: first, the love of violent exercise, and second, the law of gravitation. Both of these things are good in the main. Boys, in the rash enterprises and rough sports in which they engage, are only making the first delightful trials of a bodily and mental energy which has been bestowed upon them as necessary for their figuring properly in a scene where many energies are called for, but where the exertion of these powers is ever a source of happiness. By gravitation, all moveable things, our bodies included, are kept stable on the surface of the earth. But when it chances that the playful boy loses his hold (we shall say) of the branch of a tree, and has no solid support immediately below, the law of gravitation unrelentingly pulls him to the ground, and thus he is hurt. Now it was not a primary object of gravitation to injure boys; but gravitation could not but operate in the circumstances, its nature being to be universal and invariable. The evil is, therefore, only a casual exception from something in the main good.

The same explanation applies to even the most conspicuous of the evils which afflict society. War, it may be said, and said truly, is a tremendous example of evil, in the misery, hardship, waste of human life, and misspending of human energies, which it occasions. But what is it that produces war? Certain tendencies of human nature, as keen assertion of a supposed right, resentment of supposed injury, acquisitiveness, desire of admiration, combativeness, or mere love of excitement. All of these are tendencies which are every day, in a legitimate extent of action, producing great and indispensable benefits to us. Man would be a tame, indolent, unserviceable being without them, and his fate would be starvation. War, then, huge evil though it be, is, after all, but the exceptive case, a casual misdirection of properties and powers essentially good. God has given us the tendencies for a benevolent purpose. He has only not laid down any absolute obstruction to our misuse of them. That were an arrangement of a kind which he has nowhere made. But he has established many laws in our nature which tend to lessen the frequency and destructiveness of these abuses. Our reason comes to see that war is purely an evil, even to the conqueror. Benevolence interposes to make its ravages less mischievous to human comfort, and less destructive to human life. Men begin to find that their more active powers can be exercised with equal gratification on legitimate objects; for example, in overcoming the natural difficulties of their path through life, or in a generous spirit of emulation in a line of duty beneficial to themselves and their fellow-creatures. Thus, war at length shrinks into a comparatively narrow compass, though there certainly is no reason to suppose that it will be at any early period, if ever, altogether dispensed with, while man's constitution remains as it is. In considering an evil of this kind, we must not limit our view to our own or any past time. Placed upon the earth with faculties prepared to act, but inexperienced, and with the more active propensities necessarily in great force to suit the condition of the globe, man was apt to misuse his powers much in this way at first, compared with what he is likely to do when he advances into a condition of civilisation. In the scheme of providence, thousands of years of frequent warfare, all the so-called glories which fill history, may be but a subordinate consideration. The chronology of God is not as our chronology. See the patience of waiting evinced in the slow development of the animated kingdoms, throughout the long series of geological ages. Nothing is it to him that an entire goodly planet should, for an inconceivable period, have no inhabiting organisms superior to reptiles. Nothing is it to him that whole astral systems should be for infinitely longer spaces of time in the nebular embryo, unfit for the reception of one breathing or sentient being out of the myriad multitudes who are yet to manifest his goodness and his greatness. Progressive, not instant effect is his sublime rule. What, then, can it be to him that the human race goes through a career of impulsive acting for a few thousand years? The cruelties of ungoverned anger, the tyrannies of the rude and proud over the humble and good, the martyr's pains, and the patriot's despair, what are all these but incidents of an evolution of superior being which has been pre-arranged and set forward in independent action, free within a certain limit, but in the main constrained, through primordial law, to go on ever brightening and perfecting, yet never, while the present dispensation of nature shall last, to be quite perfect!

The sex passion in like manner leads to great evils. Providence has seen it necessary to make very ample provision for the preservation and utmost possible extension of all species. The aim seems to be to diffuse existence as widely as possible, to fill up every vacant piece of space with some sentient being to be a vehicle of enjoyment. Hence this passion is conferred in great force. But the relation between the number of beings, and the means of supporting them, is only on the footing of general law. There may be occasional discrepancies between the laws operating for the multiplication of individuals, and the laws operating to supply them with the means of subsistence, and evils will be endured in consequence, even in our own highly favored species. But against all these evils, and against those numberless vexations which have arisen in all ages from the attachment of the sexes, place the vast amount of happiness which is derived from this source—the basis of the whole circle of the domestic affections, the sweetening principle of it, the prompter of all our most generous feelings, and even of our most virtuous resolves and exertions—and every ill that can be traced to it is but as dust in the balance. And here, also, we must be on our guard against judging from what we see in the world at a particular era. As reason and the higher sentiments of man's nature increase in force, this passion is put under better regulation, so as to lessen many of the evils connected with it. The civilized man is more able to give it due control; his attachments are less the result of impulse; he studies more the weal of his partner and offspring. There are even some of the resentful feelings connected in early society with love, such as hatred of successful rivalry, and jealousy, which almost disappear in an advanced state of civilisation. The evils springing, in our own species at least, from this passion, may therefore be an exception mainly peculiar to a particular term of the world's progress, and which may be expected to decrease greatly in amount.

With respect, again, to disease, so prolific a cause of suffering to man, the human constitution is merely a complicated but regular process in electro-chemistry, which goes on well, and is a source of continual gratification, so long as nothing occurs to interfere with it injuriously, but which is liable every moment to be deranged by various external agencies, when it becomes a source of pain, and, if the injury be severe, ceases to be capable of retaining life. It may be readily admitted that the evils experienced in this way are very great; but, after all, such experiences are no more than occasional, and not necessarily frequent—exceptions from a general rule of which the direct action is to confer happiness. The human constitution might have been of a more hardy character; but we always see hardiness and insensibility go together, and it may be of course presumed that we only could have purchased this immunity from suffering at the expense of a large portion of that delicacy in which lie some of our most agreeable sensations. Or man's faculties might have been restricted to definiteness of action, as is greatly the case with those of the lower animals, and thus we should have been equally safe from the aberrations which lead to disease; but in that event we should have been incapable of acting to so many different purposes as we are and of the many high enjoyments which the varied action of our faculties places in our power: we should not, in short, have been human beings, but merely on a level with the inferior animals. Thus, it appears, that the very fineness of man's constitution, that which places him in such a high relation to the mundane economy, and makes him the vehicle of so many exquisitely delightful sensations—it is this which makes him liable to the sufferings of disease. It might be said, on the other hand, that the noxiousness of the agencies producing disease might have been diminished or extinguished; but the probability is, that this could not have been done without such a derangement of the whole economy of nature as would have been attended with more serious evils. For example—a large class of diseases are the result of effluvia from decaying organic matter. This kind of matter is known to be extremely useful, when mixed with earth, in favoring the process of vegetation. Supposing the noxiousness to the human constitution done away with, might we not also lose that important quality which tends so largely to increase the food raised from the ground? Perhaps (as has been suggested) the noxiousness is even a matter of special design, to induce us to put away decaying organic snbstances into the earth, where they are calculated to be so useful. Now man has reason to enable him to see that such substances are beneficial under one arrangement, and noxious in the other. He is, as it were, commanded to take the right method in dealing with them. In point of fact, men do not always take this method, but allow accumulations of noxious matter to gather close about their dwellings, where they generate fevers and agues. But their doing so may be regarded as only a temporary exception from the operation of mental laws, the general tendency of which is to make men adopt the proper measures. And these measures will probably be in time universally adopted, so that one extensive class of diseases will be altogether or nearly abolished.

Another large class of diseases spring from mismanagement of our personal economy. Eating to excess, eating and drinking what is noxious, disregard to that cleanliness which is necessary for the right action of the functions of the skin, want of fresh air for the supply of the lungs, undue, excessive, and irregular indulgence of the mental affections, are all of them recognized modes of creating that derangement of the system in which disease consists. Here also it may be said that a limitation of the mental faculties to definite manifestations (*vulgo*, instincts) might have enabled us to avoid many of these errors; but here again we are met by the consideration that, if we had been so endowed, we should have been only as the lower animals are, wanting that transcendently higher character of sensation and power, by which our enjoyments are made so much greater. In making the desire of food, for example, with us an indefinite mental manifestation, instead of the definite one which it mainly is amongst the lower animals, the Creator has given us a means of deriving far greater gratifications from food (consistently with health) than the lower animals generally appear to be capable of. He has also given us reason to act as a guiding and controlling power over this and other propensities, so that they may be prevented from becoming causes of malady. We can see that excess is injurious, and are thus prompted to moderation. We can see that all the things which we feel inclined to take are not healthful, and are thus exhorted to avoid what are pernicious. We can also see that a cleanly skin and a constant supply of pure air are necessary to the proper performance of some of the most important of the organic functions, and thus are stimulated to frequent ablution, and to a right ventilation of our parlors and sleeping apartments. And so on with the other causes of disease. Reason may not operate very powerfully to these purposes in an early state of society, and prodigious evils may therefore have been endured from diseases in past ages; but these are not necessarily to be endured always. As civilisation advances, reason acquires a greater ascendency; the causes of the evils are seen and avoided; and disease shrinks into a comparatively narrow compass. The experience of our own country places this in a striking light. In the middle ages, when large towns had no police regulations, society was at frequent intervals scourged by pestilence. The third of the people of Europe are said to have been carried off by one epidemic. Even in London the annual mortality has greatly sunk within a century. The improvement in human life, which has taken place since the construction of the Northampton tables by Dr. Price, is equally remarkable. Modern tables still show a prodigious mortality among the young in all civilized countries—evidently a result of some prevalent error in the usual modes of rearing them. But to remedy this evil there is the sagacity of the human mind, and the sense to adopt any reformed plans which may be shown to be necessary. By a change in the management of an orphan institution in London, during the last fifty years, an immense reduction in the mortality took place. We may of course hope to see measures devised and adopted for producing a similar improvement of infant life throughout the world at large.

In this part of our subject, the most difficult point certainly lies in those occurrences of disease where the afflicted individual has been in no degree concerned in bringing the visitation upon himself. Daily experience shows us infectious disease arising in a place where the natural laws in respect of cleanliness are neglected, and then spreading into regions where there is no blame of this kind. We then see the innocent suffering equally with those who may be called the guilty. Nay, the benevolent physician who comes to succor the miserable beings whose error may have caused the mischief, is sometimes seen to fall a victim to it, while many of his patients recover. We are also only too familiar with the transmission of diseases from erring parents to innocent children, who accordingly suffer, and perhaps die prematurely, as it were, for the sins of others. After all, however painful such cases may be in contemplation, they cannot be regarded in any other light than as exceptions from arrangements, the general working of which is beneficial.

With regard to the innocence of the suffering parties, there is one important consideration which is pressed upon us from many quarters, namely—that moral conditions have not the least concern in the working of these simply physical laws. These laws proceed with an entire independence of all such conditions, and desirably so, for otherwise there could be no certain dependence placed upon them. Thus it may happen that two persons ascending a piece of scaffolding, the one a virtuous, the other a vicious man, the former, being the less cautious of the two, ventures upon an insecure place, falls, and is killed, while the other, choosing a better footing, remains uninjured. It is not in what we can conceive of the nature of things, that there should be a special exemption from the ordinary laws of matter, to save this virtuous man. So it might be that, of two physicians, attending fever-cases, in a mean part of a large city, the one an excellent citizen, may stand in such a position with respect to the beds of the patients as to catch the infection, of which he dies in a few days, while the other, a bad husband and father, and who, unlike the other, only attends such cases with selfish ends, takes care to be as much as possible out of the stream of infection, and accordingly escapes. In both of these cases man's sense of good and evil—his faculty of conscientiousness—would incline him to destine the vicious man to destruction and save the virtuous. But the Great Ruler of Nature does not act on such principles. He has established laws for the operation of inanimate matter, which are quite unswerving, so that, when we know them, we have only to act in a certain way with respect to them, in order to obtain all the benefits and avoid all the evils connected with them. He has likewise established moral laws in our nature, which are equally unswerving (allowing for their wider range of action), and from obedience to which unfailing good is to be derived. But the two sets of laws are independent of each other. Obedience to each gives only its own proper advantage, not the advantage proper to the other. Hence it is that virtue forms no protection against the evils connected with the physical laws, while on the other hand, a man skilled in, and attentive to these, but unrighteous and disregardful of his neighbor, is in like manner not protected by his attention to physical circumstances from the proper consequences of neglect or breach of the moral laws.

Thus it is that the innocence of the party suffering for the faults of a parent, or of any other person or set of persons, is evidently a consideration quite apart from that suffering.

It is clear, moreover, from the whole scope of the natural laws, that the individual, as far as the present sphere of being is concerned, is to the Author of nature a consideration of inferior moment. Everywhere we see the arrangements for the species perfect; the individual is left, as it were, to take his chance amidst the *mêlée* of the various laws affecting him. If he be found inferiorly endowed, or ill befalls him, there was at least no partiality against him. The system has the fairness of a lottery, in which every one has the like chance of drawing the prize.

Yet it is also to be observed that few evils are altogether unmixed. God, contemplating apparently the unbending action of his great laws, has established others which appear to be designed to have a compensating, a repairing, and a consoling effect. Suppose, for instance, that, from a defect in the power of development in a mother, her offspring is ushered into the world destitute of some of the most useful members, or blind, or deaf, or of imperfect intellect, there is ever to be found in the parents and other relatives, and in the surrounding public, a sympathy with the sufferer, which tends to make up for the deficiency, so that he is in the long run not much a loser. Indeed, the benevolence implanted in our nature seems to be an arrangement having for one of its principal objects to cause us, by sympathy and active aid, to remedy the evils unavoidably suffered by our fellow-creatures in the course of the operation of the other natural laws. And even in the sufferer himself, it is often found that a defect in one point is made up for by an extra power in another. The blind come to have a sense of touch much more acute than those who see. Persons born without hands have been known to acquire a power of using their feet for a number of the principal offices usually served by that member. I need hardly say how remarkably fatuity is compensated by the more than usual regard paid to the children born with it by their parents, and the zeal which others usually feel to protect and succor such persons. In short, we never see evil of any kind take place where there is not some remedy or compensating principle ready to interfere for its alleviation. And there can be no doubt that in this manner suffering of all kinds is very much relieved.

We may, then, regard the globes of space as theatres designed for the residence of animated sentient beings, placed there with this as their first and most obvious purpose—to be sensible of enjoyments from the exercise of their faculties in relation to external things. The faculties of the various species are very different, but the happiness of each depends on the harmony there may be between its particular faculties and its particular circumstances. For instance, place the small-brained sheep or ox in a good pasture, and it fully enjoys this harmony of relation ; but man, having many more faculties, cannot be thus contented. Besides having a sufficiency of food and bodily comfort, he must have entertainment for his intellect, whatever be its grade, objects for the domestic and social affections, objects for the sentiments. He is also a progressive being, and what pleases him to-day may not please him to-morrow ; but, in each case, he demands a sphere of appropriate conditions in order to be happy. By virtue of his superior organization, his enjoyments are much higher and more varied than those of any of the lower animals ; but the very complexity of circumstances affecting him renders it at the same time unavoidable, that his nature should be often inharmoniously placed and disagreeably affected, and that he should therefore be unhappy. Still, unhappiness amongst mankind is the exception from the rule of their condition, and an exception which is capable of almost infinite diminution, by virtue of the improving reason of man, and the experience which he acquires in working out the problems of society.

