XLVII.—*Hutton's Views of the Vegetable Soil or Mould, and Vegetable and Animal Life.* By JAMES MELVIN, Vice-President.

(Read 5th May 1887.)

NIGH two years ago our Vice-President, Mr Richardson, in a most interesting notice of the life and work of the founder of the School of Scottish Geology, among other remarks, recalled the fact that, for sixteen years of his life, from 1752 to 1768, he had devoted himself to agriculture, and farmed his own estate of Slighhouses, in Berwickshire, and had prepared a work on agriculture, which was left in manuscript. This work I have been most anxious to meet with, and had applied to any friends likely to know of its whereabouts; among others, Mr Anderson, of the Society of Antiquaries. I had a note from him, saying that in the catalogue of Mr Gibson-Craig's manuscripts there was an entry which seemed to describe the work in question. I mentioned the matter to Mr Richardson, and on examining the volumes he thought they were the veritable production. I attended the sale, and here is the work.

My object in endeavouring to secure this work arose from the fact that on this subject so keen an observer, so patient and thoughtful a thinker, must have left some observations worthy of the author of the Huttonian Theory. My anxiety consisted chiefly in wishing to learn what were his ideas as to the origin and formation of the vegetable soil, and the laws which regulate the production of vegetable and animal life on the earth—in fact, what were the opinions of Hutton on the subjects which Darwin has made the question of the day.

I have glanced over these ponderous volumes, and I certainly have not been disappointed. This work is entirely in line with the description which Dr Playfair gives of Hutton's writings. His observations are often badly put, his style is often obscure, his constant reiteration of the same thoughts and observations, pall on the reader. All through, however, the workings of an honest, earnest, truthful nature is manifest, respectful to the opinions of others; and while confident his own views are worthy of regard, he nowhere dogmatizes or denies others are entitled to differ from him.

This work seems to have been written at intervals over the last twenty-five years of his life; and copied from his notes by an amanuensis. After his death, it had been submitted to Dr Playfair, and the doctor's criticism is along with the work, also in manuscript.

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This document shows that Playfair had a practical acquaintance with agriculture, and his views are stated with the same acuteness and clearness as were his wont. These are not all in sympathy with those of Hutton. It was a great loss, the non-publication of this work. Had it been submitted to judicious pruning, the opinions stated would have been most useful. His object, as the doctor states in the Preface, is scientifically to examine agriculture in general, so as to allow practical men to judge of their art. He devotes many chapters to the influence of climate on plants and animals, and urges the establishment of weather register stations all over the country, up to the limit of the cultivation of corn, and to the weekly publication in the newspapers of the state of the weather at each station. He supports Adam Smith's views as to Free Trade, on the ground that other countries can better supply our wants with certain products than we can from our climate, and our climate can better supply people of other countries with what they want of our produce. He says while it is well all engaged in agriculture should be so far educated, it is essential that a few be thoroughly so in the highest science of the day. He warns against the allowing of foreign diseases to be introduced, whether affecting vegetables or the more serious contagious diseases that had been so calamitous among cattle in Europe. It is not with his agriculture I am now to try to interest you, but with his views as to the nature and origin of the vegetable mould or soil, and the vegetable and animal life which it maintains.

I shall endeavour to place before you such extracts as shall show you in his own words what his opinions were. These, however, have been detached more or less from the practical questions they were explaining, and are not therefore so connected as they would have been if read *in situ*.

ON THE FORMATION OF THE SOIL OR VEGETATING SURFACE OF
THE EARTH.

"It has long been my peculiar study to investigate this subject; and I have found it precisely as I here represent it; but it is not the proper subject of this work, and I shall have another opportunity of enquiring more particularly into this geological operation."

"Here, then, in the constitution of this earth, we shall see a final cause for that various and universal production of soil, by means of which there is a bounteous provision made for such a diversity of organised living bodies."

For the purpose of his explanation he says there are two formations—primary and secondary. The first is chiefly the higher portions of the land, the second the lower. The first has much less covering of superficial materials, from the fact that much of the strata is vertical and of a harder nature, while being the higher the washing effects of rain and the wind have carried the covering or disintegrated matter to the lower land or sea. The secondary or lower, flatter country has a much thicker covering, and generally consists of shales, sandstones, and softer rocks. He guards himself from saying all the Highlands are primary and all the Lowland secondary; although it is generally so. He then describes the rocks included in both, and proceeds to give a detailed account—

VOL. I.—OF THE NATURAL HISTORY OF SOILS, AND VIEW OF
THE MINERAL MATERIALS OF WHICH THEY ARE FORMED.

