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Analytical and Critical Reviews.

I.—The Evolution of Species.[1]

In the criticism he has hitherto met with, the illustrious author of 'The Origin of Species' has been peculiarly unfortunate. That just and temperate discussion which is a real help to a man of scientific culture in an attempt to solve a most intricate problem, has been denied him; instead of critics he has met with detractors, and instead of criticism with abuse.

At length, however, Mr. Darwin would seem to have found a critic, we had almost said an adversary, worthy of him. Mr. Mivart's 'Genesis of Species' can scarcely be praised too highly for the candid spirit in which it is written, and for the wide knowledge it displays.

We propose in the following article to examine in detail the arguments of its author, and so by implication those of Mr. Darwin himself, rather than specially to criticise the 'Descent of Man,' the appearance of which happens almost to synchronise with that of Mr. Mivart's work.

Mr. Mivart's own account of his work is that[1]

"It is its object to maintain the position that 'Natural Selection' acts, and, indeed, must act; but that still in order that we may be able to account for the production of known kinds of animals and plants, it requires to be supplemented by the action of some other natural law or laws as yet undiscovered. Also that the consequences

[1] 1. *On the Genesis of Species.* By St. George Mivart, F.R.S. London, 1871. 1 vol., small 8vo.

2. *The Descent of Man, and Selection in relation to Sex.* By Charles Darwin, M.A., F.R.S., &c. In 2 vols. London, 1871.

[2] Page 5.

which have been drawn from evolution, whether exclusively Darwinian or not, to the prejudice of religion, by no means follow from it, and are, in fact, illegitimate."

In a note to this, Mr. Mivart points out "that Mr. Darwin himself admits that natural selection has not been the exclusive means of modification, though he still contends that it has been the most important one." Mr. Mivart here and elsewhere fails to see that Mr. Darwin is strictly philosophical in treating only of the action of known causes; and is more likely to lead to the discovery of those at present unknown, by leaving their results as a distinctly marked remainder after subtracting all the results of natural selection, than is Mr. Mivart, by his desultory examination of particular cases, which struck him as difficulties, without the guidance of any theory.

Mr. Mivart, in his introductory chapter, proceeds to say that [1]—

"Probably the genesis of species takes place partly, perhaps mainly, through laws which may be most conveniently spoken of as special powers and tendencies existing in each organism, and partly through influences exerted on each by surrounding conditions and agencies, organic and inorganic, terrestrial and cosmical, among which the 'survival of the fittest' plays a certain but subordinate part."

We hardly think that many biologists will be found willing to relegate the subject of evolution almost to the obscurity in which it lay before Mr. Darwin, Mr. Wallace, and Mr. Herbert Spencer threw light upon it by their labours, by attributing all unexplained phenomena to the working of these unformulised [2] "special powers and tendencies," or content to regard "the whole organic world as arising and going forward in one harmonious development similar to that which displays itself in the growth and action of each separate organism," without attempting to assign reasons for such development; seeing that even in the case of each organism the development is rarely one and harmonious, but a confused series of progressions and retrogressions, such that nothing but the evolution-history of the form seems at all competent to explain it.

Mr. Mivart, at the end of his introductory chapter, brings forward eight allegations against Natural Selection:[3]

"That 'Natural Selection' is incompetent to account for the incipient stages of useful structures.

"That it does not harmonise with the coexistence of closely similar structures of diverse origin.

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[1] P. 20. [2] P. 20. [3] P. 21.

"That there are grounds for thinking that specific differences may be developed suddenly instead of gradually.

"That the opinion that species have definite, though very different limits to their variability, is still tenable.

"That certain fossil transitional forms are absent, which might have been expected to be present.

"That some facts of geographical distribution supplement other difficulties.

"That the objection drawn from the physiological difference between 'species' and 'races' still exists unrefuted.

"That there are many remarkable phenomena in organic forms upon which 'Natural Selection' throws no light whatever, but the explanations of which, if they could be attained, might throw light upon specific organization."

The first six of these he proceeds to substantiate in the following chapters; and as the question of what Natural Selection can and cannot explain lies at the root of the matter, we must ask our readers' patience while we examine in detail some of Mr. Mivart's cases, premising that too much weight ought not to be attached to "minute" criticisms of any biological theory, for our present ignorance is such that we cannot as yet hope to discern the actual operation of any law in a vast number of cases of difficulty.

In Chapter II the difficulty of explaining the first appearance of variations of which we can only see the use when variation has progressed to some considerable extent is considered. We have here the old difficulty of the number of grains of corn necessary to constitute a heap, for who shall decide how small a variation may be immediately useful in any particular case?

The first case considered—the neck of the giraffe—scarcely comes under this head, but involves wider considerations, as it shows how great care is necessary in advancing any instance of the working of natural selection in any particular way, and how almost any instance, if not sufficiently considered, may appear open to attack. Mr. Mivart, after stating the usual explanation of its development, namely, that a slightly longer neck gives a great advantage to its owner in seasons of drought, by enabling him to reach higher branches of trees, says that if this were so the necks of some other ungulates ought to have been lengthened likewise. We submit, however, that this does not follow from the premises; for no animal originally less high-reaching than the ancestor of the giraffe could have competed with him; and there is no reason for supposing that any mammal of greater height, with at all similar habits, ever inhabited South

Africa. Mr. Mivart proceeds to quote Mr. Herbert Spencer [1] to show the disadvantage of size to the developing giraffe. In this passage it is pointed out that among animals differing only in size, while the strength to resist incident forces varies as the square of a linear dimension (for it varies as the transverse sections of the bones, muscles, &c.), the forces it is called upon to resist vary as the cube of a linear dimension, that is, as its mass. But the argument of Mr. Spencer is to some extent fallacious, as it does not take account of the fact that the absolute power of work of a muscle varies as its mass, not as its transverse section, and that greater size admits to some extent of a more favorable distribution of matter to resist incident forces.

