The Variation of Animals and Plants under Domestication. By CHARLES DARWIN, M.A., F.R.S., etc. Two vols. 8vo. London. 1868.

Anthropologie. Cours de M. de QUATREFAGES. Reported in the *Revue des Cours Scientifiques.* 1868.

La Variabilité des Espèces et ses Limites. Par ERNEST FAIRRE. 1868. Paris: Baillière. London: Williams and Norgate.

WE entertain so profound a respect for Mr. Darwin's unrivalled powers as an observer, for his rigid truthfulness, and for the boldness with which he propounds doctrines that he well knows must be received with hostility by a large proportion of readers, that we shall not attempt to criticise the two volumes with which he has now presented us. We shall simply endeavour to lay before our readers a sketch of Mr. Darwin's views, and at the same time to notice the principal objections which have been brought forward against them. About ten years have now elapsed since the scientific world welcomed the appearance of "The Origin of Species," and ever since that time the author has devoted himself, so far as (we regret to say) ill-health would permit him, to the accumulation of further evidence in support of his theory of "natural selection," which is now universally known over the civilised world as "The Darwinian Theory." The present work treats of the whole subject of the variations of animals and plants under domestication. In a second work the author intends to discuss the variability of organic beings in a state of nature—namely, the individual differences presented by animals and plants, and those slightly greater and generally inherited differences which are ranked as varieties. In that work he will show the difficulty of distinguishing between races and sub-species, and between sub-species and true species, and will discuss the problem of the conversion of varieties into species.

"We shall therein see," he observes, "that all organic beings, without exception, tend to increase at so high a ratio that no district, no station, not even the whole surface of the land, or the whole ocean, would hold the progeny of a single pair after a certain number of generations. The inevitable result is an ever-recurrent struggle for existence. It has truly been said that all nature is at war; the strongest ultimately prevail, the weakest fail; and we well know that myriads of forms have disappeared from the face of the earth. If, then, organic beings in a state of nature vary in a slight degree, owing to changes in the surrounding conditions, of which we have abundant geological evidence; if, in the long course of ages, inheritable variations ever arise in any way advantageous to any being under its excessively complex and changing relations of life, and it would be a strange fact if beneficial variations did never arise, seeing how many have arisen which man has taken advantage of for his own profit or pleasure—if, then, these contingencies ever occur, and I do not see how the probability of their occurrence can be doubted—then the severe and often-recurrent struggle for existence will determine that those variations, however slight, which are favourable shall be preserved or selected, and those which are unfavourable shall be destroyed."—Pp. 5-6.

In the chapter on "Natural Selection" in that work, the author intends to show, from experiment and from a multitude of facts, that the greatest amount of life can be supported on

each spot by great diversification or divergence in the structure and constitution of its inhabitants. In a third work, after treating of the variation of organisms in a state of nature, of the struggle for existence, and the principle of natural selection, he will discuss the difficulties which are opposed to his theory, such as "the apparent impossibility in some cases of a very simple organ graduating by small steps into a highly perfect organ; the marvellous facts of instinct; the whole question of hybridity; and lastly, the absence at the present time and in our geological formations of innumerable links connecting all allied species;" while, in a fourth work, which will complete the series, he will try the principle of natural selection, by seeing how far it will give a fair explanation of such classes of facts as the geological succession of organic beings, their distribution in past and present times, and their mutual affinities and homologies. We heartily trust that our author may live to realise his gigantic plan, and to see the Darwinian theory established on an imperishable basis; but, even if this great work never attains completion, he has already done enough in advancing biological science to insure for himself a lasting reputation as one of the greatest intellectual athletes of the nineteenth century.

We now proceed to attempt to give those of our readers who have not time to study these volumes for themselves some idea of their nature and plan. The first eight chapters treat of domestic dogs, cats, horses, apes, pigs, cattle, sheep, goats, rabbits, pigeons, fowls, ducks, geese, peacocks, turkeys, guinea fowls, canary birds, gold fish, hive bees, and silk-moths. There are perhaps none of our domestic animals that are more quickly and directly affected by the conditions of life than horses. The horses of Chili, which have lived under nearly the same conditions as their Spanish progenitors, remain unaltered, while the Pampas horses and the Puno ponies are considerably modified. There is no doubt that horses become greatly reduced in size and altered in appearance by living on mountains and islands, and this is apparently due to want of proper food. In the Falkland Islands the offspring of the horses imported in 1764 have already (in a single century) so much deteriorated in size and strength that they are unfitted for catching wild cattle with the lasso. The reduced size of the horses in those islands or in Iceland cannot be due to cold, for wild horses live and thrive in Iceland, and aboriginally the horse must have inhabited countries annually covered with snow, which he must instinctively have scraped away to get at the herbage. The horses which have run wild in the Falkland Islands have this habit, which is the more remarkable because their immediate progenitors could not have followed this instinct. Wild cattle, on the other hand, on these islands never scrape away the snow, and perish when the ground is long covered with it.

The breeds of pigs, and the effects of cultivation in modifying the habits and the bodily shape of these animals, have of late years been carefully studied by von Nathusius and Rütemeyer. From their researches it appears that all the known breeds may be divided into two great groups, one represented by the common wild boar, which may be called the *Sus scrofa* group, while the other group is somewhat unfortunately named *Sus Indica*, as the wild aboriginal does not inhabit India, and the best known domesticated breeds come from Siam and China. Different breeds of the first group still exist in various parts of central and northern Europe, but these are now rapidly disappearing by being crossed with improved Indian breeds, especially the Chinese. It is believed that the Chinese have studied the domestication and breeding of their pigs for 4900 years; and hence, as might be expected, the pigs of that country display in an eminent degree the characters of a highly cultivated race. Nathusius tells us that the infusion of $\frac{1}{32}$nd or even of $\frac{1}{64}$th of the blood of *S. Indica* into a breed of *S. scrofa* modifies the form of the skull of the latter. The modifications which the skull is capable of undergoing by cultivation are so remarkable that we shall quote Mr. Darwin's paragraph on this subject, which contains a condensation of the views of Nathusius—"The whole of the exterior of the skull in all its parts has been altered; the hinder surface, instead of sloping backwards, is directed forwards, entailing many changes in other parts; the front of the head is deeply concave; the orbits have a different shape; the auditory meatus has a different direction and shape; the incisors of the upper and lower jaws do not touch each other, and they stand in both jaws above the plane of the molars; the canines of the upper jaw stand in front of those of the lower jaw, and this is a remarkable anomaly; the articular surfaces of the occipital condyles are so greatly changed in shape that no naturalist, seeing this important part of the skull by itself, would suppose that it belonged to the genus *Sus*. The whole head is much shortened; thus, whilst in common breeds its length to that of the body is as 1 to 6 in the 'cultur-races,' the proportion is as 1 to 9, and even recently as 1 to 11." (P. 71.) Mr. Darwin gives excellent portraits of the head of a wild boar and that of a highly cultivated Yorkshire pig (copied from Sidney's edition of "The Pig," by Youatt), which show at a glance the results of cultivation in modifying the shape of the skull. The influence of food in effecting these changes is clearly brought out by Nathusius, who finds, both by common experience and his own experiments, that rich and abundant food given during youth tends to make the head broader and shorter, and *vice versâ*. He shows, moreover, that the manner of obtaining the food, independently of the nature of the food itself, influences the form of the skull. All wild and semi-domesticated pigs begin in early life to plough up the ground with their muzzles, and thus to call into action the powerful muscles fixed to the back of the head, while in cultivated well-fed pigs this habit is not followed; and hence with each generation the back of the skull deviates more widely from the original form. It is doubtful how far such a change of habits will suffice to account for the great reduction in the length of the skull and for its concave front, although its influence to a certain degree is unquestionable; and Mr. Darwin points out that in many domestic animals—in bull- and pug-dogs, in certain breeds of cattle and sheep, in Polish fowls, etc.—there is a strong tendency for the bones of the face to become greatly shortened. Again, the nature of the food in the course of many generations seems to modify the length of the intestinal canal; for while in the wild boar its length is to that of the body as 9 to 1, in the common domestic boar it is as 13 5 to 1, and in the Siam breed as 16 to 1. Moreover, the number of mammæ, the period of gestation, and the age at which the teeth are developed vary with cultivation.

