CHAPTER XXXVI.

(3.) *Variation under Domestication.—Artificial Selection.*

(3.) VARIATION UNDER DOMESTICATION.—It has been often stated that the variation of living beings under domestication is a truism. Ordinary people need to be reminded of truisms, especially when argument is to be based thereon. The first part of the "Origin of Species" is, therefore, devoted to this subject. (*a*) In plants. Familiar to everyone, and especially to floricultural folk, is the way wherein florists, by careful observation and selection, produce new varieties of fashionable flowers. The numbers of varieties of pelargonium or of fuchsia produced within the memory of those now living illustrate that to which I refer. The florist does not originate the changes ultimating in these new varieties. He watches. Nature, in her infinite variety, offers to him upon some particular plant a new form of leaf, a new blending of colors in the flower. He observes, he selects, he breeds carefully from the oddity. Within a short space of time, by his careful selection, he has aided in the production of a form of flower with the original faintly-marked peculiarity so intensified that the plant is hailed with delight as a new variety, and named Mrs. This, or General That. Let it be noted carefully, man has done this. Man, with his small powers, following the bent of his inclination, not following out what is of benefit to the plant, has helped to produce a new variety.

In 1793 some wild Scotch roses were planted in a garden. One of them bore flowers tinged with red. From this one, by selection, were produced twenty-six varieties within twenty years. In 1841 three hundred varieties were recognisable, all originating from the one variable plant of 1793. Between 1813 and 1835 four hundred varieties of pansy were derived from the wild and the garden violet. All the

varieties of dahlia have sprung from one original species since the year 1802 in France, since the year 1804 in this country. The varieties of apricot are all derivable from one wild species now to be found in the region of the Caucasus. All the various forms of plums have been formed by man's selection and evolved from the bullace, or *Prunus insititia*.

(*b*) In animals. So far reference has only been made to examples of the production of varieties of plants under the treatment of human beings. But in the investigation of animals similar facts are encountered. Horses, dogs, cattle, at once are suggested to our minds. Let us take, however, the more striking instance chosen by Charles Darwin. It is the case of the domestic pigeon. Under this general head rank carriers, tumblers, runts, barbs, pouters, turbits, jacobins, trumpeters, laughers, fantails. These differ in appearance, in the nature of their skeletons, in the period whereat the full plumage is acquired, in their eggs, in the manner of flight, in voice, in numberless points of internal structure. Yet all these varieties are believed by naturalists to have taken origin from the rock pigeon (*Columba livia*). For at least 5,000 years pigeons have been the pets of man, and during that time the selection of birds showing at first only slightly marked peculiarities has been pursued so carefully, so steadily, that there are now at least twenty sorts of pigeons, presenting differences more marked than are those obtaining between some genera of birds and of mammals. Few people could be found who would for a moment question the origin of all these widely varying forms from the one common parent within the period of man's sojourn upon the earth. The carrier, more especially the male bird, is remarkable for the wonderful development of the carunculated skin about the head; and this is accompanied by greatly elongated eyelids, very large external orifices to the nostrils, and a wide gape of mouth. The short-faced tumbler has a beak in outline almost like that of a finch; and the common tumblers have the singular inherited habit of flying at a great height in a compact flock, and tumbling in the air head over heels. The runt is a bird of great size, with long massive beak and large feet; some of the sub-breeds of runts have very long necks, others very long wings and tails, others singularly short tails. The barb is allied to the carrier, but, instead of a long beak, has a very short and broad one. The pouter

has a much elongated body, wings, and legs; and its enormously-developed crop, which it glories in inflating, may well excite astonishment, and even laughter. The turbit has a short and conical beak, with a line of reversed feathers down the breast; and it has the habit of continually expanding slightly the upper part of the œsophagus. The jacobin has the feathers so much reversed along the back of the neck that they form a hood; and it has, proportionally to its size, elongated wing and tail feathers. The trumpeter and laugher, as their names express, utter a very different coo from the other breeds. The fantail has thirty or even forty tail feathers, instead of twelve or fourteen—the normal number in all the members of the great pigeon family; these feathers are kept expanded, and are carried so erect that in good birds the head and tail touch; the oil-gland is quite aborted.

"Yet they are all pigeons," cries the thoughtless one, "you can never make them anything but pigeons." This cry is but another instance of the habit of mistaking names for things. They are all pigeons because their history is known. Were it not known, each would be placed in a separate species, perhaps a separate genus, from all the rest. The name simply expresses their community of origin.

(*c*) Circumstances favorable to man's selection. These are a high degree of variability in the individual animals and plants, many individuals, upon whom to work and from whom to select, favorable conditions for the propagation of the variation and careful attention by man to the living beings under consideration. These all explain themselves, but two other circumstances call for comment.

The changed conditions to which our domestic plants and animals are subjected appear to act directly on the organism as a whole, or indirectly on the organism by causing changes in the reproductive organs.

In connexion with the use and disuse of parts, it should be noted that not one of our domesticated animals is known that has not, in some country or another, drooping ears. As they are, when in a domesticated condition, no longer subject to being hunted by their quondam foes, they are no longer on the alert, no longer constantly listening and starting at the slightest sound that can be construed as sign of danger. Hence, ears are no longer erected at frequent intervals and

have not been these many years. Hence, the old habit has been lost and the ears, once habitually erect, droop. The statement that our domestic animals, when allowed to run wild, revert to the aboriginal condition, rests upon no decisive facts.

Above have been given one or two of the instances of human ability, with limited knowledge, with limited power, with limited time, to produce by artificial selection, on the basis of pleasure to mankind, not of profit to the plant or animal, varieties that, but for ancient prejudice, would be regarded as distinct species, or even as distinct genera.

CHAPTER XXXVII.

(4.) *Variation under Nature.*

(4.) I TURN from the consideration of variation under domestication to variation under nature. This exists. Of that no doubt can be. Those differences that mark off individuals of the same species, nay, actual descendants of the same two parents one from another, those individual differences are due to the infinite variation of nature. Man has times and again taken advantage of her variability in connexion with plants or animals under his own observation.

Does anyone exist whose youthful being was not brightened by a ray of hope when some far-seeing friend tendered the problematical half-crown as payment for the discovery of two blades of grass exactly alike? I, for one, can remember not a few fruitless hours, spent in the search for the identical grass blades, at a period when time was of less value and half-crowns of as great moment as now. Not altogether fruitless were the hours. I came face to face with the great mother even in those childish seekings, and no child, no man can do that without being the happier and the holier. Nay more, even then the great truth sank into the mind of one unconscious, to dawn upon me again in the after time as almost a new revelation, that she was not uniform, but infinitely variable. One has to give up the idea that the two identical grass blades are to be found, as one has to abandon the hope of finding the pot of money at the foot of the rainbow, and many another dream of childhood; but one is not the worse for parting with the fanciful beliefs, nor the worse, let us hope, for having held them once upon a time.

