SOME REMARKS ON MR. DARWIN'S THEORY.

By Frederick Wollaston Hutton, F.G.S.

> I said that "all the years invent;
> Each month is various to present
> The world with some development."—*Tennyson.*

Although most of my readers will be perfectly acquainted with the theory proposed by Mr. Darwin to account for the various forms of life that we see on the globe, yet, for the sake of clearness, I will briefly enunciate it.

Mr. Darwin first shows that individuals of the same species vary one with another.

He then shows that, owing to the rapid increase of animal and vegetable life, by which many more are born each year than can possibly survive, there is a continual warfare going on among them for food and other necessaries. This he calls the "struggle for life."

He then shows that if any animal or plant should have, by variation, any organ or property so modified as to give it some advantage over its fellows in the struggle for life, it will, as a general rule, live longer and produce more offspring; and these offspring will have a tendency to inherit the organ or property modified in the same manner: but if in one of these offspring the organ should be still further modified, it will give him a like advantage over his brethren, and his offspring again will have a tendency to reproduce the organ in its more modified state; and so on. This he calls "Natural Selection."

Mr. Darwin thinks that this, together with the minor causes of habit, use and disuse, climate, &c., are sufficient to account for all the various forms of organic life, by the gradual transmutation of one species into another.

As all naturalists allow that species vary, it seems that the difference in the opinions of some of them on this subject arise on the question of limits. Are these varieties of species limited, or are they unlimited?

A limiting value of a variable is a quantity to which the variable may approach ever so near, but never reach; if therefore it can be shown that there is a limiting value to the variation of species, Mr. Darwin's theory could not be extended beyond that limit. At present no one has been able to assign to it any limits at all; in fact it will be a very difficult thing to do so, for it would be of no use to prove that any one organ of a particular animal could not change into the rare organ of another particular animal, as it is never supposed that the higher form of life has passed through every lower form; for the same reason that the sap which nourishes one leaf of a tree has not passed through all the other leaves.

The way this question has generally been argued is, not by trying to define any one strict limit beyond which variation cannot pass, but

by trying to show that there are reasons for believing that a limit does exist somewhere. The following are the most important ones that have been brought forward to this effect.

1. All varieties made by man, if left to themselves, show a tendency to revert to the original forms; while natural species do not.
2. All varieties made by man interbreed freely, while natural species do not.
3. Species remain constant for immense periods of time, as is proved by the exact resemblance of the mummies of Egypt, and many fossils, to living forms.
4. Some genera, as Lingula, &c., have existed with very little variation from the most ancient times to the present.
5. Instead of progressing, some animals seem to have degenerated; as the recent armadillo from the glyptodon, &c.
6. We have no right to argue on domestic breeds, since they have been chosen on account of their plasticity.

I will now give answers that have been made to these objections.

1. It cannot be proved that many of our domestic animals revert to their original forms when left to themselves; for it has always been found impossible to say what their original forms were: but if this was the case, a simple experiment would decide. Recent varieties certainly do show this tendency, because of the extremely short time during which selection has been going on; and the rapidity, owing to artificial causes, in which the change took place. In a wild state the changes progress very slowly by natural causes, and therefore by the time a variety has changed sufficiently to be called a new species, it has given up all thought (if I may so express myself) of reverting to its original form.
2. "Man can hardly, or only with great difficulty, select any deviation of structure, except such as are externally visible, and he rarely cares for what is internal." Besides, the varieties formed by man have only been in existence for a few thousand years, while natural species have been so for hundreds of thousands; for until they have been formed long enough to deviate markedly from other species they are only called varieties.
3. The answer to this argument is that they have not yet had time to change, owing to their conditions of life not having been much altered. The mummies of Egypt are perhaps four thousand years old, but Mr. L. Horner, the President of the Geological Society, has shown that man, sufficiently civilized to manufacture pottery, existed in the valley of the Nile thirteen or fourteen thousand years ago. And the same with the fossils; as we go further back in time we see living forms get rarer and rarer until at last they die out altogether. If a form has managed to exist for a long time without change, it is

triumphantly produced by the anti-transmutationists; if, on the contrary, it has changed in ever so slight a degree from an extinct form it is called a new species.

