THE

VARIATION OF ANIMALS AND PLANTS

UNDER DOMESTICATION.

INTRODUCTION.

THE object of this work is not to describe all the many races of animals which have been domesticated by man, and of the plants which have been cultivated by him; even if I possessed the requisite knowledge, so gigantic an undertaking would be here superfluous. It is my intention to give under the head of each species only such facts as I have been able to collect or observe, showing the amount and nature of the changes which animals and plants have undergone whilst under man's dominion, or which bear on the general principles of variation. In one case alone, namely in that of the domestic pigeon, I will describe fully all the chief races, their history, the amount and nature of their differences, and the probable steps by which they have been formed. I have selected this case, because, as we shall hereafter see, the materials are better than in any other; and one case fully described will in fact illustrate all others. But I shall also describe domesticated rabbits, fowls, and ducks, with considerable fulness.

The subjects discussed in this volume are so connected that it is not a little difficult to decide how they can be best arranged. I have determined in the first part to give, under the heads of the various animals and plants, a large body of facts, some of which may at first appear but little related to our subject, and to devote the latter part to general discussions. Whenever I have found it necessary to give numerous details, in support of any proposition or conclusion, small type has been

used. The reader will, I think, find this plan a convenience, for, if he does not doubt the conclusion or care about the details, he can easily pass them over; yet I may be permitted to say that some of the discussions thus printed deserve attention, at least from the professed naturalist.

It may be useful to those who have read nothing about Natural Selection, if I here give a brief sketch of the whole subject and of its bearing on the origin of species.[1] This is the more desirable, as it is impossible in the present work to avoid many allusions to questions which will be fully discussed in future volumes.

From a remote period, in all parts of the world, man has subjected many animals and plants to domestication or culture. Man has no power of altering the absolute conditions of life; he cannot change the climate of any country; he adds no new element to the soil; but he can remove an animal or plant from one climate or soil to another, and give it food on which it did not subsist in its natural state. It is an error to speak of man "tampering with nature" and causing variability. If a man drops a piece of iron into sulphuric acid, it cannot be said strictly that he makes the sulphate of iron, he only allows their elective affinities to come into play. If organic beings had not possessed an inherent tendency to vary, man could have done nothing.[2] He unintentionally exposes his animals and plants to various conditions of life, and variability supervenes, which he cannot even prevent or check. Consider the simple case of a plant which has been cultivated during a long time in its native country, and which consequently has not been subjected to any change of climate. It has been protected to a certain extent from the competing roots of plants of other kinds; it has generally been grown in manured soil; but probably not richer than that of many an

[1] To any one who has attentively read my 'Origin of Species' this Introduction will be superfluous. As I stated in that work that I should soon publish the facts on which the conclusions given in it were founded, I here beg permission to remark that the great delay in publishing this first work has been caused by continued ill-health.

[2] M. Pouchet has recently ('Plurality of Races,' Eng. Translat., 1864, p. 83, &c.) insisted that variation under domestication throws no light on the natural modification of species. I cannot perceive the force of his arguments, or, to speak more accurately, of his assertions to this effect.

alluvial flat; and lastly, it has been exposed to changes in its conditions, being grown sometimes in one district and sometimes in another, in different soils. Under such circumstances, scarcely a plant can be named, though cultivated in the rudest manner, which has not given birth to several varieties. It can hardly be maintained that during the many changes which this earth has undergone, and during the natural migrations of plants from one land or island to another, tenanted by different species, that such plants will not often have been subjected to changes in their conditions analogous to those which almost inevitably cause cultivated plants to vary. No doubt man selects varying individuals, sows their seeds, and again selects their varying offspring. But the initial variation on which man works, and without which he can do nothing, is caused by slight changes in the conditions of life, which must often have occurred under nature. Man, therefore, may be said to have been trying an experiment on a gigantic scale; and it is an experiment which nature during the long lapse of time has incessantly tried. Hence it follows that the principles of domestication are important for us. The main result is that organic beings thus treated have varied largely, and the variations have been inherited. This has apparently been one chief cause of the belief long held by some few naturalists that species in a state of nature undergo change.