“Soil is always composed of the separated and decayed parts of the solid land which is immediately below the soil, that this soil is composed; for the materials of a soil are often travelled or transported from afar, or gathered from different parts, as is always the case with those soils which are deposited by rivers in Britain.

“In thus taking a view of the superficial soils and their mother-strata, we must attend to this, that the derivation of the soil from the strata may be either more immediate or extremely remote,—so remote indeed, that it is in understanding the great geological operations of the earth that this connection between these two things may be acknowledged.”

“It must be considered that this earth had been under the sea, and at that time all the strata which are now found under our soils were exposed to the destructive operations of that mass of water, agitated by the winds and moved by the tides. In this situation of things, the more loose and softer strata must have been washed away when exposed, and the harder masses of stone broken, agitated, and formed by attrition into gravel. These water-worn materials, as well as those of the same kind from the destruction of the rocks, would be deposited very irregularly, from the shape of the bottom and currents.”

“First. We are thus to consider the original broken and the wasted strata as being covered more or less with those travelled materials (as they may be called), and when this mass of earth had been covered with a secondary deposit, which, though not regular strata, nor any way consolidated or mineralised, had been so far formed in the manner of mineral strata by having subsided or settled in the water by which they had been agitated.”

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It seems from this he believed the debris of the broken and wasted strata had been covered over with drift, and that beds of debris, travelled earth or drift, were thus formed under the sea, and the vegetable soil found on the top of them, as will be seen from what follows, after the land had risen and vegetation spread—

“Thus from the summits of the mountains, which is the one extreme, to the flat-lands of this island, which is the other extreme, we find an indefinite variety of appearances in the *earth below the vegetable soil*; but all these appearances may be referred to either the one or other of those two cases which have been described, or to a mixture of them both.”

ON TRAVELLED BEDS OR BEDS FORMED OUT OF THE ROCK
IN SITU.

“Therefore in explaining the origin of our vegetable soils, we must always keep in view this distinction of the original mineral strata of the earth, and of the collections of travelled materials, which, though not properly the original strata, often represent them, and may be difficult upon some occasions to distinguish from the original strata, as both have been evidently formed by being deposited in water.”

Certainly the doctor in these extracts is sorely puzzled to account for the various surface coverings of the original strata from the lowest in the till to the upper drift. He evidently never had his attention directed to the effects of ice in shaping the surface and accumulating much of the covering of the rocks. It was only in the last year of his life the work of Saussure was seen by him, and this manuscript must have been completed years before then. He however clearly shows, by his frequent references to the surface of the earth having been depressed under the sea, and receiving the covering of clays, drifts, and gravels, that his uninformative view includes both an elevating and depressing action in the operations of nature.

In speaking of the waste of land, he says :

“Let us look round, and I believe we shall not be able to determine which of those two extremes take place, that is, whether the movable soil on the one hand, or the solid basis on the other, are made most perishable on the whole.

“On the one hand, the whole surface of the earth is covered with soil, except the faces of those rocks on which it cannot lie, and which faces are necessary for the habitation of a tribe of musci; on the other hand, the basis which supports our soil, though truly perishable in its nature, is actually made so permanent as to have imposed upon acute observers, who, taking

things in too partial a view, have maintained that the land is daily gaining on the sea."

"Therefore we conclude that in the system of this earth, *the provision of a soil or vegetating surface* to the earth has been made upon the wisest principle, and also in the most just proportion."

He then proceeds to inquire into the nature of the vegetable soil or mould, or as he calls it, "THE VEGETATING SURFACE," a most descriptive expression.

VOL. I.—"There are three different states in which we find the soil which we are to employ, viz., woodlands, pasturage or meadow, and moorlands. Each of these three states has its proper character."

"With regard to the first, we may consider in what condition we find the soil, and how disposed with regard to culture and fertility. If in a woody state, the soil shall be considered as having been rested, which it surely is with respect to cultivation, then we may conclude that naturally a soil does not weary with producing, for here, after producing an enormous load of vegetable substances, the soil seems rested, and is in a fertile state,—that is, not exhausted of its vegetative power, as it may be afterwards by means of culture. But in order to see how this soil, after producing so weighty a crop as that of wood, should not be exhausted of its vegetative power, and should be in a fertile state, it will be necessary to consider what happens to this soil during the incumbence of that wood."