4. Suppose a large area covered with sea, and Lingula, &c., spread over it. Now suppose a part of this area to be gradually elevated, the Lingulæ and other animals living on it would undergo variation to meet the change of conditions; but those on the stationary area would remain constant. Next suppose the elevated part to sink again: the new forms on it must either die out or change, and the Lingulæ would again spread over the whole area; and being better adapted to those conditions, from long residence in them, would kill off, perhaps, some of the new forms. Again, another part of the area might be raised; and so on. The chances are that some of the Lingulæ would always be on a stationary portion, and thus hand down their offspring with little variation, for any length of time. It is a fact which strongly corroborates this, that nearly all the genera which have a long range in time are inhabitants of the deep sea, and therefore have also a large range in space.
5. It is not supposed that the armadillo is descended from the glyptodon; on the contrary the latter seems to have become extinct, and to have left no progeny, while some other form may have been the progenitor of the former.
6. "On the contrary domestic breeds show all degrees of variation, as the pigeon, dog, &c., on one side, and the cat and goose on the other. Perhaps there is not much difierence of variability in animals, constancy can generally be accounted for; pigeons can be mated for life, and are kept in large quantities, and therefore vary much; cats ramble at night and cannot be watched, and are kept in small quantities; donkeys and peacocks are also kept in small quantities, and the breeding of donkeys is not much cared for; geese are only valued for two purposes, food and feathers, and no pleasure seems to have been felt for different breeds."

Let us now see what reasons there are for supposing that variation is *at present* unlimited; or, in other words, that all animals have descended from a common prototype. By admitting it to be true we can easily understand—

1. Why species have come into the world slowly and successively.
2. Why "the families of each divlsion (of moluscs) which are least unlike (*Orthoceratidæ* and *Belemnitidæ*) were respectively the first developed.*
3. Why species have not necessarily changed together, or at the same rate, or in the same degree; yet in the long run all *have* undergone modification to some extent.

* Woodward's "Recent and Fossil Shells," p. 417.

4. Why the extinction of old forms is the almost inevitable consequence of the production of new ones.
5. Why, when a species disappears, it never re-appears (although this is within the range of possibility).
6. Why groups of species increase in number slowly, and endure for unequal periods of time.
7. Why, the more ancient a form is, the more it generally differs from those now living.
8. Why all the forms of life are linked together.
9. Why there is often great difficulty in drawing a line between two species.
10. Why, as a general rule, in life on the globe there have been "an ascent, and progress in the main."
11. Why the lower forms of life have larger specific existences than the higher ones*.
12. Why the older forms lived unchanged for longer periods of time than the newer ones, † because they were more widely distributed.
13. Why the deep-sea shells and those of the land and fresh-water enjoy a longer range in time than the littoral species; for the littoral species being confined to narrow zones in depth are much more likely to suffer from elevation or subsidence than those that live in the deep-sea, or on the land and in fresh-water.
14. Why some animals and plants have rudimentary, and sometimes useless organs.
15. Why the homologous parts, so different in the adult, are alike in the embryo.
16. Why the embryos of the higher animals resemble, at different stages of their existence, the embryos of the lower animals.‡
17. Why "in their infancy the molluscous animals are more alike, both in appearance and habits, than in after life.§"
18. Why the limbs, &c., of all animals are formed on the same plan.
19. Why the flowers, branches, &c., of plants and trees are but rudimentary or metamorphosed leaves.‖
20. Why animals very often resemble in colour and appearance the localities which they frequent.
21. Why in geographical distribution there are generic as well as specific centres.
22. Why typical groups and species are widely distributed, while aberrant forms are usually confined to small areas.
23. Why the inhabitants of islands bear some relation to those of the nearest continent.