In his remarks on cattle and their different breeds, he notices a monstrous breed called niatas or natas, of which he saw two small herds on the north bank of the Plata. This breed bears the same relation to other breeds as bull- or pug-dogs do to other dogs, or as improved pigs do to common pigs. "The forehead is very short and broad, with the nasal end of the skull, together with the whole plane of the upper molar teeth, curved upwards. The lower jaw projects beyond the upper, and has a corresponding upward curvature. It is an interesting fact that an almost similar conformation characterises the extinct and gigantic Sivatherium of India, and is not known in any other ruminant." Professor Owen, who has described a skull of this breed which was presented to him by Mr. Darwin, points out its great deviations from the normal types. The nasals are so stunted in their development as to be only one-third the ordinary length, while they retain almost their normal breadth. The fore part of the lower jaw is also stunted and curved upwards so as to come in contact with the premaxillaries. The lachrymal bone articulates with the premaxillary, and thus prevents any junction between the maxillary bones and the nasal; and various other differences might be added. "In fact, on comparison with the skull of a common ox, scarcely a bone presents the same exact shape, and the whole skull has a wonderfully different appearance." (P. 90.) It is known that this breed existed about 1760 near Buenos Ayres, and that they must have originated subsequently to 1552, when cattle were first introduced, so that this variation must have developed itself in less than two centuries. The breed may be regarded as permanently established, for it has now lasted for more than a century, and a niata bull and cow invariably produce niata calves. It would seem that in disposition, as well as in anatomical characteristics, these animals were relapsing to the Sivatherium type, for even at the present day they show their less civilised nature in being fiercer than common cattle, and in the cow, if visited too often, deserting her first calf. When the pasture is tolerably long, these cattle feed in the ordinary manner, but in the great droughts not very common in the district of La Plata they would, if not attended to, become extinct; for, while the common cattle, like horses, etc., can just keep alive by browsing on the twigs of trees and on reeds with their lips, the niatas starve before the common cattle, in consequence of their lips not joining. We have entered into these particulars because, as Mr. Darwin observes, we have here "a good illustration of how little we are able to judge from the ordinary habits of an animal on what circumstances, occurring only at long intervals of time, its rarity or extinction may depend. It shows us, also, how natural selection would have determined the rejec

tion of the niata modification had it arisen in a state of nature." (P. 91.)

Mr. Darwin also describes in less detail other breeds of cattle which must have originated through variation, independently of descent from distinct species—as, for example, *pelones* and *calongos*, occurring in Columbia, S.A., the former having very thin and fine hair, while the latter is absolutely naked—breeds with reversed hair, with peculiar horns, etc.

During the last twenty years much light has been thrown on the apparent descent of living domestic races (or races that were known to have lived in historic times) from races found fossil in the most recent tertiary deposits of Europe. Thus, according to Rütemeyer, *Bos primigenius* was domesticated in Switzerland as early as the neo-lithic period, existed as a wild animal in Cæsar's time, and is now found in a semi-wild state and degenerated in size in Lord Tankerville's park at Chillingham. *Bos longifrons* (or *brachyceros*) was domesticated in England during the Roman period, and Professor Owen thinks that the Welsh and Highland cattle are descended from this form. Mr. Darwin concludes this section with a few remarks on the probable causes through which each separate district in Great Britain came to possess in former times its own peculiar breed of cattle. This may be referred partly to descent from the distinct species which have just been noticed, and perhaps from others; but this cause will not suffice, and he arrives at the conclusion "that, although slight differences in the nature of the climate, food, etc., as well as changed habits of life, aided by correlation of growth, and the occasional appearance from unknown causes of considerable deviations of structure, have all probably played their parts, yet that the occasional preservation in each district of those individual animals which were most valued by each owner has, perhaps, been even more effective in the production of the several British breeds."

Sheep afford more striking instances of new breeds suddenly originating than perhaps any other animal. The history of the *otter* or *ancon* breed was so universally quoted in the reviews of Mr. Darwin's original work nine or ten years ago, that it is probably still in the recollection of many of our readers, and we will, therefore, merely state regarding it that in 1791 a ram-lamb was born in Massachusetts, having short crooked legs, and a long back like a turnspit-dog. From this one lamb the new breed was raised, retaining all their ancestor's peculiarities. As they could not leap over fences it was thought that they would be preferable to common sheep; but after a time they were supplanted by the merinos, and then exterminated. The following equally interesting case is less generally known:—A merino ram-lamb was born on the Mauchamp farm (in France) in 1828, which was remarkable for its long, smooth, straight, and silky wool. By 1833 the new breed was fairly established; and so valuable is the wool, that it sells at 25 per cent. above the best merino wool. Even the fleeces of half-bred animals are valuable, and are known as the "Mauchamp-merino." "It is interesting," Mr. Darwin observes, "as showing how generally any marked deviation of structure is accompanied by other deviations, that the first ram and his immediate offspring were of small size, with large heads, long necks, narrow chests, and long flanks; but these blemishes were removed by judicious crosses and selections. The long smooth wool was also correlated with smooth horns; and as hair and horns are homologous structures, we can understand the meaning of this correlation."—Vol. i., p. 101.