I shall in this volume treat, as fully as my materials permit, the whole subject of variation under domestication. We may thus hope to obtain some light, little though it be, on the causes of variability,—on the laws which govern it, such as the direct action of climate and food, the effects of use and disuse, and of correlation of growth,—and on the amount of change to which domesticated organisms are liable. We shall learn something of the laws of inheritance, of the effects of crossing different breeds, and on that sterility which often supervenes when organic beings are removed from their natural conditions of life, and likewise when they are too closely interbred. During this investigation we shall see that the principle of Selection is highly important. Although man does not cause variability and cannot even prevent it, he can select.

preserve, and accumulate the variations given to him by the hand of nature almost in any way which he chooses; and thus he can certainly produce a great result. Selection may be followed either methodically and intentionally, or unconsciously and unintentionally. Man may select and preserve each successive variation, with the distinct intention of improving and altering a breed, in accordance with a preconceived idea; and by thus adding up variations, often so slight as to be imperceptible by an uneducated eye, he has effected wonderful changes and improvements. It can, also, be clearly shown that man, without any intention or thought of improving the breed, by preserving in each successive generation the individuals which he prizes most, and by destroying the worthless individuals, slowly, though surely, induces great changes. As the will of man thus comes into play, we can understand how it is that domesticated breeds show adaptation to his wants and pleasures. We can further understand how it is that domestic races of animals and cultivated races of plants often exhibit an abnormal character, as compared with natural species; for they have been modified not for their own benefit, but for that of man.

In another work I shall discuss, if time and health permit, the variability of organic beings in a state of nature; namely, the individual differences presented by animals and plants, and those slightly greater and generally inherited differences which are ranked by naturalists as varieties or geographical races. We shall see how difficult, or rather how impossible it often is, to distinguish between races and sub-species, as the less well-marked forms have sometimes been denominated; and again between sub-species and true species. I shall further attempt to show that it is the common and widely ranging, or, as they may be called, the dominant species, which most frequently vary; and that it is the large and flourishing genera which include the greatest number of varying species. Varieties, as we shall see, may justly be called incipient species.

But it may be urged, granting that organic beings in a state of nature present some varieties,—that their organization is

in some slight degree plastic; granting that many animals and plants have varied greatly under domestication, and that man by his power of selection has gone on accumulating such variations until he has made strongly marked and firmly inherited races; granting all this, how, it may be asked, have species arisen in a state of nature? The differences between natural varieties are slight; whereas the differences are considerable between the species of the same genus, and great between the species of distinct genera. How do these lesser differences become augmented into the greater difference? How do varieties, or as I have called them incipient species, become converted into true and well-defined species? How has each new species been adapted to the surrounding physical conditions, and to the other forms of life on which it in any way depends? We see on every side of us innumerable adaptations and contrivances, which have justly excited the highest admiration of every observer. There is, for instance, a fly (Cecidomyia)[3] which deposits its eggs within the stamens of a Scrophularia, and secretes a poison which produces a gall, on which the larva feeds; but there is another insect (Misocampus) which deposits its eggs within the body of the larva within the gall, and is thus nourished by its living prey; so that here a hymenopterous insect depends on a dipterous insect, and this depends on its power of producing a monstrous growth in a particular organ of a particular plant. So it is, in a more or less plainly marked manner, in thousands and tens of thousands of cases, with the lowest as well as with the highest productions of nature.

This problem of the conversion of varieties into species,—that is, the augmentation of the slight differences characteristic of varieties into the greater differences characteristic of species and genera, including the admirable adaptations of each being to its complex organic and inorganic conditions of life,—has been briefly treated in my 'Origin of Species.' It was there shown that all organic beings, without exception, tend to increase at so high a ratio, that no district, no station, not even the whole surface of the land or the whole ocean,

[3] Léon Dufour in 'Annales des Scienc. Nat.' (3rd series, Zoolog.), tom. v. p. 6.

would hold the progeny of a single pair after a certain number of generations. The inevitable result is an ever-recurrent Struggle for Existence. It has truly been said that all nature is at war; the strongest ultimately prevail, the weakest fail; and we well know that myriads of forms have disappeared from the face of the earth. If then organic beings in a state of nature vary even in a slight degree, owing to changes in the surrounding conditions, of which we have abundant geological evidence, or from any other cause; if, in the long course of ages, inheritable variations ever arise in any way advantageous to any being under its excessively complex and changing relations of life; and it would be a strange fact if beneficial variations did never arise, seeing how many have arisen which man has taken advantage of for his own profit or pleasure; if then these contingencies ever occur, and I do not see how the probability of their occurrence can be doubted, then the severe and often-recurrent struggle for existence will determine that those variations, however slight, which are favourable shall be preserved or selected, and those which are unfavourable shall be destroyed.