VOL. II.—"In the first place, this wood maintains a multitude of animals which die and are returned to the soil; secondly, it sheds an annual crop of leaves, which contribute in some measure to the fertility of the soil; and lastly, *the soil thus enriched with animal and vegetable bodies feeds the worms, its proper inhabitants, which penetrate the soil, and introduce fertility as they multiply.* We may thus conceive a soil, after having borne a wood, to be in a more fertile state than it has been before the wood had grown."

This reasoning is, I believe, confirmed by experience: as from the cultivation of woodlands the soil is often in such a fertile state as to yield rich crops for some time until it be exhausted "of its *occasional* fertility."

"The most opposite state to that of wood, in which we find our soil, is that of pasture, meadow, or grass-ground. Here we suppose the crop to be annually consumed, whereas in the wood the annual produce was accumulated on the ground. To the soil it is perhaps all one; for in both cases there are animals fed, and fertilizing matter returned to the earth; and in both

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cases we find, from experience, that the soil is left in a state of *occasional* increased fertility."

"The two natural states now mentioned may exist in soil of the greatest natural fertility; but the third state, which is now to be examined, happens only to land or soil of an inferior fertility. Consequently, here it is proper to draw the line of distinction between what may be considered as fertile soil on the one hand, and that which should be reckoned sterile on the the other."

He then says:—"We cannot suppose the fertile soil remaining in this natural state without *increasing its natural fertility*, unless we shall suppose that all its annual produce were carried away from off the ground. The produce of the sterile soil is almost wholly accumulated without being restored to the soil, and it formed a soil of itself above the natural soil."

This is the case with the peaty covering of the hills or the bogs, which consists entirely of vegetable matter, such as mosses and heather, which cover so much of Scotland and Ireland, and do not increase the soil or add to its fertility as do grasses or other similar plants or wood. Thus there are the three forms in which the natural soils of the country are found. He then treats of

SOIL IN RELATION TO FERTILITY.

"Soils in general possess fertility not only in different degrees, but also upon different principles, which now it will be proper to examine. There are three distinct principles upon which a soil may possess its fertility. First, the simple structure, or mechanical construction of its mineral substances; secondly, the chemical quality of its mineral substances; and lastly, the vegetable and animal substances which may enter into the composition of a soil.

"The acquired fertility again consists chiefly in the soil having animal or vegetable substances, which are not proper to the mineral soil, but which have been introduced into the earth; whether this is done by Nature, who makes plants to grow on all the surface, and animals to live and perish in that soil, or whether it is done by man. . . ."

"Through disease to keep the balance equal and by insect plagues, such as caterpillars. . . ."

It appears to me that these extracts show that Hutton held that the true vegetating surface, or mould, was formed and is forming out of the material on which it rests by the growth and decay of vegetables and animals. That the sub-soil, or "solid basis" may have been transported and deposited, or it may be

the strata decaying and supplying whatever waste is taking place; but that the vegetating surface or mould where the annual crop is not removed is increasing in fertility by the organic matter so produced on it in its decay adding to the soil and affording food and lodging for all the various living creatures which inhabit it, thus affording room for the worms to drain, aerate and enrich it, "and this upon the wisest principle and upon the most just proportion."

In thus describing the nature and origin of the "vegetating surface," or vegetable mould of Darwin, Hutton has explained the true conditions under which it has come to be as it is, and allotted to each of the factors in its formation its proper place. Darwin, in his "Treatise on the Formation of Vegetable Moulds by Earthworms," has given a most elaborate description of the structure, life, and labours of earthworms, but in attributing to them the "formation of mould which covers the whole surface of the land," gives them credit for doing what Hutton says is due to a multitude of animals which die and are returned to the soil. So vegetation, both roots and leaves, all of which go to feed the worms, which are its proper inhabitants, as they penetrate the earth, introduce fertility.