A chapter, of twenty-eight pages, is devoted to the subject of domestic rabbits. It abounds in interesting details, from which we have only space to quote one or two isolated points, and to give the author's summary of the modifications which these animals have undergone when domesticated. It is almost universally believed that the several breeds of domestic rabbits are descended from the common wild species, which has been tamed and cultivated from the earliest times. The origin of the Himalayan breed (sometimes called Chinese, or Polish, or Russian) is so singular that Mr. Darwin gives it in detail. They are white, except their ears, noses, and fore feet, and the upper side of the tail, which are all of a brownish-black, and they have red eyes. From these symmetrical marks they were regarded as a distinct species; but a writer in 1857 described the following method of producing them. It must be premised that there are two breeds known as silver-greys or silver-sprigs and chinchillas or tame silver-greys, the former of which have black heads and legs and fine grey fur, which is interspersed with long black and white hairs, while the latter have short paler fur interspersed with similar hairs. Mr. Bartlett, of the Zoological Gardens, has found that by simply crossing silver-greys with chinchillas he could always produce some few Himalayans, which, notwithstanding their sudden origin, if kept separate, bred perfectly true, as is also the case with both silver-greys and chinchillas. When first born they are quite white, and it is only after they are a few months old that the parts mentioned become coloured. Silver greys and chinchillas, on the other hand, are born perfectly black, but soon assume their characteristic tints. A similar change occurs in grey horses, which as long as they are foals are nearly black, but soon become grey, and gradually get whiter as they grow older. In a later part of his work Mr. Darwin endeavours to prove by a large mass of facts that when two varieties are crossed, both of which differ in colour from their parent-stock, there is a strong tendency in the young to revert to the original colour, this reversion occasionally supervening during the growth of the animal, instead of before its birth, as might have been anticipated. If in the present case it could be shown that silver-greys and chinchillas were the offspring of a cross between a black and albino variety, which is, according to Mr. Darwin, by no means impossible, and is supported by certain observations, then all these paradoxical facts on the changes of colour in these breeds would fall under "the law of reversion."

Our author discusses at considerable length the effects of use and disuse of parts in reference to this animal, but we have only space for an abstract of his summing up of the most important modifications which the domestic rabbit has undergone. By the supply of abundant food, combined with little exercise, and by the continued selection of the heaviest animals, the weight of the larger breeds has been more than doubled. (An English lop-eared rabbit weighing 16 lbs. has been exhibited, and a weight of 10 lbs. is not uncommon, while a full-sized wild rabbit weighs 3¼ lbs.) The bones of the limbs have increased in weight in due proportion to the increased weight of the body; but they have not duly increased in length, in consequence probably of insufficient exercise. With the increased size, the third cervical vertebra assumes the ordinary characters of the fourth, and corresponding changes are stamped on the eighth and ninth dorsal vertebræ. The skull is slightly but not proportionally enlarged, and the brain has not duly increased, or has actually diminished; and this might have been expected when we remember that domesticated rabbits that have been domesticated and closely confined for many generations have little or no demand on their intellectual functions or even on the exercise of their senses; and hence the law of decrease in size from disuse acts on their brains. Hence the bony case containing the encephalon remains narrow, and by correlation affects the bones of the face and the entire length of the skull. From unknown causes, the supraorbital processes of the frontal bones and the free ends of the malar bones have increased; and the ears, which have been enormously increased by selection, have materially altered the size, form, and direction of the bony meatus. This influence is better shown in the plate of the skull of a Half-lop rabbit given in vol. i. p. 119, than by any verbal description. This change of the meatus by correlation affects, to a certain degree, the position of almost every bone in the upper part of the skull.

(To be continued.)

GENERAL CORRESPONDENCE.

A HOSPITAL FOR OLDHAM.

LETTER FROM MR. A. T. THOMSON.

[To the Editor of the Medical Times and Gazette.]

SIR,—The town of Oldham, distant about six miles from Manchester, though virtually a suburb of that city, contains a population of about 90,000. It has hitherto been without a charitable Medical institution of any description. Its numerous workshops and cotton factories have supplied a fertile field for the treatment of acute Surgical cases, and these, with the exception of a comparatively small number sent to the Manchester Infirmary, have been treated, through the liberality of the employers of labour, at their own homes. The comfortable circumstances and, as a rule, the excellent condition of the dwellings of the working population have enabled this to be done not only without disadvantage, but, I am persuaded, from the favourable results almost uniformly seen after capital

REVIEWS.

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[SECOND PART.]

THE greater part of Mr. Darwin's first volume was made up of a series of essays on various animals and plants, in which the author collected all the facts he could meet with to show the amount and nature of the changes induced by domestication and to illustrate the general principles of variation. The second volume, which we now proceed to notice, consists of a series of general discussions on the subjects of inheritance, crossing, sterility, hybridism, selection, variability and laws of variation, and the hypothesis of pangenesis, by which the author shows the means by which characters of all kinds are transmitted from generation to generation. The subject of inheritance is one of such vast extent that we must confine ourselves to a few of the leading points touched on by Mr. Darwin. Several recent writers of high position, amongst whom the late Mr. Buckle must be included, have called in question the force of inheritance. Their doubts must have arisen from their ignorance of facts known to all breeders of animals from the earliest time. From the first history of Arabian horses we find that their pedigrees were carefully recorded; and can we suppose that it is not without good reason that, during the many years that horse-racing has been carried on in this country, the same system has been studiously carried out? The prices which yearling colts, owning a high descent, produce afford a practical answer to this question. It is the same with shorthorn and other cattle. If inheritance is not to be believed in, why should a thousand guineas or more be given for a bull? The same remarks apply to dogs (especially to greyhounds), to gamecocks, and to pigs, the breeders preserving and printing pedigrees. It is hardly possible in a moderate space to impress on the minds of those who have not specially studied the subject a full conception of the force of inheritance. The following are a few of the facts which have most influenced the author's mind. In man and the domestic animals certain peculiarities have appeared in an individual at rare intervals, but have reappeared in several of the children and grandchildren. Thus the porcupine-man, whose skin was covered with warty projections, which were periodically moulted, had all his six children and two grandsons similarly affected. In three successive generations of a Siamese family the face and body were covered with long hair, accompanied by deficient teeth, and other cases of completely hairy faces are recorded. A race of two-legged pigs has been described, the hinder extremities being entirely wanting, and this peculiarity was transmitted through three generations. And the cases of the Mauchamp sheep and niata cattle, previously described, are similar instances, except that the deviations of structure which they present are more persistent.