To secure the immediate means of happiness, it would seem to be necessary for men first to study with all care the constitution of nature ; and, secondly, to accommodate themselves to that constitution, so as to obtain all the realizable advantages from acting conformably to it, and to avoid all likely evils from disregarding it. It will be of no use to sit down and expect that things are to operate of their own accord, or through the direction of a partial deity, for our benefit ; equally so were it to expose ourselves to palpable dangers, under the notion that we shall, for some reason, have a dispensation or exemption from them; we must endeavor so to place ourselves, and so to act, that the arrangements which Providence has made impartially for all may be in our favor, and not against us; such are the only means by which we can obtain good and avoid evil here below. And, in doing this, it is especially necessary that care be taken to avoid interfering with the like efforts of other men, beyond what may have been agreed upon by the mass as necessary for the general good. Such interferences, tending in any way to injure the body, property, or peace of a neighbor, or to the injury of society in general, tend very much to reflect evil upon ourselves through the reaction which they produce in the feelings of our neighbor and of society, and also the offence which they give to our own conscientiousness and benevolence. On the other hand, when we endeavor to promote the efforts of our fellow creatures to attain happiness, we produce a re-action of the contrary kind, the tendency of which is towards our own benefit. The one course of action tends to the injury, the other to the benefit of ourselves and others. By the one course, the general design of the Creator towards his creatures is thwarted; by the other it is favored. And thus we can readily see the most substantial grounds for regarding all moral emotions and doings as divine in their nature, and as a means of rising to and communing with God. Obedience is not selfishness, which it would otherwise be—it is worship. The merest barbarians have a glimmering sense of this philosophy, and it continually shines out more and more clearly as men advance in intelligence. Nor are individuals alone concerned here. The same rule applies as between one great body or class of men and another, and also between nations. Thus, if one set of men keep others in the condition of slaves—this being a gross injustice to the subjected party, the mental manifestations of that party to the masters will be such as to mar the comfort of their lives; the minds of the masters themselves will be degraded by the association with beings so degraded; and thus, with some immediate or apparent benefit from keeping slaves, there will be in a far greater degree an experience of evil. So also, if one portion of a nation, engaged in a particular department of industry, grasp at some advantages injurious to the other sections of the people, the first effect will be an injury to those other portions of the nation, and the second a re-active injury to the injurers, making their guilt their punishment. And so when one nation commits an aggression upon the property or rights of another, or even pursues towards it a sordid or ungracious policy, the effects are sure to be redoubled evil from the offended party. All of these things are under laws which make the effects, on a large range, absolutely certain; and an individual, a party, a people, can no more act unjustly with safety, than I could with safety place my leg in the track of a coming wain, or attempt to fast thirty days. We have been constituted on the principle of only being able to realize happiness for ourselves when our fellow-creatures are also happy; we must therefore both do to others only as we would have others to do to us, and endeavor to promote their happiness as well as our own, in order to find ourselves truly comfortable in this field of existence. These are words which God speaks to us as truly through his works, as if we heard them uttered in his own voice from heaven.

Whether the human race will ever advance far beyond its present position in intellect and morals, is the last question belonging to the scientific part of our subject. It is one which has engaged much attention, but never appeared likely to approach a settlement, perhaps from the elements for its discussion being hitherto so defective. When judged by the general light arising from the hypothesis of development we may safely pronounce that the human type is likely yet to experience considerable improvements, though it may be many centuries before a decided change will take place. A progression resembling development may be traced in human nature, both in the individual and in large groups of men. The individual is in childhood under the influence of the propensities and instinctive aptitudes; in youth, he is swayed by marvellousness, the love of the beautiful, the imaginative; in full maturity, he passes under (comparatively) the domination of reason. In perfect analogy, a nation is at first impulsive and unreasoning: afterwards it is conducted by the second class of sentiments (the age of mythologies, hierocracies, man and idea worships); finally, its institutions begin to approximate to an accurate regard for what is convenient and profitable, under the control of justice and humanity. The advance of knowledge favors the progress of the moral conditions, and in improved moral conditions knowledge becomes more sound. In tolerably favorable circumstances, this tendency onward never fails to make itself visible; and it is evident that, though many nations seem nearly stationary and others appear to retrograde, there is always a progress in some place, so that no long space of time ever elapses without showing, upon the whole, a certain advance. Now all this is quite in conformity with what we have seen of the progress of organic creation. It seems but the minute hand of a watch, of which the hour hand is the transition from species to species. Knowing what we do of that latter transition, the possibility of a decided and general retrogression of the highest species towards a meaner type is scarce admissible, but a forward movement seems anything but unlikely. This view is favored even by zoological science. We there see order after order of animals, from the bottom of the scale upwards, consisting of many genera, each of these again presenting various species, until we come to the highest order of all—BIMANA; and behold of this order but one genus—nay, but one species to represent that genus, namely, Man! Take any of the highest orders next to man—the Lemuridæ, the Vespertilionidæ, the Quadrumana, and into what multitudes of species do we find them varying! The Bimana alone is *of one species*. For this no shadow of a zoological reason can be presented. It is supported by none of the analogies of nature, but, on the contrary, is in decided contradiction to them, that there should be but one species of the highest type of animated being. If species are determined by circumstances in external nature, we should rather expect to see man bourgeoning into great variation; for man is the being of all beings most various in his destiny with respect to such circumstances. Yet so the fact is—man is of but one species. The zoological series appears here, as it were, broken short, or interrupted in its progress towards a general symmetry. Is not this a strong indication of further progress in development being designed? Is not the right explanation simply this—that the animated creation is seen by us at *a particular point in its progress?*—a progress yet to be continued. To this conclusion, all our knowledge of the past external conditions of the earth conduces. We there see ages marked by rock formations, and a succession of new animals in shadowy conformity with these; but the rock formations and all the associated conditions make no stoppage or marked change at the time of man's appearance. He comes in the course of them, and goes—is still going along, in accordance with them. He is only a new guest, who has entered and sat down at a feast where other guests were before him, and which goes on and on continually: may there not be other guests to come and take their places at this perennial banquet of the High and Bountiful Master? Meaning by other guests, beings, not descending (as common genealogical language would have it), but *ascending*, from the now living Mankind,—possessing a superior development of the human character in accordance with the better external conditions which shall then have come into play,—favored latter children of Nature, who have not lived till the throes and troubles of her maternal state were past. But is the improvement of these conditions to be left to the advance of physical nature, as that was seen before the existence of man? I suspect not. When man came upon the scene, a new agency was evidently added to those formerly operating to this effect. Men, by the work of their thoughtful brains and busy hands, modify external nature in a way never known before. Under the operations of tillage, of mechanism, of building, making, and inventing; of those applications of natural powers and forces which human wit turns to account in so many ways; of all the results of social experience, of knowledge, and of arrangement; the earth tends to become a much serener field of existence than it was in the earlier ages of man's history. Its progress in this respect may not be clearly seen at a particular time, through the obscuring effect of temporary and accidental causes ; but that the tendency of the physical improvements wrought by man upon the surface, and of the mechanic movements which he sets agoing for the saving of his own labor, is to improve the daily comforts, and allow room for the intellectual and moral advancement of earth's children, cannot be denied without something like flying in the face of Providence itself. These improvements, then, thus partly wrought out by the exertions of the present race, I conceive as at once preparations for, and causes of, the *possible development* of higher types of humanity,—beings less strong in the impulsive parts of our nature, physical nature giving less matter for that nature to contend with and subdue to its needs,—more strong in the reasoning and the moral, because there will be less of the opposite to keep these in check,—more fitted for the delights of social life, because society will then present less to fear and more to love. This is but a speculation—some will call it a dream ; but I certainly would not have brought it forward here, if there were not some countenance for it in what we know of nature and her history. As a mere speculation resting on that knowledge, and possessing the further recommendation of being agreeable to our best feelings, I leave it to the judgment of the reader.

The history and constitution of the world have now been explained according to the best lights which an humble individual has found within the reach of his perceptive and reasoning faculties. We have seen a system in which all is regularity and order, and all flows from and is obedient to a divine code of laws of unbending operation. We are to understand from what has been laid before us, that man, with his varied mental powers and impulses, is a natural problem, of which the elements can be taken cognizance of by science, and that all the secular destinies of our race, from generation to generation, are but evolutions from a primeval arrangement in the counsels of Deity. It does not, according to this view, appear necessary that God should exercise an immediately superintending power over the mundane economy; he might be pronounced to repose in silent contemplation of his works, unoffended by evil, pitiless of suffering, satisfied with one eternal round of such doings as we see exemplified upon earth, liable as these presumably are to a progress in an improving direction. But this view, however supported, being attended with these sequences, is certainly one which no large portion of mankind will ever embrace. It may be a view of truth, but there is a monitor within which denies that it is the whole truth. We intuitively shrink from it in its isolated sternness, and demand to know if there are not other truths which require to be associated with it before it can be received even in its most limited application.

To such requirements of our nature, so that we are satisfied of their being purely intuitive, and so I consider the present to be—it is necessary that the philosopher give full attention, for they are as truly facts as any other which he ever has occasion to consider. Such instinctive apprehensions cannot be there for nothing, for no such thing is made in vain. Reasonings may appear to be against them, and for ages they may be destitute of that kind of proof which rigid seekers for truth demand. But how often has it happened that they have after all been shown and admitted as true! Forty years ago—to take an example—it was advanced by one philosopher, and approved by many, that population tends to advance more rapidly than the productive powers of the soil, so that many human beings must come into the world, only by an irreversible doom of nature to sink out of it again. The notion was repelled by mankind generally, as disrespectful to Providence, and suggesting a painful idea of the constitution of human nature. For years the objection was thought by the disciples of Mr. Malthus to be futile; but its validity is now pretty generally acknowledged by the men of highest intelligence. It is seen that the philosopher erred in his calculations, and was therefore wrong in his conclusions. The lowly and unpretending minds are allowed to have been, albeit on no ratiocinative grounds, in the right. It was in considering such triumphs of unenlightened judgment, that Pascal gave forth his beautiful saying, that the heart has its aphorisms as well as the understanding. Such impulses appear to be the fore-cast shadows of great truths, and, when they are clearly seen to spring from no superficial or evanescent feeling, are assuredly worthy of being taken into account in all questions to which they relate.

So thinking, I would seek to add to the truths which have already been eliminated from facts ascertained in science, some others which claim a place on the strength of their being dictated by the universal feelings of man. Something in our nature—as it appears to me—tells us that the Author of the universe is nearer to us, is in a more familiar and paternal relation to us, than would seem to be implied by a theory which represents him as only an author of laws. We cling to the idea that he has been the immediate breather of our life, that he continually watches over us, that we can come by rightly directed thought into communion with him, and that, when life's changeful scene is over, we shall, if found worthy, be received in a new form of being into his fatherly bosom. We feel, in our dependent state here below, a need for some ultra-mundane being, on whom to rest, as we would do upon the breast of a friend, and to whom to look as an ultimate refuge from the trying vicissitudes of life. We also feel how far short our best doings and designings are of that perfect goodness which our imagination can suppose—how deeply injurious and offensive must our ordinary life be to one so purely good. Something seems necessary to reconcile us to him, or to fit us for being restored to his society. Hence the idea of penitence and its wondrous potency—hence, in short, religion. Now these emotions are all so natural to man, they rise so readily in the civilized bosom, and meet so ready a reception in all neophytes who have not been perverted by baser feelings or grossly corrupt systems, that, if the principle which has been explained be a right one, they must point to truths. Admit that our reason cannot at present entirely justify them, we may expect that it will yet do so. They may be regarded (putting all other evidence aside) as truths in the dawning stage—suggested by the feelings—waiting only the final approbatory stamp of the understanding, and sure in time to receive it.

But how to reconcile the two sets of truths? As to do this effectually, in the present imperfect state of our knowledge, would be one of the highest possible feats of human genius, so I cannot but feel that to fail somewhat in an effort to do it, cannot justly be reckoned a discredit. It occurs to me, at the very first, that there is nothing to prevent our regarding God as revealed to us in two capacities; first, as the author and sustainer of nature by fixed laws, and second, as our spiritual father, ever present in all that we do and think, and to be yet more clearly revealed to us. It may be that we are left by him to all the contingencies arising in the course of the fixed procedure of mundane affairs, and yet are capable of communing with him, may be affected in the strain of our life by results flowing from that communion, and are in the end received into his presence. There may be, behind the screen of nature, a system of mercy and grace which is to make up for all casualties endured here, and the very largeness of which is what makes these casualties a matter of indifference to God. For the existence of such a system, the actual constitution of nature is indeed a powerful argument. The reasoning may proceed thus:—the system of nature assures us that benevolence is a leading principle in the Divine Mind. But that system is at the same time deficient in a means of making this benevolence of invariable operation. To reconcile this to the character of the Deity, it is necessary to suppose that the present system is but a part of a whole, a stage in a Great Progress, and that the Redress is in reserve. Another argument here occurs—the economy of nature, beautifully arranged and vast in its extent as it is, does not satisfy even man's idea of what might be; he feels that, if this multiplicity of theatres for the exemplification of such phenomena as we see on earth were to go on for ever unchanged, it would not be worthy of the Being capable of creating it. An endless monotony of human generations, with their humble thinkings and doings, even though liable to a certain improvement, seems an object beneath that august Being. But the mundane economy might be very well as a portion of some greater phenomenon, the rest of which was yet to be evolved. It therefore appears that our system, though it may at first appear at issue with other doctrines in esteem amongst mankind, tends to come into harmony with them, and even to give them support. I would say, in conclusion, that, even where the two above arguments may fail of effect, there may yet be a faith derived from this view of nature sufficient to sustain us under all sense of the imperfect happiness, the calamities, the woes, and pains of this sphere of being. For let us but fully and truly consider what a system is here laid open to view, and we cannot well doubt that we are in the hands of One who is both able and willing to do us the most entire justice. And in this faith we may well rest at ease, even though life should have been to us but a protracted disease, or though every hope we had built on the secular materials within our reach were felt to be melting from our grasp. Thinking of all the contingencies of this world as to be in time melted into or lost in the greater system, to which the present is only subsidiary, let us wait the end with patience, and be of good cheer.

NOTE CONCLUSORY.

Thus ends a book, composed in solitude, and almost without the cognizance of a single fellow-being, for the sole purpose (or as nearly so as may be) of improving the knowledge of mankind, and through that medium their happiness. For reasons best to be appreciated by the author, his name is retained in its original obscurity, and, in all probability, will never be generally known. I do not expect that any word of praise which the work may elicit shall ever be responded to by me; or that any word of censure shall ever be parried or deprecated. It goes forth to take its chance of instant oblivion, or of a long and active course of usefulness in the world. Neither contingency can be of any importance to me beyond the regret or the satisfaction which may be imparted by my sense of a lost or a realized benefit to my fellow-creatures. The book, as far as I am aware, is the first attempt to connect the natural sciences into a history of creation. As such, it must necessarily be in some measure crude and unsatisfactory, even overlooking errors of detail justly attributable to my own defective knowledge.* Yet I

* In the present edition a few alterations and omissions have been made, either because of doubts which had entered my mind

have thought that the time was come for attempting to weave a great generalization out of the truths already established, or likely soon to be so—not that these were to be held as absolutely sufficient for the perfect completion of such an object, but that it is well at certain times to make advances into the field of speculation, in order that a direction may be given for the acquisition of new facts. If my doctrines shall appear to have general probability in their favor, I anticipate that attention will be drawn to the dubious point in question; observations will be made, and discussions will take place; and in the long run, we shall find we have made a movement, and that towards a settlement of some of the greatest questions affecting humanity.

My sincere desire in the composition of the book was to give what upon mature reflection I conceive to be the true view of the history of nature, with as little vexatious collision as possible with existing beliefs, whether philosophical or religious. I have made little reference to any doctrines of the latter kind which may be thought inconsistent with mine, because to do so would have been to enter upon questions for the settlement of which our knowledge is not yet ripe. Let the conciliation of whatever is true in my views with whatever is true in other systems come about in the fulness of calm and careful inquiry. I cannot but here remind the reader of what Dr. Wiseman has shown so strikingly in his lectures, how different new philosophic doctrines are apt to appear after we have become

with regard to the passages concerned, or merely because it appeared advisable to remove out of the way illustrations or arguments which had been made the grounds of sweeping objections, while in reality they were all but indifferent to the general question.

somewhat familiar with them. Geology at first seems inconsistent with the authority of the Mosaic record. A storm of unreasoning indignation rises against its teachers. In time, its truths, being found quite irresistible, are admitted, and mankind continue to regard the Scriptures with the same respect as before. So also with several other sciences. Now the only objection that can be made on such ground to this book, is, that it brings forward some new hypotheses, at first sight, like geology, not in perfect harmony with that record, and arranges some associated facts into a system which partakes of the same character. But may not the sacred text, on a liberal interpretation, or with the benefit of new light reflected from nature, or derived from learning, be shown to be as much in harmony with the novelties of this volume as it has been with geology and natural philosophy? What is there in the laws of organic creation more startling to the candid theologian than in the Copernican system or the natural formation of strata? And if the whole series of facts is true, why should we shrink from inferences legitimately flowing from it? Is it not a wiser course, since reconciliation has come in so many instances, still to hope for it, still to go on with our new truths, trusting that they also will in time be found harmonious with all others? Thus we avoid the damage which the very appearance of an opposition to natural truth is calculated to inflict on any system presumed to require such support. Thus we give, as is meet, a respectful reception to what is revealed through the medium of nature, at the same time that we fully reserve our reverence for all we have been accustomed to hold sacred, not one tittle of which it may ultimately be found necessary to alter.

APPENDIX.

REVIEW OF THE VESTIGES OF CREATION.

FROM THE

NORTH BRITISH REVIEW,

For July, 1845.

