in the hall, and she appears also to have had them in her keeping. During this time the king of the Franks died, and was succeeded by Gunthere, who immediately threw up his dependence upon Attila, and refused his tribute; and the Frankish hostage, Hagano, made his escape from Attila's court, and fled back to his home. But Walthere remained one of the most distinguished leaders in the army of the Huns, and their king, at the suggestion of his wife, sought to retain him by pressing upon him a Hunnish wife. But Walthere found, or pretended to find, an excuse for declining this proposal in the plea that the attractions of a female companion might withdraw him from, or make him less eager in, his path of glory. At length, on his return from a great victory he had gained for the Huns, Walthere, in a private interview with Hildegund, becomes enamoured of her while she is offering him the festive cup, still ignorant of the treaty of alliance which their fathers had formed for them. The result is, they agree to fly together, and make their way to the land of the Burgundians. As the opportunity for their escape, they choose a great feast-day, at which Walthere contrives that the whole royal household shall be made more drunk than usual, and, when they are all stretched helpless on the floor, he selects a swift horse from the stables, arms himself, and carries with him part of the king's most valuable treasures, and with his lover makes for the forest. Their adventures on the way, their dangers and escapes, the patience and constancy of the lady, and their final success, form the subject of the remainder of the poem. The romance of Walthere may be considered as belonging to that branch of the Teutonic race which established itself in Gaul.

VARIATIONS OF ANIMALS AND PLANTS UNDER DOMESTICATION.*

Charles Lyell and Charles Darwin are the two men who have most deeply affected the tone of scientific thought of the present generation. The one, assisted by a host of followers, has abolished spasmodic geology, and the other has contributed more than any other writer to suggest views of development in affinity with that exceedingly slow and orderly progression of the physical frame of the earth from one stage to another, which palæontological and

* "The Varieties of Animals and Plants under Domestication." By Charles Darwin, M.A., F.R.S., etc. 2 vols., with illustrations. John Murray.

lithological investigations have established beyond a doubt. The Darwinian theory may or may not account for the whole range of facts involved in the "Origin of Species," but the principles expounded by Mr. Darwin cannot be denied to exert, at the present time, a very important action upon organic beings, and to have exerted a similar action in past periods to an extent which must have been enormous though its limitations are unknown. Formerly, with the exception of a few daring minds, speculative science tried to accommodate itself to the prevailing theory that our globe was a novelty of some six thousand years date. Geology has completely overthrown this notion, and it is remarkable that while students of this particular science have made increasing demands upon time, they have been followed by investigators in almost all departments of knowledge. The ethnologist, the philologist, the anthropologist, the cultivator of the new and rising science of comparative mythology, all require the lapse of ages to account for the phenomena which their researches disclose, and the astronomer, reinforced by recent discovery in the belief in what is called the "nebular hypothesis," regards our planet as a portion of a system to which a great, though at present an incalculable antiquity must be assigned. Objections to Darwinism founded upon the time required for the supposed methods of operation now only linger in those portions of society which, considered from a scientific point of view, must be regarded as the least informed; but difficulties of other descriptions remain scarcely touched by accumulation of facts or by ingenuity of hypothesis. The opponent of Darwinism who repeats the old demand for connecting links, is indeed satisfactorily answered to a certain extent. Originally his question was based upon the belief that if numerous so-called species had descended from a common ancestor, or pair of ancestors, the transition forms ought to be abundantly discovered in living beings, or in the geologic record. If, instead of having to account for all the known changes in organic life, and in the structure of the earth-crust, by the supposition of causes acting very slowly and gradually, philosophers had only been allowed to add a few thousand years to the accepted chronology, they must have supposed natural operations so crowded together that the earliest parents and their remotest descendants could have been but slightly separated from each other, and immense portions of the whole scheme might have been simultaneously viewed at a single glance. But this is known not to be the case. Little progress has been made in converting geologic time into historic time, but the scheme of organic life as

unfolded by modern discovery, is so vast in its extent, that theories of development which did bring organically remote links into close chronological approximation, would, for that very reason, be rejected as untrue.