* Owen's Palæontology, p. 49.

†Anniversary Address of Professor Phillips to the Geological Society in Feb. 1860

‡ Carpenter's "Principles of Comparative Physiology," p. 95.

§ Woodward's "Recent and Fossil Shells," p. 10.

‖ Lindley's "Elements of Botany," p. 354.

24. Why the extinct fauna of a country bears a close analogy to the living fauna.
25. Why the proportion of species increases from the oldest formations to the newest.
26. Why species were more widely distributed formerly than now; for as more species were developed, the more local they must have become.

I know of no answers to these arguments; they are simply facts acknowledged by everybody, except perhaps those for which I have given my authority.

Taking everything then into consideration, I think that the evidence is greatly in favour of variation being at present unlimited.*

The second argument against Mr. Darwin's theory is that natural selection, although allowed to be a "vera causa" of variation, is not powerful enough to produce the great differences that exist among organic forms; or, in other words, that the cause is not equal to the effect.

The cause may be compared to the power of a machine that has to be increased or diminished according as the time in which it is required to produce a given effect is shortened or lengthened. I believe that no one but a geologist has any conception of the enormous length of time comprehended in the term "geological period;" and, although all or nearly all of my readers will be geologists, yet I think that it will perhaps be as well to try to get some very rough idea of it, especially as "time" has been brought forward in answer to other arguments.

Mr. Darwin has shown that for long periods of geological time volcanic action has been pretty regular and persistent beneath Chili, and that the average elevation of the coast is about three feet in a century;† but in the "Pampean mud," in which the remains of Megatherium, Mylodon, &c., are found, is sometimes twelve thousand feet above the level of the sea; this would make its age four hundred thousand years, yet it is only of Pleistocene age, and was formed perhaps since man inhabited the globe. How old then is the Pliocene? How old the Eocene? How old the chalk? Ten million years is the least that can represent it; and yet it is not more than a twenty-fifth part of the thickness of the sedimentary strata of Great Britain.

In such an enormous time, then, how small may have been the cause of the gradual change of the lowest form of life into the highest?—much less than a struggle for life or death.

* By at present unlimited, I mean that there is no limit between the lowest and the highest known forms of life, but beyond the highest there may be a limit to which we are approaching.

† Proceedings of the Geological Society, vol. ii., p. 446, and Darwin's "Geology of South America." London: 1846.

(To be Continued.)

oxygen, less carbonic acid—after a plant has grown in it than before. True, they give out carbonic acid at night, but not so much as they take in. All the plant (except water) is so much gained from this carbonic acid. Hence, the air is purified by plants.

Now coal being of vegetable origin, it is calculated that for every pound of coal, all this carbon, and at least two pounds of *water* have disappeared from the atmosphere. And if we consider the millions upon millions of tons, fixed in solid black masses in the crust of the earth, we must see that we are living in an atmosphere far purer, and more fit for the respiration of the higher animals, than it could have been without the aid of coal.

It may have been, as the sagacious De la Beche observed, that this enormous supply of carbonic acid was due to the ejections from many volcanic mouths, which we know breathed forth their fiery exhalations in coal times. It is also true, as Sir C. Lyell has said, that these gases so readily mix with the atmosphere, that little appreciable difference would be made by any quantity of volcanic action. But look at the subject in any light we may, there was the carbonic acid in the air, and there it now is, for our benefit, in the earth.

This rank vegetable produce, then, of quick growth and soft tissue —constantly wet, fermenting as soon as covered up—its heat kept in by a blanket of wet sand or clay, with pressure for ages, gives us all the conditions necessary for the production of lignite, brown coal, jet, and pit-coal; and when volcanic heat had driven away its gaseous parts, and left the carbon pure—even anthracite.

As this month's communication has extended to an unreasonable length, I will not now enter into the question of the different qualities of coal, or its uses, but defer what little I have to say on those subjects till next month.

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(Continued from page 136).