This preservation, during the battle for life, of varieties which possess any advantage in structure, constitution, or instinct, I have called Natural Selection; and Mr. Herbert Spencer has well expressed the same idea by the Survival of the Fittest. The term "natural selection" is in some respects a bad one, as it seems to imply conscious choice; but this will be disregarded after a little familiarity. No one objects to chemists speaking of "elective affinity;" and certainly an acid has no more choice in combining with a base, than the conditions of life have in determining whether or not a new form be selected or preserved. The term is so far a good one as it brings into connection the production of domestic races by man's power of selection, and the natural preservation of varieties and species in a state of nature. For brevity sake I sometimes speak of natural selection as an intelligent power;—in the same way as astronomers speak of the attraction of gravity as ruling the movements of the planets, or as agriculturists speak of man making domestic races by his

power of selection. In the one case, as in the other, selection does nothing without variability, and this depends in some manner on the action of the surrounding circumstances on the organism. I have, also, often personified the word Nature; for I have found it difficult to avoid this ambiguity; but I mean by nature only the aggregate action and product of many natural laws,—and by laws only the ascertained sequence of events.

It has been shown from many facts that the largest amount of life can be supported on each area, by great diversification or divergence in the structure and constitution of its inhabitants. We have, also, seen that the continued production of new forms through natural selection, which implies that each new variety has some advantage over others, inevitably leads to the extermination of the older and less improved forms. These latter are almost necessarily intermediate in structure, as well as in descent, between the last-produced forms and their original parent-species. Now, if we suppose a species to produce two or more varieties, and these in the course of time to produce other varieties, the principal of good being derived from diversification of structure will generally lead to the preservation of the most divergent varieties; thus the lesser differences characteristic of varieties come to be augmented into the greater differences characteristic of species, and, by the extermination of the older intermediate forms, new species end by being distinctly defined objects. Thus, also, we shall see how it is that organic beings can be classed by what is called a natural method in distinct groups—species under genera, and genera under families.

As all the inhabitants of each country may be said, owing to their high rate of reproduction, to be striving to increase in numbers; as each form comes into competition with many other forms in the struggle for life,—for destroy any one and its place will be seized by others; as every part of the organization occasionally varies in some slight degree, and as natural selection acts exclusively by the preservation of variations which are advantageous under the excessively complex conditions to which each being is exposed, no limit

exists to the number, singularity, and perfection of the contrivances and co-adaptations which may thus be produced. An animal or a plant may thus slowly become related in its structure and habits in the most intricate manner to many other animals and plants, and to the physical conditions of its home. Variations in the organization will in some cases be aided by habit, or by the use and disuse of parts, and they will be governed by the direct action of the surrounding physical conditions and by correlation of growth.

On the principles here briefly sketched out, there is no innate or necessary tendency in each being to its own advancement in the scale of organization. We are almost compelled to look at the specialization or differentiation of parts or organs for different functions as the best or even sole standard of advancement; for by such division of labour each function of body and mind is better performed. And as natural selection acts exclusively through the preservation of profitable modications of structure, and as the conditions of life in each area generally become more and more complex from the increasing number of different forms which inhabit it and from most of these forms acquiring a more and more perfect structure, we may confidently believe, that, on the whole, organization advances. Nevertheless a very simple form fitted for very simple conditions of life might remain for indefinite ages unaltered or unimproved; for what would it profit an infusorial animalcule, for instance, or an intestinal worm, to become highly organized? Members of a high group might even become, and this apparently has often occurred, fitted for simpler conditions of life; and in this case natural selection would tend to simplify or degrade the organization, for complicated mechanism for simple actions would be useless or even disadvantageous.

The arguments opposed to the theory of Natural Selection, have been discussed in my 'Origin of Species,' as far as the size of that work permitted, under the following heads: the difficulty in understanding how very simple organs have been converted by small and graduated steps into highly perfect and complex organs; the marvellous facts of

Instinct; the whole question of Hybridity; and, lastly, the absence in our known geological formations of innumerable links connecting all allied species. Although some of these difficulties are of great weight, we shall see that many of them are explicable on the theory of natural selection, and are otherwise inexplicable.