Hutton's "Origin of Life" does not touch on the origin of life on the earth, or make any allusion to the theory of Buffon as to evolution, or even of those of his neighbour in Berwickshire, Lord Kames, who, in his work published in 1776—the "Gentleman Farmer,"—says, "What means were employed at the creation to cover the earth with plants may be *conjectured*, but is far beyond the reach of evidence. It is to me a *rational conjecture* that a number of plants and animals were originally created and endowed with proper powers of generation, and from these all the plants and animals existing in the world are descended."

It would appear from a perusal of this manuscript that Hutton was most careful to base his reasoning on observed facts, and however deeply he was committed to his theory he never stretches any of his views to support it. Indeed Playfair in criticising his account of the formations of the surface-covering of the strata, says that one would be apt to imagine the doctor was a Neptunist. It is different with Darwin, who, after publishing his "Theory of the Origin of Species from Natural Selection," wrote all his subsequent books as buttresses to this theme. So much indeed was the opposite tendency manifest in Hutton, that Professor Huxley says, in declining to go beyond observed facts, he was false to his system. It occurs in the *Nineteenth Century*, April 1887, as follows:—

"A great many years ago ("Presidential Address to the Geolo-

logical Society, 1869"), I ventured to indicate that which seemed to me to be the weak point, not in the fundamental principles of uniformitarianism as taught by Lyell. It lay, to my mind, in the refusal by Hutton, and in a less degree by Lyell, to look beyond the limits of the time recorded by the stratified rocks. I said, 'This attempt to limit, at a particular point, the progress of inductive and deductive reasoning from the things which are to the things which were, this faithlessness to its own logic, seems to me to have cost uniformitarianism the place as the permanent form of geological speculation, which it might otherwise have held.' "

This dislike of analogy and conjecture kept Hutton from indulging in speculation, or in reasoning on subjects where there are no facts to guide him. The vegetable and animal life around is enough.

ON SEEDS.

"The principle on which depends the doctrine of seed is this—That plants in growing propagate their like. Were plants not to propagate their like, that is, bodies similar to themselves, there could be no science in the subject of vegetation—the natural history of plants would be an uninteresting list of disjointed particulars, which could have no effect in the generalisation of our knowledge. Were plants, again, always to propagate bodies in all respects always the same as themselves, we could have no varieties in plants of the same species. But we have great varieties in plants of the same species; consequently this conclusion must be admitted, that the plants propagate their species—the race may deviate in some measure from its parent. That is to say, plants in propagating their kind admit of special varieties.

"It being the object of agriculture to propagate plants most useful for the purposes of man, and there being in the laws of vegetation a source of variation from the parent plant, so as to beget diversity in the production, it belongs to the science of agriculture to inquire into the subject to discover the causes of that diversity, and to reduce to rule the art of changing plants through variable generations, as well as that of preserving the progeny without any material deviation from its parent. I am sorry to observe how little our botanical philosophers have advanced in this part of science. Occupied with the necessary business of distinguishing and describing plants, they seem only hitherto to be preparing the way for this useful part, in which the variations of plants will be the subject of investigation. They have *but little penetrated into the laws of vegetable*

economy, although this is a tract in which observation is most pleasant, if not most easy to be pursued.

"The sexual system of plants surely opened a great field for discovery ; neither have experiments been wanting to show that in the fructification of vegetable bodies, *the race is changed by the admission of a different species of male*. But this hybrid race proceeds not on the propagation of the compound species by seed, no more at least in the animal economy.

"We are therefore still left in the dark, or reduced to vague reasoning of analogy and conjecture in filling up this part of natural history—the varieties of species."

This was written a hundred years ago or more, "hence naturalists have been led to lay down this general rule: That those bodies are only of one species which can propagate; and that those are of different species which cannot propagate in continuing that breed.

"But now let us consider what is the nature of this rule of our forming. If it be absolute, as implying no propagation at all between different species, in that case every hybrid would transgress our present system of specific distinctions by uniting in one species things which we are constrained to believe diverse. If, again, the rule be not absolute, it must be conditional. And now we may enquire into the nature of those conditions: How different species may be allowed to propagate together, but this hybrid body must not propagate again.

"But hybrid bodies have been known to propagate, therefore we are obliged to abandon that precise condition and assume a new one, one which is again conditional, viz., that the second hybrid should not propagate. But this is a condition which, perhaps, it is not in our power to examine properly ; for we find great difficulty in making the first hybrid bodies propagate, and, without great experience, we should pronounce the thing to be impracticable. This fruitful operation of the second hybrid has, however, happened, and therefore we must allow the thing to be in nature, although we are altogether ignorant of the conditions which are required in order to make the operation successful.