Nature is infinitely variable. You will never see two human beings exactly alike. Even the two Dromios and the brothers Antipholus have points of difference that the master, after his wont, does not fail to bring out in the im-

mortal farce. Two wild roses built on precisely the same model never bloomed. The very leaves upon the same bough are never quite identical.

CHAPTER XXXVIII.

(5.) *Natural Selection.*

(5.) NATURAL SELECTION.—Given this variation under nature, the question arises—how is it connected with the formation of species? What is the relation between this universal variation and the Evolution of the many from the one? To understand this it is needful to consider the struggle for life that is unceasingly visible.

(*a*) The struggle for life. The world is one great battle-field. Over all its surface, within the depths of its waters, in the very air that belts it round is eternal strife. All living beings, from loftiest to lowest, are fighting unceasingly. The life of our huge cities, with its struggle of class against class, and of individual against individual, with, on the part of him that would triumph, an unremitting toil and an intense devotion to himself and his that are needful as they are awful in their desperation, with its doing unto death of the many that is the inevitable accompaniment of the success of the one—that life, I say, that is so full of the terrible that the very stars shiver as they look down upon it and hear the sound of the city's inarticulate moaning pass by them into the infinite, like a wandering ghost—that life is the type of all life. In the darkness of the soil of the earth the roots of the plants are struggling with each other for food. In the microscopic drop of water the Infusoria sweep ceaselessly round and round, striving for the food that is not sufficient for them all. Never ending contest. Interminable strife. Every living being is an Ishmael. Its hand is against all others. The hands of all others are against it. And as among men, so also among the more lowly organized creatures, the bitterest struggle is ever between those who are akin one to another. Wherefore is the contest? For wealth or glory, or a lasting name? Nay, for bare life. The struggle everlasting is for the very means of existence. It is as the

struggle of a famine-stricken multitude for the bread that is not sufficient for their wants. *Væ victis*, woe to the conquered is the cry of the world. If plant or animal succeed not, away with it! Let it perish, trodden to death beneath the feet of its stronger brethren hurrying onwards for food.

How does Nature, in her silent fashion, take advantage of the eternal variations occurring in the flowers that turn her bosom into a firmament of many colors, of the variations occurring in the animals that traverse her wide plains or pass through her solemn woods?

(*b*) The theory. By Natural Selection or the Survival of the Fittest. The former phrase is Charles Darwin's; the latter is that of Herbert Spencer. Let us try to understand them, for phrases such as these are as the utterances of the prophets of old times, and are to stir the thoughts of men long years after they are first spoken.

Who, then, are to be the survivors in this battle? Who are doomed to be numbered among the slain? Those best fitted for the struggle will survive. Those least adapted to the circumstances of the unending fight are doomed. The fittest will hold out the longest. That which possesses in strength or in any other way an advantage over its fellows will conquer them in the struggle for existence. Now, mark! If any variation in any individual plant or animal is of such a nature that its possessor will be better fitted for life-work, that possessor will have an advantage over its fellows—will stand a better chance than they of surviving, will transmit its variation to its offspring, possibly in intensified form. The offspring, even better fitted than their parent for life, triumph yet more completely over their fellows. Thus is the original slight variation strengthened until, after a long time, forms result so differing from the first individual that presented the variation, that the biologist is constrained to regard them as belonging to a species other than that comprising the original plant or animal.

This is the great principle of Natural Selection, or the Survival of the Fittest. The variations that are of benefit to the beings possessing them are naturally selected. The enunciation of this principle, and the elucidation thereof, have been in especial the work of Charles Darwin.

(*c*) Multiplication and checks. Following his plan let

us dwell for a moment on this life-struggle wherein all living things take part. All plants and animals tend to increase at a rate that to those who have not considered the question appears marvellous. Man, one of the slowest of breeders, will double in numbers if population is unchecked, in between twenty and twenty-five years. It has been calculated that one pair of elephants, the animals ranking lowest in this respect, would produce in 750 years no less than 19,000,000 descendants all living at the same time. What checks exist then to prevent this world-embracing increase of organised beings? The old answer is only too ready—Disease and Death. No living beings can exist without food. The quantity of food for any given plant or animal within the reach of that plant or animal and obtainable by it, determines whether it will live or die. The average number of any particular species is dependent, therefore, on the amount of its food. Very often the average number is dependent on whether the species under consideration is a prey to other beings or not. Climate again plays an important part in this determination as to which are to survive, which are to succumb. It is hardly necessary to point out that climate reacts upon animals and plants in their life-struggle by acting upon their food supplies. Epidemics are another limiting check. With the lower plants or animals, as with the highest, these agencies for the limitation of numbers work, and with the lower beings these and such as these alone. But in each of these is, as it were, an element of brutality. Nature does not prevent the production of living things. She remorselessly kills them by the thousand after they have been produced. It is well, therefore, when advancing knowledge gives to the highest of animals other means of limiting the number of its offspring than are offered by the blindly acting forces named above. Animals of a predatory nature are also a cause of destruction to others and to plants. These all play their part in the universal struggle. Certain other points of great moment remain in connexion with this struggle for life.

(d) That the relations of organised beings in this contest are infinitely complex. Red clover depends for its existence as a species on humble bees. The number of humble bees depends on the number of field-mice, for the field-mice destroy the combs and the nests of the bees.

The number of mice is not altogether unconnected with that of the cats in the locality. "Hence," says Charles Darwin, "it is quite credible that the presence of a feline animal in large numbers in a district might determine the frequency of certain flowers in that district."

(e) Closely allied species will wage the most internecine warfare. They have similar structure, similar habits, require similar food. They therefore come into contact with each other—nay, they are face to face contesting for the food whereon their very existence depends.

(f) The structure of every living being will be related even though the relation is not always perceptible by us to that of all others wherewith it comes into competition, wherefrom it has to escape or whereon it has to prey.

(g) Again, Natural Selection works upon living beings at all ages, not necessarily upon adults alone. Any variation in the larval condition of an insect that better fits its possessor for its struggle with its fellows and its surroundings will be likely to become established, and in not a few cases to react upon the organs of the adult.

(h) Further, the theory of Natural Selection is not opposed to those remarkable instances among animals where a number of individuals live together in colonies with division of labor, the result of the different capacities and different structures of members of the same species. Of this the hive bees furnish the most familiar example. Here are drones or males, queen bees or females, neuters or ordinary working bees. Division of labor is a distinct advantage. Bees, therefore, tending to produce eggs, which, under certain conditions, become males, under others become females, and under yet others become workers for the community at large, will have such advantages over bees only producing eggs that will develop into males or females as to determine their survival, as the fitter.

