Review of *The Origin of Species* (1867)

Fleeming Jenkin

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The theory proposed by Mr. Darwin as sufficient to account for the origin of species has been received as probably, and even as certainly true, by many who from their knowledge of physiology, natural history, and geology, are competent to form an intelligent opinion. The facts, they think, are consistent with the theory. Small differences are observed between animals and their offspring. Greater differences are observed between varieties known to be sprung form a common stock. The differences between what have been termed species are sometimes hardly greater in appearance than those between varieties owning a common origin. Even when species differ more widely, the difference they say, is one of degree only, not of kind. They can see no clear, definite distinction by which to decide in all cases, whether two animals have sprung from a common ancestor or not. They feel warranted in concluding, that for aught the structure of animals shows to the contrary, they may be descended from a few ancestors only, —nay, even from a single pair.

The most marked differences between varieties known to have sprung from one source have been obtained by artificial breeding. Men have selected, during many generations, those individuals possessing the desired attributes in the highest degree. They have thus been able to add, as it were, small successive differences, till they have at last produced marked varieties. Darwin shows that by a process, which he calls natural selection, animals more favourably constituted than their fellows will survive in the struggle for life, will produce descendants resembling themselves, of which the strong will live, the weak will die; and so, generation after generation, nature, by a metaphor, may be said to choose certain animals, even as man does when he desires to raise a special breed. The device of nature is based on the attributes most useful to the animal; the device of man on the attributes useful to man, or admired by him. All must agree that the process termed natural selection is in universal operation. The followers of Darwin believe that by that process differences might be added even as they are added by man's selection, though more slowly, and that this addition might in time be carried to so great an extent as to produce every known species of animal from one or two pairs, perhaps from organisms of the lowest type.

A very long time would be required to produce in this way the great differences observed between existing beings. Geologists say their science shows no ground for doubting that the habitable world has existed for countless ages. Drift and inundation, proceeding at the rate we now observe, would require cycles of ages to distribute the materials of the surface of the globe in their present form and order; and they add, for aught we know, countless ages of rest may at many places have intervened between the ages of action.

But if all beings are thus descended from a common ancestry, a complete historical record would show an unbroken chain of creatures, reaching from each one now known back to the first type, with each link differing from its neighbour by no more than the several offspring of a single pair of animals now differ. We have no such record; but geology can produce vestiges which may be looked upon as a few out of the innumerable links of the whole conceivable chain, and what, say the followers of Darwin, is more certain than that the record of geology must necessarily be imperfect?

The records we have show a certain family likeness between the beings living at each epoch, and this is at least consistent with our views.

There are minor arguments in favour of the Darwinian hypothesis, but the main course of the argument has, we hope, been fairly stated. It bases large conclusions as to what has happened upon the observation of comparatively small facts now to be seen. The cardinal facts are the production of varieties by man, and the similarity of all existing animals. About the truth and extent of those facts none but men possessing a special knowledge of physiology and natural history have any right to an opinion; but the superstructure based on those facts enters the region of pure reason, and may be discussed apart from all doubt as to the fundamental facts.

Can natural selection choose special qualities, and so breed special varieties, as man does? Does it appear that man has the power indefinitely to magnify the peculiarities which distinguish his breeds from the original stock? Is there no other evidence than that of geology as to the age of the habitable earth? and what is the value of the geological evidence? How far, in the absence of other knowledge, does the mere difficulty in classifying organized beings justify us in expecting that they have had a common ancestor? And finally, what value is to be attached to certain minor facts supposed to corroborate the new theory? These are the main questions to be debated in the present essay, written with the belief that some of them have been unduly overlooked. The opponents of Darwin have been chiefly men having special knowledge similar to his own, and they have therefore naturally directed their attention to the cardinal facts of his theory. They have asserted that animals are not so similar but that specific differences can be detected, and that man can produce no varieties differing from the parent stock, as one species differs from another. They naturally neglect the deductions drawn from facts which they deny. If your facts were true, they say, perhaps nature would select varieties, and in endless time, all you claim might happen; but we deny the facts. You produce no direct evidence that your selection took place, claiming only that your hypothesis is not inconsistent with the teaching of geology. Perhaps not, but you only claim a 'may be,' and we attack the direct evidence you think you possess.

To an impartial looker-on the Darwinians seem rather to have had the best of the argument on this ground, and it is at any rate worth while to consider the question from the other point of view; admit the facts, and examine the reasoning. This we now propose to do, and for clearness will divide the subject into heads corresponding to the questions asked above, as to the extent of variability, the efficiency of natural selection, the lapse of time, the difficulty of classification, and the value of minor facts adduced in support of Darwin.

Some persons seem to have thought his theory dangerous to religion, morality , and what not. Others have tried to laugh it out of court. We can share neither the fears of the former nor the merriment of the latter; and, on the contrary, own to feeling the greatest admiration both for the ingenuity of the doctrine and for the temper in which it was broached, although, from a consideration of the following arguments, our opinion is adverse to its truth.

Variability. —Darwin's theory requires that there shall be no limit to the possible differences between descendants and their progenitors, or, at least, that if there be limits, they shall be at so great a distance as to comprehend the utmost differences between any known forms of life. The variability required, if not infinite, is indefinite. Experience with domestic animals and cultivated plants shows that great variability exists. Darwin calls special attention to the differences between the various fancy pigeons, which, he says, are descended from one stock; between various breeds of cattle and horses, and some other domestic animals. He states that these differences are greater than those which induce some naturalists to class many specimens as distinct species. These differences are infinitely small as compared with the range required by his theory, but he assumes that by accumulation of successive difference any degree of variation may be produced; he says little in proof of the possibility of such an accumulation, seeming rather to take for granted that if Sir John Sebright could with pigeons produce in six years a certain head and beak of say half the bulk possessed by the original stock, then in twelve years this bulk could be reduced to a quarter, in twenty-four to an eighth, and so farther. Darwin probably never believed or intended to teach so extravagant a proposition, yet by substituting a few myriads of years for that poor period of six years, we obtain a proposition fundamental in his theory. That theory rests on the assumption that natural selection can do slowly what man's selection does quickly; it is by showing how much man can do, that Darwin hopes to prove how much can be done without him. But if man's selection cannot double, treble, quadruple, centuple, any special divergence from a parent stock, why should we imagine that natural selection should have that power? When we have granted that the 'struggle for life' might produce the pouter or the fantail, or any divergence man can produce, we need not feel one whit the more disposed to grant that it can produce divergences beyond man's power. The difference between six years and six myriads, blinding by a confused sense of immensity, leads men to say hastily that if six or sixty years can make a pouter out of common pigeon, six myriads, may change a pigeon to something like a thrush; but this seems no more accurate than to conclude that because we observe that a cannon-ball has traversed a mile in a minute, therefore in an hour it will be sixty miles off, and in the course of ages that it will reach the fixed stars. This really might be the conclusion drawn by a savage seeing a cannon-ball shot off by a power the nature of which was wholly unknown to him, and traversing a vast distance with a velocity confusing his brain, and removing the case from the category of stones and arrows, which he well knows will not go far, though they start fast. Even so do the myriads of years confuse our speculations, and seem to remove natural selection from man's selection; yet, Darwin would the first to allow, that the same laws probably or possibly govern the variation, whether the selection be slow or rapid. If the intelligent savage were told, that though the cannon-ball started very fast, it went slower and slower every instant, he would probably conclude that it would not reach the stars, but presently come to rest like his stone and arrow. Let us examine whether there be not a true analogy between this case and the variation of domestic animals.