In some respects the evidence of inheritance is more striking in the reappearance of trifling peculiarities, as of a single lock of hair differently coloured from the rest, the similarity of handwriting, peculiar manners, etc. Of these last Mr. Darwin gives the following curious case which fell under his own observation:—"A boy had the singular habit, when pleased, of rapidly moving his fingers parallel to each other, and when much excited, of raising both hands, with the fingers still moving, to the sides of his face, on a level with the eyes; this boy, when almost an old man, could hardly resist this trick when much pleased, but from its absurdity concealed it. He had eight children. Of these, a girl, when pleased, at the age of four and a half years, moved her fingers in exactly the same way; and what is still odder, when much excited, she raised both her hands, with her fingers still moving, to the sides of her face, in exactly the same manner as her father had done, and sometimes even still continued to do so when alone. Imitation was, in this instance, out of the question" (vol. ii. p. 6). If any one who doubts that genius and talent are hereditary will glance over a few pages of that most valuable little book, Hole's "Brief Biographical Dictionary," in which a life is almost invariably condensed into a single line, or will read Mr. Galton's able paper on this subject (published in *Macmillan's Magazine* for 1863), his doubts will soon be dispelled. The ancients were as well acquainted as

we are with the hereditary tendency of various forms of disease, as gout, insanity, consumption, cancer, etc. Confining his remarks to a single organ, the eye and its appendages, Mr. Darwin adduces evidence of the following inherited malformations and diseases:—1. Drooping eyelids; 2. A peculiar arrangement of the hair in the eyebrows; 3. Morbidly long sight; 4. Short sight; 5. Squinting; 6. Cataract; 7. Amaurosis; 8. Congenital absence of the iris; 9. Cleft iris (this has been noticed for four generations, being limited to the males); 10. Opacity of the cornea; 11. Day and night blindness (a case of the latter is recorded which ran through six generations and affected eighty-five persons); and 12. Daltonism or colour blindness, which has been traced through five generations, in which it was confined to the female sex. Even if we knew nothing of hereditary diseases and malformations in man, the horse would supply abundant evidence. Ringbones curbs, splints, spavin, roaring, blindness, crib-biting, jibbing, and ill-temper are generally recognised as hereditary. Fortunately good qualities, as sound health, vigour, and longevity, are equally inherited, both by man and animals, with evil qualities.

Inequalities in the two sides of the body, though opposed to the law of symmetry, may be transmitted. Thus a rabbit produced in a litter a young animal with only one ear, and from this animal a breed was formed which steadily produced one-eared rabbits; and a case is related of a one-horned stag that was seen in a German forest in 1781 which originated a breed of stags having only one horn on the right side of the head. There is a considerable amount of evidence showing that even mutilations and the effects of accidents, especially, or perhaps exclusively, if followed by disease, are occasionally inherited; but this is a subject on which it is difficult to come to a conclusion. Against this view is the fact that a vast number of generations have practised the rite of circumcision, but that the operation is as much called for now as in the days of Abraham. On the other hand, it must be stated that Blumenbach asserts that in Germany Jews are often born in a condition rendering circumcision impossible, and to these a term signifying "born circumcised" is applied. The perpetual repetition of the operation for nearly forty centuries has produced, as is generally believed, no inherited effect. Various other mutilations have for ages been practised by savage races, but, as in the case of the Jews, without inducing any apparent tendency to inheritance. But in favour of this view, on the other hand, there are many cases on record of cats, dogs, and horses which have had their tails, legs, etc., amputated or injured, producing offspring with the same parts ill-formed; indeed, Professor Lucas, in his great work "De l'Hérédité Naturelle," gives so long a list of apparently well-authenticated cases of this kind, that it is hardly possible not to believe in them. Amongst other cases quoted by Darwin is that of a soldier who, fifteen years before his marriage, lost his left eye from purulent ophthalmia; his two sons were microphthalmic on the same side. Guinea-pigs afford one of the most remarkable facts in favour of this view, it being ascertained by Dr. Brown-Séquard that by performing a certain experiment on these animals he could induce a form of epileptic disease, which in many instances was inherited by their progeny.

In reference to inheritance generally, Mr. Darwin observes that the wonder is not that any characters should be transmitted, but that the power of inheritance should ever fail, and he mentions the following as checks to uniformity:—(1) Circumstances hostile to the peculiar character in question—thus, dray-horses would not long transmit their great size if compelled to live in a cold, damp, mountainous region; (2) conditions of life incessantly inducing fresh variability; and (3) the crossing of distinct varieties during some previous generation, together with reversion or atavism—that is, the tendency of the offspring to resemble its grandparents or more remote ancestors instead of its immediate parents.

Reversion, or atavism, has been recognised both in man (a) and animals from the earliest period, but it is only in recent times that it has received the attention to which its physiological importance entitles it. The cases of reversion may be divided into two principal classes—namely, (1) those occurring in a variety which has not been crossed, but has lost by variation some character that it formerly possessed, and which afterwards reappears; and (2) those in which an individual subvariety, race, or species has formerly been crossed with a distinct form, and a character derived from this cross, after disappearing for one or more generations, suddenly reappears. Examples of the first class are often seen in pigeons, in the occasional reappearance, in variously coloured pure breeds, of blue birds resembling the original stock; in the appearance in the common ass of the stripes which normally exist on the legs of its wild progenitor; in the occasional birth of a horned calf amongst Galloways and Suffolk cattle which have been hornless for the last century or more, etc. Analogous cases are seen in the vegetable kingdom, where, for example, the seeds of the finest cultivated varieties of heartsease often yield perfectly wild plants; and in most of our cultivated vegetables there is the same tendency to reversion to the original state. The second form of reversion—that, namely, where there has been a cross—is well illustrated by the following case, which was communicated to the author on good authority. A pointer bitch produced seven puppies, four of which were marked with blue and white, which is so rare a colour with pointers that she was thought to have had an illicit amour with a greyhound, and hence the litter was condemned. One, however, was saved as a curiosity, and two years after a friend of the owner saw the young dog, and declared that he was the image of his old pointer bitch, Sappho, the only blue and white pointer of pure descent he had ever seen. On inquiry, it was found that he was great-great-grandson of Sappho, so that he had only one-sixteenth of her blood in his veins. Here we have a character derived from a cross reappearing after passing over three generations.

When two distinct races are crossed, the tendency of the progeny to revert to one of the parent forms is very enduring. In a litter of Essex pigs, two young ones appeared which were the image of the Berkshire boar that had been used twenty-eight years before in improving the breed; and a case is recorded of fowls showing a likeness to the Malay breed, although the cross had taken place forty years previously. Hence it is difficult to say when a breed that has once been crossed is safe from all danger of reversion; most breeders think six, seven, or eight generations are necessary.

The effect of crossing on the disposition and temper seems to be established beyond a doubt. When a domesticated animal is crossed with a distinct species, whether this is a domesticated or only tamed animal, the hybrids are often wild to such a degree that the fact can be only explained on the supposition that the cross has caused a partial return to the primitive disposition. In corroboration of this statement, Mr. Darwin quotes cases of the crossing of some domesticated humped cattle from India with English breeds of a distinct species; of the crossing of a domesticated Chinese sow with a naturally wild Alpine boar which had become very tame, and yet the progeny was extremely wild, and "would not eat swill like English pigs;" of the crossing of tame cock-pheasants with fowls of different breeds, etc. Some exceptions have, however, been noticed—the offspring of crossed canaries, for example—and mules from the horse and ass are not wild,(b) although their tempers are often notoriously bad. These facts remind us of the statements made by travellers regarding the debasing effect of the crossing of different human races. Mr. Darwin himself, long before he had taken up the special subject which has made his name a household word, was struck with the fact that in South America men of a complicated descent between negroes, Indians, and Spaniards seldom had a good expression.(c) Agassiz, in his recent voyage up the Amazon,

(a) In a very curious work by Helkiah Crooke published in 1615, and entitled "Description of the Body of Man," we happened to meet with the following passage bearing on this subject:—"So Helia, who accompanied with an Æthopian, did not bringe foorth a blacke daughter, but yet that daughter of hers brought foorth a blacke sonne. And Musæus, the poet of Constantinople, though begotten of white parents, did degenerate into the colour of his grandfather, who was an Æthopian" (p. 311).