(*i*) Natural Selection is aided by that intercrossing of individuals that seems universal. Of course, where the two sexes are in separate individuals, as in the higher animals and in some plants, such intercrossing must occur, and the different natures of the male and female parents will give opportunity of variation in their offspring. In most plants, and in some animals, the sexes are united in the same individual. An ordinary flower contains both pollen or ferti-

lising dust and ovules or unripe seeds. Nevertheless, self-fertilisation in plants is the exception, not the rule. Of late years it has been shown, notably by Charles Darwin and Sir John Lubbock in England, that in the flowers that the botanists of the past believed to be always self-fertilising exist the most elaborate arrangements for the prevention of self-fertilisation. Precautions in structure, precautions in function, are taken, as it were, to prevent the unripe seeds of flower A from being fertilised by the pollen of flower A, whilst structural and functional facilities are afforded for the fertilisation of the ovules of A by the pollen of B—*i.e.*, some other member of the same species. Even in the few cases where self-fertilisation does seem to occur, an occasional intercross with some other individual of the same species is always attended with increased vigor on the part of the offspring. In fact, the intercrossing of individuals among both plants and animals, either constantly or occasionally, seems universal. It is almost needless to point out that this concourse of two separate beings in the reproduction of their kind gives much more opportunity for variation, and therefore a much wider field for the action of Natural Selection.

(k) The principle of Natural Selection involves the idea of divergence. If the principle be true, as variations occur useful ones will be selected, and in transmission to descendants they will be strengthened. More than one kind of variation—nay, many variations, may occur in the same species of animals or plants. Those that are of use will all be perpetuated and intensified, and as they are of different natures, affecting different organs, it follows that the individuals possessing these variations, and their descendants, will tend to differ more and ever more from one another and from their common ancestor. There are so many places to be filled up, there are so many different kinds of circumstances to be encountered, the surroundings of living things are so endless in their diversity, that the more diversified, the more strongly marked off one from another the descendants of primordial forms become, the more chance have they of taking places as yet unoccupied in nature, of adapting themselves to conditions as yet not satisfied.

(*l*) This principle helps to explain the advancement that is so recognisable in organised beings. Natural Selection

must lead to the improvement of species. Variations occur. Only those variations that are of use are selected and last. Hence a steady advance in organisation, an ever-increasing adaptation of the structure and functions of the living thing to the conditions of its environment. The old talk as to the perfection of nature must be reconstructed. There is much that is very remarkable in the adaptation of certain structures to particular functions, but it is quite impossible to speak of nature, as a whole, as if absolute perfection reigned. There are thousands of gigantic blunders in the universe, blunders that we can see, and whose ill effects are too sadly evident, though we are powerless to remedy them. The world is only "in its go-cart." Terrible errors, the most wanton waste, the awfullest sacrifice of living things, meet us at every turn. The "perfection" of nature is not in her having attained. It is in her increasing advancement. She stands not still, rests not quiescent in a beatific seventh heaven of perfect, designed adaptation. She is ever advancing, ever improving, ever casting away the weaker and the worthless, rejecting the results of her false trials, and retaining the strong, the worthy, the true. Nothing is more comforting, nothing more peace-giving, when one is weary by reason of the way, than this consciousness that in the evolution of all things, of thought as well as of form, the best must survive. Its development is slow, is the work of so many, many years that some of us are apt to grow impatient. But it is certain. The fittest survives in thought as in form. But the evolution of the highest species occupies centuries; an advance of one step towards better things occupies years, and the lifting of a world of thinking men and women to a loftier standpoint than they held aforetime is a labor that lasts long, and involves toil and patience without end. Natural Selection involves the extinction of intermediate forms. Some alteration in the structure or the habits of a living being is for its good. The more marked that alteration becomes, up to a certain limit, the better for its possessor. When that stage in development is attained wherein the change is so noticeable that the adaptation of the organ or the function to the circumstances of life is as complete as possible, the representatives of that stage will have a better chance than all their predecessors in the struggle for existence. They will therefore slay

those predecessors. The intermediate forms less adapted to the life conditions than those to which they have given rise, and even, perhaps, in some senses than those whence they took origin, must die out. They have done their work, and they pass. They have been the stepping-stones for all things to advance to something better than had been attainable before. They are like the Russian soldiers who fell slain into the ditch, and made a path for their successors to tread onward and take the citadel.

(*m*) Low forms. And yet certain lowly organised forms last. All the world does not consist of men and oak-trees. Low down among the animals and vegetables are beings possessed of life, but in its humblest, dullest forms. Without nerves or sense-organs, with little or no power of movement, they lead their strange, solemn life without a dream of the mightiness around them. The tree grows its hundred years, and spreads giant arms leaf-laden to all the winds of heaven. Its time comes and man fells it, and hews it into timbers for some stupendous vessel that shall bear men and women, and merchandise, and books and messages of love, and news of births and deaths, over fathomless seas to continents that are leagues asunder. And through it all, and through time dating back to the days when ships were unknown, perhaps when man himself was not, the one-celled Protococci, the specks of protoplasm called Amœbæ live out their little lives, and are born and die every hour. Does Natural Selection account for these? Assuredly yes. They are fitted to the conditions wherein they are, and they survive. From such as they, it may be, originated in the past, by variation, the beings that in the myriads of years have by variation under Natural Selection given origin to the loftier plants and animals. They, however, are the lineal descendants of the beings that underwent no variation. They are adapted to the same life-conditions as their ancestors. They fill the same place. They survive because they are exactly adapted to their surroundings.

(*n*) Circumstances favorable to Natural Selection. Charles Darwin names: great individual variability, large numbers of individuals, inheritance, little tendency to reversion, isolation, large areas. It will be seen that some of these are identical with those of value for Artificial Selection. The first needs but little discussion. But, to my thinking

a word ought to be said on the second point. The more especially is this necessary when we bear in mind the use often made of Darwin's insistment on the value of numbers in Natural Selection by the teachers of improvidence and worse than improvidence to the people. The folk who are most opposed to that needful conjugal prudence that is at once the safeguard and the hope both of individual and nation, on the few occasions when they introduce aught of scientific talk into the discussion, persistently remind us that Darwin speaks of the value of numbers in Evolution. Therefore man is to endeavor to produce as many of his kind as he can, that thus Nature may have large store whereon to work, and that thus may be the chance of many variations. Placing for the moment entirely on one side the crime of bringing into the world beings whose lives can only be a burden to themselves and to others, I believe that even if we regard this momentous question from the Evolution point of view alone, it may be shown that large numbers are not necessarily of great value in Natural Selection. Truly, with large numbers there is more probability of variation. But the variation is not necessarily a good one. It is not necessarily a variation in the direction of advance. Nay, it is more likely to be a retrograde variation, in the direction of lower organisation and less perfect working. Repetition of similar parts or of similar offspring does not mean loftiness, but lowness of organisation with man. The production of numberless children of a sad sameness cannot give so much opportunity of variation in the direction of better physique and better performance of bodily functions from the lowest to the highest, that known as mental, as the production of a smaller number under more favorable conditions as to descent, as to birth, and as to after surroundings. I have discussed this question at greater length in my pamphlet on "Darwinism and Small Families."

Inheritance, or transmission of qualities structural and functional from parent to offspring, is an essential for the view maintained in the "Origin of Species," and the fact that it exists is familiar to all.

Reversion, or the throwing back to an ancestral form, as when a horse is born marked with stripes, is antagonistic to the last principle, and where reversion is weakest Natural Selection will work best.