"The general conclusion is this: That while nature has permitted a certain degree of difference in species to mingle in propagating new individuals of a different, she has as carefully provided against the confusion of species by placing certain difficulties in the way of that future procreation. Nevertheless, seeing that there is no absolute prohibition against the mixing of species, it is the business of science to enquire what are those conditions which allow the propagation of living bodies by their like, and the conditions in which this fruitful operation is denied."

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"We have been now supposing that the special varieties among plants have arisen from the forming or generating power of seminal propagation ; but there is another way of endeavouring to explain this appearance of variety in species without the aid of the sexual system. This is to suppose the influence of soil and climate such upon the constitution of the plant as in the course of time to form variety without changing the species.

"Which of those suppositions is the just, or whether any of them be true, or how far they may not all of them be so in a certain degree, is a point which growing science must endeavour to discover.

"In consequence of this actual state or order of things the progeny is diversified, and there are thus introduced into the vegetable system varieties in the produce of the earth which is for the use of man. Now these varieties the intelligent being—man—may have it in his power in some measure to direct."

"If we shall allow the effect which I have been ascribing to the influence of soil and climate in vegetation, as making a small and imperceptible change in the organical constitution of the plant, then that change, which may be imperceptible in the form and qualities of the continued reproduction of the plant, may become considerable in its effect upon the flower, and consequently in the constitution of the procreated seed ; it might thus appear sensible in the seminal reproduction of that plant—more especially in the continued influence of that imperceptible effect—repeated through a succession of seminal generations.

"We may also conceive small changes of this kind either to proceed in augmentation or diminution, according as circumstances shall be favourable for the one or other ; and thus there may be perpetual changes, which only come occasionally to produce any great or considerable effect."—See "Origin of Species," p. 75, as to Darwin's views.

DEGENERACY.

The "diminution" he treats of as degeneracy occupies much of his attention, and in endeavouring to account for it, he attributes this to one or both of two causes : first, that the variety being the result of a cross from two others, is not in itself stable, or that the soil and climate are unfavourable, resulting in liability to disease.

"Nothing more evident than that every species of plant has its proper soil and climate, in which it is made to grow in the greatest perfection ; here then we are to suppose that our seed or plant would not degenerate. Let us now change the soil, or

change the climate, we cannot suppose the plant to grow the same."—Page 3.

Hutton goes on :

"But if we shall allow of the connubial intercourse of the most immediately connected species of different families, which can be hardly refused, we shall see how there may be produced new races in a family without endangering in general the distinction of species, at least, of not producing any more confusion of that kind than what appears actually to be the case at present, in considering all the varieties which are found to exist upon the earth.

"We are certain of this great source of variety which may be termed connubial, but we are at present ignorant—what may be the utmost extent—of this procreating economy for the change of plants, or what may be the limits prescribed by nature for preserving that distinction of things which we term species."

May I ask, notwithstanding all that has been written, are we any way now more certain of the process?

CULTIVATION.

In writing of the effects of cultivation, he says :

"We see perhaps an example of this in the various coloured flowers of highly pampered plants, in the monstrous double flowers without fruit, and in those fruits that grow without being accompanied with the seed which properly belongs to them. But this source of change, from the influence of soil and climate upon the reproduction flower of a plant, appears to be a very gradual and imperceptible operation in general; so that in the continued reproduction of the same plant, without generation, we commonly find no sensible change.

"We thus may propagate any particular race of a family, or any variety in a race, the same, or at least indistinguishably similar so far as we know, without end."—See 'Patrick Sherriſ's Treatise on Cereals.'

"Thus I have endeavoured to show that there is in nature two distinct methods of reproducing vegetable bodies, and that there are also means for varying the species of things within certain limits, of which we do not precisely see the bounds."

Thus I assume these two different methods of Hutton's to be—first, crossing, resulting in new varieties; second, changes by the effects of climate, soil, and exposure.

ON ANIMAL LIFE.

VOL. II.—“The question that seems to be of greatest importance in this subject, is to know how those varieties, which we find in every species, are procured; whether by simple propagation from original models which had been created with the species, or whether from certain laws of variation in the process of propagation of each species by the influence of physical causes.