We all believe that a breeder, starting business with a considerable stock of average horses, could, by selection, in a very few generations, obtain horses able to run much faster than any of their sires or dams; in time perhaps he would obtain descendants running twice as fast as their ancestors and possibly equal to our race-horses. But would not the difference in speed between each successive generation be less and less? Hundreds of skilful men are yearly breeding thousands of racers. Wealth and honour await the main who can breed one horse to run one part in five thousand faster than his fellows. As a matter of experience, have our racers improved in speed by one part in a thousand during the last twenty generations? Could we not double the speed of a cart-horse in twenty generations? Here is the analogy with our cannon-ball; the rate of variation in a given direction is not constant, is not erratic; it is a constantly diminishing rate, tending therefore to a limit.

It may be urged that the limit in the above case is not fixed by the laws of variation but by the laws of matter; that bone and sinew cannot make a beast of the racer size and build go faster. This would be an objection rather to the form than to the essence of the argument. The existence of a limit, as proved by the gradual cessation of improvement, is the point which we aim at establishing. Possibly in every case the limit depends on some physical difficulty, sometimes apparent, more often concealed; moreover, no one can *a priori*calculate what bone and sinew may be capable of doing, or how far they can be improved; but it is unnecessary further to combat this objection, for whatever be the peculiarity aimed at by fancy-breeders, the same fact recurs. Small terriers are valuable, and the limit below which a terrier of good shape would be worth its weight in silver, perhaps in gold, is nearly as well fixed as the possible speed of a race-horse. The points of all prize cattle, of all prize flowers, indicate limits. A rose called 'Senateur Vaisse' weighs 300 grains, a wild rose weighs 30 grains. A gardener, with a good stock of wild roses, would soon raise seedlings with flowers of double, treble, the weight of his first briar flowers. He or his grandson would very slowly approach the 'Cloth of God' or 'Senateur Vaisse,' and if the gradual rate of increase in weight were systematically noted, it would point with mathematical accuracy to the weight which could not be surpassed.

We are thus led to believe that whatever new point in the variable beast, bird, or flower, be chosen as desirable by a fancier, this point can be rapidly approached at first, but that the rate of approach quickly diminishes, tending to a limit never to be attained. Darwin says that our oldest cultivated plants still yield new varieties. Granted; but the new variations are not successive variations in one direction. Horses could be produced with very long or with very short ears, very long or short hair, with large or small hooves, with peculiar colour, eyes, teeth, perhaps. In short, whatever variation we perceive of ordinary occurrence might by selection be carried to an extravagant excess. If a large annual prize were offered for any of these novel peculiarities, probably the variation in the first few years would be remarkable, but in twenty years' time the judges would be much puzzled to which breeder the prize should fall, and the maximum excellence would be known and expressed in figures, so that an eighth of an inch more or less would determine success or failure.

A given animal or plant appears to be contained, as it were, within a sphere of variation; one individual lies near one portion of the surface; another individual, of the same species, near another part of the surface; the average animal at the centre. Any individual may produce descendants varying in any direction, but is more likely to produce descendants varying towards the centre of the sphere, and the variations in that direction will be greater in amount than the variations towards the surface. Thus, a set of racers of equal merit indiscriminately breeding will produce more colts and foals of inferior than of superior speed, and the falling off of the degenerate will be greater than the improvement of the select. A set of Clydesdale prize horses would produce more colts and foals of inferior than superior strength. More seedlings of 'Senateur Vaisse' will be inferior to him in size and colour than superior. The tendency to revert, admitted by Darwin, is generalized in the simile of the sphere here suggested. On the other hand, Darwin insists very sufficiently on the rapidity with which new peculiarities are produced; and this rapidity is quite as essential to the argument now urged as subsequent slowness.

We hope this argument is now plain. However slow the rate of variation might be, even though it were only one part in a thousand per twenty or two thousand generations, yet if it were constant or erratic we might believe that, in untold time, it would lead to untold distance; but if in every case we find that deviation from an average individual can be rapidly effected at first, and that the rate of deviation steadily diminishes till it reaches an almost imperceptible amount, then we are as much entitled to assume a limit to the possible deviation as we are to the progress of a cannon-ball from a knowledge of the law of diminution in its speed. This limit to the variation of species seems to be established for all cases of man's selection. What argument does Darwin offer showing that the law of variation will be different when the variation occurs slowly, not rapidly? The law may be different, but is there any experimental ground for believing that it *is*different? Darwin says (p. 153), 'The struggle between natural selection, on the one hand, and the tendency to reversion and variability on the other hand, will in the course of time cease, and that the most abnormally developed organs may be made constant, I can see no reason to doubt.' But what reason have we to believe this? Darwin says the variability will disappear by the continued rejection of the individuals tending to revert to a former condition; but is there any experimental ground for believing that the variability *will*disappear; and, secondly, if the variety can become fixed, that it will in time become ready to vary still more in the original direction, passing that limit which we think has just been shown to exist in the case of man's selection? It is peculiarly difficult to see how natural selection could reject individuals having a tendency to produce offspring reverting to an original stock. The tendency to produce offspring more like their superior parents than their inferior grandfathers can surely be of no advantage to any individual in the struggle for life. On the contrary, most individuals would be benefitted by producing imperfect offspring, competing with them at a disadvantage; thus it would appear that natural selection, if it select anything, must select the most perfect individuals, having a tendency to produce the fewest and least perfect competitors; but it may be urged that though the tendency to produce good offspring is injurious to the parents, the improved offspring would live and receive by inheritance the fatal tendency of producing in their turn parricidal descendants. Yet this is contending that in the struggle for life natural selection can gradually endow a race with a quality injurious to every individual which possesses it. It really seems certain that natural selection cannot tend to obliterate the tendency to revert; but the theory advanced appears rather to be that, if owing to some other qualities a race is maintained for a very long time different from the average or original race (near the surface of our sphere), then it will in time spontaneously lose the tendency to relapse, and acquire a tendency to vary outside the sphere. What is to produce this change? Time simply, apparently. The race is to be kept constant to all appearance, for a very long while, but some subtle change sue to time is to take place; so that, of two individuals just alike in every feature, but one born a few thousand years after the other, the first shall tend to produce relapsing offspring, the second shall not. This seems rather like the idea that keeping a bar of iron hot or cold for a very long time would leave it permanently hot or cold at the end of the period when the heating or cooling agent was withdrawn. This strikes us as absurd, now, but Bacon believed it possibly true. So many things may happen in a very long time, that time comes to be looked on as an agent capable of doing great and unknown things. Natural selection, as we contend, could hardly select an individual because it bred true. Man does. He chooses for sires those horses which he sees not only run fast themselves, but produce fine foals. He never gets rid of the tendency to revert. Darwin says species of pigeons have bred true for centuries. Does he believe that it would not be easier by selection to diminish the peculiarities of the pouter pigeon than to increase them? and what does this mean, but that the tendency to revert exists? It is possible that by man's selection this tendency may be diminished as any other quality may be somewhat increased or diminished, but, like all other qualities, this seems rapidly to approach a limit which there is no obvious reason to suppose 'time' will alter.