Isolation, if only as lessening the chances of an intercross with other living beings whose character might be such as to obliterate the new variation, is of value.

Large area over which the modifying species may range, Darwin considers as of even more moment. For the life conditions are more complex, and each new form will come into collision with more numerous beings.

CHAPTER XXXIX.

(6.) *Laws of Variation.*

(6.) LAWS OF VARIATION. An interesting question, as difficult as it is interesting. Is it possible to lay down any generalisations that can be educed from the many observed facts? Our Master says, "Our ignorance of the laws of variation is profound." Nevertheless he has given us not a little help and instruction in this as in all other matters.

(*a*) Changed conditions have clearly much effect. Altered climate, altered food, altered modes of life, all work greatly. But they are not enough to explain all the variations that occur.

(*b*) Tendency to vary. For the present, as so many instances occur of variations that are not explainable on the ground of changed conditions, the evolutionist is obliged to speak of a "tendency to vary." He is fully conscious of the vagueness of the phrase. He only uses it for the time, as convenient, and in no sense as explaining these variations, that are due to causes at present not comprehended by him.

(*c*) Use and disuse. We find that parts falling into less and less use, and even ultimately into disuse, become aborted, whilst parts in full employ are apt to become especially developed. A few instances of abortion from lessened use may with advantage be given. In the island of Madeira are over 550 species of beetles; 200 of these have wings so reduced that they cannot fly, and of the 29 genera peculiar to Madeira all the species of 23 are in this state. The eyes of the burrowing mole are rudimentary. The various animals inhabiting the darkness of the caves of Kentucky are for the most part blind. The muscles for moving the ear are present in man, but are very small, and, as a rule, not functional.

(*d*) Acclimatisation. Our domestic animals live and breed in the most diverse climates. On page 113 we read:—"As we may infer that our domestic animals were originally chosen by uncivilised man because they were useful and because they bred readily under confinement, and not because they were subsequently found capable of far-extended transportation, the common and extraordinary capacity in our domestic animals of not only withstanding the most different climates, but of being perfectly fertile (a far severer test) under them, may be used as an argument that a large proportion of other animals now in a state of nature could easily be brought to bear widely different climates."

(*e*) Correlated variation. "Correlated growth" implies that in living creatures the modification of certain parts of the body structure is invariably accompanied by variation of other parts without apparently any known connexion between the two. The time will come when we shall see something of the "why" dogs without hair are provided with imperfect teeth. And, indeed, may it not in this very case be suggested that hair is a modification of epidermis, and that teeth are developed from the epithelium or mucous membrane of the mouth, while all the world knows that epidermis and epithelium are largely identical in nature? The time will come when we shall be able to explain why short beaks in pigeons are associated with small feet, long beaks with large feet—why a relation exists between the color of hair, eyes, and skin, and the liability to consumption—why mildewed vetches, when eaten by horses, affect only those that are marked with white, and affect them only on the white regions of their body.

(*f*) *Balancement* or compensation. Excess of development in one part of an organism entails lessened development in some other part. The varieties of the cabbage that yield many leaves do not yield many seeds. The male cirripede wholly given up to reproduction has all other functions and the organs that perform them reduced exceedingly. (See page 228.)

(*g*) Multiple, rudimentary, lowly-organised structures are variable. The many similar stamens of a rose flower or the many similar body segments of a Centipede are multiple organs. They are eminently liable to variation. That rudimentary organs vary may be due to the fact that, as they

are useless any variations in them are not liable to be checked by Natural Selection.

(h) Highly developed parts variable. Thus the brain of man, an organ highly developed in him as compared with its development in his allies is highly variable in different individuals.

(i) Specific characters more variable than generic. The marks that distinguish one species of a given genus from another species are much more likely to exhibit variation than the marks that distinguish one genus from another genus of the same order.

CHAPTER XL.

(7.) *Difficulties.*

THAT there are great difficulties in the way of a full acceptance of the theory of Natural Selection—that there are many facts not easily to be reconciled with the theory—that much, very much, is to be done ere we can feel that more than a very partial explanation of natural phænomena is possible by this hypothesis, none is so conscious as the distinguished philosopher who first enunciated the principle. With the charming frankness and honesty that have ever marked his every utterance he states these difficulties in full. He states them with a clearness not always discoverable in the statements of those who are opposed to his views. Indeed, the strongest arguments they are able to adduce in controverting the views of Charles Darwin are those that he himself has brought forward in his "Origin of Species" as opposing his own conclusions on that most momentous question. He arms his antagonists. He places in their hands the strongest weapons that can be used against his theory. Thankfully enough have they accepted at his hands these same weapons, and it is matter for regret that they have not in all cases further learned from him something of that stately and peaceful courtesy that has been his throughout all the years of controversy, throughout all the time when such coarse and virulent abuse has been hurled at him as only falls to the lot of the founders of great creeds or of great philosophies. Charles Darwin is too honest not to state the objections to his own views. He is too confident in the truth of his doctrine not to meet those objections face to face and to strive his utmost to show that they are, in not a few cases at least, groundless. And, finally, ere we proceed under his guidance to the discussion of these objections, let it be noted that on the view that all species are separate creations, that none is evolved from any other,

the difficulties that lie in the path of the student of biology increase a thousandfold. The objections that are not easily overcome by the evolutionist are insurmountable by the advocate of Special Creation save by the formula, "It is the will of god."

If Natural Selection be a true hypothesis; if the many species that now live on earth have been evolved in the course of ages from a few forms, perhaps from one form of living matter, the first difficulty encountered is *(a)* the absence of the intermediate forms, the dearth of connecting links. If B has been evolved from A by successive gradations, why do we not find forms representing every stage in the process? Where are the multitudinous beings with particular structures or habits more marked than they are in A, less marked than they are in B? These questions seem to the present writer to be the outcome of a failure to fully comprehend the great principle under discussion. At least, there should be no indulgence of the expectation of meeting these transitional forms alive on the earth at the same time as that whereunto they have given rise, or even in many cases at the same time as that whence they took origin. For the principle of Natural Selection involves the idea of extinction. This cannot be too often stated. If a variation is naturally selected because it is of use to its possessor in the battle of life, the more strongly marked that variation becomes, up to a certain point, the better for the possessor. When that limit is reached, when the point of maximum satisfaction of the conditions of life then present is attained, the animal or plant is better fitted for living than any representative of the preceding stages. It will, therefore, infallibly slay its precursors. Further, whilst B is more likely to survive than any of the transitional forms connecting it with A, the latter probably will have a better chance than the forms that lie between it and B; for it must be remembered that there are numberless individuals of A that have not varied. Only some few, possibly only one, varied and gradually evolved B. Those that did not present any variation still remain fitted to their conditions of life. Their structures and functions are well adjusted to the conditions of their particular environment. They will therefore play their part in the extermination of the intermediate forms.

