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 the mammalia. Confining our attention, in the meantime, to the animal kingdom—it does not appear that this gradation passes along one line, on which every form of animal life can be, as it were, strung; there may be branching or double lines at some places; or the whole may be in a circle composed of minor circles, as has been recently suggested. But still it is incontestable that there are general appearances of a scale beginning

with the simple and advancing to the complicated. The animal kingdom was divided by Cuvier into four sub-kingdoms, or divisions, and these exhibit an unequivocal gradation in the order in which they are here enumerated:—Radiata, (polypes, &c.;) mollusca, (pulpy animals;) articulata, (jointed animals;) vertebrata, (animals with internal skeleton.) The gradation can, in like manner, be clearly traced in the *classes* into which the sub-kingdoms are subdivided, as, for instance, when we take those of the vertebrata in this order —reptiles, fishes, 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, shews 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. Such are called rudimentary organs. With this class of phenomena are to be ranked the useless mammæ of the male human being, and the unrequired process of bone in the male opossum, which is needed in the female for supporting her pouch. Such curious features are most conspicuous in animals which form links between various classes.

As formerly stated, the marsupials, standing at the bottom of the mammalia, shew 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 struphionidæ (birds of

the ostrich type) 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 ornithorynchus 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 the bones of a caudal extremity exist in an undeveloped state in the *os coccygis* of the human subject. 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 all

* Daubenton established the rule, that all the viviparous quadrupeds have seven vertebræ in the neck.

other quadrupeds, with almost the solitary exception of the bear, 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 pterodactyle, 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.

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 has 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 a metamorphose of a leaf.

These facts clearly shew 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 irreconcilable 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 the laws of organic development. It is only in recent times that physiologists have observed that each animal passes, in the course of its germinal history, through a series of changes resembling the *permanent forms* of the various orders of animals inferior to it in the scale. Thus, for instance, an insect, standing at the head of the articulated animals, is, in the larva state, a true annelid, or worm, the annelida being the lowest in the same class. The embryo of a crab resembles the perfect animal of the inferior order myriapoda, and passes through all the forms

of transition which characterize the intermediate tribes of crustacea. The frog, 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, the spinal marrow better marked; it is now the brain of a reptile. The change continues; by a singular motion, certain parts (*corpora quadragemina*) 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.

Another illustration here presents itself with the force of the most powerful and interesting analogy. Some of the earliest fishes of our globe, those of the Old Red Sandstone, present, as we have seen, certain peculiarities, as the one-sided tail

* Lord's Popular Physiology. It is to Tiedemann that we chiefly owe these curious observations; but ground was first broken in this branch of physiological science by Dr. John Hunter.

and an inferior position of the mouth. No fishes of the present day, in a mature state, are so characterized; but some, at a certain stage of their existence, have such peculiarities. It occurred to a geologist to inquire if the fish which existed before the Old Red Sandstone had any peculiarities assimilating them to the fœtal condition of existing fish, and particularly if they were small. The first which occur before the time of the Old Red Sandstone, are those described by Mr. Murchison, as belonging to the Upper Ludlow Rocks; *they are all rather small.* Still older are those detected by Mr. Philips, in the Aymestry Limestone, being the most ancient of the class which have as yet been discovered; *these are so extremely minute as only to be distinguishable by the microscope.* Here we apparently have very clear demonstrations of a parity, or rather identity, of laws presiding over the development of the animated tribes on the face of the earth, and that of the individual in embryo.

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 the faith of mankind.

The whole train of animated beings, from the simplest 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 favour 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 perfect 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 electric agency will produce—though not perhaps usher into full life—in albumen, one of those compound elements of animal bodies, of which another (urea) has been made by artificial means. 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*

* 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 archetypes, 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."

simple germinal vesicles were produced. This is so much, but what were the next steps? Let a common vegetable infusion help us to an answer. There, as we have seen, simple forms are produced at first, but afterwards they become more complicated, until at length the life-producing powers of the infusion are exhausted. Are we to presume that, in this case, the simple engender the complicated? Undoubtedly, this would not be more wonderful as a natural process than one which we never think of wondering at, because familiar to us —namely, that in the gestation of the mammals, the animalcule-like ovum of a few days is the parent, in a sense, of the chick-like form of a few weeks, and that in all the subsequent stages—fish, reptile, &c.—the one may, with scarcely a metaphor, be said to be the progenitor of the other. I suggest, then, as an hypothesis already 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 favour 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, &c. They are called