Again, the external surface from which heat is lost by radiation also varies as the square of a linear dimension, and therefore, although the lung surface from which much of the loss takes place varies more nearly as the mass of the lung, and therefore assuming proportionality as the cube of a linear dimension, the loss of heat, which is the most important form in which energy leaves the body, does not vary nearly as the cube of a linear dimension. Mr. Herbert Spencer mentions this part of the subject in a somewhat unsatisfactory manner, mixing up his mechanical treatment of the subject with the physiological consideration that "organic heat is a concomitant of organic action, and is so abundantly produced during action that the loss of it is then of no consequence; indeed, the loss is often not rapid enough to keep the supply from rising to an inconvenient excess." As a matter of fact, however, organisms are so balanced that it is only the stimulus of unwonted muscular exertion that causes an inconvenient rise of temperature in any animal; also the slightest consideration of the case will show that all work done must be really done at the expense of a corresponding amount of heat that the food taken would otherwise be able to produce. This is an example of the extreme difficulty and danger of the application of deductive reasoning on abstract principles to biological problems, to cope with which properly more extensive data than we at present possess are almost always necessary.

Mr. Mivart next takes up the question of mimicry, and meets with difficulty both in the first beginnings from the mutual neutralisation and obliteration of conflicting tendencies, and also from the extreme minuteness of detail sometimes found, which appears to him unnecessary.

No doubt Mr. Bate and Mr. Wallace place most unwarrantable faith in mimicry, whose value as Darwinic evidence

[1] 'Principles of Biology,' i, 122.

recent observation shows to have been much exaggerated. For the appearance of many striking resemblances in cases in which the habits of the mimic are such that it could not possibly be mistaken for the object mimicked, and the fact that the importance of the enemies against which the mimicry is a protection is often comparatively trifling, seem to show that many mimicries have not arisen as such, but are accidental likenesses.

The asymmetry of the Pleuronectidæ is another stumbling-block to Mr. Mivart. Surely the origin of the shifting over of the eye, especially if we allow for the direct action of pressure, is not nearly so obscure as that of the optic nerves in many lower vertebrates; and the remarkable shiftings that nerve-roots undergo during development show that this is merely an extreme manifestation of a common occurrence.

Another difficulty is found in the origin of limbs and their strict limitation to four throughout the Vertebrata. Fortunately we have a sufficiently perfect series of limbs in this class to enable us, with some assistance from the imagination, to trace their development and modification. With regard to their limitation to four, no doubt the presence of a tail, admitting of endless modifications to enable it to be used in every conceivable manner as an aid to locomotion, has rendered the development of additional limbs unnecessary. In this case Mr. Spencer's argument with regard to increase of mass possesses real value, for additional limbs could only be useful at first for some one definite purpose, and if that need were not present would only be an incumbrance to the animal, and add greatly to the expenses of the animal economy.

Again, Mr. Mivart carps at the appearance of the prolonged larynx in the young kangaroo and in the Cetacea, and in no other mammals, whereas, as he says, it could do no harm. A little consideration will show that such a structure would be most injurious when sexual selection or the social instincts of the animal rendered a more highly developed voice desirable, and that in many cases it would interfere with deglutition, and be liable to injury during the process.

The presence of other unexplained structures, and the course of development of some other animals, are also brought up as arguments against "pure Darwinism." On the other hand, it seems to us that Darwinism is the only hypothesis which attempts to grapple satisfactorily with difficulties of this kind, for to attribute the origin of roundabout and uneconomical courses of development, and of elaborate but, from the author's point of view, nearly useless structures, to the action of some higher but unexplained law, seems in the highest degree absurd.

In fact, Darwinism alone explains the coexistence of gigantic universal waste of energy in the inorganic world, accompanied by an economy in some of the details of organized nature far surpassing that found in the working of systems of human design. We cannot help thinking, from the way in which Mr. Mivart states difficult points, that he has in many cases scarcely given them the consideration they deserve. Much that is to him insuperable disappears or becomes greatly lessened before a careful investigation.

Thus, one of his greatest difficulties is the origin of the mammary gland. We have not the advantage of knowing accurately the mammalian pedigree, although Professor Häckel's labours have greatly lessened our ignorance, and evidence as to the nature of many ancestors can only be obtained from collateral branches; we may, however, fairly assume that the earlier mammals carried their young in more or less perfect pouches.[1]

Again, it may be almost necessary for the imperfectly developed young in the pouch to be kept from being dried up by the sebaceous secretion of its walls.

Every step after this towards deriving nourishment, first by absorption through the skin, and then directly through the mouth, would be advantageous. The irritation caused by the contact of the young would stimulate the glands. Finally, the young animal might reach the point of applying its muzzle directly to the skin, as it does in Echidna, and would aid by pressure and suction in the conversion under natural selection of the protuberance caused by the ducts of the enlarged glands into a nipple. (In the Echidna the development of a nipple may have been rendered unnecessary by the young being held in a fixed position by the walls of the little convolution representing the pouch.) The disappearance of the pouch in proportion as the young are more and more developed *in utero* is a natural step, and is illustrated by the Thylacine, which at the birth of its young has a functional pouch; but when the young are able to run alone its enormous dugs hang from a nearly flat surface, bounded by what was the lip of the pouch. The fact that, according to Mr. Lockwood, the young of some fish provided with a marsupium, such as the Hippocampus, are nourished by the mucous secretion of its walls in which they

[1] It is noticeable that in the collateral branch, Aves, there are many forms which more or less habitually carry their young. The woodcock conveys its young to feeding grounds between its thighs; many water-fowl carry their young to the ground from their nests, and also allow them to take refuge on their backs; and penguins, which, though highly specialised in some respects, retain certain resemblances to reptiles and monotremes, are said to carry their eggs under the feathers of their abdomen.

are immersed, illustrates by analogy the most difficult step in the course of development above sketched out. To confute Mr. Mivart's argument, it is not necessary to show what the actual course of development has been, but only to point out a way in which it may have taken place.

Mr. Mivart, in arguing that the hood of the Cobra and the rattle of the Rattlesnake are not of use to the animals, and are, therefore, inapplicable in the theory of natural selection, denies the existence of the power of fascination in predatory animals, and claims support from Mr. Bartlett's observations upon snakes in confinement. Such observations, however, are of little value, as a snake in confinement must know that his victim cannot escape, and that he can kill him at leisure; but that some animals capture their prey through the terror which they inspire, no one who has seen a stoat in pursuit of a rabbit can deny. No doubt, however, sexual selection has had the greater share in the production of the organs in question.

The possibility of the improvement by natural selection of an organ like the eye, the perfection of which depends on the harmonious adaptation of so many parts, has been a stumbling-block to Mr. Murphy, Professor Pritchard, and others, besides Mr. Mivart. We can fortunately, however, find eyes in every stage of development, and also of retrogression, and a careful study of them will, we think, answer most objections.