In connexion with this subject it seems advisable to point out another very common source of misconception as to the origin of species. So many of us seem to look for actual transitions between species now existing, forgetting that in many cases two species now existing and allied to each other have probably descended from a third form. My meaning will be rendered more apparent if I take a particular case. The opponents of the theory of the survival of the fittest, and even not a few of its adherents, are constantly complaining that they cannot see any connecting links between man and the higher apes. With a passing suggestion that a certain lack of perceptive ability seems evident here, and a casual reference to Aztecs, Bushmen, Hottentots, and English roughs, one turns to this aspect of the question. It has never, to my knowledge, been stated by any evolutionist that man is a lineal descendant of the man-like or anthropoid apes. It is more probable that he and they are the common descendants of some one ancestral form; that from that one ancestral form by variation along different lines were evolved the huge bestial gorilla and the human being that culminates in a Christ or a Shakspere. But though he that understands the full meaning of the term "Natural Selection" will not expect to find connecting links between species that are allied living synchronously with those species upon the earth, he will expect to find them represented in the past. His expectation will at present be but imperfectly realised. Turning to our chief record of the living things of the centuries that are past—turning to the series of fossil remains that lie embosomed in the earth, the student anticipates that there at least he will encounter these intermediate forms. He is not wholly disappointed. Many are met with, and the number is increasing every hour. But to say that at present we have found a hundredth part of the beings we desired would be false. Place side by side all known fossils, all known living things and the series is, alas! only too incomplete. We are still far from the day when the whole wondrous series, from the lowest speck of protoplasm up along a thousand different lines, through myriads of slight, accumulating variations to the loftiest plants and animals may lie before the awe-stricken gaze of humanity.

Here then is a difficulty of no small magnitude. Why

are not the connecting forms present in the strata of the earth? How does the advocate of the view held by Charles Darwin answer? In the first place, as has been shown, some such intermediate forms are found, and the presence of even one would be a distinct argument in favor of the idea of Natural Selection, Again the geological record is most imperfect. Of this no doubt can exist. Many living things in the past times had structures that did not admit of preservation. It is more than probable that there were long periods during which no provision was made by Nature for the preservation of living bodies when they had ceased to live. Only under certain favorable conditions can organic remains be preserved. Such favorable conditions have not always been forthcoming, and millions of organised beings must have died, and decaying, broken up into the carbonic acid, water and ammonia, that are the ultimate destination of all bodies of plants or animals, without any of them being preserved either in whole or in part, to teach a future age. Coming down to our time, with all our ghastly ceremony and retention of the dead matter after life has ceased, how much likelihood is there of the preservation of many of our endless varieties of domestic plants, domestic animals, or men? Many living beings have been so constructed as not to allow of their bodies becoming preserved. Long periods of time, many long periods of time, have elapsed during which no plant or animal remains could under the conditions then obtaining, be preserved. But of greater moment than these, in the reply to the difficulty to be combatted, is the fact that of the geological record, imperfect as it is, our knowledge is imperfect. What wide areas, what depths of earth, what seas and foundations of seas are yet to be explored! Man has been working for a fragment of time over an atom of space. In the future, working in the light of Evolution it is our hope, nay, our assured conviction, that link after link in the infinitely ramifying chain of living things will be found. The whole, in all probability, never will, never can be known, but each new discovery will not only in itself be of importance. It will, without doubt, suggest so much. For a discovery is like an uttered or written thought. Its value lies not alone in what it is, but in that which it suggests. No higher praise can be awarded to a thought either written or spoken than that it sets other

people thinking, that it takes its place in many minds, and entering the great world of ideas, finds it has kinship with not a few of the inhabitants.

(*b*) Is it possible, cry the opponents of Natural Selection, to conceive that a highly organised structure—such for example, as the human eye—can have been evolved from a more simply constructed sight organ? Is it possible, say they, to conceive that, from the minute collection of pigment cells constituting the eye of an infusorian, the visual organ of a Mammal can have been evolved? The study of Comparative Anatomy reveals, however, every single step in the gradation from the one to the other, in the particular instance chosen, at least, and there is less difficulty in believing that each term of this series have been evolved from its predecessor and will evolve its successor, than in believing that each, with all the co-ordinated structures that with it constitute a given organ, have been the result of an act of special creation. As bearing upon this question of the origin of complex structures, it is worthy of note that of late years the remarkable organs connected with the senses of sight, hearing, smell, and taste have all been shown to originate from involutions of the integument of the embryo. The tongue, with its three kinds of sensory papillæ; the nose with its convoluted bones covered by the delicate membrane with its internal world of microscopical structures; the ear with its canal, its membranes, bones and fluids; the eye, with its coats, the least whereof presents a succession of six or seven layers, with its lenses, muscles, and ligaments—all these are formed from the integument and the tissues immediately subjacent. Yet again we must never forget that we are far too ignorant of what is or is not of actual use to a living being to determine offhand that this or that particular modification, however slight, is of no value. We can only judge for the most part of large effects, and therefore in our usual complacent fashion, are ready to state that slight alterations, though tending towards some palpable result, are of no conceivable importance.

(*c*) One great argument, usually brought forward in opposition to the Darwinian hypothesis, is that the animals and plants of Egypt have, during the last three or four thousand years, presented scarcely any variation. The fact tells as strongly for Charles Darwin as against him; for

during the last three or four thousand years the conditions of life in Egypt have remained absolutely uniform.

(*d*) Many structural characters appear to be valueless to their possessors. These therefore, say the antagonists, cannot have been influenced by Natural Selection. In reply it has been urged, (i.) That great caution must be exercised in determining what are useful and what are useless. Who would have anticipated that the multitude of curious structures encountered in the flower of the orchid, had one and all the most minute and special reference to the cross-fertilisation of that plant by means of insects? (ii.) The principle of correlated growth must be borne in mind. The modification of some one part may be of use to the creature. Alterations in its structure will be accompanied in other organs by alterations not necessarily of use to the being under study. (iii.) Once again the conditions of life play an important part.

(*e*) Instinct. It is especially when the student turns to the habits of living animals that he is inclined to join issue with the advocates of Natural Selection. Even though he be willing to grant its potency in the modifications of form, he may experience difficulty in applying its principles to those functions in living beings which are frequently looked upon as holding a different rank from the ordinary bodily functions. He may feel some doubt whether the principle of the survival of the fittest will explain the gradual evolution of instinct, or that untaught ability whose highest phases seem to blend with the lower forms of reason. But none will deny that in the higher animals at least there are infinite variations in mental qualities. Few will deny that similar variations in mental qualities occur even amongst beings lower in the scale than man and the domestic animals. Of such mental variations some are for the advantage, some to the disadvantage of their possessor. The good and the bad alike come under the great law of inheritance, and will be transmitted to descendants. As surely as a particular variation in structure, better fitting plant or animal for the life struggle, will be transmitted with intensification, so surely will a variation in mental qualities better fitting an animal for the battle of existence, be transmitted with intensification, until the bee is building its cell, the ants present their classes of soldiers, slaves, food suppliers, egg producers, or