The sudden appearance in cultivated plants of characteristics divergent from the parent stock, and capable of hereditary transmission has been deemed to supply valid arguments against Mr. Darwin's system, which involves the belief that important changes have, for the most part, been extremely slow; but facts of this kind, lessened in value by the well-known tendency of the offspring of varieties to go back to ancestral forms, do not give much help to account for the extent of change that has taken place, or for the expenditure of time which there is evidence to show actually occurred. Spasmodic geology might account for the disappearance of one race of creatures, and special miraculous interposition might be assumed as the cause of another race of creatures taking the place of those which had been summarily swept away; but if the advocate of such notions complains that Mr. Darwin does not show sufficient connection between the present and the past, it may be retorted upon him that palæontology exhibits more resemblances between the fauna and flora of distant periods than ought to exist upon an hypothesis of frequent cataclysms and fresh creations.

If Darwinism is to be proved inductively, it must be conceded that the transition from simple invertebrate to vertebrate forms, from one vertebrate form to another, has to be exhibited by facts not yet known to exist. If it is to be proved deductively, we must be in possession of biological laws not yet discovered; but no science progresses without theory, and the Darwinian theory is entitled to provisional acceptance until a more probable one appears. Experience and observation, however industriously carried on, do not suffice unless they are made upon a system, so that they affirm or deny definite propositions. A new and unexpected fact may occur in the experience of two men—one supposes it may be correlated with certain other facts, and makes observations or experiments to find out if this is the case; the other observes or experiments without any distinct purpose. The first may arrive at an important law, or generalization, while the latter can at best only increase our stock of disjointed facts. Mr. Darwin's hypotheses are certainly admirable aids to a philosophical method of inquiry; and if, notwithstanding the amazing amount of research displayed in his present work, he has not materially affected the probability pre-

viously attaching to his speculations, he has more fully shown the ground on which they stand, and suggested almost innumerable directions in which further inquiry must be made.

In another work which is to follow the present one, he proposes to deal with the variations of organisms in a state of nature; and in a third work, to try the principle of natural selection by ascertaining how far it will account for the entire group of facts brought together in his previous publications.

A large part of the present work is devoted to elaborate details not given in his "Origin of Species." The additional evidence of this kind is highly important, but the greater part of it is confined to a few groups of animals on which man has exercised his ingenuity from early historic times to our own day, such as dogs, horses, cattle, pigs, rabbits, and poultry, in which latter term we may shock fanciers by including pigeons. As domesticated dogs date back to the days when pre-historic races formed the well-known "kitchen middens," it is not astonishing that the origin of the animals should be exceedingly difficult to trace, and Mr. Darwin inclines to the belief that they have descended from several wild stocks, much modified by breeding and human selection. Different breeds of dogs would certainly have been taken for different species, if their bones only had come down for the anatomist to examine. Isidore Geoffrey St. Hilaire "has shown that in size some dogs are six times as long, the tail being excluded, as others; and that the height relatively to the length of the body varies from between one and two, and one to nearly four." Cuvier remarked that their skulls differ more from each other than those of any wild species belonging to the same genus, and there are differences in the number of their teeth. Within very moderate periods, great changes, capable of hereditary transmission, have been produced in breeds of dogs, and Mr. Darwin adduces some curious facts concerning the effects obtained by crossing. Thus, "Lord Orford crossed his famous greyhounds which failed in courage with a bull-dog—this breed being chosen from being deficient in the power of scent: 'after the sixth or seventh generation,' says Youatt, 'there was not a vestige left of the form of the bull-dog, but his courage and indomitable perseverance remained.'"