But not only do we require for Darwin's theory that time shall first permanently fix the variety near the outside of the assumed sphere of variation, we require that it shall give the power of varying beyond that sphere. It may be urged that man's rapid selection does away with this power; that if each little improvement were allowed to take root during a few hundred generations, there would be no symptom of a decrease of the rate of variation, no symptom that a limit was approached. If this be so, breeders of race-horses and prize flowers had better change their tactics; instead of selecting the fastest colts and finest flowers to start with, they ought to begin with very ordinary beasts and species. They should select the descendants which might be rather better in the first generation, and then should carefully abstain from all attempts at improvement for twenty, thirty, or one hundred generations. Then they might take a little step forward, and in this way, in time, they or their children's children would obtain breeds far surpassing those produced by their overhasty competitors, who would be brought to a stand by limits which would never be felt or perceived by the followers of the maxim, *Festina lente [make haste slowly]* . If we are told that the time during which a breeder or his descendants could afford to wait bears no proportion to the time used by natural selection, we may answer that we do not expect the enormous variability supposed to be given by natural selection, but that we do expect to observe some step in that direction, to find that by carefully approaching our limit by slow degrees, that limit would be removed a little further off. Does any one think this would be the case?

There is indeed one view upon which it would seem natural to believe that the tendency to revert may diminish. If the peculiarities of an animal's structure are simply determined by inheritance, and not by any law of growth, and if the child is more likely to resemble its father than its grandfather, its grandfather than its great-grandfather, etc., then the chances that an animal will revert to the likeness of an ancestor a thousand generations back will be slender. This is perhaps Darwin's view. It depends on the assumption that there is no typical or average animal, no sphere of variation, with centre and limits, and cannot be made use of to prove the assumption. The opposing view is that of a race maintained by a continual force in an abnormal condition, and returning to that condition so soon as the force is removed; returning not suddenly, but by similar steps with those by which it first left the average state, restrained by the tendency to resemble its immediate progenitors. *A priori* , perhaps, one view is as probable as the other; or in other words, as we are ignorant of the reasons why atoms fashion themselves into bears and squirrels, one fancy is as likely to meet with approval as another. Experiments conducted in a limited time point as already said to a limit, with a tendency to revert. And while admitting that the tendency to revert may be diminished though not extinguished, we are unaware of any reason for supposing that pouters, after a thousand generations of true breeding, have acquired a fresh power of doubling their crops, or that the oldest breed of Arabs are likely to produce 'sports' vastly surpassing their ancestors in speed. Experiments conducted during the longest time at our disposal show no probability of surpassing the limits of the sphere of variation, and why should we concede that a simple extension of time will reverse the rule?

The argument may be thus resumed.

Although many domestic animals and plants are highly variable, there appears to be a limit to their variation in any one direction. This limit is shown by the fact that new points are at first rapidly gained, but afterwards more slowly, while finally no further perceptible change can be effected. Great, therefore, as the variability is, we are not free to assume that successive variations of the same kind can be accumulated. There is no experimental reason for believing that the limit would be removed to a great distance, or passed, simply because it was approached by very slow degrees, instead of by more rapid steps. There is no reason to believe that a fresh variability is acquired by long selection of one form; on the contrary, we know that with the oldest breeds it is easier to bring about a diminution than an increase in the points of excellence. The sphere of variation is a simile embodying this view; —each point of the sphere corresponding to a different individual of the same race, the centre to the average animal, the surface to the limit in various directions. The individual near the centre may have offspring varying in all directions with nearly equal rapidity. A variety near the surface may be made to approach it still nearer, but has a greater tendency to vary in every other direction. The sphere may be conceived as large for some species and small for others.

Efficiency of Natural Selection . -Those individual of any species which are most adapted to the life they lead, live on an average longer than those which are less adapted to the circumstances in which the species is placed. The individuals which live the longest will have the most numerous offspring, and as the offspring on the whole resemble their parents, the descendants from any given generation will on the whole resemble the more favoured rather than the less favoured individuals of the species. So much of the theory of natural selection will hardly be denied; but it will be worth while to consider how far this process can tend to cause a variation in some one direction. It is clear that it will frequently, and indeed generally, tend to prevent any deviation from the common type. The mere existence of a species is a proof that it is tolerably well adapted to the life it must lead; many of the variations which may occur will be variations for the worse, and natural selection will assuredly stamp these out. A white grouse in the heather, or a white hare on a fallow would be sooner detected by its enemies than one of the usual plumage or colour. Even so, any favourable deviation must, according to the very terms of the statement, give its fortunate possessor a better chance of life; but this conclusion differs widely from the supposed consequence that a whole species may or will gradually acquire some one new quality, or wholly change in one direction and in the same manner. In arguing this point, two distinct kinds of possible variation must be separately considered: *first* , that kind of common variation which must be conceived as not only possible, but inevitable, in each individual of the species, such as longer and shorter legs, better or worse hearing, etc.; and, *secondly* , that kind of variation which only occurs rarely, and may be called a sport of nature, or more briefly a 'sport,' as when a child is born with six fingers on each hand. The common variation is not limited to one part of any animal, but occurs in all; and when we say that on the whole the stronger live longer than the weaker, we mean that in some cases long life will have been due to good lungs, in others to good ears, in others to good legs. There are few cases in which one faculty is pre-eminently useful to an animal beyond all other faculties, and where that is not so, the effect of natural selection will simply be to kill the weakly, and insure a sound, healthy, well-developed breed. If we could admit the principle of a gradual accumulation of improvements, natural selection would gradually improve the breed of everything, making the hare of the present generation run faster, hear better, digest better, than his ancestors; his enemies, the weasels, greyhounds, etc., would have improved likewise, so that perhaps the hare would not be really better off; but at any rate the direction of the change would be from a war of pigmies to a war of Titans. Opinions may differ as to the evidence of this gradual perfectibility of all things, but it is beside the question to argue this point, as the origin of species requires not the gradual improvement of animals retaining the same habits and structure, but such modification of those habits and structure as will actually lead to the appearance of new organs. We freely admit, that if an accumulation of slight improvements be possible, natural selection might improve hares as hares, and weasels as weasels, that is to say, it might produce animals having every useful faculty and every useful organ of their ancestors developed to a higher degree; more than this, it may obliterate some once useful organs when circumstances have so changed that they are no longer useful, for since that organ will weigh for nothing in the struggle of life, the average animal must be calculated as though it did not exist.