the cuckoo ceases to make its own nest, and by force wrests from its weaker fellows a home for its young. Herein, moreover, once again lies man's greatest hope. Of physical advance on the part of man the future holds out but little prospect. Of the mental advance of human kind the probability is as great as our longing for it. Of variations in thought, in taste, in creed, in philosophy, there will be, as far as we can judge, no end. And he that fears and doubts as to the future of his race when he sees the myriad forms of mental variation of this very day—he that raises his voice aloud in the cry that humanity is drifting towards the quicksand, or on to the rocks, or over boundless seas that beat on no created shore—he that can see looming in the future nothing but hopelessness and ruin—knows not of the calm assurance wherewith the student, in his better moments at least, looks into the dread face of the coming time. For him, firmly cleaving to his belief that the tendency of all things is to the better, there is no absolute freedom from anxiety, no entire absence of dread, for he is human. But he looks beyond his own narrow and ever narrowing life, looks beyond the scene and the time wherein he plays his infinitesimal part, and in the dim haze of the after years beholds, shaping themselves forth, still as shadows and as yet unformed, the creatures of a world which shall be as the fabled Eden of old and as the earth was in the golden age when the gods dwelt among men. He knows that the men and women of the ages he is never to look upon will be of a race higher than his; that envy and selfishness and pride will not always hold their accursed sway, but that all living shall move over the broad and bounteous earth, informed with gentleness and inspired with love. He believes that towards that far off divine event the whole creation moves, and in his every thought, word, and deed, that are not marred by his baser self, he strives, as he has strength, to hasten on the time when the peace and beauty of that hour shall descend upon a sorrow-stricken world.

(*f*) Hybridism. If the pollen of a flower of a given species is placed on the stigma of another flower of an allied but not identical species, very generally the resulting plant, whilst partaking of the nature of both parents, differs from both of them in being sterile. The mention of the name of the mule is enough to remind everyone that in the animal kingdom

the same sterility of the offspring of closely allied species is a recognised phænomenon. By many the fact is regarded as overwhelming evidence against the views of Charles Darwin. If that distinguished naturalist had ever said that new species were formed by the crossing between older forms, the facts connected with hybridism would tell strongly against him. But it is hardly necessary to say that he has never made any such statement. Nay, more, he has endeavored to show that the sterility of crosses and their hybrid progeny has not even been acquired through Natural Selection. Those who hold that species are in every case the result of a separate act of creation, point to the sterility of crosses between species as a proof of an arrangement to prevent variation and consequent formation of new forms. It is as just to drag in the phrase of "special provision of sterility to prevent crossing." as it would be to speak of a special provision whence result difficulties in grafting trees that are closely allied. Sterility, be it observed, results from causes other than crossing. Thus, species exposed to new unusual life conditions are often for a time sterile. As Charles Darwin has pointed out, here is a remarkable case of parallelism. Slight changes in the conditions add to the fertility of living beings; considerable changes temporarily destroy it. Crossing between forms very closely allied, as in the constant cross fertilisation of plants, has distinct advantages ; crossing between forms more widely differing destroys fertility.

In the words of the great author of that work, I would remind all that in the hypothesis of Natural Selection we have only a hypothesis. There is at present, on the main question, only one other hypothesis before us, that of the numberless species on the earth having each and all originated from distinct acts of creation. It is the bounden duty of all whose minds are not in bondage to choose of the two theories the one that is in accordance with, links together, and makes comprehensible the larger number of facts. The theory of Natural Selection is in accordance with our knowledge of the domestic animals and plants, and with our knowledge of animals and plants not yet under the sway of man. The theory of Natural Selection links together the species, genera, classes and sub-kingdoms of living things, and renders intelligible the wonderful series of organic life. We see, after studying this hypothesis, a meaning in the

endless gradations whereby every form of plant and animal graduates into all others. The presence in so many beings of rudimentary organs apparently of no functional importance, the facts in connexion with development whose number and value are hourly increasing, the great principle of structural types in the two kingdoms of animated nature—a thousand things such as these are full of meaning to us now. The flood of light thrown by Charles Darwin on the labors of the biologist have given to him the power of working as one no longer blindly groping in the dark. He toils in the light of a dawn that is to grow into a day of knowledge, the brightness whereof is by us not to be conceived.

With the acceptance of this view there is no loss of the beautiful. Nay, in very truth a new loveliness is added to all nature as we study her with this for guide. A holier wonder than we knew aforetime falls upon us, a deeper awe dwells within us, and in our heart of hearts we feel our reverence deepening as our superstition fades away.

CHAPTER XLI.

(8.) *Arguments for Natural Selection.*

IN truth the whole of the "Origin of Species," and of this analysis of the book up to this point, have been reasoning and fact-producing in favor of the theory. But the latter part of the book and the latter part of this epitome are specially devoted to the statement of arguments on behalf of the survival of the fittest.

(*a*) Distribution of organic beings in time. The student of geology, despite the small amount of evidence as yet at his command, has ere this recognised the important fact that there has been much extinction of animals and of plants in the past, accompanied by the appearance of new and more highly organised forms. As he traces out the fossils of the strata that are the burying-grounds of past ages, he finds that forms that are prevalent in certain layers are not to be found in adjacent ones, while other forms have appeared that were not encountered before. This extinction and appearance are not comprehensible on any theory of Special Creation. But they are both understandable, and, indeed, are intimately connected, on the view of Natural Selection. Of course, the extinction is not in reality sudden. Rarity precedes it. And in the more recent tertiary formations, as in the cases where, through man's agency, animals have been exterminated, there is evidence enough of this precedent rarity and subsequent extinction.

The marine forms of life change almost simultaneously throughout the world. Thus our European chalk formation can be recognised in many distant regions under the most different climates, where not a fragment of the mineral chalk itself can be found—namely, in North America, in equatorial South America, in Tierra del Fuego, at the Cape of Good Hope, and in the peninsula of India. For at these distant points, the organic remains in certain beds

present an unmistakeable resemblance to those of the chalk.

As to the land forms we have not at present sufficient evidence to decide whether a kindred truth obtains in relation to them. Now this parallel succession of living beings of kindred nature throughout the world fits in with the great theory. For the new species resulting from successful variation are dominant as having advantages over their parents who once were dominant. The new forms that win will be of allied nature, having the advantageous variation in common. The older forms that lose and are extinguished will be of allied nature having the disadvantageous characteristic or characteristics in common.

The close connexion structurally between extinct forms and also between them and living beings is only to be understood on the view of descent from a common form.

Again, on the theory of Natural Selection the later animals and plants in the geological strata ought to be more highly organised than the earlier ones. And this is the case.

(b) Distribution in space. Three large facts stand out prominently in the study of the geographical distribution of living things. (i.) Neither the similarity nor the dissimilarity of the inhabitants of various regions can be wholly accounted for by climatal and other physical conditions. The old and the new world present in physical conditions a striking parallelism. Yet their flora and fauna are very different. (ii.) Barriers such as mountains on land or an isthmus in the ocean are closely related to the differences between the productions of various land or sea regions. (iii.) There is a notable affinity between the living beings of the same continent or of the same sea. The species differ from each other, but they are related.