(b) If Mr. Darwin had seen Mr. Harvey Riley's treatise on *The Mule*, just published at New York, he would scarcely have made this hybrid an exception to the general rule regarding wildness. As Mr. Riley, in a single year's official duty, examined 74,000 mules, he must be regarded as qualified to write with authority. He tells us that, from its birth, the mule betrays fear of man, and that as a general rule "mules are born kickers. Breed them as you will, the moment they are able to stand up, and you put your hand on them, they will kick." He thinks, however, that their natural timidity is heightened by the rough treatment which they commonly experience in the process of training. Amongst other useful information contained in this volume, we learn that "if any gentleman wants to purchase a mule for the saddle, let him get one bred closer after the mare than the jack. They are more docile, handled easier, and are more tractable; if possible, also get mare mules." Stud mules are described as more troublesome and useless than any other animals. "It is next to impossible to keep them from breaking loose and getting at mares, and they are exceedingly dangerous to have amongst horses. They will frequently fly at the horse like a tiger, and bite, tear, and kick him to pieces. I have known them to shut their eyes, become furious, and dash over both man and beast to get at a mare; and a white mare seems to have the greatest attraction for them."

(c) *Journal of Researches*, 1845, p. 71.

has made some most important observations on this subject, and Livingstone's evidence regarding African and Portuguese half-castes tends in the same direction. There is something truly epigrammatic in the statement made by an inhabitant of the Zambesi region to the last-named traveller—"God made white men and God made black men, but the Devil made half-castes."

Prepotency in the transmission of character is a subject to which we next devote a few words. When individuals of the same family, but distinct enough to be recognised, or when two well-marked races or two species are crossed, it is not unfrequently found that certain individuals, races, or species are *prepotent* in transmitting their likeness.

In certain families—as the Austrian royal family—some one ancestor, and after him others in the same family, must have had great power of transmitting their likeness through the male line. The famous bull, Favourite, is believed to have had a prepotent influence on the shorthorns, and similar observations have been made on racehorses of both sexes. In crossing races the prepotency is sometimes stronger in one sex and sometimes in the other. On crossing a male Manx cat (which has no tail) with common cats, Dr. Wilson found that out of twenty-three kittens seventeen were destitute of tails; but when the female Manx cat was crossed by common males all the kittens had tails, though they were generally short and imperfect. In crossing species we find that the jackal is prepotent over the dog, and the ass is prepotent over the horse, the prepotency in this case running more strongly through the male than through the female ass. The whole subject of prepotency is extremely intricate for various reasons, amongst which may be mentioned its great variability in strength in different animals, its sometimes running equally in both sexes, and sometimes strongly preponderating in one, etc. Hence no general laws can be laid down regarding it.

Limitation of inheritance by sex is a subject of considerable importance. New characters often appear in one sex, and are more or less exclusively transmitted to that sex. Thus, the porcupine-man transmitted his peculiarity to his sons and grandsons, while the female progeny were unaffected; and many similar cases are quoted by Mr. Darwin, most of them taken from Dr. Prosper Lucas's great repertory of facts bearing on this and kindred subjects.

In our domesticated animals we sometimes find that characters not belonging to the parent species are confined to one sex alone, although we do not know the history of the first appearance of such characters. Thus, in certain races of sheep and goats the males differ greatly from the females in the shape of the horns, which in some female breeds are absent. The colour called tortoise-shell is rarely seen in a male cat; and many other cases might be given.

The last point to notice in connexion with inheritance is its latency in the offspring up to the age corresponding to that at which it originally appeared. For example, short-sightedness, greyness of the hair, gout, insanity, etc., often appear in the offspring at the same age as they appeared in the parent from whom they have been inherited. Certain pigeons do not attain their peculiar plumage until the bird has moulted two or three times; and many similar illustrations might be given.

We have not space to attempt to follow our author through his highly instructive chapters, bristling with facts, on the subject of crossing, and must content ourselves with giving some of his conclusions.

"The evil consequences of long-continued close interbreeding are not so easily recognised as the good effects from crossing, for the deterioration is gradual; but it is generally held by the best qualified judges that the evil is sure to follow, sooner or later, and at different rates in different animals. A male animal may sometimes be paired with his daughter or granddaughter, and so on, even for seven generations, without any manifest bad result; but the experiment has never been tried of matching brothers and sisters, which is regarded as the closest form of interbreeding, for an equal number of generations. There is good reason to believe that by keeping the members of the same family in distinct bodies, especially if exposed to somewhat different conditions of life, and by occasionally crossing these families, the evil results—such as loss of constitutional vigour, size, and fertility—may be much diminished or quite eliminated." In the case of pigs, first-rate animals have been produced after long-continued close interbreeding, although they became very infertile when paired with their near relations. Although offspring descended from the nearest relations are not necessarily deteriorated in structure, many good observers believe that they are specially liable to malformations and imperfections of various kinds (as blindness, deafness, etc.); and, observes Mr. Darwin, "this is not improbable, as everything which lessens the vital powers acts in this manner" (vol. ii. p. 143). From the evidence collected by Professor Devay and other writers, we think that Mr. Darwin might safely have expressed a more decided opinion on this point.

(To be continued.)

PROVINCIAL CORRESPONDENCE.

SCOTLAND.

Edinburgh, November 10.

I cannot remember any occasion in which the opening of our session was accompanied by so many or so exciting contests for various appointments connected with the University. The Chancellorship is vacant, and partisans are warmly advocating the claims of the two candidates; Mr. Carlyle's term of office as Rector will shortly close, and the students have already subdivided themselves into numerous sections, each of which supports a claimant with the spirited and somewhat noisy energy of youthful electors; and the University Council is now, for the first time, taking its share in the party strife that, in normal circumstances, accompanies the election of a member of Parliament.