The difficulty of the development side by side of two such superficially similar eyes as those of the cuttlefishes and the vertebrates is only an apparent one, as in the cuttlefish the layer supposed to correspond to the rods and cones of the vertebrate eye lies inside instead of outside the nerve layer, and differs fundamentally in structure. The structure of the lens is also different. In fact, the resemblances are no more than such as seem to be determined by the functional identity of the two organs.

It may be mentioned that among Mollusca the eyes of all the *Cephalophora* agree fundamentally with those of the dibranchiate Cephalopoda, while the eyes of Pecten, and, therefore, probably of other Lamellibranchiates, are more nearly formed on the vertebrate type. Therefore, the divergence in eye-structure agrees with what we know of the divergence of the Cephalophora from an Ascidian-like stock common to them, the Lamellibranches and the Vertebrates.

It is, perhaps, worth mentioning that the eye of the nautilus is utterly aberrant, as, according to Dr. Hensen,[1] no lens exists,

[1] "Ueber das Auge einiger Cephalopoden," 'Zeitschrift für Wiss. Zoo.,' xv, 1865, p. 154.

but the pupil is simply a small hole, the nervous structure agreeing, however, generally with that of the dibranchiate type of eye.

The extreme perfection of the vocal and oral organs in man, and of the former and probably the latter in many animals which make but little use of it, is, no doubt, hard to explain; but without such perfection we should lose, not only æsthetic advantages, but the power of recognising individuals of our own species when out of sight, which must be useful to all animals.

But to criticise as minutely as they deserve all Mr. Mivart's "minute" criticisms would require a volume larger than his, and exhaust the patience of any reader.

The arguments of the writer in the 'North British Review' for June, 1867, on the 'Origin of Species,' some of which are quoted by Mr. Mivart, are sweeping in their scope, and directed rather against the reasoning than the data of Darwinism. The writer first attacks the possibility of indefinite variability, contending that in all cases there exists a limit to variability in any direction. This, no doubt, is true in the main of variation under artificial selection, from which the writer's instances are taken, for most artificial selection is directed only to particular points, and when these have been cultivated up to a certain limit any further development of them would produce monstrosity; but Natural Selection attacks to some extent every part of the organism, and, therefore, tends to produce homogeneous wholes. And we maintain that it would cease to be equally true under Artificial Selection, when the variation is of such a character as to alter considerably the relations of the organism and its environment. Thus, although it is impossible to increase the size of a rose or the swiftness of a racehorse, or diminish the size of a pigeon's head indefinitely, no difficulty has been found in establishing breeds of dogs differing as much in proportions and powers as do the members of the whole family of Carnivora to which they belong. Then follow some objections to the efficiency of natural selection, in which it is attempted to show that, estimated numerically, the value of an advantage derived from a variation is not sufficient to account for the origin of a new species. We will give the argument as it stands.[1]

"A million creatures are born; ten thousand survive to produce offspring. One of the million has twice as good a chance as any other of surviving; but the chances are fifty to one against the gifted individual's being one of the hundred survivors (*sic*).

[1] 'North British Review,' June, 1867, p. 288.

No doubt the chances are twice as great against any one other individual, but this does not prevent their being enormously in favour of *some* average individual. However slight the advantage may be, if it is shared by half the individuals produced it will probably be present in at least fifty-one of the survivors, and in a larger proportion of their offspring; but the chances are against the preservation of any one 'sport' in a numerous tribe. The vague use of an imperfectly understood doctrine of chance has led Darwinian supporters, first, to confuse the two cases above distinguished; and secondly, to imagine that a very slight balance in favour of some individual sport must lead to its perpetuation. All that can be said is, that in the above example the favoured sport would be preserved once in fifty times. Let us consider what will be its influence on the main stock when preserved. It will breed and have a progeny of say 100; now, this progeny will, on the whole, be intermediate between the average individual and the sport. The odds in favour of one of this generation of the new breed will be, say $1\frac{1}{2}$ to 1, as compared with the average individual; the odds in their favour will, therefore, be less than that of their parent; but owing to their greater number, the chances are that about $1\frac{1}{2}$ of them would survive. Unless these breed together, a most improbable event, their progeny would again approach the average individual; there would be 150 of them, and their inferiority would be say in the ratio of $1\frac{1}{4}$ to 1; the probability would now be that nearly two of them would survive, and have 200 children, with an eighth superiority. Rather more than two of these would survive; but the superiority would again dwindle, until after a few generations it would no longer be observed, and would count for no more in the struggle for life than any of the hundred trifling advantages which occur in the ordinary organs."

This argument is, no doubt, correct, but it is only partially applicable; for although in the ordinary functions of life the amount of food, &c., obtained by an organism may be proportional to its fitness for the position it occupies, yet some of the most important acts of its existence are of the character of a contest or of a competitive examination, and in all such a very slight superiority gives an organism almost a certainty of success over its competitors, instead of only doubling or trebling its chance of living and breeding. Periods of scarcity or disease give rise to such competitions, and sexual selection owes its great power to its acting in this manner. It must also be remembered that all these arguments based upon probabilities have precisely the same weight when applied to the question of the origin of permanent varieties as to that of the origin of species,

and we have observed and know that varieties do appear; therefore they do not affect Mr. Darwin's attempt to prove that the origin of species is the same in kind with that of varieties.

The reviewer goes on to state very clearly the bearing of the principle of the dissipation of energy in the time allowable for the production of species. The complexity and abstruseness of this subject renders any lengthened treatment of it here out of place. We can only remind our readers of the extreme difficulty of all calculations in cosmical physics, and the great uncertainty of numerical results based on data so little known as those which determine the rate of loss of the sun's heat and the retardation of the earth's rotation. Even the very causes that retard the earth must convert its *vis viva* into heat, and thereby prolong its habitability. Some of Sir William Thomson's arguments are open to the gravest objections; for instance, it does not follow that, because the form of the earth is that due to its present velocity of rotation, therefore it must have solidified when it had a rate of rotation not much differing from the present, if, as many physicists suppose, the earth must be regarded as viscid under the action of such forces as determine its shape, and, therefore, as having its shape altered as these forces alter. Similarly, calculations as to the rate of loss of the sun's heat must, until some one theory of the constitution of the sun meets with general acceptance, be regarded with the greatest suspicion, however high may be the authority of their author.