(iv.) A question of deepest import arises in this connexion. Have species appeared originally at one or at more than one place on the earth's surface? Was there for each new species one centre of evolution or more than one? Charles Darwin decides in favor of the former view. He considers it as probable that one particular area has been the scene of the appearance of each new species and that from that area certain of its individuals have migrated to "fresh woods and pastures new." This decision necessitates the discussion of means of dispersal. If one area of land or sea

was the primal home of a given species it behoves us to inquire by what methods that species has spread thence into other regions. Change of level in the land or the floor of the sea is one means. Water-currents are other agents. The flow of brook or river seawards and the waves of ocean play their part in bearing seeds of plants far from their original home. It is surprising how many seeds are entirely uninjured by prolonged immersion in sea-water. Winds as well as waters aid in the diffusion. Living birds in their flight from place to place bear seeds adherent to their soil-stained claws or to their feathers, or even carry them uninjured, undigested within their bodies to be deposited on the earth of other lands. And the consideration of the fact that icebergs are no inconsiderable helpers in this prevalent dispersal leads to reference to the glacial period.

There is overwhelming evidence that within a very recent period, geologically speaking, Europe and North America were arctic regions. Further, there have been in the past alternations often repeated of cold or glacial epochs with times when the temperature was higher, and thus arctic forms of living things would slowly move southwards and northwards, southwards and northwards age after age. Every ten or fifteen thousand years, says Mr. Croll, these glacial conditions return, and it is not difficult to imagine what changes in the geographical distribution of plants and animals would be effected by these vast recurring transitions from lower to higher temperature and from higher to lower.

The denizens of fresh-waters are wonderfully allied throughout the world. At first when we consider the physical barriers between lakes and lakes, rivers and rivers, this seems rather inexplicable. But here again birds are agents in the transportal of seeds from one piece of water to others.

(v.) Oceanic Islands. Certain facts in regard to the distribution of plants and animals upon islands are very understandable on the theory of Evolution but not upon that of Special Creation. The total number of species on an island is usually small, but the number of endemic species or those not found elsewhere is relatively large. Galapagos islands have only twenty-six species of land-birds; of these twenty-one are endemic. Again, members of the great Vertebrate

class Amphibia (frogs, toads, newts, salamanders) are not known upon oceanic islands. And this is to be expected, as these animals and their ova are killed by sea-water. So also on islands over 300 miles from a mainland no terrestrial mammal is encountered for the like reason. But aerial mammals, such as bats, are to be met with on these islands.

Again, there is a connexion of deepest interest between the depth of the water that lies between two adjacent islands or an island and an adjacent continent and the relationship between the flora and fauna of the two places. When the depth is not great the difference is not great. When the depth is excessive the difference between the living beings of the two places is more marked.

Again, the fact that the species on any given island have affinity to those on the nearest mainland is intelligible enough upon the view taken and taught by Charles Darwin.

(*c*) Classification. It is well-known that all systems of classification are essentially artificial. Nature knows no classification. Time was when men believed that they could draw hard and fast lines between one group of living beings and another. On the theory of Special Creation this ought to have been eminently possible. But further study has shown this to be impossible. All living things graduate one into the other. It is not only impossible to separate man from his allies, the Quadrumana from the rest of the Mammalia, the Mammalia from the Birds, the Vertebrata from the Invertebrata. It is not possible to separate absolutely animals from the plants or even the living from the non-living. And all this is both instructive and encouraging. It is all strong evidence in favor of Evolution and against Special Creation. On the latter view no reason can be shown why this gliding of species into each other should be. On the former this is fully to be understood. And thus as man comprehends the connexion of all forms of matter, living and non-living, he is led to embrace Evolution as the only explanation of this as of so many other facts.

Whilst this is the broad and most general aspect wherein to regard the facts of classification one or two minor points are not important. We can by aid of Evolution understand why parts that are not concerned with any habits special to the being possessing them are important in classi-

fication. The reproductive organs are the most valuable in classification. It is also possible to understand why rudimentary organs are useful in grouping animals or plants, and why mere analogical resemblances as that of a bat to a bird or of a mouse to a shrew-mouse are very misleading and valueless to the classifier.

(*d*) Morphology. The study of organs. More especially is it Homology or the study of likenesses in structure that strengthens in every case the view of the Evolutionist. That man's arm and hand, and the bird's wing, and the crocodile's fore-leg, and the fish's fin are all built on the same general plan is very intelligible when we conceive that man, bird, crocodile, fish have all evolved from a common Vertebrate progenitor. Not, I think, very intelligible on any other hypothesis.

(*e*) Development. In their life-history the higher animals pass through stages that represent the adult conditions of animals lower in the scale. These stages are not identical with the adult conditions of the more lowly organised beings. They only resemble them. They suggest rather than actually imitate. What is the meaning of this on the theory of Special Creation? No explanation is offered by the advocates of this view. But this development of man from a form that is not distinguishable at first from the complete condition of one of the lowest living things, through stages that suggest invertebrate adults, fishes, reptiles, birds, to his final condition is all very understandable if we hold that man is the result of development of lower forms into higher and yet higher until that which is to-day the highest is reached.

(*f*) Rudimentary organs. Here again are structures that are, to the special creationist, insurmountable objections, that are to the evolutionist guides and supporters. Man has, on the back of his hands, rudimentary hairs. No one has seriously suggested that these are of any functional import. On the one theory they are meaningless, redundant. On the other they are meaningful and tell of descent from an ancestral form, covered from top to toe with hair. So also with the useless wisdom teeth of man. They are troublesome in their arrival, are not used during their stay, and are a cause of pain in their departure. They are of no use because the jaw of man is nearly rectangular in outline, and in the right angle these teeth cannot work on the food. Once on a time,

when the jaw of our progenitor was obtuse angled, these teeth could and did work on the food. To-day they are slowly vanishing, are rudimentary. Still they are present. Without any significance on the theory of Special Creation, other than that of blundering, they are quite to be understood on the theory of Evolution. And thus with hundreds of rudimentary organs in plants and animals

And now let us pause and look back. Species is an arbitrary name for a group of beings having certain points of resemblance one to another. Two views have obtained as to their origin. That each species is the result of a separate act of creative power on the part of a god. That the many species of to-day are the result of development from some few forms or one primordial form of living being. In favor of the former view are the first chapters of Genesis and no facts. In favor of the latter are the following. Variation under domestication occurs. Artificial selection, exercised by man according to his tastes and fancies, not necessarily in accordance with the well-being of the plant or animal, has produced new beings that but for their known history would be named species or even genera distinct from any yet known. There is also variation under nature. There is a natural selection or survival of the fittest. As all plants and animals vary, whenever any variation is of such nature that it gives its possessor a better chance in the eternal life battle, that variation is likely to be transmitted, to be intensified, to become permanent. Against the theory are the absence, either to-day or in the yesterday, as recorded in fossils, of transitional forms, organs of great complexity as the human eye, organs that seem of little importance, instinct, hybridism. Not one of these same difficulties is in any degree lessened by the doctrine of Special Creation. They are not surmounted by saying, "It is the will of god." Each one of them can be and has been encountered and explained by the evolutionist. On the other hand, the facts of the distribution of living things in time and in space, of classification, of homology, of development, of rudimentary organs, all strengthen and are explained by the theory of Evolution, all weaken and are inexplicable by that of Special Creation. Let it be added that every new discovery of every hour ranks itself on the side of Evolution, and is foe to Special Creation, that all scientific thinkers of every order of thought are to-day

Evolutionists, whilst the ignorant are, to a person, Special Creationists. Choose you, reader, this day, whom you will serve

CHAPTER XLII.