At no period in the annals of religion and science have these spring tides of civilisation advanced with a more irresistible energy, and a less mutual disturbance than in the present day. Freighted with the moral and physical interests of our species, they have rolled onward in one parallel course, disclosing to man new sources of happiness, and providing him with new instruments of power, and new elements of intellectual and animal enjoyment. In other times, and these not very distant from our own, the wisdom of this world stood in painful conflict with the revelations of the next. The sage and the Christian were names but seldom conjoined; and when human genius had unlocked the crypts of the primeval world, and partially lifted the veil which concealed their treasures, Faith stood aghast amid the monuments of Death, repudiating their lessons as still charged with error, and striving by a spurious ingenuity or an unworthy compromise, to reconcile truths partially demonstrated with truths fully revealed. Geology was thus arrayed against the Mosaic record, and with so powerful an ally infidelity took up a commanding position, wielding weapons of a more lethal edge than she had ever before wrested from the quiver of the blasphemer, or the armory of the metaphysician.

Hutton and his disciples had the courage to announce the startling truths that there were, at least, three distinct periods of animal existence previous to the creation of man; and that the natural history of the earth exhibited "no vestige of a beginning, and no prospect of an end." Though denounced as atheistical, and hostile to revealed religion, these views of creation were widely disseminated, and warmly received. To refute or to confirm them, the depths of the earth were ransacked, its bonded vaults unbarred, and its caverns and its abysses explored. The cemeteries of primeval times gave up their dead; the crumbling pavement of the globe surrendered its forms of organic life; and though the dumb creation had no historian to write its annals, and record its fate, it yet addressed us in articulate language from its hieroglyphics of stone, and exhibited on its marble sarcophagi the impressive handwriting of buried generations.

While the inspired volume describes the creation of man—the zoological denizens of his paradise, and the preparation of the earth for their reception, and details also the early history of our race during the cycle to which we belong—the pages of the subterranean record, though gathered like sibyl's leaves from widely distant localities, contain the history of successive generations of living beings, which occupied the earth in its primeval rudeness—which perished in some great catastrophes—and which were again replaced by new and more perfect creations from the immediate hand of their Maker. Thus did Science plant her standard on a domain which man never trod; and thus did she investigate the history of extinct animals over which he never exercised dominion. The book of Nature was thus kept distinct from the book of Revelation, and divine truth preserved from the leaven of secular knowledge, and the contamination of speculative error. The light of science fell upon the sacred page, and that page threw back in return its softer and more hallowed radiance.

In our own day, at least, we did not expect that this holy alliance would be disturbed either by the philosopher or the divine. Discoveries in geology, or in physics, imperfectly developed, and portions of Scripture imperfectly interpreted, might be expected to place themselves in temporary collision; but who could have anticipated any general speculations on the natural history of creation, which would startle the pious student, or for a moment disturb the serenity of the Christian world? Such an event, however, has occurred, and on the author of the work before us rests its responsibility. Prophetic of infidel times, and indicating the unsoundness of our general education, "The Vestiges of the Natural History of Creation" has started into public favor with a fair chance of poisoning the fountains of science, and sapping the foundations of religion. Popular in its subject, as well as in its expositions, this volume has obtained a wide circulation among the influential classes of society. It has been read and applauded by those who can neither weigh its facts, nor appreciate its argument, nor detect its tendencies; while those who can—the philosopher, the naturalist, and the divine—have concurred in branding it with their severest censure. Although the author's name is concealed, and a factitious interest thus excited in the public mind, it is not difficult to delineate his intellectual character. That he is not a philosopher every page of his work proves;—and among the extravagances of conjecture he has never been supposed a divine. He is an avowed phrenologist, and therefore we have no fear of being foiled by his dialectics. He is an ill-disguised materialist, and therefore he is not likely to over-estimate the dignity of man, or to celebrate the glory of his Maker. A naturalist from books and not from observation, he has gathered the data of his speculations from the records of science, without separating what is true from what is false; and, laden with this motley collection of facts and conjectures, he marches, torchless, through the richest domains of knowledge, blind to the beacons by which others have been warned, and stumbling over barriers by which others have been stayed. A work thus composed, is in its materials but the detritus of natural history and physics, where the ingredients occur in no definite proportions, and where the affinities of nature have had no part to play;—or it is at best an intellectual breccia of amorphous fragments, which equally defy the anatomy of the crystallographer, and the analysis of the chemist. Nor has the author been more happy in the combination of his materials. Trained in less severe schools than those of geometry and physics, his reasonings are in general loose and inconclusive; his generalizations seem to have been reached before he had obtained the materials on which they are made to rest; his facts are often conjectures, and sometimes fancies; and the grand phenomena of the material world, which other minds have woven into noble and elevating truths, have become in his hands the basis of dangerous and degrading speculations.

We are unwilling to charge our author with a systematic attempt to undermine the foundations of natural and revealed religion,—but we should ill discharge the duties of our calling, were we to conceal the opinion that every individual speculation which his work contains, and the entire hypothesis which it is written to support, have a direct tendency to expel the Almighty from the universe which he has made—to degrade the godlike race to whom he has intrusted the development and appreciation of his power—to render the revelation of his will an incredible superstition—and to extinguish those glorious aspirations, and "longings after immortality," in which regenerated man yearns after the perfection of his nature, pants for the consummation of his affections, and anticipates with rapture the perennial exercise of his powers in serving and glorifying his Maker.

That Great Name, indeed, which true philosophy has never failed to respect, and which religion loves to cherish, has not been wholly omitted in the speculations which we condemn;—but the Divinity which they recognize is little more than the electric spark which disappears for ever, when it has lighted the train of causes and effects by which the planetary systems are to be framed, and all the orders of living beings fashioned and perpetuated. That tender parent, who longs to gather his children "as a hen gathereth her chickens under her wing;"—who opens when they knock;—who gives good things to them that ask him, and without whose knowledge not a hair of their head falls to the ground, takes no charge of the family of orphans who people the gloomy universe of our author. The volcano may blaze—the earthquake engulf—the lightning rend—the floods desolate—and the last enemy strike his blow, without any eye to pity or any hand to help the victim of the elements, or any voice to console him in the last agony of his nature.

In such a state as this, however, our author professes himself unwilling to leave us. His "sincere desire in the composition of his book, is to give the *true view of nature with as little vexatious collision as possible with existing beliefs, whether philosophical or religious*," and "though his system may at first appear at issue with *other doctrines in esteem among mankind*, * * * * there *may yet be a faith* derived from *this view of nature*, sufficient to sustain us under the calamities and woes and pains of this sphere of being." The grand "system of causation," therefore, from which we are to derive this new and sustaining faith, well deserves our most anxious study; but before we proceed to analyze and expose it, we must try to obtain the assent of our readers to some general principles, which ought to be kept in view by those who are ambitious, like the author of the work before us, to establish *a general Theory of Creation*, or to give a particular explanation of any of its departments.

When an astronomer or a naturalist enters upon the study of the celestial or the sublunary world, the discovery of truth—the only sure road to fame—is his single object. Wherever reason leads he must follow—whatever mysteries confound him he must strive to unveil—and whether his inductions run counter to vulgar prejudice, or to cherished truths, he must maintain them fearlessly, because he believes them firmly. Should the phenomena and laws of nature, when accurately observed and irrefragably established, invalidate, or even contradict, the truths of revelation, the Reason of faith must grapple with the Reason of philosophy, till truth has been elicited in the conflict. The voice of God is uttered as articulately, and may be heard as distinctly, in his Works as in his Word; and he is the greatest enemy of religion who would throw a rein over genius, or limit science in the freedom of her range. It is otherwise, however, with those revellers in speculation who practise their orgies in the temple of science, ransacking its storehouse for the materials of hypothesis, and not unfrequently adulterating them for popular taste, or fashioning them for vulgar apprehension, or perchance suppressing or denouncing the testimony which they bear. Writers of this class have neither learned, nor wish to learn, the real meaning and sterling value of A FACT IN SCIENCE—that eternal and immutable truth, which every man must believe, and which all men may possess—that indestructible element of knowledge, which time cannot alter, nor power crush, nor fire subdue—that self-luminous atom, which shines brightest in the dark, and whose vestal fire an intellectual priesthood will ever struggle to maintain.

In forming a theory of creation for the study and reception of a community, either really or professedly religious, the theorist is not entitled to the privilege which we concede to the original inquirer. If his theory involves moral as well as physical results, and takes cognizance of those lofty questions which relate to the First Cause, and the responsibility and destiny of man, he is bound to weigh and discuss all the facts and opinions which oppose or confirm his views. If it has been revealed to man that the Almighty made him out of the dust of the earth, and breathed into his nostrils the breath of life, it is in vain to tell a Christian that man was originally a speck of albumen, and passed through the stages of monads and monkeys, before he attained his present intellectual pre-eminence. If it be a received truth that the Creator has repeatedly interposed in the government of the universe, and displayed his immediate agency in miraculous interpositions, it is an insult to any reader to tell him that that Being slumbers on his throne, and rules under a "primal arrangement in his counsels," and "by a code of laws of unbending operation." Let the author examine and disprove, if he can, the evidences of our common faith, and he may then find a safer bed on which to sow his tares, and a better market for their disposal, should they "grow up until the harvest."

The new theory of creation, to which we must now direct our attention, rests its foundation on the "arrangements and formation of the bodies of space." In the same manner "as men have once been boys, and boys infants;" so have we, our author thinks, in the starry system "many thousands of worlds, in all stages of formation, from the most rudimental state to that immediately preceding the present condition of those we deem perfect;" and he adds, the "unavoidable conclusion" that all the perfect (worlds) have gone through the various stages which we see in the rudimental. Hence he is "led at once" to the more general "conclusion that the whole of our firmament was at one time a diffused mass of nebulous matter," which once filled the whole of space in one connected mass, and under the influence of heat constituted an *universal fire-mist*, ready for the formation of all the systems of the universe.

By some cause or other, which neither is nor can be explained—and, in some particular point in the infinite plenum of matter, where, and why there, we do not learn—an atom of the fire-mist becomes the centre of an infant sun, destined in a given period to generate and bring to manhood a numerous family of planets, each of which, some hapless eunuch excepted, has the power of presenting grandchildren in the form of moons, to the founder of the family. The power of reproduction here terminates, unless some badly annealed world bursts its inclosures, and projects a family of asteroids to perplex the genealogist, and destroy the symmetry of the system. The theory of creation takes no notice of the illegitimate family of comets, those eccentric and lawless vagabonds, who, though they may claim a highland cousinship with different systems, have no legal domicile in any. While the central sun is thus forming, "the agglomeration brings into operation another physical law, by force of which the separate masses of matter (the suns) are either made to rotate singly (as bachelors), or, in addition to that single motion, are (like man and wife) set into a complete revolution in ellipses." The centrifugal force which accompanies that of rotation, "flings off portions of the rotating masses, which become spheres by virtue of the same law of attraction, and are maintained in orbits of revolution round the central body." The process by which the planets—these "children of the sun"—are thus formed, is the following: While the centrifugal force of the rotating mass is in "exact counterpoise" with that of gravitation, "the mass necessarily continues entire." "The least excess, however, of the centrifugal over the attractive force," would "separate the mass and its outward parts." The outer parts would thus revolve as a ring round the central body, and with the same velocity. At the recurrence of every new excess of the centrifugal force, a similar ring would be formed. If the agglomerating mass is now supposed to cool, it will become more dense, and shrink in size; and at a certain stage of solidification the crust will become a detached ring. Like that of Saturn, this ring might preserve its form, if its constitution were uniform; but as there are many chances against this uniformity, the matter will gather towards centres of superior solidity—the ring will break into masses—and the largest of these will attract the lesser, and thus become a planet of a *spherical* (spheroidal) form, revolving round the sun. The planet thus made might in like manner project similar rings, which would by the same process become satellites.

In applying this hypothesis to our solar system, we must suppose that a speck, corresponding with the centre of the sun, attracted towards itself so much of the nebulous plenum, as to fill the orbit of the outermost planet *Uranus*. A ring formed and projected in the manner already described, produced this first-born of the planets, and eldest child of the sun. Uranus again threw off *six* satellites, revolving in like manner round their primary. After a long period of gestation, during which the parental sun, still nebular, *shrinks* in place of enlarging, till it is reduced to the orbit of *Saturn*, an excess of centrifugal force now supervenes, and the planet is formed. It then throws off seven satellites from rings of matter, not uniform; but having got a little experience in ring-making, it succeeds in its two last throes to cast off two rings of such uniform consistency, that there are no attractive centres to break them, and they now form the double ring of Saturn. In like manner, Jupiter and his four moons were issued into the system; but when the solar mass was again pregnant, the ring broke into fragments, and *spherified* separately into the four asteroids, *Ceres*, *Pallas*, *Juno*, and *Vesta*. Next came Mars, moonless and sad,—doomed to spend his nights in darkness; but old mother Earth succeeded in obtaining a satellite,—a matter doubtless of some difficulty, as the shrunk and partially indurated sun had attained such a consistency, that though capable of sending Venus and Mercury into the system, yet such was the inferiority of their constitution, that they could neither produce rings nor satellites.

With the hypothesis now described we must not confound what has been called the cosmogony of Laplace, which M. Comte has so well illustrated in his *Course of Positive Philosophy*. The object of Laplace was merely to explain the general circumstances which characterize the constitution of *our solar system*,—namely, the small eccentricity of the planetary orbits—the slight deviation of their planes from that of the sun's equator—and the identity in the direction of all their motions: and though M. Comte regards it as the most plausible of all such hypotheses, *when restricted to our own planetary system*, and has attempted to discover an aspect in which it may admit of some numerical verification, yet he views it merely as an attempt to decide the question, whether or not the present state of our system presented any appreciable indications of a more simple anterior state, whose general character was susceptible of being determined. "We may conceive it possible," says he, "with some hope of success, to form a *conjecture* respecting the formation of the solar system to which we belong; but what natural basis could we have for *conjectures* respecting the formation of suns themselves? How could we confirm or refute any cosmogonical hypothesis, when we possess no phenomena of the kind that have been explored, or that are even explorable? Whatever philosophical interest there may be in Herschel's curious series of observations on the progressive condensation of nebulæ, from which he has inferred their necessary transformation into stars, such *fact*s will obviously not authorize a similar conclusion. * * * In a word, our world being in the whole universe the only one known, its formation is at the most the only one which we can reasonably investigate. The other celestial motions enter necessarily, at least, till the present time, into the vague domain of pure imagination, disengaged from every scientific condition." But if these are M. Comte's views, upon the supposition that the existence of nebulous matter different from stars is a *fact*, what will be his opinion of such speculations when that fact is disproved, and the very foundation of this class of hypotheses taken away?

It was certainly a rash generalization to maintain that nebulæ differed essentially from clusters of stars, because existing telescopes could not resolve them. The very first application of Lord Rosse's telescope to the heavens overturned the hypothesis; and with such unequivocal facts as that instrument has brought to light, we regard it as a most unwarrantable assumption to suppose that there are in the heavenly spaces any masses of matter different from solid bodies composing planetary systems. Nebulæ which appeared perfectly round in former telescopes, and supposed to be in the state of condensation into stars, are found by Lord Rosse to have *long irregular patches*, or to be fringed with appendages branching out into the surrounding space. In some the supposed nebulous matter is irregularly distributed, having several stripes or wisps in it, and in others there are prolongations of different brightness. But there is one nebula of a most extraordinary kind, to which Lord Rosse has recently applied his gigantic telescope, and a drawing of which on a large scale we have had an opportunity of seeing in his Lordship's possession. In Sir John Herschel's figure, it appears as two nebulæ entirely separate, the one being larger than the other ; but when analyzed with the great reflector, it is found to contain many stars, with something like spiral coils issuing from the principal nebula, and throwing off luminous radiations, the stars appearing principally in the spiral lines. The small attendant nebula, too, in place of being separate from the principal one, is connected with it by resolved and unresolved stars, forming a luminous band like a portion of an irregular spiral. A drawing of this remarkable nebula, which we trust Lord Rosse will soon publish, can alone convey to the reader an idea of its singular structure, and will, we are sure, discountenance those idle and unfounded speculations which we have been considering.