Thus, although Sir William Thomson leaves a very great interval between the limits which he sets to the time at which the earth became habitable, no one can receive these limits as absolutely determined. The geological data for determining the age of the earth give, if possible, still less definite results, but on the whole point to a time far earlier than Sir William Thomson's earliest limit; they can at best only give us the latest possible time at which the earth can have become habitable, for any amount of destruction and reconstruction may have taken place before the earliest extant rocks were formed. Again, as pointed out by the reviewer, from the dissipation constantly taking place, the energy of physical forces must have been greater at an early period than at present, and therefore the rate of physical change must have been greater, but by how much we cannot tell. But the most ancient deposits, not too much metamorphosed to supply means of judging, accord precisely in their physical constitution with those of many recent formations, and from similarity of effect we may in general infer similarity of operating forces.

Therefore the time of their formation may very probably have been long since the first habitability of the globe.

But this greater rapidity of physical change at an early epoch implies at least an equal increase in the rate of organic change, for fewer forms will be in that comparatively fixed state which, according to Mr. Darwin, is probably the condition of the majority at any one time, while the changing action of the environment, both directly and by conducing to migrations, will be constantly stimulating the origin of and giving permanence to new varieties.

And even were it not for this, the number of varieties that occur is so vastly in excess of the number which find places to occupy in the economy of nature, that there is little danger of any new place being made by physical change without there being found some variety ready to take advantage of it.

Attempts to compare numerically the amounts of organic differentiation required to produce varieties, species, genera, and larger groups, are at present hopeless, and but little weight can be attached to such a passage as the following:

"We doubt whether a thousand times more change than we have any reason to believe has taken place in wild animals in historic times would produce a cat from a dog, or either from a common ancestor. If this be so, how preposterously inadequate are a few hundred times this unit for the action of the Darwinian theory."[1]

In answer to this we may urge generally, that the classification of the organic world has furnished Mr. Darwin with his strongest arguments. From its being impossible to frame any accurate definition of the amount of difference necessary to constitute a variety, a species, or a genus, and from these groups being connected together like the branches of a tree, he argues the existence of a real affinity of descent. To this the North British Reviewer and others have replied that, if any limits to the possible variety of form of organisms in a group exist, as all the organisms of the group must be between them, if only they be sufficiently numerous, some of them must necessarily be very much alike, and that, therefore, confusion would exist whatever was the origin of the forms. This is illustrated by comparison with the classification of inorganic, natural, and, artificial products, the classification of which is often a matter of the highest difficulty, notwithstanding that in these cases we can generally analyse much more accurately the causes of affinity and difference. We can only say that we can trace no appearance of this close packing of forms between

[1] 'North British Review,' June, 1867, p. 301.

limits in nature, and, as the arrangement of organic nature is certainly not linear, we cannot conceive its practically occurring. There is no analogy between the classification of organic and inorganic bodies, except in cases in which the latter owe their origin to the working of the human mind, for the difficulty of classifying inorganic bodies is not so much in drawing lines between groups as in allotting individual objects, which often partake of the characters of several widely different classes, to their correct groups.

In the case of the products of the human brain, however, in the fine and the mechanical arts, a real analogy does exist between natural and artificial productions, for the productions of almost all the arts in universal use have been developed into their present forms almost precisely as the Darwinian hypothesis requires organisms to have been; the only radical difference being due to the fact that the human mind has always a share in the multiplication of individuals, and stands in the same relation to the artificial world that life, whatever it may be, does to the natural.

No better instances can be found of the operation of the principles of Darwinism than those brought to light by the labours of modern philologists;[1] the difficulties of philology are precisely those which Darwinism explains in the organic world, but, fortunately for philologists, the development-history of very many languages is pretty well known. If we consider a language as a whole, we may observe its early variation from its parent stock, and can often trace that what appear to be chance variations are due to the environment, that is, to the constitution of the race speaking it; but still more often observe that variations, which at present are so utterly inexplicable that they can only be attributed to chance, are preserved for their convenience or agreeableness;—reasons which correspond to the causes of natural and sexual selection. In nature we cannot at present altogether explain the appearance of variation; but neither Mr. Darwin nor any other evolutionist—except, possibly, the dummy "pure Darwinist" set up by Mr. Mivart only to be knocked down—would conceive that such effects could be manifested without corresponding causes. And the occurrence of parallel geographical varieties of different species—for instance, the occurrence of sets of forms in a particular district, all differing in the same manner from the corresponding forms in another district, as in the case of the twenty-nine kinds of American trees, all differing from their nearest European allies in a similar

[1] See the late Prof. A. Schleicher's work, translated by Dr. Bikkers, 'Darwinism tested by the Science of Language,' 1869.

manner, quoted by Mr. Mivart from 'Proc. Acad. Nat. Sci. Phil.' (vol. i, 28, 62), or of the butterflies, which have tailed races in some places and tailless in others, or large wings in some localities and smaller, differently shaped ones in others—may ultimately guide us to those causes.

In each particular case special causes are at work, but the law of the survival of the fittest holds throughout, and a close investigation shows that a great number of the special features of organic development are admirably displayed in the arts.

Dress, for instance, in which a desire to conform to custom takes the place to a great extent of heredity, and checks indefinite variation, affords curious instances of rudimentary organs.

The buttons above the tails of our coats now only cause a trifling annoyance by catching in chairs, not sufficient to cause rapid extinction, and will, we hope, never again support our sword-belts. Our coat-collars and cuffs, our evening coats, and innumerable parts of academical, professional, and servants' clothes, whose variations are checked by exceptional restraining causes, remain as rudiments of structures that came into existence, either directly from utility, or from the action of the environment in selecting chance modifications. Dress also shows how structures may continue long after they have become, not only useless, but even injurious in a slight degree, for probably there can be no one who has thought on the subject who could not modify his dress so as to make it more comfortable, if custom were not too strong for him.

Sir John Lubbock has shown what sufferings savages undergo under the influence of custom and sexual selection for the sake of personal adornment.

Dress also, to some extent, justifies Mr. Darwin in attaching more importance to Natural Selection operating on what, from ignorance, we must call chance variations, than the direct action of the environment, for most temporary failures arise in this way. In the purely practical arts, however, variation hardly ever takes place without obvious and sufficient reason.