We will even go further: if, owing to a change of circumstances some organ becomes pre-eminently useful, natural selection will undoubtedly produce a gradual improvement in that organ, precisely as man's selection can improve a special organ. In all cases the animals above the average live longer, those below the average die sooner, but in estimating the chance of life of a particular animal, one special organ may count much higher or lower according to circumstances, and will accordingly be improved or degraded. Thus it must apparently be conceded that natural selection is a true cause or agency whereby in some cases variations of special organs may be perpetuated and accumulated, but the importance of this admission is much limited by a consideration of the cases where it applies: first of all we have required that it should apply to variations which must occur in every individual, so that enormous numbers of individuals will exist, all having a little improvement in the same direction; as, for instance, each generation of hares will include an enormous number which have longer legs than the average of their parents although there may be an equally enormous number who have shorter legs; secondly, we require that the variation shall occur in an organ already useful owing to the habits of the animal. Such a process of improvement as is described could certainly never give organs of sight, smell or hearing to organisms which had never possessed them. It could not add a few legs to a hare, or produce anew organ, or even cultivate any rudimentary organ which was not immediately useful to any enormous majority of hares. No doubt half the hares which are born have longer tails than the average of their ancestors; but as no large number of hares hang by their tails, it is inconceivable that any change of circumstances should breed hares with prehensile tails; or, to take an instance less shocking in its absurdity, half the hares which are born may be presumed to be more like their cousins the rabbits in their burrowing organs than the average hare ancestor was; but this peculiarity cannot be improved by natural selection as described above, until a considerable number of hares begin to burrow, which we have as yet seen no likelihood of their doing. Admitting, therefore, that natural selection may improve organs already useful to great numbers of a species, does not imply an admission that it can create or develop new organs, and so original species.

But it may be urged, although many hares do not burrow, one may, or least may hide in a hole, and a little scratching may just turn the balance in his favour in the struggle for life. So it may, and this brings us straight to the consideration of 'sports,' the second kind of variation above alluded to. A hare which saved its life by burrowing would come under this head; let us here consider whether a few hares in a century saving themselves by this process could, in some indefinite time, make a burrowing species of hare. It is very difficult to see how this can be accomplished, even when the sport is very eminently favourable indeed; and still more difficult when the advantage gained is very lights, as must generally be the case. The advantage, whatever it may be, is utterly outbalanced by numerical inferiority. 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 individuals being one of the hundred survivors. 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 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 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 superiority would be say in the ratio of 1 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. An illustration will bring this conception home. Suppose a white man to have been wrecked on an island inhabited by negroes, and to have established himself in friendly relations with a powerful tribe, whose customs he has learnt. Suppose him to possess the physical strength, energy, and ability of a dominant white race, and let the food and climate of the island suit his constitution; grant him every advantage which we can conceive a white to possess over the native; concede that in the struggle for existence his chance of a long life will be much superior to that of the native chiefs; yet from all these admissions, there does not follow the conclusion that, after a limited or unlimited number of generations, the inhabitants of the island will be white. Our shipwrecked hero would probably become king; he would kill a great many blacks in the struggle for existence; he would have a great many wives and children, while many of his subjects would live and die as bachelors; an insurance company would accept his life at perhaps one-tenth of the premium which they would exact from the most favoured of the negroes. Our white's qualities would certainly tend very much to preserve him to good old age, and yet he would not suffice in any number of generations to turn his subjects' descendants white. It may be said that the white colour is not the cause of the superiority. True, but it may be used simply to bring before the senses the way in which qualities belonging to one individual in a large number must be gradually obliterated. In the first generation there will be some dozens of intelligent young mulattoes, much superior in average intelligence to the negroes. We might expect the throne for some generations to be occupied by a more or less yellow king; but can any one believe that the whole island will gradually acquire a white, or even a yellow population, or that the islanders would acquire the energy, courage, ingenuity, patience, self-control, endurance, in virtue of which qualities our hero killed so many of their ancestors, and begot so many children; those qualities, in fact, which the struggle for existence would select, if it could select anything?

Here is a case in which a variety was introduced, with far greater advantages than any sport every heard of, advantages tending to its preservation, and yet powerless to perpetuate the new variety.

Darwin says that in the struggle for life a grain may turn the balance in favour of a given structure, which will then be preserved. But one of the weights in the scale of nature is due to the number of a given tribe. Let there be 7000 A's and 7000 B's, representing two varieties of a given animal, and let all the B's, in virtue of a slight difference of structure, have the better chance of life by 1/7000th part. We must allow that there is a slight probability that the descendants of B will supplant the descendants of A; but let there be only 7001 A's against 7000 B's at first, and the chances are once more equal, while if there be 7002 A's to start, the odds would be laid on the A's. True, they stand a greater chance of being killed; but then they can better afford to be killed. The grain will only turn the scales when these are very nicely balanced, and an advantage in numbers counts for weight, even as an advantage in structure. As the numbers of the favoured variety diminish, so must its relative advantage increase, if the chance of its existence is to surpass the chance of its extinction, until hardly any conceivable advantage would enable the descendants of a single pair to exterminate the descendants of many thousands if they and their descendants are supposed to breed freely with the inferior variety, and so gradually lose their ascendancy. If it is impossible that any sport or accidental variation in a single individual, however favourable to life, should be preserved and transmitted by natural selection, still less can slight an imperceptible variations, occurring in single individuals be garnered up and transmitted to continually increasing numbers; for if a very highly-favoured white cannot blanch a nation of negroes, it will hardly be contended that a comparatively very dull mulatto has a good chance of producing a tawny tribe; the idea, which seems almost absurd when presented in connexion with a practical case, rests on a fallacy of exceedingly common occurrence in mechanics and physics generally. When a man shows that a tendency to produce a given effect exists he often thinks he has proved that the effect must follow. He does not take into account the opposing tendencies, much less does he measure the various forces, with a view to calculate the result. For instance, there is a tendency on the part of a submarine cable to assume a catenary curve, and very high authorities once said it would; but, in fact, forces neglected by them utterly alter the curve from the catenary. There is a tendency on the part of the same cables, as usually made, to untwist entirely; luckily there are opposing forces, and they untwist very little. These cases will hardly seem obvious; but what should we say to a man who asserted that the centrifugal tendency of the earth must send it off in a tangent? One tendency is balanced or outbalanced by others; the advantage of structure possessed by an isolated specimen is enormously outbalanced by the advantage of numbers possessed by the others.