The importance of Lord Rosse's observations, and the folly of speculating on the form and appearance of such bodies, will appear in a very striking point of view from a history of the nebula of which we have been speaking. According to Messier, this nebula (No. 51 of his catalogue) is a *nebula without stars*. It consists, he adds, of *two*, having each a brilliant centre 4′ 35″ distant from each other, and the *two atmospheres touch!* Sir William Herschel describes it as a "bright round nebula surrounded by a halo or glory at a distance from it, and accompanied with a companion." Sir John Herschel, who has represented it in Fig. 25 of his paper of 1833, noticed that the distant halo discovered by his father was partially subdivided into two branches, and he observes that this "is one of its most remarkable and interesting features." "Supposing it," he continues, "to consist of stars, the appearance it would present to a spectator placed on a planet attendant on one of them eccentrically situated towards the north preceding quarter of the central mass, would be exactly similar to that of our Milky Way, traversing in a manner precisely analogous, the firmament of large stars, with which the centre cluster would be seen projected, and (owing to its greater distance) appearing, like it, to consist of stars much smaller than those in other parts of the heavens. Can it, then, be that we have here a brother system bearing a real physical resemblance and strong analogy of structure to our own? Were it not for the subdivision of the ring, the most obvious analogy would be that of the system of Saturn, and the *ideas of Laplace respecting the formation of that system* would be powerfully recalled by this object. But it is evident that all idea of symmetry caused by rotation on an axis must be relinquished when we consider that the elliptic form of the inner subdivided portion indicates, with extreme probability, an elevation of that portion above the plane of the rest, so that the real form must be that of a ring split through half its circumference, and having the split portions set asunder at an angle of about 45° each to the plane of the other." Now, had the ring in this nebula been single, as observed by Sir W. Herschel, the phenomenon would have been regarded as a striking illustration of Laplace's cosmogony, and of the theory of the formation of the ring of Saturn. Sir John Herschel, however, put an end to such a speculation by discovering the split in the ring, and Lord Rosse's observations in their turn discountenance Sir John's idea of the nebula being a brother system to the nebula of the Milky Way, in which astronomers suppose that our own lot is cast. Sir John Herschel makes no observation on the companion nebula referred to both by Messier and Sir William, but he has drawn it as a planetary nebula entirely distinct from the other. Lord Rosse, on the other hand, connects it by a luminous branch with the larger nebula, consisting of spiral branches and stars, and thus takes away all its resemblance to a planetary nebula agglomerating under the influence of gravitation.*

The theory of planetary creations being thus left without any support from the nebular hypothesis, it is scarcely worth while to make any farther exposure of it; but the

* Since this portion of the Article was printed, we have had an opportunity of seeing, at the meeting of the British Association at Cambridge, a more perfect drawing of this very remarkable Nebula than the one to which we have already referred. Sir David Brewster, into whose hands it was put by the Earl of Rosse, exhibited and explained it to the Physical Section, pointing out the differences between this accurate representation of the nebula, and the descriptions given of it by preceding astronomers. The Earl of Rosse, who was present, explained the manner in which he executed the drawings of this and other nebulæ which he had observed; and Sir John Herschel expressed his admiration of the remarkable phenomena which the drawing exhibited, referring particularly to the numerous stars which it contained, and to the spiral lines, and the branch which connected the small Nebula with the large one.

magnitude of the heresy, and the use which has been made of it as a basis for other errors, renders necessary a more popular illustration of its absurdities. When a single atom in the universe of matter becomes the nucleus of a sun, it must derive this pre-eminence from some cause extrinsic to itself. The will of the Creator being excluded by our author, there can be no cause influencing one atom which does not influence millions. But passing over this difficulty, and supposing the uniformly distributed atoms to agglomerate round their ringleader, the space left *blank* by the slow advance of the atoms in radial lines converging to the nucleus, must be a ring bounded by concentric circles, the outermost circle being the limit of the nebulous matter not drawn to the centre of the nascent sun. Now, as all the forces which act upon the agglomerating particles, whether they proceed from the circumference of the undisturbed nebulous matter, or from the gradually increasing nucleus, must have their resultants in the radial lines above mentioned,—there can be no cause whatever capable of giving a rotatory motion to the mass. It must remain at rest. In Laplace's Cosmogony he assumes a sun with its atmosphere in a state of rotation, the Creator being supposed necessary to give this primitive impulse to a process which is completed by secondary causes. The motion of the satellites is of course derived from the previous motions of their primaries.

But even if these difficulties are surmounted, we are beset with others equally formidable. What cause is there to determine the particular "stages at which rings are formed and detached." The excess of the centrifugal force which presides at this operation, is supposed to occur under the influence of some law which regulates the cooling of the heated gaseous bodies employed in the process. But we have still to ask what is the cause of the cooling, and what is its law—a law capable of regulating the distance, magnitude, densities, rings and satellites of all the bodies of our planetary system. Under such processes we might expect that satellites might not only have satellites but also rings, and that the sun himself might have had a huge ring revolving round him in the plane of his equator. Leaving these difficulties for our author's consideration, we come to the cardinal absurdity of his cosmogony. In the speculation of Laplace, he assumed the existence of a revolving sun, a source of light and heat capable not only of controlling by its power the huge mass of atmosphere with which it was charged, but of illuminating by its beams, and nursing by its heat, the various planets which it was destined to form. In his cosmogony, like that of Moses, it was God that said "Let there be light, and there was light;" but in the crude sun-making under our review, no contrivance exists for providing light and heat as the emanations from the central mass. By what process can an agglomeration of nebulous matter give birth to a perennial flame, emitting those luminous, chemical, and heat-giving rays which perform such functions in the economy of nature? If these properties necessarily reside in the central mass, then every planet and every satellite ought to be suns of various magnitudes, self-luminous, and self-heated, as if they were portions of the sun itself. But supposing that the central mass were capable of retaining what was sun, and discharging what was planet, by what process was the luminiferous æther, the medium of light, diffused through universal space? and from what collection of nebulous matter, and by what law of aggregation, and with what projectile force were the various comets, moving in all directions, and in planes of every possible inclination, launched across systems in which no material for their production can be found? The difficulty cannot be removed by assigning to some other portion of space the manufacture of those wandering stars; for we have now comets whose orbits are included *within our own solar system*, and which cannot be produced by any of the processes which are supposed to have given birth to the planets. The last difficulty which demands our notice is presented in the motion of the whole of our system round a point in the constellation Hercules. By what eddies of nebulous matter this grand movement is effected, our author has not ventured to conjecture, and were he to make the attempt, he might learn, better than by any other process, the true character of his own speculations.

A hypothesis like that under consideration, so improbable in its very nature, and so gratuitous in all its assumptions, might be expected to possess some feature which, when detected and examined, would reduce it to an absurdity. That feature presents itself in the very basis upon which it rests. The whole orbit of Uranus, three thousand and six hundred million of miles in diameter, is assumed to have been filled with nebulous matter similar to that of the celestial nebulæ, and all this matter has been condensed, by the action of gravity, into a *sun*, *seven planets*, *four asteroids*, *and eighteen satellites.* Let us now assume the average density of the sun, and all his attendants, at three, four, or five times that of water. Let us also compute the diameter of a sphere equal in bulk to all these bodies, and having found how many times that sphere is contained in a sphere whose radius is the distance of Uranus from the sun, we shall have a rough estimate of the *density of the nebulous matter when it occupied its largest volume.* We should be ashamed to make such a calculation, but if any person undertake the task, he will find that the nebulous matter in question must be *many millions of times rarer than the rarest of our gaseous bodies!* How could a sphere of such matter, held together by forces so infinitely feeble, revolve as a connected mass? How could it indurate in rings—how perform the other juggleries of world-making? But the absurdity does not here end. This sphere of impalpable matter must, like the other nebulæ, be *self-luminous.* It might, therefore, if it can do anything at all, make suns self-luminous like itself; but how could it part with its native brightness to form the dark and opaque masses of primary and secondary planets?

The consideration of the self-lustre of nebulæ furnishes us with a palpable argument against the nebular hypothesis as suggested, for it was never maintained, by astronomers. A *globular* nebula, shining with its own light, must, in any of its stages, previous to induration, have its brightness a maximum in its centre, and gradually shading off into darkness at its circumference. But it is only a very small number of such nebulæ that have been found, and we have no doubt whatever that, as in the case of the companion of Messier's No. 51, a high power will not only resolve them into stars, but prove that they are wholly destitute of that symmetry of form and of illumination which countenance the idea of an agglomerating and rotating mass. Many nebulæ are uniformly luminous, as if they were flat discs; others have their light unequally distributed, while vast numbers have the most irregular shapes, indicating no appearance of rotation, and no appearance of a central accumulation. Independently, therefore, of the discoveries of Lord Rosse, there was every reason to believe, from analogy as well as from observation, that nebulæ are mere collections of stars, deriving their general lustre, or the lustre of their individual parts, from the brightness and the number of the stars of which they are composed, and often exhibiting the appearance of globes or discs, from the inability of our telescopes to detect their ramifications and appendages.

From the lofty epic on the construction of an universe, our author descends to the sublunary theme of the formation of our own globe. When our earth was thrown off from the sun, it was 482,000 miles in diameter (the diameter of the moon's orbit), at which time it revolved in twenty-nine and a half days, the period of the moon's revolution. After the earth had cooled and shrunk to a globe of its present size, its external crust consisted of primary rocks, of which granite is the type, "agglomerated directly from the nebulous or vaporiferous state." Washed by the seas which the condensed vapors had formed, these rocks were worn down, and their detritus deposited in strata of sand and mud at the bottom of the ocean. Under the influence of heat and pressure, these sedimentary formations, the gneiss and mica-slate system, were gradually indurated. The imprisoned fires, the residue of the original temperature of the mass, broke up and rent the sedimentary strata, and the rocky matter in a state of fusion burst through the rents, tossing up the broken masses from their original levels. Thus were formed the primary strata of our globe—the *hypozoic* system of Mr. Phillips—and they lie beneath all the rocks which contain animal and vegetable remains.

Our author now proceeds, in successive chapters, to describe the commencement and continuance of organic life in the clay slate and grauwacké slate system—the old red sandstone—the carboniferous formation—the new red sandstone—the oolite—the cretaceous formation—the tertiary formation—and in the superficial and recent formations of our globe. He traces, in the fossil remains of these different eras, the progress of organic life, corresponding "with the progress of physical conditions on the surface." He finds plants and animals advancing from simple to higher forms of organization. Sea plants precede those of the land, and amongst these, "the simpler (cellular and cryptogamic) before the more complex." Among the animal remains, he finds "traces all but certain of infusoria, then polypiaria, crinoidea, some humble forms of the articulata and mollusca, and afterwards higher forms of the mollusca. Ages passed away before there were any nobler types of being. Fishes, the humblest class of vertebrata, then appeared, the earliest fishes resembling the lower articulata. Land animals, beginning with reptiles, "universally allowed to be the type next in advance from fishes," form the next link in the chain of life. From reptiles we advance to birds, and thence through the low forms of marsupialia to the higher mammalia; and when the land and sea had "come into their present relations," and the principal continents had acquired the irregularity of surface necessary for man—Man appeared.

Having thus discovered, as he believes, "everywhere throughout the geological history, strong traces of a parallel advance of the physical conditions and the organic forms," our author ventures to declare "a somewhat different idea of organic creation from what has hitherto been generally entertained." He regards it as *characteristic of an humble class of intellects*, to suppose that God constantly acts in particular ways for particular occasions, thus *detracting from his foresight*, lowering Him to the *level of our own intellects*, and thus *anthropomorphizing* his creative power, or reducing it to the character borne by the ordinary proceedings of mankind. Hence he arrives at the conclusion, that as the *cosmical arrangements* of the universe, or the construction of our earth and its associates, and, inferentially, all the other globes of space, are not the result of any immediate or personal exertion on the part of the Deity, but of natural laws, which are the expressions of his will, the *organic arrangements* must be so likewise.

Thus, according to our author, did the great Creator issue his Almighty Fiat—the expression of his sovereign will—and establish natural laws, including "that endless series of phenomena," physical and moral, which constitute the past history of nature, and which will continue through all future ages. At this his *First* and LAST command was the universe and universal nature irrevocably constituted. Boundless space was instantly occupied with nebulous matter. Suns sprung from its heated atoms, and motion, the life of matter, supervened. From the first agglomerated mass, planets were thrown off into their respective orbs, and satellites in due order started from their parent sphere. Under the influence of heat and moisture—the one collected into volcanoes, and the other accumulated into seas—each globe of space was fitted for the reception of organic life. The electric spark, escaping from the wild elements around it, struck life into an elementary and reproductive germ, and sea plants, the food of animals, first decked the rude pavement of the ocean. The lichen and the moss reared their tiny fronds on the first rocks that emerged from the deep, land plants evolving the various forms of fruit and flower next arose—the upas and the bread-fruit tree—the gnarled oak and the lofty cedar. Animal life appeared when the granary of nature was ready with its supplies. *A globule, having a new globule forming within itself which is the fundamental form of organic being, may be produced in albvmen by electricity;* and as such globules may be identical with living and reproductive cells, we have the earliest germ of organic life —the first cause of all the species of animated nature which people the earth, the ocean, and the air. Born of electricity and albumen, the simple monad is the first living atom—the microscopic animalcules—the snail—the worm—the reptile—the fish—the bird—and the quadruped, —all spring from its invisible loins. The human similitude at last appears in the character of the monkey—the monkey rises into the baboon—the baboon is exalted to the ourang-outang—and the chimpanzee, with a more human toe and shorter arms, gives birth to man—the temporary autocrat of the animal world, but destined to give place to higher orders of being, in the never-ending series of metamorphoses with which futurity is pregnant.

Such is a condensed view of the poetical theory of creation which we are called upon to admire and believe. Had it been propounded in ancient times, when we had neither revealed nor demonstrated truth for our guides, it might have been accepted as a vision of philosophy, which future discoveries might realize or dispel; but its appearance and reception in modern times, amid the sober convictions of faith, and the impregnable results of science, is a phenomenon bordering on the marvellous.* We need scarcely inform our readers that a theory of creation, in which God never acts personally and specially in the works of creation and providence, stands in direct opposition to that revelation of his will, in which he is represented as creating and destroying his works—as rewarding and punishing his creatures—and as controlling and subverting the laws of organic and inorganic nature. But this opposition we must at present overlook, and in examining speculations of such a kind, which profess to lay their foundations in scientific truth, we must make an appeal to Reason and not to Faith.

The theory under our review rests itself on a triple foundation—on the supposed fact that the cosmical arrangements of the universe are clearly the effects of natural law;—on the progressive development of plants and animals, as exhibited in the geological history of our globe; —and on various scientific results which are supposed to indicate the transformation of one species into another. Did the numerous details which form the ground-work of any speculation involve only admitted truths, or sound inferences from unquestioned phenomena, an intelligent reader would experience little difficulty in estimating the value of the generalization which they were brought to support. Partial coincidences and seeming resemblances might in some cases mislead, and in others deceive; but

* "Happily," says Sir Henry de la Beche, "facts have become so multiplied, that geology is daily emerging from that state when an hypothesis, provided it were brilliant and ingenious, was sure of advocates and temporary success, even when it sinned against the laws of physics and facts themselves."—*Geological Manual*, Pref., p. vii.

the contrast of stern and undisputed facts with assertions however plausible, and views however ingenious, will never fail to expel error from her most impregnable strongholds. If the theory relates to a particular branch of science, and its students are a jury of philosophers, every fact will be weighed—every testimony sifted, and a verdict on the side of truth will be ultimately pronounced. But if the subject of inquiry is general and extensive, moral as well as physical, reaching back to primeval times, and scanning the most distant future;—if it embraces infinity of space as well as eternity in time, involving the responsibilities and destinies of our species, appealing to the reason of every race of being, and to minds male and female, of every degree of power, and every shade of culture,—then may we expect from such a subject, and with such a jury, an inquest of philosophy in which truth is not likely to triumph. Each individual mind will discover some insulated link to which it will instinctively cling. In the poetry of life and death, of renovation and decay, the youthful mind will find a chord resonant to its ardent nature. The infidel will swear a cheerful allegiance to natural in place of divine law. The shallow philosopher will find food of easy assimilation, and every possessor of an infinitesimal of knowledge will find a corresponding atom in the new philosophy of nature. Such, we believe, is not an exaggerated picture of this new theory of creation, nor an unjust description of its individual supporters. In the scrutiny of its facts, however, we shall best decide the fate of its doctrines.

We have already seen in our examination of the cosmical hypothesis of our author, that it has no foundation in nature, and stands directly opposed to mechanical laws as well as to astronomical facts. It is a romance without a hero—a drama without a plot—a dream without an interpreter. To believe in it would be treason against the sovereignty of intellect, and to express that belief would be to run the risk of a commission of lunacy. Let us proceed then to examine the geological details in which the theory of development by natural law is supposed to have its surest foundation. If these details are incorrect—if complex organizations often precede, in the geological sand-glass, those which are simpler, and have as little relation to them in structural resemblances as in their order of succession, then does the theory fail in its most prominent application. But even if its geological facts are true, it can derive no support from their truth. An order of creation advancing from what is simple to what is compound, can never establish a creation by natural law, and would indicate only the order of procedure which the Almighty chose to pursue.