Dogs, pigeons, fowls, and horses afford instances in which man, by careful breeding and selection, has made amazing changes. Cats have not offered the same facilities, as "from their nocturnal and rambling habits, indiscriminate crossing cannot without much trouble be prevented." With pigs man has been extremely suc-

cessful in producing variations from wild types, and the figures which illustrate Mr. Darwin's book bring this fact very strikingly into view. No one can suppose that very long-nosed and short-nosed pigs would have been taken for the same species if their bones only had been known. Rabbits, again, show the power of domestication and selection in modifying the skull, the vertebræ, the ribs, the scapulæ, and other bones.

In the "Origin of Species," the variations in the structure and form of pigeons was much dwelt upon. In the present volume many fresh illustrations are given, and are followed by a series of important facts concerning domestic fowls, in the study of which Mr. Darwin has been valuably aided by Mr. Tegetmeier. Naturalists suppose the varieties of domestic fowl to be all descendants of the *Gallus bankiva*, though they vary in weight from one pound to seventeen, and differ, as every visitor to a poultry-yard knows, in the form of the skull, the plumage, the presence or absence of combs and wattles, and a host of other particulars. Abundance of supposed good species, founded upon osteological and other distinctions, would have been made of fowls, if their fossil remains only had been known.

It is exceedingly curious to pass from cases in which man has succeeded in producing great variation, to such an instance as that of the goose, in which comparatively little change has been made for hundreds of years.

The plasticity of some species of domestic animals, and the comparative fixity of others, is probably parallelled in wild ones, and natural causes must frequently isolate particular groups, and check promiscuous crossing in a manner analogous to the operations of man. It is evident also that different animals possess a widely varying amount of power of accommodating themselves to, or being influenced by changes in climate or other physical conditions.

Cultivated plants offer numerous instances of great change having resulted from artificial selection and cultivation, and afford very curious illustrations of some of the laws of variability. Thus, when Colonel le Couteur began his endeavours to raise new varieties of wheat, he chose the best ears, "but soon found that the grains in the same ear differed, so that he was compelled to select them separately; and each grain generally transmitted its own character." Wheat appears to exhibit considerable tendencies to variation, though many of the differences would not be noticed by common eyes. Thus, Professor la Gasca recognized "twenty-three sorts in a field belonging to Colonel le Couteur, supposed to be at least as

pure as any of his neighbours." Professor Henslow observed similar facts.

Maize appears to have afforded a very remarkable instance of modification produced by climate. A tall kind, brought from the warmer parts of America, and cultivated in Germany by Metzler, gave the following results: "During the first year, the plants rose twelve feet high and few seeds were perfected; the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation, the plants were from nine to ten feet in height, and ripened their seed better. . . . In the third generation, nearly all resemblance to the original and very distinct parent form was lost. In the sixth generation, this maize perfectly resembled a European variety;" but "was distinguished by a somewhat more vigorous growth."

Peaches supply very interesting illustrations of variation. In the first place, there is considerable though imperfect evidence, that our peaches are descended from almonds, and numerous instances are on record of peach-trees producing nectarines; and Mr. Rivers has produced peach-trees from nectarine stones. "With respect to the more curious case of full-grown peach-trees suddenly producing nectarines by bud-variation (or sports, as they are called by gardeners), the evidence is superabundant. There is also good evidence of the same tree producing both peaches and nectarines or half-and-half fruit—by this term I mean a fruit with one half a perfect peach, and the other half a perfect nectarine."

The known variations of plants and animals of the same species from what would be deemed normal specific types are so great as to involve the definition of species in very grave difficulty. Where does variety end and species begin? Nor does the difficulty disappear by the introduction of such tests as sterility and fertility, for hybrids are not always sterile, as they ought to be, if the test were absolute, and both animals and plants have their fertility much affected by the conditions under which they live. In animals of the same species the periods of gestation are found to vary in different breeds, so that neither can this test be rigidly applied. It is obvious that as absolute sterility cannot be predicated of hybrids in general, comparative, or relative, sterility must be a very uncertain test of specific differences, unless some fixed degrees of these qualities can be agreed upon as sufficient to mark varieties and hybrids, and there does not seem to be any chance of such standards being determined. Mr. Darwin fully recognizes the importance of the fact that while crosses of varieties are often more fertile than their