"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

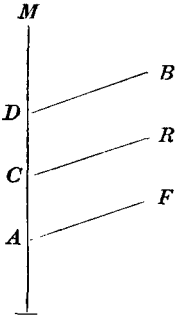
triangular numbers, because a number of points corresponding to any term can always be placed in the form of a triangle; for instance—

100,010,002 at the 100,000,002nd 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 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 shews 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 *straightforward 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 shewn that there must be some such influence within the range of natural things.

To this conclusion it must be greatly conducive that the law of organic development is still daily seen at work to certain effects, only somewhat short of a transition from species to species. Sex we have seen to be a matter of development. There is an instance, in a humble department of the animal world, of arrangements being made by the animals themselves for adjusting this law 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 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 worker in the larva state, that, when it 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 embry-

otic 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 altogether 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 labour," 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

* Kirby and Spence.

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 imago 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 is at the same time to 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 develop-

ment, 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 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 civilization also 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 favourable 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. 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 imagine an access of favourable conditions sufficient to reverse the phenomenon, and make a fish mother develop a reptile heart, or a reptile mother develop 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 ornithorynchus, or might give the progeny of an ornithorynchus 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 are, nevertheless, some facts which have chanced to be reported without any reference to this hypothesis, and which it seems extremely difficult to explain satisfactorily upon any other. One of these has already been mentioned—a progression in the forms of the animalcules in a vegetable infusion from the simpler to the more complicated, a sort of microcosm, representing the whole history of the progress of animal creation as displayed by geology. Another is given in the history of the Acarus Crossii, which may be only the ultimate stage of a series of similar transformations effected by electric agency in the solution subjected to it. There is, however, one direct case of a translation of species, which has been presented with a respect-

able 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 recognised 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, when burnt down, being succeeded (without planting) by other kinds, may yet be found most explicable, as this is, upon the hypothesis of a progression of species which takes place under certain favouring 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,

* See an article by Dr. Weissenborn, in the New Series of "Magazine of Natural History," vol. i. p. 574.

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.

The idea, then, which I form of the progress of organic life upon the globe—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. Whether the whole of any species was at once translated forward, or only a few parents were employed to give birth to the new type, must remain undetermined; but, supposing that the former was the case, we must presume that the moves along the line or lines were simultaneous, so that the place vacated by one species was immediately taken by the next in succession, and so on back to the first, for the supply of which the formation of a new germinal vesicle out of inorganic matter was alone necessary. Thus, the production of new forms, as shewn 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, for in each of them we have to trace the effect of an Almighty Will which had arranged the whole in such harmony with external physical circumstances, that both were developed in parallel steps—and probably this development upon our planet is but a sample of what has taken place, through the same cause, in all the other countless theatres of being which are suspended in space.

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 shews 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.* This scale, it may be remarked, was not made up with a view to support such an hypothesis as the present, nor with any apparent 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

* "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,

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 favour 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.

of the brains of each of the tribes stated; consisting as it does, about the second month, chiefly of the mesial parts of the cerebellum, the corpora quadrigemina, thalami optici, rudiments of the hemispheres of the cerebrum and corpora striata; and receiving in succession, at the third, the rudiments of the lobes of the cerebrum; at the fourth, those of the fornix, corpus callosum, and septum lucidum; at the fifth, the tubor annulare, and so forth; the posterior lobes of the cerebrum increasing from before to behind, so as to cover the thalami optici about the fourth month, the corpora quadrigemina about the sixth, and the cerebellum about the seventh. This, then, is another example of an increase in the complexity of an organ succeeding its centralization; as if Nature, having first piled up her materials in one spot, delighted afterwards to employ her abundance, not so much in enlarging old parts as in forming new ones upon the old foundations, and thus adding to the complexity of a fabric, the rudimental structure of which is in all animals equally simple."—*Fletcher's Rudiments of Physiology.*