In determining the succession of organic structures, as exhibited in the various eras of geology, a theorist is not entitled to collect his details under the influence of preconceived opinions, and with that imperfect knowledge of geology which falls to the lot of the general student. Geologists alone are entitled to adjudicate upon such a question, and it is to them we must appeal for that array of facts by which alone it can be decided.

The total absence of organic remains from the primary rocks, which have hence received the name of *Azoic* (without life), places it beyond a doubt that there was a time when neither plants nor animals existed upon the earth. In the group of the *grauwacké slate* which follows the primary rocks, we find the first traces of vegetable and animal remains, and hence the name of *Protozoic* (first life), has been given to them. Algæ and fuci, marine vegetables, though absent from the British, appear in the Scandinavian rocks. Corals and encrinites occur in abundance. The cuttle-fish and other molluscous animals are plentiful, and there are numerous crustacea, particularly trilobites of the genera calymene and asaphus. The remains of the bones and teeth of fish* have been found both in England and Ireland, and the abundance of Ichthyodorulites, or defensive fish bones in the grauwacké series, "shows," as Sir H. de la Beche remarks, "that the class of animals to which they belong was among the earliest inhabitants of the globe." Here then we have in the first era of organic life animals of high organization, trilobites with the most perfect organs of sensation, and the cuttle-fish with an eyeball scarcely surpassed in beauty by the human organ. The theory of development is thus utterly at fault in its very earliest application, and its author is driven to assert that "it is impossible to believe that these were the first sole examples of life which existed upon the earth," and that "the molluscs and radiates necessarily imply the previous, *or at least contemporary* existence of certain humbler forms of life, vegetable as well as animal!"

In the next group of rocks which compose the *Silurian system* of Mr. Murchison, we find almost the same fossils which existed in the grauwacké system, and even the author of "The Vestiges" allows that the latter is zoologically a continuation of the former. He contrives, however, to obtain a step in his ascending scale, from the re-

* "Neither fishes nor any higher vertebrata as yet roamed through the marine wilds."—*Vestiges.*

mains of minuter fishes, discovered by Mr. Phillips, in rocks immediately over the Aymestry limestone. These fishes he considers as "the first examples of vertebrated animals which breathed upon our planet;" but in beds *below* the Aymestry limestone the remains of a fish have been found which belong to the highest type of that division of vertebrate animals, and hence the oldest fossil fish with which geologists are acquainted, is actually one with the highest organization! In order to make the small fishes of Mr. Phillips available for his argument, our author keeps in the shade the fishes of the Upper Ludlow rocks, which he designates as the "remains of six genera of obscure character;" but Agassiz has formed out of them *seven* new species, all with a high degree of organization, and *two* of them of the very highest type. Here, then, the hypothesis of an ascending scale is positively contradicted.

We come now to the era of the *Old Red Sandstone*, or the *Devonian* system of rocks as it has been called, from its prevalence in Devonshire. The same marine organic remains which marked the Silurian reappear in the same form in the Devonian system—zoophytes, molluscs, and crustacea; but the distinguishing features of this formation are the fishes with which it abounds—fishes remarkable for their high and singular organization.* We need scarcely tell the general reader that Agassiz has divided fishes into four orders, namely, the *Placoids*, or those which are covered with scaly plates, like the sharks of our own day—the *Ganoids*, or those which like the pike have hard

* The first discovery of fishes in the old red sandstone was made by Dr. Fleming.—AGASSIZ, *Recherches sur les Poissons Fossiles*, tom. v., p. 132.

scales like enamel—the *Cycloids*, or those which have scales like the salmon—and the *Ctenoids*, or those which have jagged scales like the perch. Now, the fishes which occur in the Devonian system belong to all these orders, except that of the Cycloids, and there can be no mistake about the character of their organization, as several of them belong to existing families. Some of these are bony and some cartilaginous, though the latter character prevails in the two first orders; but all of them belong *to the most exalted types of organization*. Notwithstanding these facts, our author endeavors to draw a support for his theory from the fishes we have mentioned. He insists that the *Placoids* and *Ganoids* are *manifestly of an inferior character* to the *Cycloids* and *Ctenoids*, *which afterwards came into existence;* and in support of these groundless statements, he alleges, on the authority of Agassiz, that the two first orders have only a rudimentary or cartilaginous skeleton, while the Cycloids and Ctenoids have an osseous structure. Now this is not true; for as we have already stated, cartilaginous and osseous fishes exist in each of the four orders; and what is still more striking, several new species of Ctenoids, which had been found only in the carboniferous system, have been discovered among the fishes brought by Mr. Murchison from the old red sandstone of Russia. Resolved to make out his position, our author next asserts that certain of the Ganoids approximate, in form and armature, to the lower order of the .crustacea, the *Cephalaspis* making the smallest advances from the crustacean character, and greatly resembling the *asaphus*, a trilobite of the lower formation. The *Coccosteus*—a genus discovered in Caithness by Messrs. Murchison and Sedgwick—he considers as the next step in advance to the perfect fish type;

and he places it near the crustaceans, because its teeth are chiselled, as it were, out of the solid bone of the jaw, like the nippers of a lobster, and because its mouth opens vertically, contrary to the usual mode of the vertebrata. A third step in advance of the crustacea, our author finds in the *Pterichthys*, that remarkable fossil which was discovered by our distinguished countryman, Mr. Hugh Miller, and of which he has given so interesting a description in his elegant and instructive volume *On the Old Red Sandstone.** Now it is averred by modern geologists, that these statements are incorrect, and that the Ganoid fishes rather approach to the higher class of reptiles, than to the lower crustacea.† But even if they were correct, they are not calculated even to give probability to the opinions which they are brought to support; and if such questions are to be settled by the authority of any name,

* "Never shall I forget," says Agassiz, "the impression which the sight of the *Pterichthys*, provided with appendages resembling wings, produced upon me, when I assured myself that it belonged to the class of fishes. It was an entirely new type, which was about to figure, for the first time since it had ceased to exist, in the series of beings—again to form a link, which nothing of all that had been revealed up to the time, with regard to extinct creations, would have led us ever to suspect the existence of—showing forcibly that observation alone can lead us to the recognition of the laws of development of organized beings, and *how much we should guard against all those systems of transformations of species, which the imagination invents with as much facility as reason refutes them.*"—*Report on the Fossil Fish of the Devonian System.* Brit. Assoc., 1842, p. 81.

† Professor Agassiz has explained why the Cephalaspides, the Coccosteus, and the Pterichthys were supposed to approximate to the Trilobites of a particular genus.—*Report on the Fossil Fish of the Devonian System.* Brit. Assoc., 1842, pp. 85, 6.

we would oppose to the incognito reputation of our author, the following decision of Agassiz:*—"This primitive diversity of the Ichthyoid types, of a formation so ancient as the old red sandstone, is, in my opinion, one of the facts *the most contradictory to the theory of the successive transformation of species, and of the descent of organized beings now living, from a small number of primitive forms*."†

* Report on the Fossil Fish of the Devonian System.—*Brit. Assoc.*, 1842, p. 87.

† It will not be regarded, we trust, as an unsuitable digression in a Scottish journal, to notice the labors of an accomplished and distinguished lady in extending our knowledge of the fossil fishes of the old red sandstone in her native land; nor will that notice be less appropriate on the part of one who occasionally saw, amid the gaieties of her early life, and in the pursuits of her maturer age, indications of that fine and ardent mind which unfolded itself in her later days. Professor Agassiz has placed Lady Cumming Gordon of Altyre "in the very first rank" of recent contributors to our knowledge of the fossil fishes of the Devonian system. "Not satisfied," says he, "with collecting and distributing among geologists, with unequalled liberality, the numerous specimens of those remains which she had collected in a quarry worked on purpose, she studied them with care—placed aside the most perfect specimens—and painted them with a precision of detail and an artistic talent to which very few naturalists have been able to attain. These drawings, indeed, and those of her daughter (Lady Seymour), who constantly assisted her in her studies, will form one of the principal ornaments of my 'monograph.' On the point of presenting this selection to the public, it is painful to me to think that this noble lady will no more be able herself to receive from geologists the tribute of gratitude which she so justly deserved. May this record, planted upon her grave, remind her estimable companion, that the willingness with which she assisted her parent has contributed to raise for her a lasting monument in the scientific world."—*Report on the Fossil Fish of the Devonian System*. Brit. Assoc. Rep., 1842, p. 81, and his *Recherches sur les Poissons Fossiles*, tom. v.,

In the era of the *Carboniferous Formations*, when land plants show themselves abundantly in the strata, our author finds, as usual, new proofs of his theory. The carboniferous group comprehends the *coal measures* and the *mountain limestone*. The coal measures consist of beds of sandstone, shale, and coal. They abound in vegetable remains; and all geologists agree in regarding the coal itself as an indurated mass of plants, though they differ as to the circumstances under which the change was effected. Many hundred species of plants have been discovered in the coal formation; and in this first and most ancient Flora, the author of the work before us strives to discover an ascending scale. He asserts, that the terrestrial botany of our globe begins with classes of compara-

pp. 131, 2. To this well-merited compliment Professor Agassiz has added a more permanent memorial of his admiration, by giving the name of *Cheirolepis Cummingiæ* to a species of the first group of the Ganoid family which Lady Cumming Gordon had discovered. Inheriting a name sacred in the history of our Church, and associated with the brightest deeds of the martyr, Lady Cumming Gordon has thrown round it the softer radiance of intellectual accomplishments, not limited to the study of fossils, but embracing nobler themes, and bearing upon higher interests. May we not express the hope that such an example will not be lost upon that exalted class, whom Providence has placed in a position to influence those of a higher as well as of a lower station than themselves. Ephemeral and unprofitable as are the pursuits which too generally constitute the amusements, as well as the occupations of the female mind, we feel it incumbent upon us, when bearing witness to a noble exception, to record the sentiment, that a portion of the leisure of our sister pilgrims could not have a more elegant appropriation, than in learning to distinguish the gems which adorn their persons—in studying the minerals which may be gathered round their home—and in wandering over the embalmed relics of organic life, which are buried under the pathways upon which they daily tread.

tively simple forms and structure, the lowest place being taken by plants of cellular tissue, *without flowers*, such as the lichens, mosses, fungi, ferns, and sea-weeds; and that above these are found plants with vascular tissue, *bearing flowers*, first, the *Monocotyledons*, with one seed lobe, such as the cane and palm; and next, the *Dicotyledons*, with two seed lobes, such as the pine, elm, oak, and other British forest trees, "these subdivisions also ranking in the order in which they are here stated." "Now, it is clear," adds our author, "that a predominance of these forms in succession marked the successive epochs developed by fossil geology, the simple abounding first, and the complex afterwards. Two-thirds of the plants of the carboniferous era, are of the cellular or cryptogamic kind. . . . . . The ascertained Dicotyledons, or *higher class plants*, are comparatively few in this formation; but it will be found, that they constantly increased as the globe grew older." In the *Lepidodendra* of the Lycopodiaceous family, our author finds additional proofs of his hypothesis. From the internal structure of the stem, and the character of the seed vessels, he maintains, that they have been a link between Monocotyledons and Dicotyledons, "a fact," he adds, "worthy of note, as it favors the idea, that in vegetable, as well as in animal creation, a progress has been observed in conformity with advancing conditions."

Positive as these statements are, and bold as are the conclusions which are drawn from them, yet geologists of all classes repudiate them as incorrect and unfounded. Dr. Fleming has actually found Dicotyledonous plants in the Grauwacké slates of Cork;* and the splendid Flora of the

* See *Wernerian Memoirs*, vol. iii., p. 89. Edin., 1821.

coal measures, which our author finds it convenient to characterize as exhibiting comparatively simple forms and structures, displays, on the contrary, the most magnificent specimens of creative power, resembling the noblest pines of the South Sea Islands, rivalling existing species in the complexity of their organization, and surpassing them in the scale of development.

In the animal remains of this period, our author does not find much support to his theory. Polypiaria and Crinoidea abound in the mountain limestone; but they disappear in the superincumbent coal beds. "At this time," he adds, "the Sauroids are considered as at their point of greatest abundance,—a fact of some importance, seeing that in teeth, bones, and scales, *they make an advance to the lizard* character, a *type of a higher order of animals*, which we are soon to see entering upon the stage." Now, this attempt to assimilate the Sauroid fishes to the lizards deserves the severest censure, for Agassiz has shown that their general structure is so peculiar, that they cannot be united with the reptiles, or the one class in any way descend from the other.

In describing the monotony in the forms and colors of nature, which he supposes to mark the carboniferous era, our author states, what he doubtless considers as favorable to his theory, that neither the hum of insects, nor the music of birds, cheered the solitudes of the earth; but, in making these assertions, he is greatly mistaken. Insects have been found in this era; and it is strange that the author should not have known this, as an account of them, with engravings, was published eight years ago in Dr. Buckland's Bridgewater Treatise. Two Coleopterous insects, of the family Curculionidæ, were discovered in the nodules of ironstone from the coal formation of Coalbrook-dale, by Mr. William Anstice, of Madely Wood. Another insect, of which Mr. Anstice has several specimens, and to which Dr. Buckland has given the name of *Limulus trilobitoides*, formed the nucleus of a nodule of iron ore from the same locality.* Nor is it less hostile to the theory of development, that we have evidence much stronger than that which generally satisfies our author, that such highly organized animals as reptiles and birds existed in the carboniferous age. Mr. Lyell informs us that, in the coal formation of Nova Scotia, "Mr. Logan discovered footsteps which appear to Mr. Owen to belong to some unknown species of reptiles, constituting the first indications of the reptilian class known in the carboniferous rocks;"† and Dr. Alfred King has discovered, in the carboniferous series of Westmoreland, South Pennsylvania, the foot marks of at least seven species " of birds, or other highly-organized animals. To these species, the footmarks of which he has represented in reduced drawings, he has given the names of *Ornithichnites gallinuloides*, *O. culbertsonii*, *Spheropezium leptodactylum*, *S. pachydactylum*, *S. therodactylum*, *S. ovoidactylum*,—the last of which is supposed to have an alliance with the Batrachians.‡

The *new red sandstone*, and *magnesian limestone* formation, to which the name of *Permian* has been given by Mr. Murchison, from the greater development of these strata in the ancient kingdom of *Permia*, is next called upon to

* See Buckland's *Geology and Mineralogy*, &c., vol. i., p. 408-9; vol. ii., p. 75, 78; and Plate 46, figs. 1, 2, 3.

† American Journal of Science, Oct., 1843, vol. xlv., p. 358.

‡ Ibid , April, 1845, vol. xlviii., p. 348.

bear testimony to the theory of development. The plants of this era, which were so abundant in the carboniferous series, appear now in diminished size and quantity—but are, generally speaking, specifically the same in type. Among the animals of this era, reptiles appear for the first time—a class capable of breathing in our atmosphere. Our author regards them as a group of a higher character, and next to fishes in the zoological scale—so near to them, indeed, "that certain species stand doubtfully between the two classes, having extremities which can hardly be distinguished from fins." Among the other "reptilian vestiges" of the age, our author adduces Nothosaurus and Rynchosaurus as "of lizard-like character; the former indicating, in the fine sculpture of the cranium, and the large comparative size of the extremities, *an approach* to the crocodilian form, while the latter show *some points of affinity* to the birds." The footprints of various animals,* particularly of tortoises and birds, are among the interesting memorials of the new red sandstone. We have thus the addition of perfect birds to the Fauna of the period, though our author unscrupulously asserts that they were "probably of a low type"—an opinion which their recent discovery in America, in the pre-existing formation, so completely refutes. Our author has made reference to the genus which Professor Owen has named *Labyrinthodon*, in allusion to the peculiar and characteristic structure of the teeth. The specimens are referable to five species; and Professor Owen distinctly states, that, had these species now existed, they would have formed batrachian representatives of the highest order of reptiles,—viz., the Cro-

* See this Journal, vol. i., p. 30, 31.

codileans. "Here, therefore," he remarks, "we find the batrachian making its first appearance *under its highest*, instead of its lowest, or simplest, conditions of structure. To use the language of the transmutation theory, the labyrinthodonts are degraded crocodiles, not elevated fishes!" But the hypothetical derivation of reptiles from metamorphosed fishes, is more directly negatived by the fact, that the batrachian type is not that under which reptiles make their first appearance in the strata which succeed the coal measures. The Monitors of the Thuringian Zechstein (magnesian limestone) are older than the labyrinthodonts of the Keuper (variegated marls); and, among British reptiles, the Thecodont lizards of the magnesian conglomerates have equal claims to a more ancient origin.*

We have thus run over the six Palæozoic systems of rocks, and have, we trust, satisfied the intelligent reader, that the forms of organic life which they successively display, have not been the result of progressive development from one simple type. Our author pursues, in the four succeeding sections, his history of organic life in the secondary, tertiary, and superficial formations; but, in these interesting eras, in which we should have expected accumulated proofs of an ascending scale of creation, if it did exist, he seems incapable of finding even the pretence of an argument for it. We shall, however, do him the justice of bringing forward what he does say on the subject.