A Darwinian my grant all that has been said, but contend that the offspring of 'sports' is not intermediate between the new sport and the old species; he may say that a great number of offspring will retain in full vigour the peculiarity constituting the favourable sport. Darwin seems with hesitation to make some such claim as this, and though it seems contrary to ordinary experience, it will be only fair to consider this hypothesis. Let an animal be born with some useful peculiarity, and let all his descendants retain his peculiarity in an eminent degree, however, little of the first ancestor's blood be in them, then it follows, from mere mathematics, that the descendants of our gifted beast will probably exterminate the descendants of his inferior brethren. If the animals breed rapidly the work of substitution would proceed with wonderful rapidity, although it is a stiff mathematical problem to calculate the number of generations required in any given case. To put this case clearly beside the former, we may say that if in a tribe of a given number of individuals there appears one super-eminently gifted, and if the advantage accruing to the descendants bears some kind of proportion to the amount of the ancestor's blood in their veins, the chances are considerable that for the first few generations he will have many descendants; but by degrees this advantage wanes, and after many generations the chances are so far from being favourable to his breed covering the ground exclusively, that they are actually much against his having any descendants at all alive, for though he has a rather better chance of this than any of his neighbours, yet the chances are greatly against any one of them. It is infinitely improbable that the descendants of any one should wholly supplant the others. If, on the contrary, the advantage given by the sport is retained by all descendants, independently of what in common speech might be called the proportion of blood in their veins directly derived from the first sport, then these descendants will shortly supplant the old species entirely, after the manner required by Darwin.

But this theory of the origin of species is surely not the Darwinian theory; it simply amounts to the hypothesis that, from time to time, an animal is born differing appreciably from its progenitors, and possessing the power of transmitting the difference to its descendants. What is this but stating that, from time to time, a new species is created? It does not, indeed, imply that the new specimen suddenly appears in full vigour, made out of nothing; but it offers no explanation of the cause of the divergence from the progenitors, and still less of the mysterious faculty by which the divergence is transmitted unimpaired to countless descendants. It is clear that every divergence is not thus transmitted, for otherwise one and the same animal might have to be big to suit its father and little to suit is mother, might require a long nose in virtue of its grandfather and a short one in virtue of its grandmother, in a word, would have to resume in itself the countless contradictory peculiarities of its ancestors, all in full bloom, and unmodified one by the other, which seems as impossible as at one time to be and not to be. The appearance of a new specimen capable of perpetuating its peculiarity is precisely what might be termed a creation, the word being used to express our ignorance of how the thing happened. The substitution of the new specimens, descendants from the old species, would then be simply an example of strong race supplanting a weak one, by a process known long before the term 'natural selection' was invented. Perhaps this is the way in which new species are introduced, but it does not express the Darwinian theory of the gradual accumulation of infinitely minute differences of every-day occurrence, and apparently fortuitous in their character.

Another argument against the efficiency of natural selection is, that animals possess many peculiarities the special advantage of which it is almost impossible to conceive; such, for instance, as the colour of plumage never displayed; and the argument may be extended by point out how impossible it is to conceive that the wonderful minutiae of, say a peacock's tail, with every little frond of every feather differently barred, could have been elaborated by the minute and careful inspection of rival gallants or admiring wives; but although arguments of this kind are probably never correct, they admit of less absolute demonstration than the points already put. A true believer can always reply, 'You do not know how closely Mrs. Peahen inspects her husband's toilet, or you cannot be absolutely certain that under some unknown circumstances that insignificant feather was really important;" or finally, he may take refuge in the word correlation, and say, other parts were useful, which by the law of correlation could not exist without these parts; and although he may have not one single reason to allege in favour of any of these statements, he may safely defy us to prove the negative, that they are not true. The very same difficulty arises when a disbeliever ties to point out the difficulty of believing that some odd habit or complicated organ can have been useful before fully developed. The believer who is at liberty to invent any imaginary circumstances, will very generally be able to conceive some series of transmutations answering his wants.

He can invent trains of ancestors of whose existence there is no evidence; he can marshal hosts of equally imaginary foes; he can call up continents, floods, and peculiar atmospheres, he can dry up oceans, split islands, and parcel out eternity at will; surely with these advantages he must be a dull fellow if he cannot scheme some series of animals and circumstances explaining our assumed difficulty quite naturally. Feeling the difficulty of dealing with adversaries who command so huge a domain of fancy, we will abandon these arguments, and trust to those which at least cannot be assailed by mere efforts of imagination. Our arguments as to the efficiency of natural selection may be summed up as follows:-

We must distinguish several kinds of conceivable variation in individuals.

First , We have the ordinary variations peculiar to each individual. The effect of the struggle for life will be keep the stock in full vigour by selecting the animals which in the main are strongest. When circumstances alter, one special organ may become eminently advantageous, and then natural selection will improve that organ. But this efficiency is limited to the cases in which the same variation occurs in enormous numbers of individuals, and in which the organ improved is already used by the mass of the species. This case does not apply to the appearance of new organs or habits.

Secondly , We have abnormal variations called sports, which may be supposed to introduce new organs or habits in rare individuals. This case must be again subdivided; we may suppose the offspring of the sports to be intermediate between their ancestor and the original tribe. In this case the sport will be swamped by numbers, and after a few generations its peculiarity will be obliterated. Or, we may suppose the offspring of the sport faithfully to reproduce the advantageous peculiarity undiminished. In this case the new variety will supplant the old species; but this theory implies a succession of phenomena so different from those of the ordinary variations which we see daily, that it might be termed a theory of successive creations; it does not express the Darwinian theory, and is no more dependent on the theory of natural selection that the universally admitted fact that a new strong race, not intermarrying with an old weak race, will surely supplant it. So much may be conceded.

Lapse of Time . —Darwin says with candour that he 'who does not admit how incomprehensibly vast have been the past periods of time,' may at once close his volume, admitting thereby that an indefinite, if not infinite time is required by his theory. Few will on this point be inclined to differ from the ingenious author. We are fairly certain that a thousand years has made no very great change in plants or animals living in a state of nature. The mind cannot conceive a multiplier vast enough to convert this trifling change by accumulation into differences commensurate with those between a butterfly and an elephant, or even between a horse and a hippopotamus. A believer in Darwin can only say to himself, Some little change does take place every thousand years; these changes accumulate, and if there be no limit to the continuance of the process, I must admit that in course of time any conceivable differences may be produced. He cannot think that a thousandfold the difference produced in a thousand years would suffice, according to our present observation, to breed even a dog from a cat. He may perhaps think that by careful selection, continued for this million years, man might do quite as much as this; but he will readily admit that natural selection does take a much longer time, and that a million years must by the true believer be looked upon as a minute. Geology lends her aid to convince him that countless ages have elapsed, each bearing countless generations of beings, and each differing in its physical conditions very little from the age we are personally acquainted with. This view of past time is, we believe, wholly erroneous. So far as this world is concerned, past ages are far from countless; the ages to come are numbered; no one age has resembled its predecessor, nor will any future time repeat the past. The estimates of geologists must yield before more accurate methods of computation, and these show that our world cannot have been habitable for more than an infinitely insufficient period for the execution of the Darwinian transmutation.