SCALE OF ANIMAL KINGDOM. (The numbers indicate orders:)		ORDER OF ANIMALS IN
RADIATA (1, 2, 3, 4, 5)		Zoophyta Polypiaria
MOLLUSCA (6, 7, 8, 9, 10, 11)		Conchifera Double-shelled Mollusks
ARTICULATA	*Annelida* (12, 13, 14)	Crustacea
	Crustacea (15, 16, 17, 18, 19, 20)	Annelida
	Arachnida & *Insecta* (21—31)	Crustaceous Fishes
VERTEBRATA	*Pisces* (32, 33, 34, 35, 36)	True Fishes
	Reptilia (37, 38, 39, 40)	Piscine Saurians (ichthyosaurus, & Pterodactyles Crocodiles Tortoises Batrachians
	Aves (41, 42, 43, 44, 45, 46)	Birds
	Mammalia 47 Cetacea 48 Ruminantia	(Bone of a marsupial animal)
	Mammalia 49 Pachydermata	Pachydermata (tapirs, horses, &c.
	Mammalia 50 Edentata 51 Rodentia	Rodentia (dormouse, squirrel, &c.
	Mammalia 52 Marsupialia	Marsupialia (racoon, opossum, &c
	Mammalia 53 Amphibia 54 Digitigrada	Digitigrada (genette, fox, wolf, &c
	Mammalia 55 Plantigrada	Plantigrada (bear) Cetacea (lamantins, seals, whales)
	Mammalia 56 Insectivora	Edentata (sloths, &c.) Ruminantia (oxen, deer, &c.)
	Mammalia 57 Cheiroptera 58 Quadrumana	Quadrumana (monkeys)
	Mammalia 59 Bimana	Bimana (man)

ASCENDING SERIES OF ROCKS.	FŒTAL HUMAN BRAIN RESEMBLES, IN
1 Gneiss and Mica Slate system	
2 Clay Slate and Grawacke system	
3 Silurian system	1st month, that of an avertebrated animal;
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	
12 Superficial deposits	8th month, that of the quadrumana; 9th month, attains full human character.

The reader has seen physical conditions several times referred to, as to be presumed to have in some way governed the progress of the development of the zoological circle. 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 probably 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 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, inhabiting the subterraneous waters of Carniola, and which never acquires perfect lungs so as to become a land animal, is presumed to be an example of arrested development, from the same 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

* 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.

species to species which we have seen, 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 completion 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 an hypothesis of organic progress which deservedly incurred much ridicule, although it contained a glimmer of the truth. He surmised, and endeavoured, with a great deal of ingenuity, to prove, that one being advanced in the course of generations 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 so inadequate to account for the rise of the organic kingdoms, that we only can place it with pity among the follies of the wise. 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 shew 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. The actuality of such a conception I hold to be strikingly demonstrated by the discoveries of Macleay, Vigors, and Swainson, with re-

spect to the affinities and analogies of animal (and by implication vegetable) organisms.* Such a regularity in the *structure*, as we may call it, of the *classification of animals*, as is shewn in their systems, is totally irreconcilable with the idea of form going on to form merely as needs and wishes in the animals themselves dictated. Had such been the case, all would have been irregular, as things arbitrary necessarily are. But, lo, the whole plan of being is as symmetrical as the plan of a house, or the laying out of an old-fashioned garden! This must needs have been devised and arranged for beforehand. And what a preconception or forethought have we here! 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 required to be taken into account, and thousands of animals were to be formed suitable in organization and mental character for the concerns they were to have with

* These affinities and analogies are explained in the next chapter.

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 develop a bony net-work instead; there to arrange for a bronchial apparatus, to last only for a certain brief time; and all these animals were to be schemed out, each as a part of a great range, which was on the whole to be rigidly regular: 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. Now the idea as to the progress of organic creation, if we become satisfied of its truth, ought to be received precisely in this spirit. 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 the principle of 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 Almighty 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? Let us regard them in a proper spirit, as parts of the grand plan, instead of contemplating them in the light of frivolous prejudices, and we shall be altogether at a loss to see how there should be any degradation in the idea of our race having been genealogically connected with them.