But there are other causes that have tended to modify animals; such as habit, use or disuse of any particular organ, food, climate, &c., and these together with the fact that a variation which appears in the parent, at any period of its existence, tends to re-appear in the offspring at the same period, will enable us to account for the metamorphoses of insects, the differences of colour in the young and the adult, the horns of sheep and cattle, &c. If to these we add that of "sexual selection,"* we can see why sexes differ in organs and pro-

* Sexual Selection may be defined as the preference shown by an individual of one sex for an individual of the other from superior beauty of colour, shape, voice, &c.

perties. In fact most of the facts in natural history can be explained by this theory; but there are a few which at present cannot, such as the colours of certain larvæ, which are asexual. Even these may perhaps be the effects of the mysterious and unknown laws of correlation of growth and sympathy between different parts.

We must remember that the theory of natural selection is subordinate to, and totally distinct from, that of the transmutation of species; and that if the former should be found wanting it would not effect the latter in the least degree.

The third great argument urged against the theory of transmutation of species is the geological one; and may be divided into two heads.

1. The almost entire absence* of the remains of the numerous connecting links that must have existed.
2. The sudden appearance of groups of allied species, particularly in the lowest known fossiliferous formations.

The answer to the first is that the geological record is extremely imperfect. There are reasons for thinking that most sedimentary strata have been formed during subsidence. Besides the difficulty of accounting for the very thick ones in any other way, we must remember that during subsidence a newly-formed deposit has the advantage of remaining quiet until it has had time either to harden or to be covered up. When land is rising, on the contrary, the loose deposits will be continually washed further and further away from it until a period of rest or subsidence gives them time to consolidate; but while subsidence is going on the land and the inhabitable part of the sea will be decreasing, consequently there will be much extinction and little variation. When land is being elevated the contrary will obtain, therefore, most of the intermediate varieties will not be preserved.

Most sandstones and clays have been accumulated near land; for the finest mud or sand must sink before it can travel very far. Even in the exceptional case of the mouth of a great river, sediment has never been detected more than three hundred miles from the land. If rolled along the bottom by a current it would be stopped by the first valley it came across, which would act as a purifier to the current in the same way that a lake does to a river. Limestones may certainly be formed at any depth; but we have proofs in the organic remains of which they are generally full that most of them were deposited in not very deep water; and although some, like chalk, may be forming in the middle of the ocean, yet I think that the purity of deep water in most places, as proved by its blue colour,† is a sufficient guarantee that no deposition is going on; and that this is true is

* One reviewer has even said the "thorough and complete absence." See An. Nat. Hist, Feb. 1860, p. 140.

† It is the purity, not the depth of the blue that proves the absence of sediment; the depth of colour depends in a great measure on the quantity of salt it contains in solution. The North Atlantic between Ireland and Canada is not pure blue.

proved by the small horizontal extent of the various deposits which make up a formation, and which generally extend further in proportion to the fineness of the sediment of which they are composed. I think, therefore, that even taking into consideration submarine volcanos, we may safely conclude that no deposition is going on now over at least one-fifth of the area of the ocean.

In the present state of the globe about one-fourth of its surface is land: if we add to this one-fifth of the ocean we have two-fifths of the surface of the globe on which no deposition is taking place; and when we think that deposition could never have been universal, but that there must always have been large areas of denudation, we may feel sure that this is not very far from the truth. We may therefore conclude that the periods of repose in any one area are to the periods of deposition in about the ratio of two to three.