Painting affords an instance of the rapid development of improved forms followed by great specific fixity; sculpture, of "rudimentary organs" in mock antique costume.

In architecture rudimentary organs are very common; useless gurgoyles project beyond modern gutters: and in many modern timber roofs conspicuous but useless wooden trenails merely serve to conceal the iron bolts used in their construction; this may be considered the *reductio ad absurdum* of rudimentary organs. Even in the mechanical arts such instances are common; thus, railway carriages for a long time retained many characters inherited from chariots and coaches, and are

only now learning to be built without them. In shipping such rudiments are still more marked. Take, for instance, the painted port-holes, which, with sham wooden guns, originated in an attempt to intimidate hostile vessels and prevent their approach, but which could not, as they are now painted, deceive any one.

Perhaps, until our knowledge of organic nature is greater, as much evidence in favour of the working of Darwinic principles may be obtained from the study of the arts as of nature, and such evidence, although only collateral and not direct, is already strong enough to prove that Mr. Darwin's are "veræ causæ," their sufficiency remaining to be established by a consideration of the organic world with the help of the light thrown upon the working of the laws by a study of the simpler cases.

Mr. Mivart considers that Mr. Darwin is wrong in disbelieving altogether in sudden considerable variations being perpetuated in nature, and quotes many believers in evolution in support of his views; but that he can adduce a certain number of cases requiring the preservation of such sudden steps for their explanation, and also several instances of such jumps occurring under domestication, by no means shows that they are not exceptional, and the fact that they have attracted so much attention is rather a proof of their abnormality.

The question of the infertility of distinct species when crossed is so familiar that little remains to be said on the subject. Mr. Mivart states this difficulty in Darwinism, which is, no doubt, one of the greatest, without throwing any new light on the subject. Mr. Darwin has, in previous works, attempted the explanation of all the points raised by Mr. Mivart, with at least partial success.

It appears that, since it is manifestly impossible that widely different organisms should breed together, as heredity would entail incompatible structures on the offspring, therefore fertility must cease at some point. On the other hand, it is found that the greatest fertility does not result from the pairing of the most similar forms; for such pairing brings out, not only the excellences, but the defects of both, and these defects may require but little development to render them fatal. It seems probable that the evils of "in-and-in breeding" are wholly due to this.

From what has been said it follows that, between the limiting cases of absolute similarity and greatest difference between the parents, there must be some point at which fertility reaches a maximum; this maximum seems usually to occur when the differences between the parents is sufficient to constitute variety, and that after this it falls off, at first gradually, until we come

to that point at which the line between species and variety is usually drawn. After this the degree of fertility falls off very rapidly, but not really suddenly, and absolute infertility can only be said to be reached when even the first stages of development are not commenced after the access of the male; and even here there is no very distinct break, for some of the earlier stages seem often to occur without impregnation at all, and so sexual reproduction merges into parthenogenesis.

The fact that to a superficial observer the question of fertility between two organisms admits only of a positive or negative solution, whereas there exists really every gradation between fertility and infertility, tends to throw a false light over this subject, as does also the fact that many definitions of species draw the line between species and variety by means of the mutual fertility test, so that there is a tendency to argue in a circle; it is an almost absurd criticism upon this that, practically, the line is not drawn at the point of mutual infertility, but at that at which the product of a cross is infertile.

Mr. Mivart, after going through the ordinary objections based on palæontology, which have been sufficiently fully considered by Mr. Darwin, dwells more at length on the question of the origin of certain well-marked aberrant groups, such as the Pterodactyles, the Aves, the Ichthyosaurs and Plesiosaurs, the Whales, and the Tortoises.

Considering from what slender sources the pathological knowledge we have of Aves and Pterodactyles is derived, it can be no cause of wonder that the hiatus between them both and ordinary reptiles remains so wide. With the larger marine reptiles and cetacea his case is stronger; the number of specimens preserved is very great, and their larger bones are so indestructible that it might be thought that almost every individual of the larger forms that reached maturity would leave some remains; and we cannot suppose that the intermediate forms inhabited districts whose geology is unexplored; this difficulty, therefore, must be regarded as, at present, inexplicable. It may, however, be pointed out that the theory of sudden considerable variation fails equally, for Mr. Mivart cannot suppose that such gaps as those between Ichthyosauria and Plesiosauria, or between other mammals and whales, can have been bridged over by a single sudden step.

Mr. Mivart himself does not appear to attach much weight, except as cumulative evidence, to certain exceptions to the laws of geographical distribution, which laws may be considered as the very foundation of Darwinism. The very fact that the exceptions which he points out seem so very remarkable is the strongest confirmation of the universality of the laws in ques-

tion, and Mr. Darwin has pointed out, in the 'Origin of Species,' many ways in which exceptional cases may have arisen.

The author then proceeds to discuss the origin of serial, lateral, and vertical homologies, and rejects, as insufficient, Mr. H. Spencer's explanations, that the serial homology of Annulata is due to their being tertiary aggregates, that is, genetically, chains of individuals formed by generature, which, instead of separating, have remained coalesced as a single individual, while the homologies of the spine and limbs of vertebrates are due to similarity of condition. He says (p. 154), "But there are, it is here contended, abundant reasons for thinking that the predominant agent in the production of the homologies of the limbs is an *internal* force or tendency" (the italics are his). Having called in this *Deus ex machinâ*, the whole difficulty is solved; he may as well do all as a part of the work; the author, therefore, endeavours to make out that as much as possible remains unexplained by Mr. Spencer's theory, in order that we may feel the need of him more strongly. Mr. Spencer's theory is certainly presented to us in a highly abstract form, and is really little more than a statement with regard to organic nature of the principle, the general truth of which no one will deny, that the present state of any body is the immediate result of all the forces that have ever acted upon it, directly or indirectly, and that it therefore contains within itself all the essentials of its history, if we could only read them aright; and he would be the last to pretend that enough was known of the way in which heredity has handed on modifications produced by incident forces, sometimes preserving structures to which the forces at present in action could never have given origin, at others allowing incident forces to sweep away the hereditary insignia by which the kinship of the organism was best marked, to enable us to give anything approaching to an explanation of each particular case.