parents, "crosses of species and their hybrid offspring are almost invariably in some degree sterile;" but he considers the hypothesis of Pallas probable, that "domestication eliminates the tendency to sterility, which is general with species when crossed." He adduces reasons for believing that our domestic dogs are descended from several wild species, and that the same is true of our sheep and our pigs. The latter are referred back to "at least two specific types, *S. scrofa* and *S. Indicus*, which probably lived together in a wild state in South-eastern Europe." He observes that "a wide extended analogy leads to the belief that if these several allied species, in the wild state, or when first reclaimed, had been crossed, they would have exhibited both in their unions and in their hybrid offspring some degree of sterility. Nevertheless, the several domesticated races descended from them are now all, as far as they can be ascertained, perfectly fertile together."

Domestication of animals causes them to be supplied with suitable food in appropriate quantity, and at regular times. It also leads to the preservation of good specimens, and the destruction of bad ones, and to defence from enemies of various kinds, and from inclement weather. Natural conditions must sometimes provide similar advantages, and might be expected to produce analagous results. Domesticated species and varieties appear more fertile than wild ones, and wild ones frequently lose their fertility under confinement. The numerous facts brought together by Mr. Darwin on these, and closely-allied subjects, are well worthy of profound attention; but we must pass on to another branch of his subject, the "Causes of Variability."

We naturally look to change of conditions as a probable cause of variation in offspring, and very instructive information on this subject is afforded by horticulturalists. Thus the doctrine that excess of food induces variability is supported by the statement of Messrs. Hardy and Son, of Maldon, that when they want to keep seed true, they grow it on poor land. In growing for quantity they employ rich land, and "sometimes have dearly to repent of it," because an unwelcome departure from the required type appears. Newly introduced flowers, it seems, do not vary for some time, but, in the course of a sufficient number of generations, varieties appear. Mr. Salter remarks, "Every one knows that the chief difficulty is in breaking through the original form and colour of the species, and every one will be on the look-out for any natural sport, either from seed or branch. That being once obtained, however trifling the change may be, the result depends upon

himself." M. de Jonghe, who has had so much success in raising new varieties of pears and strawberries, remarks with respect to the former, "There is another principle, namely, that the more a type has entered into a state of variation, the greater is its tendency to continue doing so; and the more it has varied from the original type, the more it is disposed to vary still further." Wild animals under domestication usually take time to vary, though not always. Thus the wild ducks in St. James's Park lost their true plumage after a few generations, but in the first generation the Australian dingos, bred in the Zoological Gardens, produced puppies marked with white and other colours. Mr. Darwin remarks that these dingos had probably been previously kept in a domesticated state by the natives; but with respect to horses in South America, Azara noticed that while wild specimens on the Pampas were always one of three colours, and wild cattle of a uniform colour, semi-domesticated animals of the same kind exhibited a great diversity of colour.

Crossing appears to have a variable effect, sometimes leading to new varieties, and at others to "atavisim," or the reappearance of some ancestral peculiarity not shown by the immediate parents.

Cultivators of flowers record their experiences of departure from the expected type in particular seasons. Thus in 1861 many varieties of rose "came so untrue to character, that it was hardly possible to recognize them," and similar instances are given of other plants. In such cases, meteorological conditions appear to have incited the variation.

The changes which we recognize may often be preceded by other changes that escaped our notice, and consequently are really less abrupt than they seem. Thus it has been observed that the cochineal insect only flourishes on its native kind of cactus, and will not thrive on the same species from other localities, or on a so-called native kind formerly introduced at Kew. The insect thus finds a difference not visible to man.