We now know that the deep sea is inhabited; and if we suppose that on equal areas the average number of the inhabitants of the shallow sea are to those of the deep sea as eight to one, and to the inhabitants of the land as one to three and a half—both suppositions may, I think, be safely made—we find that the number of the inhabitants of the areas of repose are to the number of the inhabitants of the areas of deposition as three is to two. It therefore follows that at least one-half of the animals and plants live in places where their remains can only be very rarely preserved. And this calculation will apply also to the ancient world; for if the present ratio of land to water, viz. one-third, should not be the average we should still arrive at very nearly the same conclusion; for if it should be greater, it is evident that the ratio of the inhabitants of the areas of repose to those of the areas of deposition would be increased; if, on the contrary it should be less, the land would be more divided into islands, with of course a larger coast line and larger areas of shallow sea; but the supply of sediment from the land would also be reduced and many parts of the shallow sea, which if near a continent would be areas of deposition, will near an island be areas of repose, while at the same time they will be, perhaps, more thickly inhabited.

But even where deposition is taking place, the burying of organic remains in all deposits but limestone is perhaps the exception, and not the rule. For if the deposition is rapid vegetable life, and consequently animal life, cannot flourish. If on the contrary it is slow, all bodies must lie for a long time uncovered on the bed of the sea, while there all the soft parts will either be eaten or decay, and the rest, subjected to the action of the tides or currents, which are generally found where deposition is going on, will often be broken, worn down, and destroyed.

From these considerations we must infer that the number of organic remains imbedded bears but a small proportion to those that have lived. But even after having been safely imbedded, the chances are much against a fossil ever finding its way into the cabinet of a collector. If buried in sand it is almost sure to be destroyed by the percolation of water, and all trace of it removed; and in any case it

has to stand its chance of being obliterated by heat, or washed away by water.

As all sedimentary strata are deposited from water, it follows that for every cubic yard deposited a cubic yard must be denuded from some other place; and as the sedimentary rocks are much more common at the surface, and generally softer than the igneous ones, the burden of supplying the sediment falls chiefly on them. We may therefore feel sure that during any one period nearly as many fossiliferous strata are obliterated as are formed. In fact the power of denudation is so great, that Mr. Darwin and many other geologists think that only deposits formed during periods of subsidence are thick enough to resist its force, so that many species, and even genera, that had but a limited range may have been swept away, and all record of their existence destroyed.

This denudation added to the periods of repose will make the intervals between strata represent collectively far more time than the strata themselves, and we have many proofs that this is true in the numerous foreign strata that are intermediate in age to some of ours, in unconformability of stratification,* and in the abrupt change in the organic remains of consecutive formations.

Three-fourths of the globe are covered with water, therefore three-fourths of the strata that remain are hidden from us; and the other fourth has to be divided among all the formations that have as yet been recognised, for we can but examine the surface. Of the fourth that *is* accessible, not more than a fifth has been geologically explored;† and that only where sections happen to exist. We must also remember that large tracts of country, shown as Silurian, Devonian, &c., on our maps, are covered so deeply with drift and alluvium that they never have been, and perhaps never will be examined.

For all these reasons the geological record must be very imperfect, and when we examine it we find such to be the case; for we have no reason to suppose that the globe was less thickly inhabited in old times than now: on the contrary, when we find fossils at all they are generally in great abundance; yet the number in any one formation is almost as nothing compared to the number of living animals and plants.

Mr. Darwin has justly observed "that in order to get a perfect gradation between two forms in the upper and lower parts of the same formation the deposit must have gone on accumulating for a very long period, in order to have given time for the slow process of variation, hence the deposit will generally have to be a very thick one; and the species undergoing modification will have had to live on the same area throughout this time. But we have

* The conformability of one stratum to another is no proof of its close sequence; for strata are sometimes conformable in one place, and unconformable in another.