Before the grounds of these assertions are explained, let us shortly consider the geological evidence. It is clear that denudation and deposition of vast masses of matter have occurred while the globe was habitable. The present rate of deposit and denudation is very imperfectly known, but it is nevertheless sufficiently considerable to account for all the effects we know of, provided sufficient time be granted. Any estimate of the time occupied in depositing or denuding a thousand feet of any given formation, even on this hypothesis of constancy of action, must be very vague. Darwin makes the denudation of the Wald occupy 300,000,000 years, by supposing that a cliff 500 feet high was taken away one inch per century. Many people will admit that a strong current washing the base of such a cliff as this, might get on at least a hundredfold faster, perhaps a thousandfold; and on the other hand, we may admit, that for aught geology can show, the denudation of the Weald may have occupied a few million times more years than the number Darwin arrives at. The whole calculation savours a good deal of that known among engineers as 'guess at the half and multiply by two.'

But again, what are the reasons for assuming uniformity of action, for believing that currents were no stronger, storms no more violent, alternations of temperature no more severe in past ages than at present? These reasons, stated shortly, are that the simple continuance of actions we are acquainted with would produce all the known results, that we are not justified in assuming any alteration in the rate of violence of those actions without direct evidence, that the presence of fossils and the fineness of the ancient deposits show directly that things of old went on much as now. This last reason, apparently the strongest, is really the weakest; the deposits would assuredly take place in still waters, and we may fairly believe that still waters then resembled still waters now. The sufficiency of present actions is an excellent argument in the absence of all proof of change, but falls to utter worthlessness in presence of the direct evidence of such change. We will try to explain the nature of the evidence, which does prove not only that the violence of all natural changes has decreased, but also that it is decreasing, and must continue to decrease.

Perpetual motion is popularly recognised as a delusion; yet perpetual *motion*is no mechanical absurdity, but in given conditions is a mechanical necessity. Set a mass in motion and it must continue to move for ever, unless stopped by something else. This something else takes up the motion in some other form, and continues it till the whole or part is again transmitted to other matter; in this sense perpetual motion is inevitable. But this is not the popular meaning of 'perpetual motion,' which represents a vague idea that a watch will not go unless it is wound up. Put into more accurate form, it means that no finite construction of physical materials can continue to *do work*for an infinite time; or in other words, one part of the construction cannot continue to part with its energy and another part to receive it for ever, nor can the action be perpetually reversed. All motion we can produce in this world is accompanied by the performance of a certain amount of work in the form of overcoming friction, and this involves a redistribution of energy. No continual motion can therefore be produced by any finite chemical, mechanical, or other physical construction. In this case, what is true on a small scale is equally true on a large scale. Looking on the sun and planets as a certain complex physical combination, differing in degree but not in kind from those we can produce in the workshop by using similar materials subject to the same laws, we at once admit that if there be no resistance, the planets may continue to revolve round the sun for ever, and may have done so from infinite time. Under these circumstances, neither the sun nor planets gain or lose a particle of energy in the process. Perpetual motion is, therefore, in this case quite conceivable. But when we find the sun raising huge masses of water daily from the sea to the skies, lifting yearly endless vegetation from the earth, setting breeze and hurricane in motion, dragging the huge tidal wave round and round our earth; performing, in fine, the great bulk of the endless labour of this world and of other worlds, so that the energy of the sun is continually being given away; then, we may say this continual work cannot go on for ever. This would be precisely the perpetual motion we are for ever ridiculing as an exploded delusion, and yet how many persons will read these lines, to whom it has occurred that the physical work done in the world requires a motive power, that no physical motive power is infinite or indefinite, that the heat of the sun, and the sum of all chemical and other physical affinities in the world, is just as surely limited in its power of doing work as a given number of tons of coal in the boiler of a steam-engine. Most readers will allow that the power man can extract from a ton of coals is limited, but perhaps not one reader in a thousand will at first admit that the power of the sun and that of the chemical affinities of bodies on earth is equally limited.