Yet few will be prepared to leave this fairly safe ground for Mr. Mivart's internal force theory, of which, however, we have no opportunity of judging, as he tells us nothing as to how this force is supposed by him to act; he merely adduces a series of cases of homology and symmetrical abnormalities of structure, which, he says, are explained by no other theory, and which necessitate the hypothesis of an internal law or substantial form, and whose difficulties, together with all those of ordinary development, and also of evolution, vanish, according to him, upon the acceptation of the doctrine of some such law, which shall account, at the same time, for specific divergence as well as for specific identity.

We can only compare this part of our author's argument to that common among all uninformed people who are wont to explain

every phenomenon which they do not understand by attributing it to "electricity," and who seem to think, because they are told on good authority that many things they do not understand are due to electricity, that "what I do not understand" and electricity are convertible terms!

Mr. Darwin's theory of pangenesis, if freed from some of the restrictions with which its author surrounds it in his first enunciation of it, is sufficient to explain much for which Mr. Mivart requires his "internal force." If it once be granted that only representative gemmules need be present in the fertilised ovum, and that gemmules from homologous parts are mutually replaceable within certain limits, the correlation of the variations of homologous parts, the tendency to the repetition of similar parts and symmetrical diseases, would be accounted for. It must be conceded to Mr. Mivart that similarity of incident forces is not a sufficient explanation.

It is extremely unfortunate that Mr. Mivart's chapter on evolution and ethics appeared before 'The Descent of Man,' for many of his objections are answered in it, although the answers must have been written before seeing the objections.

Mr. Mivart contemplates civilised morality, and compares it with what may be called the morality of animals, and very naturally can trace little or no connection between them. He finds no such thing as "formal" morality among animals—no sign, for instance, of moral reprobation. No doubt, for formal morality could not exist until the human mind had so far progressed as to be capable of forming abstract ideas, notwithstanding that the moral sense on which it rests may have considerably advanced in the absence of that power of mind.

The author also objects that some very common moral acts are neither for the benefit of the individual nor of the society—for instance, the tending of the aged and infirm. This is an extension of the principle of doing good to others of the same community, and one that would almost necessarily follow when the moral sense of the community had become somewhat developed, although it is inconsistent with the causes that orginated the principle itself. Many parallel cases may be pointed out in which the instincts of animals of obvious general utility lead them to act in certain special cases against their own interest. Mr. Mivart's difficulty as to the perception of degrees in morality is well explained by Mr. Darwin in his 'Descent of Man,' where he attributes it to the more permanent sense of satisfaction resulting from the higher line of conduct, as compared with the fleeting satisfaction given by the gratification of temporary appetites and emotions.

Mr. Mivart questions with great justice many of Mr. Herbert

Spencer's views, and amongst others his opinion that for every immoral act, word, or thought, each man during this life receives minute and exact retribution. If arguments against this doctrine from history and experience were not forthcoming, we conceive that the principle of natural selection would furnish one almost unanswerable, for surely, if the bad were so heavily handicapped, the morality of the human race could never have made a progress so very halting and interrupted.

Mr. Mivart next criticises with great severity and much justice the theory of pangenesis, which, from the extreme difficulty of applying to it any crucial test, will probably long remain *sub judice*. For the benefit of some of our readers, we will give Mr. Darwin's latest enunciation of it ('Descent of Man,' vol. i, p. 280):

"According to this hypothesis, every unit or cell of the body throws off gemmules or undeveloped atoms, which are transmitted to the offspring of both sexes, and are multiplied by self-division. They may remain undeveloped during the early years of life or during successive generations; their development into units or cells, like those from which they were derived, depending upon their affinity for, and union with, other units or cells previously developed in the due order of growth."

Mr. Mivart seems to think that Mr. Darwin considers the gemmules themselves to be the ultimate atoms of the body, whereas he distinctly states that he considers their product—the cell—to be so, and on this ground objects that they cannot be allowed to be capable of self-division. Mr. Darwin probably does not suppose this self-division to take place except when the gemmules are so far developing as to be taking up nutriment, for he illustrates his theory by a comparison between the increase of the germs of cholera and rinderpest and that of his gemmules in general. If he did not do this few physiologists would be inclined to accept his theory.

Mr. Mivart produces cases which he thinks incompatible; that, for instance, of mutilation. This has occurred for a vast number of generations, in the form of circumcision, the continued necessity for which seems, at first, difficult to explain on this hypothesis. Mr. Darwin, in his 'Variation under Domestication,' vol. ii, p. 23, quotes from Blumenbach ('Philosophical Magazine,' vol. iv, 1799, p. 5) the statement that, in Germany, Jews are often born in a state such as to have given origin to the term "born circumcised," and also alleges that any mutilation, to be hereditary, according to this theory, ought to take place at the time of the first development of the organ mutilated, because, during its existence previous to mutilation, its cells have

the opportunity of giving rise to sufficient gemmules to preserve it for future generations, at least up to that stage of development at which mutilation takes place. He explains cases of the inheritance of mutilations by the hypothesis that they occur when the wound caused has remained long enough to have presented its sloughing surface, and thus to destroy all the gemmules belonging to the lost part. Certain breeds of pigs, which are born with tails, almost invariably lose them by disease at a very early age. This would seem to be a case in point.

The strong and increasing body of physiologists who have ceased to regard a cell as the physiological element, but consider it as the product under the action of the environment of an elementary portion of germinal matter, probably agree largely with Mr. Darwin in substance, although the form of his enunciation would require considerable modification to bring it in accordance with their views. It seems merely necessary to add to their statement of observed facts his theory of the almost ubiquitous distribution within the body of minute particles of the germinal matter of each homogeneous organ which we know to undergo self-division, and which may do so to a far greater degree than we suppose, to have nearly the pangenesis theory; and, perhaps, if we do not bind these gemmules always to reproduce themselves exactly—which, indeed, is inconceivable, for then no variations in kind, such as the appearance of an extra finger, would be possible—but leave them free to be developed in many different positions where tissue of apparently precisely identical structure occurs—having, indeed, a strong tendency towards precise reproduction of their parent structure, but admitting of modification by their environment—we may explain the various facts of homology of parts in an individual. No doubt this modification of the theory sacrifices much of its sharpness, but it is contended that without some such relaxation the appearance of new additional abnormal structures is inexplicable.