The important era of the *Oolitic formation*, in which one species of the Mammalia *first* appears, is distinguished by the vast number of its organic remains, the

* Report on British Fossil Reptiles. Rep. Brit. Assoc., 1841, pp. 183, 197-8.

simple enumeration of which occupies above forty closely printed pages, in Sir H. de la Beche's Geological Manual. Now, in this extended list of animal and vegetable bodies, our author finds no proof of his theory of development, except in one case, and he even admits it as "remarkable that the animals of the oolitic system are *entirely different in species from those of the preceding age, and that these species cease before the next.*"* Where then is the link in the chain of transmutation, and how could the new species of the following age have come into existence? In the case of the *Didelphis Bucklandi*, found in the Stonesfield slate, a mammal, now referred to the order *Insectivora* and genus *Amphitherium*, our author regards it as interesting that the first mammal should have belonged to the *Marsupialia*, or class of pouched animals, an order low in the scale of creation, and ranking, as he thinks, between the oviparous vertebrata (birds, reptiles, and fishes), and the higher mammalia. This, however, is a mere assertion without proof; and the very existence of this species, which has been the subject of so much controversy, overturns the supposition of its having been derived from any pre-existing species.†

In the era of the *Cretaceous system*, composed of chalk, marl, and green sand, our author is equally at fault in finding proofs of his theory, though the fossil remains which it embodies are extremely numerous. Here, as in the pre-

* This formation derives its name from a number of little spheres, like eggs, which mark the limestone, the most conspicuous member of the series.

† See Professor Owen's Report on British Fossil Mammalia, Brit. Assoc., 1842, pp. 57-62.

ceding system, there is not a single species which existed in the Palæozoic system, and where a resemblance occurs between the fossils of these systems, no links connecting them are to be found. Until the cretaceous era, the *Placoid* and *Ganoid* fishes had flourished alone, and for the first time the two orders of *Cycloids* and *Ctenoids*, embracing eighteen families, appear, which are the very fishes, generally speaking, which exist in the present seas. Whence, then, came all on a sudden this mass of new species? Our author says, that in place of the *Placoid* and *Ganoid* fishes, we find the fishes of two orders (Cycloids and Ctenoids) of *superior organization*. Now, this is a misstatement of the case, for the Placoids, to which the first fossil fish belonged, is of a higher order of organization than the Cycloids and Ctenoids, and several Ctenoids have, as has been previously stated, been brought by Mr. Murchison from the old red sandstone of Russia. Our author is puzzled with the fact that there are so few bones of birds in this era. He mentions some remains of a bird from a chalk bed near Maidstone, supposed to have been of the long-winged swimmer family; but he is sensible that this alleged occurrence is not consistent with his theory; that birds must precede mammalia, and he gets out of the difficulty by saying that they may nevertheless have lived, though no remains are found in a particular formation. He adds, too, that there is a limit to this uncertainty, because "we see from what remains have been found in the whole series, *a clear progress throughout from humbler to superior types of being*." And this unsupported assertion he considers so irrefragable, that he actually uses it as a ground for predicting what animals have existed in particular formations. "Hence," says he, "we derive a light as to what animals may have existed at particular times, *which is in some measure independent of the specialities of fossil geology!* The birds are below the mammalia in the animal scale, and therefore they may be supposed to have existed about the time of the new sandstone and oolite, although we find but slight traces of them in these formations, and it may be said till a considerably later period." If our readers desire a specimen of reasoning in a circle, they have it here in perfection.

The *Tertiary* period, in which the mammalia are abundant, and the era of the *Superficial Formations*, at which many of our existing species commence, present our author with no facts in support of his theory; and as it is not our object to give even a superficial notice of the interesting phenomena of animal life which these periods disclose, we must quit this branch of our subject by a mere reference to the opinion, that there was a wide-spread and universal submersion, destructive of animal life, in the era before our own, and that a new creation of animals afterwards took place. Our author admits the simple fact of a submersion of a wide range, extensively if not universally destructive of living species, but he does not venture to explain how the new creation could have arisen without the immediate interposition of the Deity.

We cannot conclude this part of our subject without directing our readers to an engraved Table,* in which Agassiz has represented graphically the true history and development of fossil fishes, from their earliest appearance in the Palæozoic series down to the present time. A single glance at this Table, which we regret we cannot trans-

* *Récherches sur les Poissons Fossiles*, tom. i., pp. 170, 171.

fer to our pages, will put the reader in possession of the ichthyological chronicle of the ancient world. We have already seen that all fishes are distributed into the four orders of *Placoids*, *Ganoids*, *Cycloids*, and *Ctenoids*. Now, in all the families up to the commencement of the Cretaceous, there were almost no fossil fishes but Placoids and Ganoids. The *Cestraciontes* of the Placoid order begins with only one species, and that species of the highest type. It reaches its maximum in the Triassic and Jurassic formations, and is now reduced to a few genera and species, without having lost its high type of organization. The Ganoid order commences with the *Lepidoides*, under the Palæozoic system, and these wholly disappear at the beginning of the tertiary formation. The *Cephalaspides* and the *Dipterions* appear, and become extinct in the Palæozoic period. The *Celacanthes* and the *Hybodontes* appear—the one in the middle and the other at the close of the Palæozoic period; and become extinct, the first in the middle and the second at the beginning of the Cretaceous era. The *Petalodus* appears and disappears in the coal formations, and so does the *Dictæa* in the Zechstein era. The *Pycnodonts* begin at the base of the Zechstein, and become extinct towards the end of the Tertiary period. The *Squalides* have increased from the middle of the Zechstein till the present day, and the *Rays* from the beginning of the Jurassic system till now. The new families of the *Sclerodermes*, the *Gymnodontes*, the *Lophobranches*, and the *Accipenseres*, spring into existence almost at the same time, to replace the extinct families. The simultaneous occurrence of *five* of the families of the Ctenoids and Cycloids at the very commencement of the Cretaceous formation, and of almost all the other families at the end of it, are singular facts, which, when connected with those already mentioned, stand in direct antagonism to the theory of development, and establish the great truth, which all our geological knowledge confirms, that the Almighty was present in his creative majesty, renewing, by his mighty arm, the races of being which time and the elements had destroyed.

The rise and decline of reptiles is entirely analogous to that of fishes, and equally hostile to the development principle. "If the present species of animals," says Professor Owen, "had resulted from progressive development and transmutation of former species, each class ought now to present its typical characters under their highest recognized conditions of organization. But our review of the characters of fossil reptiles *proves that this is not the case*."* Professor Owen likewise informs us, that the period of reptiles with the highest organization is past, and that the change in their species, genera, and families, has been, upon the whole, *from the complicated to the simple*. He conceives, that reptiles were suddenly introduced on the earth's surface, and that the modifications of structure which characterize the extinct species were originally impressed upon them at their creation, and have been neither derived from improvement of a lower, nor lost by a progressive development into a higher type. Although the opinion of so able and competent a judge does not require confirmation, yet, in a case where anonymous assertion has succeeded in giving currency to error, we are called upon to oppose it by authority as well a sargument. The following striking pas-

* Report on British Fossil Reptiles, in the Rep. Brit. Assoc., 1841, pp. 201, 202.

sage, bearing the impress of Professor Agassiz's name, will give assurance to every well-regulated mind, that the doctrines which we have been condemning have no foundation in nature.

"It is now," says he, "a truth which I consider as proved, that the *ensemble* of organized beings was renewed, not only in the interval of each of the great geological formations, but also at the time of the deposition of each particular member of all the formations. For example, I think I can prove that in the Oolitic formation, at least within the limits of the Swiss Jura, the organic contents of the Lias, those of the Oolitic group properly so called, those of the Oxfordian group, and those of the Portlandian group, as they occur in Switzerland, are as different from each other as the fossils of the Lias from those of the Keuper (variegated marl), or those of the Portlandian beds from those of the Neocomian (green sand system) formation. I also believe very little in the genetic descent of living species from those of the various tertiary layers which have been regarded as identical, but which, in my opinion, are specifically distinct. *I cannot admit the transformation of species from one formation to another.* In advancing these general notions, I do not wish to offer them as inductions drawn from the study of any particular class of animals (of the fishes, for instance), and applied to other classes, *but as the results of direct observation of very considerable collections of fossils of different formations, and belonging to different classes of animals, in the investigation of which I have been specifically engaged for many years*, to assure myself whether the conclusions which I have drawn from the tribe of fishes were applicable to this class only, or whether the same relations existed in the other remains of the animal kingdom."*

From his survey of the organic remains in the different geological eras of the globe, our author calls our attention in two chapters, to *general*, and *particular considerations respecting the origin of the animated tribes*. In the first he strives to establish the *general likelihood* of an organic creation by law; and in the second he inquires, "if science has any facts tending to bring the assumption more nearly home to nature." To the first of these chapters we have already made sufficient reference. We must now deal with the *scientific facts*, which he says *there certainly are* in support of his theory. In the arborescent crystallizations which are seen on the inside of a window in frosty weather, and in the *Arbor Dianæ*, produced by the action of a piece of suspended silver on an amalgam of silver and mercury, dissolved in diluted nitric acid, our author sees the forms of vegetable life, and a *crystallization* precisely resembling a shrub. He finds also vegetable figures, *the ramifications of a tree*, and its *individual leaves*, in the marks produced by positive electricity, while the marks of negative electricity recall the *bulbous or the spreading root*. Hence he concludes it to be *indubitable* that the electric

* Report on the Fossil Fish of the Devonian System. Brit. Assoc. Rep., 1842, pp. 83, 84. The following opinion of the celebrated German physiologist, M. Müller, deserves to be quoted :—" All the phenomena hitherto observed in the animal kingdom seem to prove that the species were originally created distinct, and independent of one another. *There is not a remote possibility* that one species has been produced from another." Cuvier also denounces " the chimerical project of ranging beings in a single series,—a project," he adds, " now renounced by philosophy."

energies are intimately connected with vegetable life, "for germination will not proceed in water charged with negative electricity, while water charged positively greatly favors it, and *a garden sensibly increases in luxuriance when a number of conducting rods are made to terminate in branches* over its beds!" A plant, he says, is the electrical *brush* realized! He maintains that *the fundamental form of organic being is a globule having a new globule forming within itself*, and that *globules can be produced in albumen by electricity!* He is, therefore, of opinion that electricity is the cause of life; and he then inquires if plants and animals have at any time been produced otherwise than in the ordinary way of generation. This, of course, he finds to be the case. A hydatid gives the measles to a domestic pig, while wild pigs are free from them. One moth attacks dressed and not undressed wool. One insect will sip only chocolate, and another chooses only wine and beer; and creatures called *pimelodes cyclopum* frequent only volcanic cavities, so that they must all have had their origin in modern times? But the most potent of all our author's facts, on which he rests as the mainstay of his argument, are the insects which Mr. Crosse and Mr. Weekes are supposed to have brought into existence by galvanism. We need not tell our scientific readers that the celebrated *Acarus Crossii* was not the offspring of galvanism. Professor Schulze of Berlin has set this question to rest by carefully conducted experiments; and our author ought to have been acquainted with the account given of them in Professor Owen's Lectures.

From this *indigesta moles*, this collection of statements, which no man but our author believes, he proceeds to explain in the subsequent section, the *hypothesis of the de-*

velopment of the vegetable and animal kingdoms ; and, with his usual boldness of assertion, and recklessness of scientific truth, he summons to his aid the doctrines of embryology. He avers it to be an *undoubted* fact, " that all animals pass in embryo through phases resembling the general, as well as the particular characters of those of lower grade. . . . . . . Nor is Man himself exempt from this law. His first form is that which is permanent in the *animalcule.* This organization gradually passes through conditions generally resembling a *fish*, a *reptile*, a *bird*, and the *lower mammalia*, before it attains its specific maturity. At one of the last stages of his fœtal career he exhibits an intermaxillary bone which is characteristic of the *perfect ape ;* this is suppressed, and he may then be said to take leave of the *simial* type, and become a *true human creature !*" Sex, too, our author maintains, " is fully ascertained to be a matter of development. All beings are, at one stage of the embryotic process, female, and a certain number of these are afterwards *advanced* to be of the more powerful sex !" From doctrines like these, our author rises to the sublime in his philosophy, and leaves his readers benighted and bewildered at the perilous elevation. He tells us, " that the first step in the creation of life upon this planet *was a chemico-electric operation, by which simple germinal vesicles were produced ;*" that the next step was " *an advance under favor of peculiar conditions, from the simplest forms of being to the next more complicated, and this through the medium of the ordinary process of generation ; and finally, that the simplest and most primitive type, under a law to which that of like production is subordinate, gave birth to the type next above it ; that this again produced the next higher, and so on to the very highest.*"

Conscious that these presumptuous opinions cannot even be rendered probable by any authentic instance of either plants or animals having been thus formed or transmuted, the author admits, that if the doctrine were true, "there may never have been an instance of the origination of life otherwise than by generation, since the commencement of the human species;" and he illustrates this opinion by means of the beautiful chapter in Mr. Babbage's *Ninth Bridgewater Treatise*,* entitled *Argument in favor of Design*, in which Mr. Babbage shows, that the deviation from a law may be the fulfilment of a much more extensive law than that which is supposed to exist. Hence our author infers, that during the historical era, which is but a small portion of the entire age of our globe, the limits of species may have been rigidly adhered to; but still, that this rule may have been interrupted in the past, and may be so in the future.† Now, this reasoning is quite fair, and clearly establishes the conclusion, that though the production of like by like during the era since man's creation may have been invariable, this is no proof that a change may not have taken place before that era, and may not take place in future. We cannot, it is true, tell what changes of law are to appear in the future; but our author has surely committed a radical mistake, and surrendered his argument at discretion, when he says, "We do not

* This remarkable work, distinguished by its profound thought, as well as by its eloquence and beauty of composition, is well worthy of the attention of our readers. The second edition, published in 1838, has been greatly enlarged.

† This illustration from Mr. Babbage's calculating engine has not been fairly dealt with by those who have criticized the work under our notice.

know what may have happened during the ages which preceded its commencement,"—namely, of the historical era. The object of a great part of our author's volume has been to draw proofs from geological history, that a gradual change of species took place, and that an unlike was produced from unlike. We have endeavored to show, that he has not established this proposition, and we venture to go still farther and to assert, that the chronicle of geological events is now so complete, that we do know what has happened in preceding ages; and that if the doctrine of deviation from a single species was correct, we should have found in the bowels of the earth numerous and ample proofs of its truth. To maintain, therefore, an opinion which has not one single fact in its favor,—which stands in direct opposition to all the analogies of nature,—which is repugnant to the best feelings of mankind, and subversive of all their most cherished convictions,—is a fraud committed upon the reason, and an insult cast upon the dignity of our species.

Our limits will not allow us to follow our author continuously through the remaining sections of his work, in which he considers his *Hypothesis in connexion with the Affinities and Geographical Distribution of Animals, and treats of the Early History of Mankind, and the Mental Constitution of Animals*; but we feel ourselves compelled to take special notice of the chapter in his *first* edition, entitled *The Macleay System of Animated Nature*,* in which he gave a full notice of that wild hypothesis, and expressed his highest approbation of it, as furnishing *a owerful additional proof of the hypothesis of organic pro-*

* See Macleay's Horæ Entomologicæ.

gress by virtue of law. When Mr. Macleay, an accomplished naturalist, found that he could not arrange animals in a *linear series* of progressive development, he conceived the idea of placing them in *circular groups.* Each circle was composed of *five* circular groups, and these again of other five inferior groups, till the species were exhausted. Hence it was called the *Quinary* system. Thus the animal kingdom is divided into five divisions—vertebrata, animalcula, radiata, acrita, and mollusca; the mammalia into cheirotheria, feræ, cetacea, glires, and ungulata; and so on. In following out this system, our author finds, that the *crow* is partially invested with the united properties of all other birds, while it is the pre-eminent type of its own order; and that *Man* holds the same place among the *mammalia* that the *crow* does among the *birds!* And as "the corvidæ, our parallel in *Aves*, consist of several distinct genera and subgenera, we may expect to see several varieties of the being Homo! Is our race, then, we ask, but an initial of the grand crowning type?"