It is scarcely necessary to remind your readers that the two candidates for the Chancellorship are Mr. Gladstone and the President of the Court of Session, Mr. Inglis. At the end of October, the Council met for the formal nomination of these candidates, when the election of Mr. Inglis was moved by Professor Maclagan, seconded by the Rev. Mr. Phin, and the election of Mr. Gladstone by Sir James Y. Simpson, seconded by the Rev. Dr. Guthrie. The claims of the candidates could scarcely have been entrusted to more able pleaders. We have seldom heard a speech on a similar subject characterised by greater ability and force of reasoning than that of Dr. Maclagan. Sir James had the difficult task of reply, and, although he spoke admirably, his speech was not so wonderfully effective as many we have listened to by him. He concluded with the following sentence—a sentence which evoked a burst of applause, due probably, to some extent, to recent circumstances in which Sir James had been personally concerned:—"Having now got as Principal a gentleman to aid us of great administrative experience, learning, and energy (Sir Alexander Grant), the University would go on progressing and prospering, provided their future Chancellor was not one to impede and retard its advancement." The meeting was nearly equally divided, but the Chairman, Professor Christison, stated that the advantage was slightly in favour of Mr. Inglis. A very close contest is anticipated—so close that it would be absurd to make any attempt to predict the result. The voting-papers, which have now been all issued, must be returned by the 20th inst., and the decision will be announced a few days afterwards.

The students have lost no time in inaugurating their campaign for the election of Rector. Only a day or two after the commencement of the session a general meeting was called for the nomination of candidates. This precipitancy had prevented any mature arrangement, and the candidates proposed were therefore numerous, and, in many instances, strangely unfitted for the post. Among them were the late member for the city, Mr. Moncreiff, a leading United Presbyterian clergyman, Dr. Cairns, Mr. Lowe, M.P., Mr. Ruskin, Sir William Fergusson, Bart., of London, Mr. Alfred Tennyson, Dr. Stirling, and Lord Stanley. The field has, however, been now diminished to three or four, of whom Mr. Moncreiff, Mr. Lowe, and Sir William Fergusson appear to be the favourites. Sir William Fergusson has considerable support from the Medical students, but Mr. Moncreiff's great local popularity will probably carry the day. We shall not regret this, as it is important that the Rector should be able to devote some time to attend meetings of the University Court, of which he is chairman, and as experience has shown how much inconvenience may be caused when the occupant of this post resides at a distance from Edinburgh. Meanwhile, the Rectorial contest causes the greatest excitement in the University and its immediate neighbourhood. Groups of students are to be daily seen eagerly and vehemently discussing the relative claims of the candidates; nightly meetings are held in the class-rooms to influence waverers; electioneering squibs and caricatures are largely circulated and affixed to the walls of the University,

The Variation of Animals and Plants under Domestication. By CHARLES DARWIN, M.A., F.R.S., etc. Two vols. 8vo. London. 1868.

Anthropologie. Cours de M. de QUATREFAGES. Reported in the *Revue des Cours Scientifiques.* 1868.

La Variabilité des Espèces et ses Limites. Par ERNEST FAIVRE. 1868. Paris: Baillière. London: Williams and Norgate.

[THIRD PART.]

(*Concluded from page 566.*)

AFTER a brief notice of "The Good derived from Slight Changes in the Conditions of Life," especially in the case of plants, Mr. Darwin takes up the important subject of sterility from changed conditions of life. It has been long known that many animals, though perfectly tamed, refuse to breed in captivity. The most remarkable cases are those of animals kept in their native country, which, though perfectly tamed, quite healthy, and allowed some freedom, are absolutely incapable of breeding; and abundant evidence of the existence of such cases is afforded by Rengger, who in Paraguay specifies six quadrupeds in this condition, by Bates in his work on the Amazons, by many African explorers, etc. The most notorious case of this kind is that of the elephant. These animals are kept in large numbers in their native Indian home, apparently retain their normal vigour, and live to old age, yet have scarcely ever been known to couple, although both sexes have their periodical seasons of heat. In Ava, a little eastward, the females are kept in a half-domestic state, and are allowed to roam the forest; and in that country they breed frequently, in consequence probably of their greater freedom. Most of the members of the pig family—even the Red River hog from West Africa, and the peccary—have not unfrequently bred in the Zoological Gardens. Ruminants, from whatever climate they are brought, and most of the Carnivora (excepting the plantigrades), breed quite freely in this country. The tiger, however, rarely breeds in England, but there are several cases of the female tiger breeding with the lion, and it is a remarkable fact that many animals in confinement unite with distinct species and produce hybrids quite as freely (if not more so) as with their own species. The fertility of the carnivora in the Zoological Gardens has been much increased since they have of late years been more freely exposed to air and cold. As domesti-

cated rabbits, guinea-pigs, and white mice breed so abundantly in confinement in many climates, the same might have been predicated regarding the other rodents, but this is not the case. In the Zoological Gardens some rodents have coupled, but have never conceived; some have neither coupled nor bred; and a very few, as the porcupine, lemming, agouti, and chinchilla, have bred several times. The English squirrel has never been known to breed in confinement. Passing to Quadrumana, monkeys in confinement rarely breed, even if kept in their native land. Large as is the number of monkeys in the Zoological Gardens, there were only seven births recorded in the nine years' report, although they copulated freely. Birds in captivity vary extremely in respect to fertility. While the carnivorous birds (as hawks, vultures, and owls), parrots, etc., will not breed in a state of confinement, gallinaceous birds of many genera, the pigeon family, the ducks, and some of the smaller graminivorous birds (as the canary) breed freely. After showing that this barrenness cannot be due to loss of vigour, to a failure of the sexual instincts, or to change of climate or of food, Mr. Darwin comes to the conclusion that the loss of reproductive power "depends more on the constitution of the species than on the nature of the change; for certain whole groups are affected more than others." He concludes this subject with an observation which has an intimate relation with facts observed in the human race, and brought to light in trials in the Divorce Court. "It is by no means rare to find certain males and females which will not breed together, though both are known to be perfectly fertile with other males and females. The cause apparently lies in an innate sexual incompatibility of the pair. Several cases have been communicated to me in relation to horses, cattle, pigs, dogs, and pigeons. . . A female known not to be barren has been unsuccessfully paired seven or eight times with the same male, likewise known to be perfectly fertile."

As in the case of animals, so also in plants, sterility is found to accompany changed conditions of life. For the evidence on this subject we must refer to vol. ii. pp. 163-172.