“But even the resolution of that question may not perhaps be of any great consequence in directing our practice, if it can be made to appear that, whether those useful varieties proceed from the one or the other of those natural causes, the principle on which the practice is to proceed must be the same. Now, it is in order to see this that I am here to inquire into the physiology or natural philosophy of the subject. It is an inquiry that will leave us to understand the principle that must direct the practice of an art most interesting to the agriculture of a country. Let us suppose that there are in each species certain original varieties, which would be then sub-species in a more general.

“Such, indeed, would seem to be the case in the species Dog, for in this species of animal we find such remarkable varieties—varieties so wisely adapted to various different purposes—varieties, the characters of which are so extremely different, that it is almost inconceivable that this should have arisen from the influence of external causes alone, but must have required the guidance of *some intended principle in the original constitution of the animal*. How, for example, conceive that the form of the greyhound and those of the spaniel and slowhound, which are to catch their prey by such different instinctive arts, have been produced from one original form? Perhaps it is more easy to conceive certain original varieties in that species of animal, which, generating promiscuously, make an indefinite variety in the form and the instinctive arts of those animals of one species. If this last supposition has been the case, it would be necessary to suppose, a thing consistent with our experience, that those varieties which runs in the blood, and thus continue by propagation, may all lurk in the individual, and be all again obtained in their pure or almost original state, either by continual propagation under proper circumstances in nature, or by the intelligent art of man who makes a proper selection in the breeding of those animals. It is thus by the continual propagation of a mongrel dog any of the original characters which had been blended in the mixture of those sub-species. Without this principle of separation, all the original varieties would pro-

bably have been soon entirely lost in one compound species, and we should never have seen that beautiful illustration of design in which the various forms of those animals are so wisely adapted to the different instinctive arts with which they are indued, nor should we have obtained such a power over the other animals of nature by means of this alliance, which the eloquent Buffon has represented man making with the dog."

VOL. II.—"On the other hand, let us suppose only one form originally in a species; and that there had been established in the constitution of the animal, a general law or rule of seminal variation, by which the form of the animal should be constantly changing more or less by the influence of external causes, but not with any particular attention. We should thus find varieties in the forms of a species, propagating for a long course of time under the influence of different circumstances, or in different situations; and we should in this see a beautiful contrivance for preserving the perfection of the animal form, in the variety of the species. The form of the animal would thus always be adapting itself to the instinctive arts with which the species had been indued, and the economy of this animal always would appear in perfect wisdom.

"To see this beautiful system of animal-life (which is also applicable to vegetables), we are to consider that in the indefinite variation of the breed, the form best adapted to the exercise of those instinctive arts, by which the species is to live, will be most certainly continued in the propagation of this animal, and will be always tending more and more to perfect itself by the natural variation which is continually taking place. Thus, for example, where dogs are to live by the swiftness of their feet and the sharpness of their sight, the form least adapted to this manner of chase will be the first to perish; and the same will hold with regard to all the other forms and faculties of the species, by which the instinctive arts of procuring its means of substance may be pursued.

"Here, then, we see a law of nature, and a natural principle in the breeding art, upon which depends either the preservation, the modification, or the change of any quality that may appear in a particular race.

"But in the refined practice of that art, the principle on which we are to proceed is this, that in the propagation of species there are seminal varieties—varieties that may be useful in our economy, and that may be directed in the propagation by the skilful application of the art.

"Hence nice distinction is required in the artist: first, to perceive those useful qualities that may occasionally appear, in the extensive breeding of a species; secondly, to see the value

of a nascent quality, which otherwise might be overlooked or neglected; and, lastly, to understand the ultimate perfection of that quality, or the extent to which it may be carried in the *successive propagation*, according to art, of this distinguished variety in a particular race of a species. It is thus that intelligence directs the art for valuable purposes, and that by the application of a single person a valuable acquisition may be made in the practice of a country, of which we have seen a late example—an example which I hope will be pursued through every branch of seminal propagation. Mr Bakewell has opened the eyes of his countrymen with regard to the value of this art; and by the successful application of his genius he has benefitted his country more than if he added to this kingdom tributary provinces."

Hutton has clearly described the method Bakewell took to create a new breed. He has not, however, fully explained the manner by which that breed was made permanent, though he says it was by "*successive propagation*."