In scientific investigations it is permitted to invent any hypothesis, and if it explains various large and independent classes of facts it rises to the rank of a well-grounded theory. The undulations of the ether and even its existence are hypothetical, yet every one now admits the undulatory theory of light. The principle of natural selection may be looked at as a mere hypothesis, but rendered in some degree probable by what we positively know of the variability of organic beings in a state of nature,—by what we positively know of the struggle for existence, and the consequent almost inevitable preservation of favourable variations,—and from the analogical formation of domestic races. Now this hypothesis may be tested,—and this seems to me the only fair and legitimate manner of considering the whole question,—by trying whether it explains several large and independent classes of facts; such as the geological succession of organic beings, their distribution in past and present times, and their mutual affinities and homologies. If the principle of natural selection does explain these and other large bodies of facts, it ought to be received. On the ordinary view of each species having been independently created, we gain no scientific explanation of any one of these facts. We can only say that it has so pleased the Creator to command that the past and present inhabitants of the world should appear in a certain order and in certain areas; that He has impressed on them the most extraordinary resemblances, and has classed them in groups subordinate to groups. But by such statements we gain no new knowledge; we do not connect together facts and laws; we explain nothing.

It was the consideration of such large groups of facts as these which first led me to take up the present subject. When I visited during the voyage of H.M.S. *Beagle*, the Galapagos Archipelago, situated in the Pacific Ocean about

500 miles from South America, I found myself surrounded by peculiar species of birds, reptiles, and plants, existing nowhere else in the world. Yet they nearly all bore an American stamp. In the song of the mocking-thrush, in the harsh cry of the carrion-hawk, in the great candlestick-like opuntias, I clearly perceived the neighbourhood of America, though the islands were separated by so many miles of ocean from the mainland, and differed much in their geological constitution and climate. Still more surprising was the fact that most of the inhabitants of each separate island in this small archipelago were specifically different, though most closely related to each other. The archipelago, with its innumerable craters and bare streams of lava, appeared to be of recent origin; and thus I fancied myself brought near to the very act of creation. I often asked myself how these many peculiar animals and plants had been produced: the simplest answer seemed to be that the inhabitants of the several islands had descended from each other, undergoing modification in the course of their descent; and that all the inhabitants of the archipelago were descended from those of the nearest land, namely America, whence colonists would naturally have been derived. But it long remained to me an inexplicable problem how the necessary degree of modification could have been effected, and it would have thus remained for ever, had I not studied domestic productions, and thus acquired a just idea of the power of Selection. As soon as I had fully realized this idea, I saw, on reading Malthus on Population, that Natural Selection was the inevitable result of the rapid increase of all organic beings; for I was prepared to appreciate the struggle for existence by having long studied the habits of animals.

Before visiting the Galapagos I had collected many animals whilst travelling from north to south on both sides of America, and everywhere, under conditions of life as different as it is possible to conceive. American forms were met with—species replacing species of the same peculiar genera. Thus it was when the Cordilleras were ascended, or the thick tropical forests penetrated, or the fresh waters of America searched. Subsequently I visited other countries, which in all their

conditions of life were incomparably more like parts of South America, than the different parts of that continent are to each other; yet in these countries, as in Australia or Southern Africa, the traveller cannot fail to be struck with the entire difference of their productions. Again the reflection was forced on me that community of descent from the early inhabitants of South America would alone explain the wide prevalence of American types throughout that immense area.

To exhume with one's own hands the bones of extinct and gigantic quadrupeds brings the whole question of the succession of species vividly before one's mind; and I found in South America great pieces of tesselated armour exactly like, but on a magnificent scale, that covering the pigmy armadillo; I had found great teeth like those of the living sloth, and bones like those of the cavy. An analogous succession of allied forms had been previously observed in Australia. Here then we see the prevalence, as if by descent, in time as in space, of the same types in the same areas; and in neither case does the similarity of the conditions by any means seem sufficient to account for the similarity of the forms of life. It is notorious that the fossil remains of closely consecutive formations are closely allied in structure, and we can at once understand the fact if they are closely allied by descent. The succession of the many distinct species of the same genus throughout the long series of geological formations seems to have been unbroken or continuous. New species come in gradually one by one. Ancient and extinct forms of life are often intermediate in character, like the words of a dead language with respect to its several offshoots or living tongues. All these facts seemed to me to point to descent with modification as the means of production of new species.