† By explored I mean the age of its strata well made out, not simply guessed at.

seen that a thick fossiliferous formation can only be accumulated during a period of subsidence; and to keep the depth approximately the same, which is necessary in order to enable the same species to live on the same space, the supply of sediment must nearly have counterbalanced the amount of subsidence. But this same movement of subsidence will often tend to sink the area whence the sediment is derived, and thus diminish the supply whilst the downward movement continues. In fact, this nearly balancing between the supply of sediment and the amount of subsidence is probably a rare contingency; for it has been observed by more than one palæontologist that very thick deposits are usually barren of organic remains, except near their upper or lower limits"*

We cannot, therefore, ever expect to fill up the gaps between different species and genera; still, in point of fact, there is nothing like "an entire absence of intermediate forms." All the fossils yet found are intermediate; and more than this, the older a form is the more it usually differs from living forms, and the more general is its structure. Trilobites, for instance, are more like the larvæ of living crustaceans than like the crustaceans themselves. "Owen has shown that the more generalized structure is, in a very significant degree, a characteristic of many extinct, as compared with recent, animals;"† and Mr. Woodward remarks "that the last developed groups are the most typical or characteristic of their class."‡

Next, with regard to the second part of the geological argument, I think that, remembering the imperfection of the geological record, it is very rash to affirm that "because certain genera or families are not found beneath a certain stage, therefore they did not exist before that stage," an argument that is being disproved almost every month. The progenitors of these genera may have lived long before, during the intervals that exist between the different strata, and were most likely developed during a period of elevation, and consequently when no record was kept of the event; but when the land became stationary and the conditions of life more fixed they would multiply rapidly, without much change, and spread far and wide: when a period of subsidence came their remains would be buried, perhaps in large quantities throughout the whole of the area over which they had spread. Mr. Darwin has also remarked "that it might require a long succession of ages to adapt an organism to some new and peculiar line of life, for instance to fly through the air; but when this had been effected, and a few species had thus acquired a great advantage over other organisms, a comparatively short time would be necessary to produce many divergent forms, which would be able to spread rapidly and widely throughout the world."§

It was shown long ago that different fossils came from different formations; and now, acting on this, if forms differ ever so little, or

* "On the Origin of Species," p. 295.
† Edinburgh Review, April, 1860, p. 507.
‡ "Recent and Fossil Shells," p. 417. See also p. 419.
§ "On the Origin of Species," p. 303.

even if they are positively identical, so long as they come from different formations they are classed by some palæontologists as separate species.

Migration too, must have played a very important part in the sudden appearance of species. And with regard to the first appearance of life, if even any of the remains of the oldest fossiliferous formation should still exist in that quarter of the globe which we can alone examine, it seems to me, when I think of the very small extent of country that has been geologically explored, extremely rash to infer that we have already found them.

When we take all these things into consideration we can, I think, easily account for groups of species coming apparently into the world at once; and that owing to the extreme imperfection of the geological record, we cannot ever expect to find all or most of the connecting links between species, or even feel surprised at their being absent. I therefore see no reason for disbelieving the theory on geological grounds; on the contrary, as we find that all the fossils yet brought to light *are* intermediate to living forms, they seem to my mind strong arguments in its favour.

I have, then, taken for granted that species vary, and have shown that not only has no limit been put as yet to that variation, but that the weight of the evidence is in favour of its extension.

I have taken for granted that natural selection is a "vera causa," and have, I think, shown that it is sufficiently powerful to produce the greatest differences that exist among organic forms.

I have shown that there is no real ground for dissent, because we have not yet found the missing connecting links, or because groups of species appear suddenly; but that on the contrary the geological argument is in its favour.

Therefore when we see that we can explain, by the transmutation of one species into another, nearly all the facts in the science of biology, we are, I think, entitled to look upon it as a very probable hypothesis—more probable than any other yet brought forward—and one that, by the clear and comprehensive views it gives of organic life, will lead to great discoveries. I do not wish to go further. I do not wish any one to "mistake the scaffold for the pile." I know that it rests at present on presumptive evidence alone, and that there are many "dilemmas" to be overcome before it can be accepted as true; but, in the words of Sir John Herschel, "are we to be deterred from framing hypotheses and constructing theories, because we meet with such dilemmas, and find ourselves frequently beyond our depths? Undoubtedly not."*

> This is the mystery
> Of this wonderful history,
> And the way to find it out.—SOUTHEY.

* Discourse on the study of Natural Philosophy, p. 196.