External conditions can only act upon capacities for variation possessed by plants and animals, and these capacities vary greatly in amount in different species; so that while some remain nearly unchanged under a great variety of circumstances, others are easily and quickly affected. Variation induced in one part is usually associated with variation in some other part, and such changes frequently determine whether or not the creature possessing them can live, or must perish under particular conditions.

We do not see that Mr. Darwin has carried us much nearer than

we were before to a perception of the fundamental laws of variation, though he has brought together an amazing amount of information, both as to the extent of known varieties, and the circumstances under which it has arisen.

To account for the remarkable phenomena of inheritance direct from parents, or, in the form of atavism, from remoter ancestors, he has devised the theory of "pangenesis," as he terms it, by modifying older notions on the same subject. This theory starts from the notion that every organized body is composed of cells—taking that term in a very wide sense—capable of reproducing their own sorts, and that special cells belong to each organ or part. An ovum or germ of the entire creature he imagines to contain a multitude of subordinate germs of its several parts, all the lineal descendants of similar gemmules back to the first parent of the whole lot. Ordinary reproduction on such a theory is the result of the development of such gemmules as can reproduce the parental type. Variation comes when other gemmules are brought more prominently into play. According to this theory, put forward as a "provisional hypothesis," "the child, strictly speaking, does not grow into the man, but includes germs which slowly and successively become developed, and form the man. In the child, as well as in the adult, each part generates the same part for the next generation. Inheritance must be looked at as merely a form of growth, like the self-division of a loosely organized unicellular plant. Reversion depends on the transmission, from the forefather to his descendants, of dormant gemmules, which occasionally become developed under certain known and unknown conditions. . . . . Finally, the power of propagation possessed by each separate cell, using the term in its largest sense, determines the reproduction, the variability, the development and renovation of each living organism. . . . . Each living creature must be looked at as a microcosm—a little universe, formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars in heaven."

We should certainly hesitate to accept this hypothesis, but it relates to a subject on which no rational explanation has been given. The "cell" is an indestructible entity. Deprive it of walls, of its apparent division into nucleus and surrounding plasma, it still crops up eternally. If we reject the notion that cells visible with a certain optical power are the formative agents in growth or reproduction, we are only driven to a plastic fluid in which higher powers might possibly discover minuter objects to which the term "cell"

would still be applied. Darwinically considered, everything that has hitherto been called a cell is a complex formation containing multitudes of cells. Each animal carries, in a cellular form, the descendants of all the varieties of cells of which all its grandfathers and grandmothers were made up. Such a theory must assume that every organ possessed by the most perfect animal of the present day must have had some sort of an ancestral representative in the earliest and simplest being from which the doctrine of development supposes it to have been originally derived. The cells forming the horns of the stag, or the eye of the man, must have had their ancestral representatives in the simplest form of organic life, supposed to have been the basis of the whole. To say that such a theory is astounding is certainly not to affirm its untruth, but many will rather agree to wait in acknowledged ignorance than accept suppositions so amazing, and resting chiefly upon bold conjecture.

We leave the matter here for the present, with great admiration for the extent of Mr. Darwin's research, and the skill with which he has unfolded one of the grandest and most important subjects on which the human mind can exercise its faculties. We do not, however, understand the statement of his concluding paragraph, in which he says :—"If we assume that each particular variation was from the beginning of all time pre-ordained, the plasticity of organization, 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 forms everything. Thus we are brought face to face with a difficulty as insoluble as is that of free will and predestination."

When we consider how very little of the universe we know at all, and how very imperfectly we know any part of it, we are not entitled to assume that the various steps by which a result is reached are not essential portions of one great scheme. The pre-ordination of a result does not necessarily render superfluous the particular law or method by which it is attained, and which we are just as much entitled to call pre-ordained as the result itself. No doubt natural history, as well as human history, which belongs to it, continually plagues us with the old puzzle concerning the existence of evil. The real solution of the problem is beyond our reach, but that is no reason why we should not trust the religious instincts which lead us to the conclusion "that all is well."