It is impossible in a short space to give a fair idea of Mr. Darwin's case in favour of pangenesis, and we must refer our readers to his work ('Animals and Plants under Domestication') for it; but it must be granted that it fits in with and explains a vast number of phenomena; and although it is necessary to concede to these gemmules the possession of a large number of properties difficult to reconcile with their supposed simplicity, it would seem that the same difficulties are really involved in all other theories of reproduction, although they do not appear so conspicuously in such as are less analytic.

Mr. Galton's recent experiments on the transfusion of blood in rabbits must be held to be indecisive, from their limited

number and from the probability that only the gemmules of the blood itself are present in it at any one time in any number; extensive experiments on grafting are, perhaps, more promising.

Perhaps the connection between the generative and the urinary system may stand in relation with the probable fact that gemmules would be likely to escape from the body in company with the products of the waste of the tissues in which they originated.

Mr. Mivart professes in his eleventh chapter to give his views on specific genesis by means of the internal force or tendency of which he speaks; we cannot say that we have succeeded in grasping his meaning satisfactorily. No doubt there exist internal properties and tendencies in different organisms on which the environment can act; for anything without properties is inconceivable; but that innate tendencies without any secondary cause should give rise to new species seems but a return to the Special Creation hypothesis in disguise. The author says that his views agree to a great extent with the Derivation hypothesis of Professor Owen; this may well be, for both seem equally without a *vera causa* to rest upon, and although Mr. Mivart spares us the mysterious declamation in which those of the Professor are shrouded, his real views are nearly as hard to make out.

Of the action of Natural Selection we now know a good deal, but little compared with what remains to be known; of that of the environment generally we know little or nothing, as a consideration of geographical varieties, and of the action of drugs, will show; and until we have some means of knowing how far these two causes are capable of explaining the origin of species, there is no need to go in search of purely hypothetical causes of change.

The great length to which our remarks on Mr. Mivart's most interesting book have extended leave us but little space to treat of the still more important work of Mr. Darwin; this is of less consequence, as by far the greater part of it consists of facts illustrating the subject treated, and a mere summary of these and the deductions from them is unnecessary, as the author, with his usual consideration for the weakness of the human memory, has supplied in the body of his work both special and general summaries. He has also in general so carefully verified his facts that they are safe from all attack, but in the present volume we cannot but feel some suspicion of a few of the anecdotes of animals quoted from Brehm's 'Thierleben,' and also some of the old statements about ants made by P. Huber, than whom, however, no higher authority exists. We will confine ourselves

to a few remarks on some of the more important deductions from these facts.

After showing that man's mental attributes differ in degree, not in kind, from those of the lower animals, and that we share with them almost equally many instincts and instinctive habits, Mr. Darwin comes upon the difficult ground of the origin of the belief in God. He says, vol. i, p. 65—

"There is no evidence that man was aboriginally endowed with the ennobling belief in the existence of an Omnipotent God. On the contrary there is ample evidence, derived not from hasty travellers, but from men who have long resided with savages, that numerous races have existed and still exist, who have no idea of one or more gods, and who have no words in their languages to express such an idea. The question is, of course, wholly distinct from that higher one, whether there exists a Creator and Ruler of the universe; and this has been answered in the affirmative by the highest intellects that have ever lived."

Now, we venture to maintain that the questions are not wholly distinct—that is, whether this Creator and Ruler of the universe is a concrete God, who can be worshipped and prayed to, and not the shadowy Unknowable, the truth which he whom Mr. Darwin speaks of as "our great philosopher, Herbert Spencer," finds hid at the bottom of a corrupt mass of religious beliefs as our "Ultimate Religious Idea." Now, we believe that not only an overwhelming numerical majority among civilised men, but an equally powerful intellectual one, would decline altogether to regard this as a religious belief at all. It is a necessity of thought, no doubt, and, as such, important. Mr. Darwin says (p. 68)—

"The feeling of religious devotion is a highly complex one, consisting of love, complete submission to an exalted and mysterious superior, a strong sense of dependence, fear, reverence, gratitude, hope for the future, and perhaps other elements."

Now, we venture to say that no intelligent man could look upon the Unknowable with any of the feelings here specified. Fear of the unknown is, indeed, justifiable, for it may become known and injurious; but fear of the unknowable would be worse than childishness. Possibly, amongst the doubtful "other elements" may be included a certain vague awe, inspired by anything stupendous, but not really akin to fear, which is, indeed, common to the God of civilised mankind at large and the God of Mr. Spencer, but only because the former includes the latter.

How, then, are we to reconcile Religion and Darwinism? No task is more difficult than that of bridging over the gap between

Religion based on Truth, and Deduction and Science based on Observation and Induction, and we wish that task were in abler hands, as, until it is to some extent accomplished, we fear that many evolutionists have their religious beliefs shaken, and many religious people dread Darwinism, both, we believe, most unnecessarily. The vital importance of the matter must be our excuse for a few remarks, of the imperfection of which we are deeply conscious. For brevity's sake we must refer our readers to works on the special subject for the support of our assertions.

First. We maintain that man has a soul, and not a mere belief on the part of the majority that he has one.

Secondly. That a soul does not admit of being developed like a mental quality.

Thirdly. That animals have no souls.

Therefore, we conclude that, at some time or other, when man became really man, he had a soul given him, and that this process may be called the creation of man. At what period in man's development this took place we do not venture to suggest; possibly not until he had become a tool-using, talking animal. Possibly the savages spoken of in the passage above may still be without one. In making this assertion we, of course, contradict Mr. Spencer's explanation in the 'Fortnightly,' May 1st, 1870, p. 555, "that man was led through dreams, &c., to look upon himself as a double essence of spiritual and corporeal," while granting that the idea of the distinction between body and mind has been developed. Nor would we be supposed to deny that religious ideas, both true and false, have undergone development. But we do assert that the existence of a soul, involving a belief in a future state and of the Deity implanting it, and rendering a revelation possible, cannot be due to development; and to those who deny the existence of a soul and a future state our argument has absolutely no weight. We cannot see that a belief in this one supernatural intervention need diminish the willingness of any man to receive Mr. Darwin's explanation of the origin of the Moral Sense in the succeeding chapter, in which we can detect no flaw; and we cannot but admire the wonderful fairness and judgment displayed in deducing the difference between right and wrong from the greater persistence of the instinctive tendency to action in the former case.