The innumerable past and present inhabitants of the world are connected together by the most singular and complex affinities, and can be classed in groups under groups, in the same manner as varieties can be classed under species and sub-varieties under varieties, but with much higher grades of difference. These complex affinities and the rules

for classification, receive a rational explanation on the theory of descent, combined with the principle of natural selection, which entails divergence of character and the extinction of intermediate forms. How inexplicable is the similar pattern of the hand of a man, the foot of a dog, the wing of a bat, the flipper of a seal, on the doctrine of independent acts of creation! how simply explained on the principle of the natural selection of successive slight variations in the diverging descendants from a single progenitor! So it is with certain parts or organs in the same individual animal or plant, for instance, the jaws and legs of a crab, or the petals, stamens, and pistils of a flower. During the many changes to which in the course of time organic beings have been subjected, certain organs or parts have occasionally become at first of little use and ultimately superfluous; and the retention of such parts in a rudimentary and useless condition is intelligible on the theory of descent. It can be shown that modifications of structure are generally inherited by the offspring at the same age at which each successive variation appeared in the parents; it can further be shown that variations do not commonly supervene at a very early period of embryonic growth, and on these two principles we can understand that most wonderful fact in the whole circuit of natural history, namely, the close similarity of the embryos within the same great class—for instance, those of mammals, birds, reptiles, and fish.

It is the consideration and explanation of such facts as these which has convinced me that the theory of descent with modification by mean of natural selection is in the main true. These facts have as yet received no explanation on the theory of independent Creation; they cannot be grouped together under one point of view, but each has to be considered as an ultimate fact. As the first origin of life on this earth, as well as the continued life of each individual, is at present quite beyond the scope of science, I do not wish to lay much stress on the greater simplicity of the view of a few forms or of only one form having been originally created, instead of innumerable miraculous creations having been necessary at innumerable periods; though this more simple

view accords well with Maupertuis's philosophical axiom of "least action."

In considering how far the theory of natural selection may be extended,—that is, in determining from how many progenitors the inhabitants of the world have descended,—we may conclude that at least all the members of the same class have descended from a single ancestor. A number of organic beings are included in the same class, because they present, independently of their habits of life, the same fundamental type of structure, and because they graduate into each other. Moreover, members of the same class can in most cases be shown to be closely alike at an early embryonic age. These facts can be explained on the belief of their descent from a common form; therefore it may be safely admitted that all the members of the same class are descended from one progenitor. But as the members of quite distinct classes have something in common in structure and much in common in constitution, analogy would lead us one step further, and to infer as probable that all living creatures are descended from a single prototype.

I hope that the reader will pause before coming to any final and hostile conclusion on the theory of natural selection. The reader may consult my 'Origin of Species' for a general sketch of the whole subject; but in that work he has to take many statements on trust. In considering the theory of natural selection, he will assuredly meet with weighty difficulties, but these difficulties relate chiefly to subjects—such as the degree of perfection of the geological record, the means of distribution, the possibility of transitions in organs, &c.—on which we are confessedly ignorant; nor do we know how ignorant we are. If we are much more ignorant than is generally supposed, most of these difficulties wholly disappear. Let the reader reflect on the difficulty of looking at whole classes of facts from a new point of view. Let him observe how slowly, but surely, the noble views of Lyell on the gradual changes now in progress on the earth's surface have been accepted as sufficient to account for all that we see in its past history. The present action of natural selection may seem more or less probable; but I believe in the truth of

the theory, because it collects, under one point of view, and gives a rational explanation of, many apparently independent classes of facts.[4]

[4] In treating the several subjects included in the present and my other works I have continually been led to ask for information from many zoologists, botanists, geologists, breeders of animals, and horticulturists, and I have invariably received from them the most generous assistance. Without such aid I could have effected little. I have repeatedly applied for information and specimens to foreigners, and to British merchants and officers of the Government residing in distant lands, and, with the rarest exceptions, I have received prompt, open-handed, and valuable assistance. I cannot express too strongly my obligations to the many persons who have assisted me, and who, I am convinced, would be equally willing to assist others in any scientific investigation.