It would be an unprofitable task to enter into any examination of the quinary system. The author of The Vestiges, repenting, we hope, of his adhesion to it, and of the wild notions of which he has made it the foundation, has himself condemned it. He has actually omitted from his 4th edition the whole section on the Macleay system; and though he persists in saying that it "possesses a basis in truth," he yet acknowledges that it "has been latterly abandoned by many who at one time embraced it, in consequence of its being found to involve so many difficulties."*

* An admirable exposition of the absurdities of the *Quinary System*, from the pen, we believe, of Dr. Fleming, will be found in the *Quarterly Review*, Vol. xli., p. 318, &c. 1829.

This little incident points out in a striking manner the constitution of our author's mind—a mind without fixed principles, and as ready to abandon an old position as it is willing to assume a new one.

We should not do justice to our readers were we to withhold all reference to the *system of progressive development* of Lamarck,* which, though substantially the same as that of our author, yet greatly surpasses it, in so far as it assigns intelligible causes for those successive changes of species which he endeavors to establish. Like our author, he grants us a DEITY, who communicated to Nature the power of forming all bodies from dead matter, by heat, electricity, and other agents. Small gelatinous bodies were produced in water. Cavities were formed. Subtle fluids were absorbed. Internal motion supervened, and organization and life followed. Concretions incapable of irritability went to form vegetables, and those capable of it—to form animals. These rudimentary plants and animals increased, multiplied by gemmation, and by the *force of circumstances*, assumed various forms, and evolved various systems of organs. The progressive development now took place. The snail, desirous of touching an object, made the effort, and thus were its feelers formed. Birds desirous of perching upon trees, made the effort, and claws were generated. The author of this system, which still lingers on the Continent, was not only an able naturalist, but a zealous and highly esteemed professor in the Great Museum of Natural History in Paris. We have seen and admired this handsome descendant of the Monads; dignified among his highly organized compeers, at the very

* Hist. Nat. des Animaux sans vertebres, 1815, tom. i., p. 384.

time when he was elaborating in his latter days the ingenious speculation which we have been considering.

In his section *on the purposes and general condition of the animated creation*, our author resumes his favorite topic of the development of higher types of humanity than man—of nobler guests, more exalted in intellect and morals—who are to take their place at the perennial banquet of their Maker. If it be true that intellectual and immortal man has passed through all the lowest types of animal life, our author can scarcely doubt the possibility of his apotheosis. If "Cuvier and Newton are," as he states it, "the expansion of a clown," and that clown the expansion of a reptile, why may we not creep upwards to the type of the angel? The experience of the past, however, does not, we fear, encourage us to anticipate so glorious a destiny. Advancing rapidly in our physical condition, and acquiring new powers over matter, our intellectual nature has already reached a type almost superhuman: But no such amelioration has shown itself in our moral being; and it is a problem yet to be solved, what will be the social condition of our globe when man's mental powers have been fully developed, and all the varieties of his race brought into that perilous proximity which will give free scope to the action and reaction of their interests and passions. Looking at man bound under the restraints of law, and professing to be bound by those of religion;—studying him in the dark phases of his avarice and his cruelty, and surveying him in the death field, lifting his murderous arm against his fellow, or marshalled in fierce array against a brother race, what can we hope from him when more powerful elements of his nature are brought into play—when more numerous enemies are drawn within his reach, and more deadly instruments placed in his hand? His descent from the serpent and the tiger—if that be his genealogy; and his participation in all the animal natures through which he has passed—if that be his constitution; will not justify high expectations of his future development; and though we repudiate this pedigree and that organization, we acknowledge the bitter truth, that under the highest type of his civilisation, he bears the guilt of deeds of more savage cruelty and more ferocious revenge than those of a carnivorous age, when the elephant and the rhinoceros contended for some verdant oasis, and hyænas and wolves for some disputed prey.

We confess, however, that we do not anticipate any such deterioration of our species. Knowledge may advance, and piety may decline; religious convulsions and bloody revolutions may afflict ourselves or our children; but ancient seers, whose oracles never lied, have told us that these are but the tornados that are to purify our moral atmosphere—the thunder-clouds that will leave us under a brighter and a bluer sky. That Divine Being who moulds matter to his will, will not leave unrenewed that portion of his own immaterial nature which he has given us; and in the humble step of the schoolmaster, and the firmer tread of the missionary, we may recognize those secondary means by which man is to recover the image which he has lost.

If we have been compelled to animadvert with severity on our author's doctrine of transmutation and development, we fear that we must sound a still louder note of censure in reviewing his section on the *Mental Constitution of Animals*. The tendency, if not the purpose of this essay, is to teach the doctrines of materialism; and the argument is so mixed up with religious sentiment, and so overlaid with orthodox phraseology, that it is eminently calculated to mislead an unwary reader. After characterizing the ordinary opinions respecting the difference between mind and instinct, as "a strange system of confusion and error, which it is imprudent to regard as essential to religion, since *candid* investigations of nature tend to show its untenableness," he tells us, that there is "in reality nothing to prevent our regarding man as specially endowed with an immortal spirit, at the same time that *his ordinary mental manifestations are looked upon as simple phenomena resulting from organization*, those of the lower animals being absolutely the same in character." He maintains that "the grades of mind, like the forms of being, are mere stages of development!"—that "mental action being proved to be under law, passes at once into the category of natural things"—that "its old metaphysical character vanishes in a moment," and that "the *distinction between physical and moral is annulled.*" He teaches that "the brain is an electric apparatus," that "*electricity is almost as metaphysical as ever mind was supposed to be*"—that "mental action may be imponderable and intangible," and that, if it is electric, *it may move at the rate of* 192,000 *miles in a second!* He tells us that the acts of memory are like images resuscitated on sensitive paper by the fumes of mercury,—that "conception and imagination are only intensities of the state of brain in which memory is produced," and that "free will in man is nothing more than a vicissitude in the supremacy of the faculties over each other." These various positions, strongly redolent of materialism, and leading to a godless fatalism, will, we trust, find no response in the minds of any of our readers. They form an appropriate introduction to the praise of phrenology, which our author designates as the "system of mind invented by Gall," and supported "by induction from *a vast number of actual cases.*"

We are very unwilling to meddle with Phrenology, a subject almost tabooed, and fenced with so many sensibilities, male and female, as to enjoy a sort of charmed existence, which, like the polypus, survives in its individual parts after it has been cut to pieces as a whole; but its acceptance by the author of The Vestiges, and its alliance with materialism and other heresies, exhibits it in its real character and tendencies, and compels us to devote a few sentences to its discussion. There is a condition of mind, the result of education and natural temperament, peculiarly open to the reception of novel and easily comprehended doctrines. Its leading feature is its impatience of that slow inductive process by which great truths are established by one mind, and through which they are demonstrated to other minds of similar character, though unequal power; and we need hardly tell our readers, that truths thus established, and thus capable of being communicated with the evidence of demonstration, are the only realities of science. The mould in which Providence has cast the female mind, does not present to us those rough phases of masculine strength which can sound depths, and grasp syllogisms, and cross-examine nature. With such a conformation, we should have lacked its soft and gentle temperament—its quick appreciation of character—and that yielding submission to a stronger nature, with which it is destined to blend. A jury of the Muses could not have administered the impartial justice of Rhadamanthus; nor could a quorum of the Graces have extricated Dædalus from his labyrinth. Hence it is that doctrines such as those of Phrenology and Mesmerism, have collected their followers chiefly from one sex; and if we have rightly gathered the rumors of the day, the most numerous and ardent admirers of The Vestiges of Creation, have perused it in the boudoir and the drawing-room. It would augur ill for the rising generation, if the mothers of England were infected with the errors of Phrenology: it would augur worse were they tainted with Materialism.

Every branch of study that deserves the name of science, has its system of facts and its code of laws; but Phrenology has never yet been able to adduce a single indisputable fact in favor of its doctrines. Its object is to discover a relation between certain intellectual and moral truths and certain physical magnitudes; and yet it does not directly compare those truths with these magnitudes, but with certain other magnitudes, supposed to be similar, and with which the truths in question have no connexion. In making such a comparison, we must be sure of the correctness of what we assume to be truths. The mental or moral phase must be so prominent and unambiguous, that every man can recognize its existence; and the corresponding magnitude must be so distinctly marked, that all men can see it. The feature in the brain must not be inferred from the feature in the external cranium, covered, it may be, with hair, and flesh, and skin, and possibly exaggerated or diminished by some external cause. It must be directly observed in the healthy brain itself; and if the cerebral development corresponds in magnitude with the mental feature, we become possessed of a single fact, half moral and half physical. If this correspondence is invariable in all other cases, we then have one phrenological fact in reference to one portion of the brain, which, if, as we assume, it rests on accurate observation, we can compel every sound mind to believe. But if there be one distinct and unambiguous exception, for which no reasonable cause can be assigned, the whole doctrine must be at once abandoned. Were there a single satellite in the solar system whose motion did not correspond with the inverse law of attraction, even the doctrine of gravity must be rejected. How difficult, then, must it be to determine phrenological facts, and in what storehouse can we expect to find them? Who could venture to record it as a scientific truth, that Voltaire had not, and that Sir Walter Scott had, piety as an element of his mind; and that the brain of the one wanted, while that of the other possessed, the corresponding elevation? Who can testify to us, as a fact, that a murderer possesses a truly murderous disposition, or a thief a truly thievish one? It is only insulated acts, and these generally not the result of habit, but of momentary impulse, of which man ever takes cognizance. It is God alone that can pronounce upon the real condition of the heart and soul, out of which are the issues of life. A true phrenological fact, therefore, which we can force a sound mind to believe, must involve, in one of its aspects, a species of knowledge which it is not in the power of man, and still less within his province, to attain; and in the other, a physical fact, which can be seen only in the brain itself, and which cannot be inferred from any external sign. For such facts, anxious as we have been to find them, we have long sought in vain. We have been compelled, therefore, to regard Phrenology as the twin-sister of Animal

Magnetism; and hanging Phreno-mesmerism as a millstone round their necks, we willingly cast them into the sea.

Entertaining the views which we have now expressed respecting the nature and tendency of the work before us, we regard its publication not only as calculated to sap the foundations of religion and morality, but as eminently injurious to the progress of science. Although, in Scotland, there is not *a single* clergyman either in the establishment, or the Free Church, or any of the Dissenting bodies, who cherishes the slightest hostility to any branch of science, or would in any way obstruct its cultivation, yet England has recently exhibited in one of its Universities, and in several of its clergy, a decided aversion to geological truth, and a pious horror at its dissemination. The work before us cannot fail to strengthen such prejudices wherever they had previously existed, and to create them in minds to which they would never otherwise have found admission. When we find astronomical truths made the basis of dangerous speculations, and every branch of natural history and physiology summoned to the support of materialism, it is scarcely a matter of surprise, that our most liberal and best informed divines should question the value of knowledge that admits of such ingenious, and, we fear, successful misapplication. The popularity of The Vestiges of Creation, and its wide circulation among the highest classes of society in England, cannot be overlooked by the religious community. Its reception indicates the prevalence of an unhealthy system of education, and more than justifies the fears of those who regard education without religion as one of the greatest evils which can be inflicted upon society. It becomes the duty, therefore, of all cultivators of science, but especially of geologists and naturalists, to denounce and expose that system of scientific error which is now maintained by the enemies of their faith. Nor is it less the duty of the Church and the State to guard our educational institutions—our schools, as well as our universities—against the admission of teachers who, in connexion with the grand truths of science—the language in which God addresses himself to the reason of his creatures—may instil those fatal lessons of materialism and natural law, which expel the Almighty from the universe he has made, and silence the articulate eloquence of his works.

The connexion which exists between the great truths of geology and natural history, and the evidences of revealed religion, and the prevalence of unsound opinions on these subjects, have pointed out the necessity of giving such an education to ministers of the Gospel, as will enable them to understand and expose such errors. We observe in the proceedings of the General Assembly of the Free Church of Scotland, that it is in their contemplation to establish a chair in connexion with their Theological College, the object of which is to give such a complete course of geology and natural history, that the student will find himself armed at all points not only in combating the new and infidel arguments which modern science has been arraying against religion, but in expounding those numerous portions of Scripture which are peculiarly associated with natural phenomena, and with the climatology and natural history of the Holy Land. A clergyman thus furnished with the stores of natural science, in its practical as well as its theoretical bearings, will become an useful auxiliary to the various classes of his flock with whom he daily converses, and the country gentleman, as well as the farmer, the miner, and the fisherman, may draw new supplies of secular and even professional knowledge, from him whom God has made their spiritual instructor. Nor will such an education be less useful to the missionary, whether his lot is to be cast among a barbarous or a civilized people. His arguments, drawn from science, will command respect amid an instructed though irreligious community; while his knowledge of the useful arts, as well as of natural phenomena, will open in the savage mind an easier path for the entrance of revealed truth. Nor will his own countrymen be without an interest in the career of such an intelligent instructor. His increased respectability and success among his people will communicate a new zeal to the pious body which he represents; while his general scientific researches, and his investigations of the minerals, mines, and products of the country which he visits, will secure the favorable co-operation of classes not religious, and may eventually draw their attention to the higher objects of missionary enterprise.*

At no preceding period of our history was it more necessary than it is at present to maintain the connexion of religious with scientific truth. Between such elements there can be no antagonism. That truth ceases to be religious which stands opposed to a truth in nature, whether

* We understand that, at the request of several clergymen and other persons in Aberdeen, our most distinguished philosophical naturalist, the Rev. Dr. Fleming, of the University there, who has so often stood forward as the champion of Revelation against perverted Science, has been preparing a short course of Lectures on the subjects above referred to, which we trust he will afterwards publish. We earnestly hope that the Free Church will lose no time in establishing a Chair for the same purpose, in connexion with their Theological College in Edinburgh.

it be a phenomenon which we observe, or a result which we prove. Religious truth, thus insulated and pure, will yet be, as it ever ought to have been, the controlling principle of the political, as well as of the moral world—the central sun to which reason and conscience must necessarily gravitate. The star of science can shine but in its reflected light. The noblest lyre is struck in vain unless it vibrates to immortal strains. Even social life, in its brightest phases, demands the balm and the stimulus of things eternal. Aiming at still higher ends, religious truth has begun to irradiate the judicial and the legislative mind—traversing, with electric life, the wire-wove institutions of man—rousing in its transit the northern serf and the southern slave—guarding the poor man's heritage, and staying the strong man's arm—clinging to the great social questions now agitating the world—and destined to keep its hold till our common nature shall achieve and enjoy its common rights.

While reflecting on the opinions so openly avowed, and so insidiously taught in the work before us, and recollecting the perplexities which beset the young inquirer when questions associated with omnipotence of power, infinity of space, and eternity of time, are submitted to the scrutiny of his reason, we have felt anxious to discover that peculiar character of mind, and that train of thought, under the influence of which one man has been left in skepticism, and another conducted to truth. When the idea of an uncreated and underived spirit first fixes itself in the mind, and becomes the origin of speculations respecting our responsibilities and destiny, the attributes of omnipotence and omniscience, the necessary postulates in our reasoning, lead us forward to the axiomatic truths of fore-knowledge and predestination, which so generally entrench themselves in the ardent mind. Thus drawn into a track which it cannot quit, and spell-bound amid great truths which it cannot fathom, the mind shrinks from a pursuit in which no resting-place can be found. On one side it descries NATURE and CHANCE seated on their sackcloth throne—on the other, the grisly spectre of FATALISM moulding man's lot, and measuring the thread of his existence. From this dilemma, the inquirer can only escape by retracing his steps, and acknowledging the humbling fact, that he has been occupied with ideas beyond his grasp, and seeking in vain that spiritual thread, more to be coveted than that of Ariadne, which could alone extricate him from his labyrinth. The cardinal error which this mode of inquiry involves, is that of viewing the Creator chiefly in reference to the universe of matter, and dissociated, as it were, from the living beings he has made. The author of The Vestiges, as we have seen, regards it as lowering God, and detracting from his foresight, to assimilate his mode of acting to "that of the ordinary proceedings of mankind." But the very opposite opinion appears to us to be true. The only *sure* mode of acquiring sound ideas of our relation to the Creator is to begin with the study of ourselves, and to view God as a Father and Friend, dealing with us in precisely the same way as we would deal with others over whom we exercise authority. Conscience, that infallible Mentor "that sticketh closer than a brother," tells us that we are responsible beings; and in the domestic, as well as the social circle, we speedily feel the discipline and learn the lesson of rewards and punishments. The law written in man's heart points to the past as pregnant with events which may affect the future ; and in the earnestness of his aspirations, and the activity of his search, he is gradually led to the mysterious history of his race. He learns, that on tables of stone have been engraven the *same law* to which his heart responded ;—that when all were dead, one died for all ; and in the contemplation of the great sacrifice, he obtains a solution of the interesting problem of his individual destiny. The Sacred Record which is now his guide, speaks to him of fore-knowledge and predestination, while, in perfect consistency, it records the ministration of descending spirits, and the holier communings of God with man. The Divine decrees no longer perplex him. They transcend, indeed, his Reason—but that Reason, the faithful interpreter of Conscience, does not falter in proclaiming the Freedom of his Will, and the Responsibility of his Actions.