But little remains to be added to his treatment of the subject. In urging arguments in favour of the heredity of virtue the case is even understated. The subject is complicated by the difficulty of estimating the effect of education, which seems to be very great, for we often find that the families of men whose eminent excel-

lence has brought them into a position in which they have but little time for their domestic duties are often much below the average in moral goodness.

The most important question of the probable effect of civilised man having, to a great extent, released himself from the action of natural selection is treated of at some length by Mr. Darwin. That this is an element of serious danger to modern nations cannot be doubted; and as far as we can see, our best hope lies in the springing-up of the idea of the immorality of those who are in any way physically or mentally unsound marrying, for we fear no legislative enactments will control men in this matter. The spread of self-respect and education will rapidly diminish the numbers of those degraded classes which multiply with great rapidity from the absence of all prudential restraint after marriage, and the feeling that nothing can further impoverish them.

Of the remainder of Mr. Darwin's account of the principal difficulties in tracing the connection of man with the lower animals we have no space to treat, neither can we examine the enormous collection of facts bearing on sexual selection, which, with a most careful investigation of the laws which appear to be deducible from these facts, occupy two thirds of Mr. Darwin's work. We confess to a slight feeling of disappointment when first we found how small a portion of the book was taken up by matter bearing directly on the development of man, but this feeling soon passed away when we discovered the extreme interest of the part on sexual selection and its important indirect bearing on the main question. The excellence and lucidity of the descriptions, and the remarkable merit of the woodcuts, especially those which are original, do much to heighten the pleasure of reading it. Those who are familiar with Mr. Darwin's writings will be much struck by his increased self-reliance, and by the many indications that he feels himself entitled to take many things for granted which formerly he would have thought it necessary to prove. In this he is fully justified by the marvellously rapid change which has taken place of late years in the view generally taken of his theory.

We have observed above that the philosophical way of attacking the subject of the origin of species is by considering what may be accounted for by the known *veræ causæ* of the action of the environment and of natural selection, and then endeavouring to find an explanation for the remaining phenomena, if any. It appears to us that a set of phenomena is already separated out which, although due to the action of the environment, yet involve special questions and deserve consideration apart.

It is manifest that the liability to being variously modified by

drugs and new and unusual conditions of climate cannot have been developed in organisms by natural selection; it is what Mr. Mivart would call innate, that is, it is due to the various physico-chemical properties of the components of the organism.[1]

It is a very general feature in the effect of these agents that they at first give a great shock to the organism, which, if it survives, is followed by an organic change often very obvious, though only understood in a very few cases, possibly due to the replacement of certain chemical compounds in the organism by substitutive products—metameis, isomers, &c.—and after this change has taken place the organism is but little influenced by the continued operation of the agent, and even suffers if it ceases, but is able to live under circumstances that would prove fatal to a number of the same species that had been through this change. Now, in different geographical districts different agents must operate on organisms. We know how great are the changes produced on man by waters containing minute quantities of certain substances and by small changes of diet or of climate. Similarly Mr. Darwin mentions that a diet of fish or the acrid secretion of toads will cause changes in the plumage of parrots, and it is commonly known that a diet of hemp-seed will turn a bullfinch nearly black. Now, the species or geographical varieties of bullfinch inhabiting the Palæarctic region must be submitted to differences of diet, &c., far greater than that between a diet of rape- and canary-seed and a diet of hemp-seed: will not this account for their differences, which are but little more important than that between an ordinary and a blackened bullfinch ?[2]

It seems highly probable that the sudden appearance of the black-shouldered variety of pea-fowl, which Mr. Sclater considers a distinct species, independently in several flocks of pea-fowl in England, may be explained in this way, as well as other analogous instances, some of which we have mentioned above.[3]

We even venture to suggest that mimicry may be sometimes due to these causes; for instance, the same causes may have determined the general coloration of both the mimicked and the mimicking butterfly, and the minuter likenesses alone may be due to Natural Selection.

Similarly, animals mimicking plants are exposed to the same

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[1] See 'Descent of Man,' pp. 151, 152.

[2] In connection with this must be considered the facts of correlation, such as the deafness of white cats with blue eyes, and the liability of animals of certain colours to certain poisons. See 'Animals and Plants under Domestication,' vol. ii, ch. xxi, for many instances.

[3] Page 269.

physical and even to some extent the same chemical conditions as the parts of the plants they mimic; the colouring matter in both is often identical, or nearly so, and often depends to a great extent upon the light to which it is subjected. For instance, spiders that are in the habit of hiding in the axils of leaves must be subjected to the same conditions of pressure, light, and air, as the buds themselves, and these conditions may produce likeness enough for Natural Selection to operate on.

It is found that the presence of minute quantities of certain substances in saturated solutions will determine the form in which a salt crystallizes, and other similar facts are known which by analogy elucidate this subject. Such are the phenomena of allotropism

Enough has, we think, been said to show that nothing is at present likely to throw more light on the origin of species than a careful investigation of the effects of chemical and physical agencies on an organism slightly different from those under which it usually lives, and this ought to be followed up by an analysis of the circumstances under which geographical varieties exist, and an endeavour to find the cause of their differences.

II.—Diseases of Women.[1]

PROBABLY no branch of the medical art has made more important progress within the last twenty years than that generally comprehended under the title of "diseases of women."

Long a neglected, if not a despised department of medicine, it lay, as it were, dormant for years, and it was only after the invention of exact methods of physical examination, such as the speculum and the uterine sound, that its advance towards the prominent position it now holds commenced. Greatly as the speculum has been abused by those ignorant of its uses, it is certain that the services it has rendered to this department of the profession can hardly be over-estimated. Indeed, it is

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[1] 1. *The Diagnosis, Pathology, and Treatment of Diseases of Women.* By GRAILY HEWITT, M.D., F.R.C.P., Professor of Midwifery, University College. London.

2. *Traité Pratique des Maladies de l'Utérus et des ses Annexes.* Par A. COURTY, Professeur de Clinique à la faculté de Médecine de Montpellier. Paris.

3. *A Practical Treatise on the Diseases of Women.* By T. GAILLARD THOMAS, M.D., Professor of Obstetrics, &c., in the College of Physicians, New York. Philadelphia.

4. *A Practical Treatise on the Diseases of the Sexual Organs of Women.* By F. W. VON SCANZONI, Professor of Midwifery in the University of Wurzburg. Translated by A. K. GARDNER, A.M., M.D. New York.