There is a loose idea that our perpetual motions are impossible because we cannot avoid friction, and that friction entails somehow a loss of power, but that nature either works without friction, or that in the general system, friction entails no loss, and so her perpetual motions are possible; but nature no more works without friction than we can, and friction entails a loss of available power in all cases. When the rain falls, it feels the friction as much as drops from Hero's fountain; when the tide rolls round the world it rubs upon the sea-floor, even as a ball of mercury rubs on the artificial inclined planes used by ingenious inventors of impossibilities; when the breeze plays among the leaves, friction occurs according to the same laws as when artificial fans are driven through the air. Every chemical action in nature is as finite as the combustion of oxygen and carbon. The stone which, loosened by the rain, falls down a mountain-side, will no more raise itself to its first height, than the most ingeniously devised counter-poise of mechanism will raise an equal weight an equal distance. How comes it then that the finite nature of natural actions has no been as generally recognised as the finite nature of the so-called artificial combinations? Simply because, till very lately, it was impossible to follow the complete cycle of natural operations in the same manner as the complete cycle of any mechanical operations could be followed. All the pressures and resistances of the machine were calculable; we knew not so much as if there were analogous pressures and resistances in nature's mechanism. The establishment of the doctrine of conservation of energy, showing a numerical equivalence between the various forms of physical energy exhibited by *vis viva* , heat, chemical affinity, electricity, light, elasticity, and gravitation, has enabled us to examine the complete series of any given actions in nature, even as the successive actions of a train of wheels in a mill can be studied. There is no missing link; there is no unseen gearing, by which, in our ignorance, we might assume that the last wheel of the set somehow managed to drive the first. We have experimentally proved one law, —that the total quantity of energy in the universe is constant, meaning by energy something perfectly intelligible and measurable, equivalent in all cases to the product of a mass into the square of a velocity, sometimes latent, that is to say, producing or undergoing no change; at other times in action, that is to say, in the act of producing or undergoing change, not a change in amount, but a change in distribution. First, the hand about to throw a ball, next, the ball in motion, lastly, the heated wall truck by the ball, contain the greater part of the energy of the construction; but, from first to last, the sum of the energies contained by the hand, the ball, and the wall is constant. At first sight, this constancy, in virtue of which no energy is ever lost, but simply transferred from mass to mass, might seem to favour the notion of a possible eternity of change, in which the earlier and later states of the universe would differ in no essential feature. It is to Professor Sir W. Thomson of Glasgow that we owe the demonstration of the fallacy of this conception, and the establishment of the contrary doctrine of a continual dissipation of energy, by which the available power to produce change in any finite quantity of matter diminishes at every change of the distribution of energy. A simple illustration of the meaning of this doctrine is afforded by an unequally heated bar of iron. Let one end be hot and the other cold. The total quantity of heat (representing one form of energy) contained by the bar is mensurable and finite, —the heated end may become cooler and the cold end warmer. So long as any two parts differ in temperature, change may occur; but so soon as all parts of the bar are at one temperature, the bar *quoad* heat can produce no change in itself, and yet if we conceive radiation or conduction from the surface to have been prevented, the bar will contain the same total energy as before. In the first condition, it had the power of doing work, and if it had not been a simple bar, but amore complex arrangement of materials of which the two parts had been at different temperatures, this difference might have been used to set wheels going, or to produce a thermo-electric current; but gradually the wheels would have been stopped by friction producing heat once more, the thermo-electric current would have died out, producing heat in its turn, and the final quantity of heat in the system would have been the same as before. Its distribution only, as in the simple case, would have been different. At first, great differences in the distribution existed; at last, the distribution was absolutely uniform; and in that condition, the system could suffer no alteration until affected by some other body in a different condition, outside itself. Every change in the distribution of energy depends on a difference between bodies, and every change tends, on the whole, to diminish this difference, and so render the total future possible change less in amount. Heat is the great agent in this gradual decay. No sooner does energy take this form than it is rapidly dissipated, *i.e.* , distributed among a large number of bodies, which assume a nearly equal temperature; once energy has undergone this transformation, it is practically lost. The equivalent of the energy is there; but it can produce no change until some fresh body, at a very different temperature, is presented to it. Thus it is that friction is looked upon as the grand enemy of so-called perpetual motion; it is the commonest mode by which *vis viva*is converted into heat; and we all practically know, that once the energy of our coal, boiling water, steam, piston, fly-wheel, rolling mills, gets into this form, it is simply conducted away, and is lost to us for ever; just so, when the chemical or other energies of nature, contained, say, in our planetary system, once assume the form of heat, they are in a fair way to be lost for all available purposes. They will produce a greater or less amount of change according to circumstances. The greater the difference of the temperature produced between the surrounding objects, the greater the physical changes they will effect, but the degradation is in all cases inevitable. Finally, the sun's rays take the form of heat, whether they raise water or vegetation, or do any other work, and in this form the energy quits the earth radiated into distant space. Nor would this gradual degradation be altered if space were bounded and the planets enclosed in a perfect non-conducting sphere. Everything inside that sphere would gradually become equally hot, and when this consummation was reached no further change would be possible. We might say (only we should not be alive) that the total energy of the system was the same as before, but practically the universe would contain mere changeless death, and to this condition the material universe tends, for the conclusion is not altered even by an unlimited extension of space. Moreover, the rate at which the planetary system is thus dying is perfectly mensurable, if not yet perfectly measured. An estimate of the total loss of heat from the sun is an estimate of the rate at which he is approaching the condition of surrounding space, after reaching which he will radiate no more. We intercept a few of his rays, and can measure the rate of his radiation very accurately; we know that his mass contains many of the materials our earth is formed of, and we know the capacity for heat and other forms of energy which those materials are capable of and so can estimate the total possible energy contained in the sun's mass. Knowing thus approximately, how much he has, and how fast he is losing it, we can, or Professor Thomson can, calculate how long it will be before he will cool down to any given temperature. Nor is it possible to assume that, *per centra* , he is receiving energy to an unlimited extent in other ways. He may be supplied with heat and fuel by absorbing certain planetary bodies, but the supply is limited, and the limit is known and taken into account in the calculation, and we are assured that the sun will be too cold for our or Darwin's purposes before many millions of years —a long time, but far enough from countless ages; quite similarly past countless ages are inconceivable, inasmuch as the heat required by the sun to have allowed him to cool from time immemorial, would be such as to turn him into mere vapour, which would extend over the whole planetary system, and evaporate us entirely. It has been thought necessary to give the foregoing sketch of the necessary a gradual running down of the heavenly mechanism, to show that this reasoning concerning the sun's heat does not depend on any one special fact, or sets of facts, about heat, but is the mere accidental form of decay, which in some shape is inevitable, and the very essential condition of action. There is a kind of vague idea, when the sun is said to be limited in its heating powers, that somehow chemistry or electricity, etc., may reverse all that; but it has been explained that every one of these agencies is subject to the same law; they can never twice produce the same change in its entirety. Every change is a decay, meaning by change a change in the distribution of energy.

Another method by which the rate of decay of our planetary system can be measured, is afforded by the distribution of heat in the earth. If a man were to find a hot ball of iron suspended in the air, and were carefully to ascertain the distribution in the ball, he would be able to determine whether the ball was being heated or cooled at the time. If he found the outside hotter than the inside, he would conclude that in some way the ball was receiving heat from outside; if he found the inside hotter than the outside, he would conclude that the ball was cooling, and had therefore been hotter before he found it than when he found it. So far mere common sense would guide him, but with the aid of mathematics and some physical knowledge of the properties of iron and air, he would go much further, and be able to calculate how hot the ball must have been at any given moment, if it had not been interfered with. Thus he would be able to say, the ball must have been hung up less than say five hours ago, for at that time the heat of the ball would have been such, if left in its present position, that the metal would be fused, and so could not hang where he saw it. Precisely analogous reasoning holds with respect to the earth; it is such a ball; it is hotter inside than outside. The distribution of the heat near its surface is approximately known, and hence an approximate calculation can be made of the period of time within which it must have been hot enough to fuse the materials of which it is composed, provided it has occupied its present position, or a similar position, in space. The data for this calculation are still very imperfect, but the result of analogous calculation applied to the sun, as worked out by Professor Sir W. Thomson, if five hundred million years, and the results derived from the observed temperatures of the earth are of the same order of magnitude. This calculation is a mere approximation. A better knowledge of the distribution of heat in the interior of the globe may modify materially our estimates. A better knowledge of the conducting powers of rocks, etc., for heat, and their distribution in the earth, may modify it to a less degree, but unless our information be wholly erroneous as to the gradual increase of temperature as we descent towards the centre of the earth, the main result of the calculation, that the centre is gradually cooling, and if uninterfered with must, with a limited time, have been in a state of complete fusion, cannot be overthrown. Not only is the time limited, but it is limited to periods utterly inadequate for the production of species according to Darwin's views. We have seen a lecture-room full of people titter when told that the world would not, without supernatural interference, remain habitable for more than one hundred million years. This period was to those people ridiculously beyond anything in which they could take an interest. Yet a thousand years is an historical period well within our grasp, —as a Darwinian or geological unit it is almost uselessly small. Darwin would probably admit that more than a thousand times this period, or a million years, would be no long time to ask for the production of species differing only slightly from the parent stock. 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!

But it may be said they are equally inadequate for the geological formations which we know of, and therefore your calculations are wrong. Let us see what conclusion the application of the general theory of the gradual dissipation of energy would lead to, as regards these geological formations. We may perhaps find the solution of the difficulty in reconciling the results of the calculation of the rate of secular cooling, with the results deduced from the denudation or deposition of strata in the following consideration. If there have been a gradual and continual dissipation of energy, there will on the whole have been a gradual decrease in the violence or rapidity of all physical changes. When the gunpowder in a gun is just lighted, the energy applied in a small mass produces rapid and violent changes; as the ball rushes through the air it gradually loses speed; when it strikes rapid changes again occur, but no so rapid as at starting. Part of the energy is slowly being diffused through the air; part is being slowly conducted as heat from the interior to the exterior of the gun, only a residue shatters the rampart, and that residue, soon changing into heat, is finally diffused at a gradually decreasing rate into surrounding matter. Follow any self-contained change, and a similar gradual diminution on the whole will be observed. There are periods of greater and less activity, but the activity on the whole diminishes. Even so must it have been, and so will it be, with our earth. Extremes tend to diminish; high places become lower, low places higher, by denudation. Conduction is continually endeavouring to reduce extremes of heat and cold; as the sun's heat diminishes so will the violence of storms; as inequalities of surface diminish, so will the variations of climate. As the external crust consolidates, so will the effect of internal fire diminish. As internal stores of fuel are consumed, or other stores of chemical energy used up, the convulsions or gradual changes they can produce must diminish; on every side, and from whatever cause changes are due, we see the tendency to their gradual diminution of intensity or rapidity. To say that things must or can always have gone on at the present rate is a sheer absurdity, exactly equivalent to saying that a boiler fire once lighted will keep a steam-engine going for ever at a constant rate; to say all changes that have occurred, or will occur, since creation, have been due to the same causes as those now in action; and further, that those causes have not varied in intensity according to any other laws than they are now varying, is, we believe, a correct scientific statement, but then we contend that those causes must and do hourly diminish in intensity, and have since the beginning diminished in intensity, and will diminish, till further sensible change ceases, and a dead monotony is the final physical result of the mechanical laws which matter obeys.