In the brief analysis we have given of Geological History, it was our chief object to controvert the theory of development as deduced from the order of succession in which animal and vegetable remains are found in strata of different ages; and in the performance of such a task it was impossible to give our readers any satisfactory view of the actual progress of creation. Without such a view, however, our duty would be ill discharged ; and though the task, if rightly performed, would require a volume, we may yet within our limited space trace with a rapid pen that mysterious chronicle which records the physical history of the earth.

It is not within our province to inquire by what process, and in what condition the Almighty brought matter into existence—what the space was which it occupied, or what the forms were which it assumed. Of such things we know nothing. In the depths of primeval time, the globe we inhabit may have enjoyed a planetary existence, wheeling along its ethereal railway without a breathing passenger to count its periods, and without a living plant to measure the day by its opening and closing blossoms, or to mark the rolling seasons by the yearly increments of its stem. Or it may have been the theatre on which vast cycles of animal and vegetable life have been run—now its birth-place, and now its grave. But we have no data to guide us in our conjectures, and even imagination fails us if we call it to our aid. Whatever may have been, had ceased to be at the commencement of our history, when the primary rocks, forming the molten nucleus of the globe, were first exposed to the action of the elements. In these primary rocks, consisting of granite, basalt, green stone and porphyry, not a trace of animal or vegetable remains is to be found, and hence we learn that there was a time when neither plants nor animals existed on our globe. That these primary rocks have been melted by heat, and have in many places been elevated into hills, and ejected in various ways by internal forces, are facts now admitted by every geologist. When the rugged surface of the earth, thus formed, was exposed to the action of the elements, now broken into fragments, by mechanical forces, now abraded by the descent of these fragments, the detritus would be washed down into the bottom of the sea, and the strata thus deposited, when indurated by the internal heat of the earth, would form the derivative or metamorphic strata of geologists, consisting of beds of gneiss, and various kinds of crystalline slates, containing hornblende, mica, and clay. These strata are many miles thick, and their accumulation must have been the work of many ages. In certain beds of gneiss, and in many of the slate strata, we find the first traces of vegetable life. Algæ and fuci, probably the earliest food of animals, were found prepared for their use. In the strata nearest to these we find a few shells of the genus producta, though it is highly probable that medusæ and other animals of a fleshy nature may have existed at the same time.

In the grauwacké or transition series, consisting of conglomerate rocks and slaty sandstones and limestones, numerous remains of plants and animals occur. The conglomerate rocks exhibited in their rounded pebbles the action of water in rapid motion, and the slates and shales were obviously deposited in the state of mud or sand at the bottom of the sea. Fishes are the only vertebrated animals which these rocks contain. Many genera of the molluscs, some of which are extinct, and others still exist, also occur. In the division of articulata, we have numerous species of trilobites, most of which are extinct, and among the *Radiata*, the *Crinoidea,* or lily-shaped animals of the fossil corallines, are the most interesting. The plants in the inferior rocks of this series are chiefly marine ; but in the superincumbent beds of coal, we find the most splendid assemblage of plants with forms and characters now unknown, and along with these, beds of rich iron ore, with lime in its neighborhood, to give its aid in separating the metal from its ore.

In the next cycle of this strange history, we find numerous beds of rock-salt, and numerous salt springs, occurring for the first time. Fossils belonging to the four great divisions of the animal kingdom present themselves during this period ; but those of the terrestrial mammalia are few and insignificant, being limited to two or three marsupial animals allied to the opossums. The aristocrats of the land, as well as the sea, were now the gigantic Saurian reptiles, some restricted to the ocean, others swarming on the margin of lakes and rivers ;—some enjoying the rank luxuriance of tropical jungles, while others mounted also into the air like the fiend of the poet—

> "That swims, or sinks, or wades, or creeps, or flies."

In this age of reptile ascendency, the species were peculiarly fitted for the occupancy of a globe, while preparing, by the tumult of the elements, for a higher order of beings. Their right of possession was not disputed either by the carnivorous or the lacustrine mammalia. The Saurians reigned alone in lizard majesty, the types of new forms of being, to which there had been no approximation, and which were destined to disappear amid the future revolutions of our globe. Of these reptiles, one of the most remarkable is the Ichthyosaurus, or fish lizard. According to Professor Owen, it must have presented the general external figure of a huge predatory abdominal fish, with a larger tail and smaller caudal fin than usual, and covered with a smooth or finely wrinkled skin. It had four broad feet or paddles, the posterior pair being of the same size as the anterior pair ; and Professor Owen is of opinion that the anterior paddles might be subservient to locomotion, not only in the water but on land, and that when applied to the resisting soil, they might re-act with due force upon the trunk. Supposing the animal to have been oviparous, he conceives that, like the crocodile, it might have come on shore to sleep, or to deposit its eggs.

In the Ichthyosaurus platyodon, whose length must have exceeded *thirty feet*, the cavity for the eyeball is no less than *fourteen inches* in its larger diameter, and on the front of this cavity there are seventeen sclerotic plates ranged round a certain aperture, like the scales of an artichoke.*

One of the most singular facts in the history of these reptiles, is the existence of the half-digested remains of the fishes and reptiles which they had devoured; and throughout the strata in which their skeletons are entombed, Dr. Buckland has discovered their petrified fæces, often in such a perfect state as to indicate, not merely the food of the animal, but even the dimensions, form and structure of its stomach, and intestinal canal. These fæcal remains resemble oblong pebbles, about 3 inches long and 1½ in

* Professor Owen, in his report on *British* Fossil Reptiles, divides the whole class of reptiles into nine orders,—1. Enaliosauria, including the genera *Plesiosaurus*, with 16 British species; *Ichthyosaurus*, with 10 species; and *Pliosaurus*, with 2 species. 2. Crocodilia, including the genera *Teleosaurus*, 3 species; the *Cetiosaurus*, 4 species; the *Steneosaurus*, 1 species; the *Streptospondylus*, 2 species; and the *Suchosaurus*, *Crocodilus*, *Geniopholis*, *Poikilopleuron*, each 1 species. 3. Dinosauria, with 3 genera. *Megalosaurus*, *Thylæosaurus*, and *Iguanodon*, each 1 species. 4, Lacertilia, including 8 genera, *Palæosaurus* and *Lacerta*, each 2 species; *Mosasaurus*, *Leiodon*, *Raphiosaurus*, *Rhynchosaurus*, *Thecodontosaurus*, and *Cladiodon*, each 1 species. 5. Pterosauria, with one genus, the *Pterodactylus*, 2 species. 6. Sauria incertæ sedis, including 2 genera, *Polyptichodon* and *Rysosteus*, each with 1 species. 7. Chelonia, including 6 genera, *Testudo*, *Tretosternon*, *Trianyx*, each 1 species; *Emys* and *Platemys*, each 3 species; and *Chelone*, 10 species. 8. Ophidia, with 1 genus, *Palæophis*, 1 species. 9. Batrachia, with 1 genus, *Labyrinthodon*, 5 species. See *Brit. Assoc. Rep.*, 1837, p. 126; and 1841, p. 189, &c.

average diameter. Some of them exhibit the gigantic calibre of the thirty feet reptile, while others are flat and amorphous, either from their original fluid state or from superincumbent pressure. They have commonly three coils, and contain the scales and undecomposed teeth, and bones of the fishes which had been devoured.

Not less wonderful in its character and structure is the Plesiosaurus, another genus of the Enaliosaurian order, discovered in 1823, and established by Sir Henry de la Beche and Mr. Conybeare. Cuvier has pronounced it to be the most monstrous of all the inhabitants of a former world, uniting the teeth of a crocodile to the head of the lizard, having a neck of enormous length, equal to the body and tail together, with thirty-five vertebræ, resembling the body of a serpent; and combining with the trunk and tail of an ordinary quadruped the ribs of a chameleon and the body of a whale. It has four paddles, like the Ichthyosaurus, and seems to have lived in shoal water, occasionally visiting the shore. Cuvier supposes it to have had the power of changing the color of its skin; and hence it may have been a sort of submarine chameleon.

The great animal of Maestricht, as it was called, the gigantic Mosasaurus, was discovered near that city in 1780. It was a *marine* reptile, allied to the Monitors or lizards, and yet it vastly exceeds, in its dimensions, that race of beings, of which there is not existing, at this present moment, a single species that could live in the sea. It has 133 vertebræ, and instead of legs, four paddles like the whale.

But of all the fossil animals the *Pterosaurians*, or flying lizards, are the most extraordinary. Externally, they are like our bats and vampires, with the head and neck of a bird, the wings of the bat, and a body and tail approximating to those of quadrupeds. Their eyes were of enormous size, probably to enable them to fly in the dark; their wings had projecting claws by which they might creep or climb, and they seem also to have had the power of swimming like the vampire bat of Benin.

In the train of these extraordinary beings follow the *Megalosaurus* and the *Iguanodon*—the first an enormous gigantic reptile about 40 or 50 feet long, and uniting the structures of the crocodile and monitor, and the second a still more gigantic lizard, whose length has been computed to be 70 feet, the length of its body 52½ feet, and the circumference of its body 14½ feet! although the living iguana, to which it is allied, is never found of a greater size than five feet.

Such were the denizens of the earth in that early age which preceded the formation of the secondary strata. Without natural descent, they came fresh from the hand of their Maker, adapted by his infinite wisdom to inhabit the muddy lakes and estuaries of a globe not yet fitted for other forms of life; and when the earth was ready for the reception of quadrupeds, the gigantic lizards disappeared, and the Almighty again displayed his creative power in races of living beings not less extraordinary than those which had perished. The most interesting examples of this new creation are the gigantic mammalia called the *Dinotherium* and the *Megatherium*. The first of these animals was the largest of the terrestrial mammalia. The length of the largest species has been computed to be 18 feet. The form of its shoulder-blade, resembling that of a mole, indicates a peculiar adaptation of the foreleg to the operation of digging, and this indication is corroborated by the structure of the lower jaw, which is four feet long, and carries at its extremity two enormous tusks, which, combining the functions of the pickaxe and the saw, Dr. Buckland regards as instruments for raking and grubbing up the roots of large aquatic vegetables.

In its character of a huge, herbivorous, and aquatic quadruped, Dr. Buckland recognizes adaptations to the lacustrine condition of the earth during the tertiary periods to which the existence of such animals has been confined. No less interesting is the *Megatherium*—a gigantic animal, surpassing in bulk the largest rhinoceros, and approximating to the modern sloth, armadillo or chlamyphorus; the first residing upon trees, and the two last burrowing for food and shelter in the sand. It is cased in a coat of armor. Its haunches are about five feet wide, its body twelve feet long and eight high, its feet a yard long, and its huge tail is clad in armor. "His entire frame," as Dr. Buckland states, "was an apparatus of colossal mechanism; strong, and ponderous in proportion as his work was heavy, and calculated to be the vehicle of life and enjoyment to a gigantic race of quadrupeds." Both these extraordinary animals, the *dinotherium* and the *megatherium*, along with many others of the same periods, exist only in their fossil remains, exhibiting the infinite skill and variety of contrivance which distinguish all the works of creation. Did our limits permit it, we should willingly pursue these enticing details, and describe the various other remains of carnivorous animals which swarmed in the temperate and tropical regions of the globe in the cycle which immediately preceded our own. These animals gradually approached to a resemblance with those which at present exist, though several of them, like more ancient races, are now extinct. The lion, the tiger, and the hyæna, ranged through our woods and jungles; gigantic birds of "fearful magnitude," and wingless, stalked over our plains, and still more gigantic tortoises, equalling the elephant in size, crawled upon our shores. The *Dinornis*,* a bird one-third larger than the African ostrich, has been resuscitated, by Professor Owen, from bones collected by the Rev. Mr. Williams from the alluvial mud in Poverty Bay, New Zealand; and there is some reason to believe that it may have existed in our own day, though the footprints of wingless birds, of the same size and character, have been found upon the new red sandstone of Connecticut and Massachusetts. No less remarkable is the colossal fossil *Tortoise*† of the Sivalick Hills, recently discovered by Dr. Falconer and Captain Cautley, in strata supposed to be of the newer tertiary period. This enormous animal must have been eighteen feet long, and upwards of seven feet high—a fit representative of the mythological tortoise which, according to the Indian cosmogony, supported the globe.

In the formations which immediately precede the era of man, various animals, similar to those of our own age, have been discovered. Huge waves seem to have swept over the earth, moulding and grooving its surface, transporting huge masses of gravel and clay, and carrying along with them the enormous boulders which stood in their way. Gigantic blocks of granite, carried either by floods, or icebergs, or glaciers, were swept from their native beds;

* From δεινος, *fearfully great*, and ορνις, a bird. A leg bone of this bird is 2 feet 4½ inches, and a thigh bone 4 inches long, and 7½ in circumference.

† The *Colossochelis Atlas* of Dr. Falconer and Captain Cautley.

and there is reason to believe that it was at this period that sea-beaches were raised, or lakes emptied, by those subterranean forces which have produced such powerful effects in different parts of the earth.

In the diluvian matter thus scattered over the globe, the bones of extinct and living species are found in fragments, along with portions of fresh-water shells and vegetable remains; but neither in these, nor in the more ancient cemeteries of primeval times, is the least vestige of man to be found. No tablets of bronze, nor obelisks of granite, record his deeds—no work of human skill proves that he lived—no fragment of his bones indicates that he died. The earth was trodden by more gigantic footsteps than his, and mightier carcases strewed the battle-field of the carnivorous age. The chronicles of the primeval world present us with no other spoils but the skeletons of its irrational denizens, and the plants and forests which fed and sheltered them. Governed by a ferocious population, its political economy must have presented singular phases. When instinct drew up the statute-book, and law and equity were its oracular responses, justice must have been quickly, and impartially and cheaply administered. When there was no gold to bribe, and no conscience to give in exchange for office, a four-footed Premier must have been tolerably just, if his nature prevented him from being wise; and when the amount of killed and wounded in battle depended on what an enemy could swallow and carry off, a Commander-in-chief on all-fours could not have won his baton by unnecessary bloodshed. The government of brutes must have been stable before man disturbed it—its police active, and its executioners merciful. Dumb nature was never stretched on the rack nor broken on the wheel.

It was never burnt by faggots—nor tortured by poison—nor immured in dungeons—nor suffocated in caverns. Reason had not then ennobled animal life—and animal life was not then degraded by cruelty.

After the reign of Instinct had terminated, that of Reason began. When Inorganic Nature was prepared for its reception, Organic life was ready to possess it. No sooner had the sea and the dry land taken their allotted place, than God created the green herb for the support of animals, and in due time all nature moved with the various forms of living things. Man was created in God's image, and woman was given as his helpmatė. The dust of the earth was his substance, and his living soul was the breath of the Almighty. Tempted to disobey, he sinned and fell. His progeny became more wicked than himself, and a mighty deluge was sent to destroy it. The waters rose above the highest mountains, cutting off man and beast; and when their commission of death was executed, they returned in quiet to their native fountains. The solid pavement of the globe was neither upheaved nor rent by their receding tide, nor were the cemeteries of the primeval dead broken up by their reflux. The myriads of living beings, the cattle, and the beast, and the fowl, and every creeping thing that perished in the flood, were entombed in the bottom of the ocean, along with the thousands of human beings that suffered the penalty of their crimes. Since that catastrophe, 4000 years have passed away; earthquakes and volcanoes, floods and tempests have changed the face of nature, and plants and animals of every age have been deposited at the bottom of the sea. The superincumbent pressure of its waters, and the central heat beneath, may have already prepared these submarine deposits for the surface of new continents; and in our own, or in some future cycle, they may yet give up their dead, and exhibit to some inquiring pilgrim the history of his race written on stone. How interesting would be the disinterment of the antediluvian victims! How instructive to study the ethnology of the globe in races buried and embalmed! If the siliceous caskets of imprisoned animalcules have mocked the destructive agency of time, the warrior may yet be found in his shroud of mail; and if the tender leaves and twigs of plants have left their impress on the solid slab, the Hierarch may yet be resuscitated with his surplice and his crosier, and the Monarch may reappear with his sceptre and his crown.