His pupil, Culley, in his Treatise of 1794, says:—"Bakewell has not had a cross for upwards of twenty years. His best stock has been bred by the nearest affinities. Breeding in-and-in, or from the nearest affinities, is absolutely requisite to secure permanence." Darwin never faced this difficulty. This has always seemed a very strong point against natural selection and the survival of the fittest, as, unless in-and-in breeding is carried out in any variety exclusively, and in every case, the offspring revert back; and for this reason almost all breeds have now their pedigree books, purity of descent being essential to maintain an artificial form with quality. This system of breeding in-and-in is attended with great difficulties under domestication. These would become insuperable in the wild state. It implies the necessity of all the individuals of the herd or flock becoming assimilated through the service of the one male which has varied, and the exclusion of those of the progeny which have differed from that type. The longer this in-and-in breeding continues, the less fit are the males so bred to continue the variety, as they are not the fittest to continue the breed. It may be stated in-and-in breeding is essential to render any variety permanent. The products of in-and-in breeding are the least capable of continuing the breed.

Let us compare Darwin's act of "Natural Selection with Variation" as the origin of species with Hutton's opinions.

Darwin says every kind of animal or plant transmits a general likeness, with individual differences, to its offspring. These differences may be indifferent deteriorations or improve-

ments. In the struggle for existence, those animals or plants having improvements survive; those having deteriorations perish.

Hutton says variations are in nature, hybrids, and second hybrids are known to have been in nature. The conditions of their continuance is doubtful. But nature carefully provides against confusion of species. Small imperceptible changes may become considerable, either as augmentations or diminutions. But where the conditions are unchanged plants and animals remain the same without end.

Hutton's view of the permanence of vegetable forms has received additional confirmation recently—it having been discovered by competent authorities that the flowers which formed the wreaths wound with pious care round the Egyptian dead, perhaps four thousand years ago, are identical with those growing in Egypt now; and it is a well-known fact, that since the time of Flying Childers and Eclipse, more than a hundred years ago, no increase of speed has been attained by the race-horse, notwithstanding all that science, backed with wealth and unbounded ambition, could offer. So also with the breeding of sheep and cattle, a limit has been reached; even with the most intense in-and-in breeding, there has been no progress since Bakewell's time, 130 years ago, though a levelling-up has taken place of all breeds, as hoped for by Hutton.

DARWIN AS TO STRUGGLE FOR EXISTENCE.

Every kind of animal and plant tends to increase in numbers in a geometrical progression.

Every individual has to endure a struggle for existence, owing to the geometrical increase of all animals and plants, while the total remains almost stationary. By anticipation, Hutton meets the fundamental proposition of Darwin by saying that nature prevents this increase by a Malthusian system, by disease, and insect plagues, as follows:—

“There would seem to be a remedy, variously contrived, in nature, against the excessive multiplication of any particular species, to the prejudice of the whole, or of that which is an object to preserve.

“First. Plants in nature never fail to calculate the production in proportion to limited nutriment; they spare the growth of useless stalks and reserve all for the production of a fruitful ear. In proportion to defect of aliment the number of seeds is diminished; I have often observed this with wheat, barley, and pease. I have had a single stalk of very little length; on this stalk a single ear or pod, containing a single grain. That grain was perfect, fit to produce the most luxuriant vegetation.

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"Second. In nature, means are taken to keep the balance equal, and partial destruction is required occasionally. And in the extirpation of one species, another, which was before oppressed, naturally succeeds."

"Here is the system of nature, whatever judgment we may pass upon that system; and in those changes of things there is no evil in relation to the whole, nor any error in relation to that system; one which has for principle to sustain a living world."

"We have great reason to believe nature has ordained everything aright; but man, a being of intelligence, a spark of the Divinity, has obtained the right of having a certain ruling power in nature."

Just let me say, in conclusion, these extracts seem to me to shew that Hutton was no one-ideal man, who had conceived a happy thought and worked it out, but that he was a true student of nature, ever observant, ever thoughtful; always honest, never dogmatic, anticipating in no small degree the theories of the past thirty years. This love of truth kept him from indulging in analogies and conjectures, never mingling the fairy tales of science with the long results of time; he used the power, in his own words, the Divinity conferred on him, to try to see the meaning of the facts the hills and the fields, the rivers, the lakes, and the living things around supplied, and he found that everything was for the best and in the highest wisdom.