B.—*Animals and Plants under Domestication.*

THIS is the sequel to the "Origin of Species" promised in that volume. It contains the immense collection of facts upon which the conclusions arrived at and stated in its predecessor were based. Such a collection of facts has rarely, if ever, been made by one man. Necessarily, as the two large volumes are the record of accumulated facts, this is a work to be read rather than analysed. To comprehend it the student must master its innumerable details for himself. It is the duty of the analyser here to stand aloof. The detailed analysis that has been made of each of the other books would here be out of place. It is, again, superfluous to enumerate the beings as to which facts are recorded. Their name, like the number of the facts, is legion.

It is within the limits of this volume that Dr. Darwin broaches the idea of his theory of Pangenesis. The facts to be connected by this hypothesis are the various methods of reproduction in plants and animals, the action of the male element upon the female, the phænomena of development, the functional independence of the elements of which the body is composed, variability, inheritance, and reversion.

The attempt to connect all these various facts is made by the suggestion of the provisional hypothesis of Pangenesis. This assumes that (1) Every part of the body throws off gemmules, or exceedingly minute portions. (2) These gemmules circulate through the body, and, if supplied with proper nutriment, multiply by self-division and develop into the cellular structures or simpler structures whence they sprang. (3) They are transmitted from parent to offspring. (4) They may be developed in the immediately succeeding generation, or may lie dormant through many generations, at last to develop. (5) They are thrown off by cells or simpler structures at all stages of development.

(6) They have a mutual affinity, and tend to aggregate in buds, or in the sexual elements. (7) Their development depends upon their union with other gemmules that naturally precede them in the ordinary course of growth. Such union with their normal predecessors determines their development.

The conclusions arrived at are in the main identical with those broached in other volumes. This book is the supporter of those others by multitudes of facts. All, therefore, that is wisely to be done in regard to it is to briefly summarise those conclusions. They are as follows.

(1) Wild animals can be tamed. Complete subjugation by man depends on the tamed animal being social in habit, fertile under domestication, of service to man.

(2) Domesticated animals and plants vary greatly. They have been none the less exposed to greater condition changes than their wild fellows. Therefore

(3) Natural species probably vary.

(4) These variations are not only structural, but functional. Not only does the nervous system vary, but the mental attributes also change in the different individuals.

(5) New characters appear and disappear at any stage in the life-history, and are generally inherited by the descendants at corresponding periods of life. New characters are especially liable to appear in the male. Both these facts have much bearing on sexual selection.

(6) Not only do structural differences and mental differences obtain among our domestic animals. What are vaguely named "constitutional" differences also appear. The time of the second dentition, the period of gestation, adaptation to varying climates, tendencies to disease, liability to parasites and to the action of poisons differ much in different animals. Plants also differ under domestication in their adaptation to soils, power of resisting frost, times of flowering and fruiting, proportion of certain chemical substances in their seeds.

(7) There is a difference between domestic races and species and the wild. The latter are sterile when crossed. The former are not. The sterility of species when crossed seems to depend exclusively upon differences in the reproductive organs of the individuals that are crossed. Again, species long domesticated cease to be sterile when crossed. And finally in this connexion it is known that the life-con-

ditions of species in a state of nature have long been uniform. Now domesticated living beings have been subject to changed life-conditions within a very recent period. And changed life-conditions act specially on the reproductive organs.

(8) The points of resemblance between domestic varieties and natural species are many. (*a*) Both transmit their characters to their offspring. (*b*) In both prepotency of one form over another occurs. (*c*) In both there is liability to reversion to ancestral forms. (*d*) In both the laws of variability are the same. (*e*) The sub-division of both on the principle of descent with modification is possible.

(9) Domestic varieties differ from species in that when they do present points of difference one from another, those differences affect parts of the body of less moment than those that differ in species. If we remember that the differences in the former case are due to man's artificial selection, and in the latter to natural selection, this is understandable.

(10) Some domestic breeds, like almost all species, have varied by slow and insensible degrees. Some breeds and scarcely any species have originated from an original variation strongly marked.

(11) The tendency to reversion when domesticated living beings are exposed to the old wild conditions has been very greatly exaggerated.

(12) As causes of variation we have again—(*a*) Changed conditions. (*b*) Unequal combination of the characters of the two parents. (*c*) Reversion. (*d*) Use and disuse of parts. (*e*) The law of compensation or balancement. (*f*) That of correlation.

Finally, it may be interesting to quote the last few sentences of this remarkable book of facts and conclusions. They give no little insight into the views of Charles Darwin upon a topic of interest to all.

"An omniscient Creator must have foreseen every consequence which results from the laws imposed by Him. But can it be reasonably maintained that the Creator intentionally ordered, if we use the words in any ordinary sense, that certain fragments of rock should assume certain shapes, so that the builder might erect his edifice? If the various laws which have determined the shape of each fragment were not predetermined for the builder's sake, can it with any greater probability be maintained that He specially

ordained for the sake of the breeder each of the innumerable variations in our domestic animals and plants—many of these variations being of no service to man, and not beneficial, far more often injurious, to the creatures themselves? Did he ordain that the crop and tail-feathers of the pigeon should vary in order that the fancier might make his grotesque pouter and fantail breeds? Did He cause the frame and mental qualities of the dog to vary in order that a breed might be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport? But if we give up the principle in one case—if we do not admit that the variations of the primeval dog were intentionally guided in order that the greyhound, for instance, that perfect image of symmetry and vigor, might be formed—no shadow of reason can be assigned for the belief that variations, alike in nature and the result of the same general laws, which have been the groundwork through Natural Selection of the formation of the most perfectly adapted animals in the world, man included, were intentionally and specially guided. However much we may wish it, we can hardly follow Professor Asa Gray in his belief 'that variation has been led along certain beneficial lines,' like a stream 'along definite and useful lines of irrigation.' If we assume that each particular variation was from the beginning of all time preordained, the plasticity of organisation, which leads to many injurious deviations of structure, as well as that redundant power of reproduction which inevitably leads to a struggle for existence, and, as a consequence to the Natural Selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything and foresees everything. Thus we are brought face to face with a difficulty as insoluble as is that of free will and predestination."