We now come to the consideration of two very important subjects—selection and variability. The possibility of selection coming into action, either through the intervention of man or by natural causes, rests solely on variability; and this latter is caused, as we shall presently see, by changes in the conditions of life. It has probably never occurred to the majority of our readers that selection is a most difficult art, requiring "indomitable patience, the finest powers of discrimination, and sound judgment exercised during many years." The fundamental principle of selection mainly lies in the power which distinguished breeders exhibit of selecting scarcely appreciable differences which are capable of being transmitted, and which can be accumulated until the result is unmistakably recognisable. Our author divides the principle of selection into three kinds—viz, the *methodical*, the *unconscious*, and the *natural*—methodical selection being "that which guides a man who systematically endeavours to modify a breed according to some predetermined standard;" unconscious selection being "that which follows from men naturally preserving the most valued and destroying the least valued individuals, without any thought of altering the breed;" while natural selection "implies that the individuals which are best fitted for the complex and, in the course of ages, changing conditions to which they are exposed, generally survive and procreate their kind." The value of methodical selection and of the results which it has effected is sufficiently proved by our agricultural shows. "Our pigs during the last twenty years have undergone, through rigorous selection, together with crossing, a complete metamorphosis;" and, to a greater or less degree, the same may be said of our cattle, sheep, poultry, and silkworms.(a) With plants selection has been followed with equally good results; for example, the early maturity of peas has been very considerably hastened, and the beet plant, since its cultivation in France, has doubled its yield of sugar. It is difficult to give direct proofs of the results which follow from unconscious selection, but the indirect evidence is abundant. "In fact, except that in the one case man acts intentionally and in the other unintentionally, there is little difference between methodical and unconscious selection." Amongst other illustrations of the effect of unconscious selection as effected by the destruction of individuals having a peculiar character, Mr. Darwin quotes the diminished height of modern Frenchmen, all the tall men having been destroyed in the wars of Napoleon, and only the short ones left to perpetuate the race. How far this apparently fanciful view may be founded on fact we cannot say, but there can be no doubt that during the last half-century the standard height for the army has been lowered two or three times. Another strange illustration of "unconscious selection in the strictest sense of the word—that is, the saving of the more useful animals and the slaughter of the less useful"—is afforded by the Fuegians, who, when hard pressed by want, kill their old women for food rather than their dogs, on the ground, in their own phraseology, that "old women no use—dogs catch otters." Of natural selection, or the survival of the fittest, as affecting domestic production, we know little; but Mr. Darwin has collected a large number of facts "showing that natural selection often checks, but occasionally favours, man's power of selection." Colour has far more to do in affecting our domestic animals and vegetables than is commonly supposed. Professor Wyman, well known as an excellent observer, states that, on being surprised at all the pigs in a certain part of Virginia being black, he made inquiries, and found that these animals feed on the roots of *Lachnanthes tinctoria*, which colours their bones pink, and, excepting in the case of the black varieties, causes the hoofs to drop off. Hence the breeders select the black members of a litter for raising, as they alone have a good chance of living. Mr. Darwin cites a similar case as occurring in the Tarentino, where the inhabitants keep only black sheep, because the *Hypericum crispum* abounds there, and poisons white sheep, while it does not affect black ones. There is, moreover, a connexion between colour and liability to certain diseases and to parasites. Thus white terriers suffer more than others from the distemper. In certain American plum-trees there is a disease which only attacks those bearing purple fruit, and in Mauritius the white sugar-canes have of late years been attacked by a destructive disease, while the red canes remain unaffected. White chickens are much more liable to the *gapes* (which is caused by a parasitic worm in the air-passages) than dark-coloured ones; while, on the other hand, the silkworms that produce white cocoons resist the deadly fungus (which has recently made such havoc in France and elsewhere) better than those producing yellow cocoons. Cattle of a grey, white, or pale colour are much more troubled by insects than red, brown, or black cattle, and for this reason probably black cattle are always selected for work in the West Indies. Many other illustrations of the importance of colour in both the animal and vegetable kingdoms might be readily given. In the vegetable world many apparently very trifling differences are of importance, as the relative hardness of the shell and of the bark, the presence or absence of glands on the leaves, the difference in flavour or in the amount of nutriment (which causes some varieties to be more eagerly attacked by various enemies than others), etc.

The improvement of a breed by judicious selection is well shown in the case of the ass, which in this country is of little value, because, being usually bred on a small scale by poor people, there has been no selection, and hence distinct races have not been formed. But when selection is brought to bear all is changed. Near Cordova, where these animals are carefully bred, a good stallion ass will sell for £200; and in Kentucky asses imported from Spain have by careful selection produced descendants of fifteen or even sixteen hands high. A celebrated Kentuckian ass has been sold for a thousand pounds!

Such astounding results as these naturally lead to the question, what is the limit to the possible amount of variation? and consequently is there any limit to what selection can effect? The following is, in a condensed form, Mr. Darwin's view of the mode in which these difficult questions should be answered. In some lines of variation, as in the reduction of bone in some of our sheep, the limit has probably been reached. But, seeing the great improvement within recent times in our cattle, sheep, and pigs, and the enormously increased weight of our poultry, it would be dangerous to assert that perfection has been reached. Whether the limit of speed that was reached by Eclipse may ever be exceeded is, we think, doubtful, as the selection of the best horses for many generations has failed to produce his equal. Hardly any fruit has been more improved than the strawberry, yet a great authority, quoted by Mr. Darwin, holds that "we are far from the extreme limits at which we may arrive." It must never be overlooked that, to improve a breed, a large number of indi-

(a) In 1784 a race of silkworms was introduced into France, in which 100 out of 1000 failed to produce white cocoons; but now, after careful selection during sixty-five generations, the proportion of yellow cocoons has been reduced to 35 in 1000, and the full reduction is probably not yet completely attained.

viduals must be reared, and that those with the slightest defect must be rejected,(b) and that length of time is an essential element of success.

We now come to the subject of the "causes of variability" on which the principle of selection is based. Some authors regard variability as a necessary contingent on reproduction; others hold that it depends exclusively on the crossing of primordially distinct forms; while others, again, refer it to an excess of food in relation to the exercise taken, or to the effects of a more genial climate. That all these causes are effective is highly probable, but Mr. Darwin takes the broader view, "that organic beings, when subject during several generations to any change whatever in their conditions, tend to vary," the kind of variation depending far more on the nature of the being than on that of the change. Some writers believe variation to be so general that each individual differs from every other, and Mr. Darwin has adduced various instances supporting this view. That *we* are not able to recognise such differences is no proof that they do not exist. The Laplanders distinguish by name each reindeer from the others, although "they were like ants on an anthill" for numbers. A shepherd, after a fortnight's acquaintance with a flock of 100 sheep, has been able to recognise each, and, what is more remarkable, the able Dutch florist Voorhelm, who kept above 1200 varieties of the hyacinth, almost always could recognise each variety by the *bulb alone*.

Few of our readers are probably aware of the extent to which variation has been carried in the case of cultivated plants. "In the deserts of northern Africa the date-palm has yielded thirty-eight varieties; in a single Polynesian island twenty-four varieties of the bread-fruit, the same number of the banana, and twenty-two varieties of the arum are cultivated; the mulberry tree in India and Europe has yielded many varieties, serving as food for the silkworm; and in China no fewer than sixty-three varieties of the bamboo are used for various domestic purposes"(p. 256). From the numerous facts collected by Mr. Darwin he concludes that the variability of domesticated animals and cultivated vegetables may be caused by slight changes in the conditions of life, the most efficient single cause being excess of nutriment; that the power of changed conditions accumulates, so that several generations must be exposed to new conditions before any effect is visible; and that the causes which induce variability act on the mature organism, on the embryo, and on both sexual elements before impregnation has been effected.

No fewer than three chapters are devoted to the laws which govern variability. "These may be grouped under the effects of use and disuse, including changed habits and acclimatisation—arrests of development—correlated variation—the cohesion of homologous parts—the variability of multiple parts—compensation of growth—the position of buds with regard to the axis of the plant—and, lastly, analogous variation"(p. 293). We must content ourselves with giving an abstract of Mr. Darwin's summary of these chapters. Increased use or action strengthens muscles, glands, sense-organs, etc., and disuse, on the other hand, weakens them.(c) Increased pressure thickens the epidermis, and an alteration of food from animal to vegetable, or *vice versâ*, increases or diminishes the length of the intestine. Animals which for many generations have taken little exercise have their lungs diminished, and, as a consequence, the bony fabric of the chest modified. When the wings are little used, as in most of our domestic birds, these organs are slightly reduced, and induce corresponding changes in the crest of the sternum, the scapula, etc. By the term *correlated variation* must be understood that "when one part varies certain other parts always or nearly always simultaneously vary." In his "Origin of Species" Mr. Darwin brought forward a curious case of correlation which excited great general interest. He asserted that white cats, if they have blue eyes, are always deaf. He has since heard of a few exceptions to this apparently marvellous law, but not enough to affect its general accuracy. If one eye be not blue, the cat hears. In relation to this subject, Dr. Sichel (the eminent French oculist) gives the remarkable case of a cat in which the iris did not begin to grow coloured till it was four months old, and then it first began to hear. The wool and the horns of sheep vary together. Hairless dogs are deficient in their teeth, and pigs with little hair are liable to lose their tails; while over-hairy men have abnormal teeth, either in deficiency or in excess.

From this brief notice of the important law of correlation we turn to the most difficult part of our task—namely, to the consideration of Mr. Darwin's *Provisional Hypothesis of Pangenesis*, by which he proposes to explain "how it is possible for a character possessed by some remote ancestor suddenly to reappear in the offspring; how the effects of increased or decreased use of a limb can be transmitted to the child; how the male sexual element can act not solely on the ovule, but occasionally on the mother form; how a limb can be reproduced on the exact line of amputation with neither too much nor too little added; how the various modes of reproduction are connected, and so forth" (p. 357). To use his own words, "the hypothesis of pangenesis implies that the whole organism, in the sense of every atom or unit, reproduces itself." While physiologists generally maintain that every cell in the animal body, though to a great extent dependent on others, is in a certain sense independent, Mr. Darwin goes a step further, and assumes (freely admitting that it is a mere assumption) that each cell casts off a free gemmule, which is capable of reproducing a similar cell. These gemmules multiply and aggregate themselves into the sexual elements, buds, etc., and they are capable of transmission in a dormant state to successive generations. In a highly organised and complex animal they must be inconceivably numerous and minute. "Each unit of each part," says the author, "as it changes during development (and some insects undergo at least twenty metamorphoses), must throw off its gemmules. All organic beings, moreover, include many dormant gemmules derived from their grandparents and more remote progenitors, but not from all of them. These almost infinitely numerous and minute gemmules must be included in each bud, ovule, spermatozoon, and pollen-grain" (p. 402). "Reversion depends on the transmission from the forefather to his descendants of dormant gemmules, which occasionally become developed under certain known or 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" (p. 404). Thus not only are healthy gemmules diffused throughout the body, but likewise morbid gemmules, giving rise to hereditary diseases, malformations, etc.

The time has not yet arrived at which it is possible to decide with certainty for or against this hypothesis. In the meantime it gives us the clearest and most systematic explanation of the phenomena of reproduction and inheritance that has yet appeared. Let us, therefore, thankfully accept it as a provisional hypothesis (which is all that its distinguished author claims for it) "to be further tested, and only to be discarded when a more plausible one shall be brought forward."

At the commencement of this article we stated that we intended to notice the principal objections that have been brought forward in opposition to Mr. Darwin's views. We have not done so because, since the earlier pages of this review were written, the subject has been taken up by one who is pre-eminently qualified to give a judicial opinion upon it; and as Dr. Hooker's admirable address to the members of the British Association at their late meeting at Norwich has been diffused over the whole civilised world in the columns of the *Times* newspaper, it is unnecessary for us to go over the same ground.

We have placed M. de Quatrefages' Course of Lectures on Anthropology amongst the list of works heading this article, because, although he is a decided opponent of Mr. Darwin's views, both writers to a certain degree take up the same subjects. In his sixth lecture he discusses the different views that naturalists have adduced regarding the nature and significance of *species*. The doctrines on this subject are, according to him, (1) those of the positive school, who, like Linnæus, Buffon, and Cuvier, maintain the invariability of species; (2) those of the philosophic school, who, like Bacon (in his *Sylva Sylvarum* and *Nova Atlantis*), De Maillet (better known in the reversed form of Telliamed), Lamarck, etc., admit the transformation, or even the transmutation, of one species into others having no resemblance to it; and (3) those who believe in limited variability, represented by Geoffroy Saint-Hilaire, Faivre of Lyons, and others.

"The eminent zoologist Darwin" is placed by De Quatrefages "amongst the most illustrious partisans of the philo-

(b) Lord Rivers, when asked how he succeeded in always having first-rate greyhounds, answered, "I breed many and hang many."

(c) Considering that Mr. Darwin scarcely ever misses any existing illustration of his views, we are surprised to find no reference to the remarkable visual powers possessed by certain savage or semi-savage races. There is undoubted evidence that the unaided human eye has, on at least two occasions, witnessed the occultation of one of the satellites of Jupiter.

sophic school," and his views are compared and contrasted with those of Lamarck. In summing up the doctrines of the contending schools, he points out that the supporters of the absolute fixity of species are compelled to admit a certain degree of variability, and conversely that the supporters of variability admit a certain amount of fixity, and he endeavours to frame a definition that, to a certain degree, will be accepted by both schools. The following is M. de Quatrefages' definition:—"Species is the collection (*l'ensemble*) of individuals more or less similar to one another, who are descended, or who may be considered as descended, from a single primary pair by an uninterrupted succession of families;" and if naturalists would only agree to accept this or any other moderately accurate definition of the long-disputed term *species*, much future controversy would be avoided. As far as they are yet published, these lectures include the consideration of arguments in support of the invariability of species, the variability of the individual, variability of species, varieties, races, and the variations of cultivated vegetables and domestic animals. The lectures on our cultivated plants and domestic animals, as also M. Faivre's excellent little book, *On the Variability of Species and its Limits*, will afford an additional series of facts for Mr. Darwin's use in the preparation of the next edition of his work.

In conclusion, may we venture without offence to throw out a hint to the illustrious naturalist whose work forms the subject of this article? We all know with regret that his health has partially given way under his gigantic labours. Could he not find an associate to assist him in completing the remainder of his work? And who would be a fitter associate than his distinguished friend Dr. Hooker?