Once this is granted, the calculations as to the length of geological periods, from the present rates of denudation and deposit, are blown to the winds, They are rough, very rough, at best. The present assumed rates are little better than guesses; but even were these really known, they could by no means be simply made use of in a rule-of-three sum, as has generally been done. The rates of denudation and deposition have been gradually, on the whole, slower and slower, as the time of fusion has become more and more remote. There has been no age of cataclysm, in one sense, no time, when the physical laws were other than they now are, but the results were as different as the rates of a stem-engine driven with a boiler first heated to 1500 degrees Fahrenheit, and gradually cooling to 200.

A counter argument is used, to the effect that our argument cannot be correct, since plants grew quietly, and fine deposits were formed in the earliest geological times. But, in truth, this fact in no way invalidates our argument. Plants grow just as quietly on the slope of Vesuvius, with a few feet between them and molten lava, as they do in a Kentish lane; but they occasionally experience the difference of the situation. The law according to which a melted mass cools would allow vegetation to exist and animals to walk unharmed over an incredibly thin crust. There would be occasional disturbances; but we see that few feet of soil are a sufficient barrier between molten lava and the roots of the vine; each tendril grows not the less slowly and delicately because it is liable in a year or two to be swallowed up by the stream of lava. Yet no one will advance the proposition that changes on the surface of a volcano are going on at the same rate as elsewhere. Even so in the primeval world, barely crusted over, with great extremes of climate, violent storms, earth quakes, and a general rapid tendency to change, tender plants may have grown, and deep oceans may have covered depths of perfect stillness, interrupted occasionally by huge disturbances. Violent currents or storms in some regions do not preclude temperate climates in others, and after all the evidence of tranquillity is very slight. There are coarse deposits as well as fine ones; now a varying current sifts a deposit better than a thousand sieves, the large stones fall first in a rapid torrent, then the gravel in a rapid stream, then the coarse sand, and finally, the fine silt cannot get deposited till it meets with still water. And still water might assuredly exist at the bottom of oceans, the surface of which was traversed by storms and waves of an intensity unknown to us. The soundings in deep seas invariably produce samples of almost intangible ooze. All coarser materials are deposited before they reach regions of such deathlike stillness, and this would always be so. As to the plants, they may have grown within a yard of red-hot gneiss.

Another class of objections to the line of argument pursued consists in the suggestion that it is impossible to prove that since the creation things always have been as they are. Thus, one many says, —'Ah, but the world and planetary system may have passed through a warm region of space, and then you deductions from the radiation of heat into space go for nothing; or, a fresh supply of heat and fuel may have been supplied by regular arrivals of comets or other fourgons; or the sun and centre of the earth may be composed of materials utterly dissimilar to any we are acquainted with, capable of evolving heat from a limited space at a rate which we have no example of, leaving coal or gunpowder at an infinite distance behind them. Or it may please the Creator to continue creating energy in the form of heat at the centre of the sun and earth; or the mathematical laws of cooling and radiation, and conservation of energy and dissipation of energy may be actually erroneous, since man is, after all, fallible.' Well, we suppose all these things *may*be true, but we decline to allow them the slightest weight in the argument, until some reason can be shown for believing that any one of them *is*true.

To resume the arguments in this chapter —Darwin's theory requires countless ages, during which the earth shall have been habitable, and he claims geological evidence as showing an inconceivably great lapse of time, and as not being in contradiction with inconceivably greater periods than are even geologically indicated, —periods of rest between formations, and periods anterior to our so-called first formations, during which the rudimentary organs of the early fossils became degraded from their primeval uses. In answer, it is shown that a general physical law obtains, irreconcilable with the persistence of active change at a constant rate; in any portion of the universe, however large, only a certain capacity for change exists, so that every change which occurs renders the possibility of future change less, and, on the whole, the rapidity or violence of changes tends to diminish. Not only would this law gradually entail in the future the death of all beings and cessation of all change in the planetary system, and in the past point to a state of previous violence equally inconsistent with life, if no energy were lost by the system, but this gradual decay from a previous state of violence is rendered far more rapid by the continual loss of energy going on by means of radiation. From this general conception pointing either to a beginning, or to the equally inconceivable idea of infinite energy in finite materials, we pass to the practical application of the law to the sun and earth, showing that their present state proves that they cannot remain for ever adapted to living beings, and that living beings can have existed on the earth only for a definite time, since in distant periods the earth bust have been in fusion, and the sun must have been mere hot gas, or a group of distant meteors, so as to have been incapable of fulfilling its present functions as the comparatively small centre of the system. From the earth we have no very safe calculation of past time, but the sun gives five hundred million years as the time separating us from a condition inconsistent with life. We next argue that the time occupied in the arrangement of the geological formations need not have been longer than is fully consistent with this view, since the gradual dissipation of energy must have resulted in a gradual diminution of violence of all kinds, so that calculations of the time occupied by denudations or deposits based on the simple division of the total mass of a deposit, or denudation by the annual action now observed, are fallacious, and that even as the early geologists erred in attempting to compress all action into six thousand years, so later geologists have outstepped all bounds in their figures, by assuming that the world has always gone on much as it now does, and that the planetary system contains an inexhaustible motive power, by which the vast labour of the system has been, and can be maintained for ever. We have endeavoured to meet the main objections to these views, and conclude, that countless ages cannot be granted to the expounder of any theory of living beings, but that the age of the inhabited world is proved to have been limited to a period wholly inconsistent with Darwin's views.

Difficulty of Classification . —It appears that it is difficult to classify animals or plants, arranging them in groups as genera, species, and varieties; that the line of demarcation is by no means clear between species and sub-species, between sub-species and well-marked varieties, or between lesser varieties and individual differences; that these lines of demarcation, as drawn by different naturalists, vary much, being sometimes made to depend on this, sometimes on that organ, rather arbitrarily. This difficulty chiefly seems to have led men to devise theories of transmutation of species, and is the very starting point of Darwin's theory, which depicts the differences between various individuals of any one species as identical in nature with the differences between individuals of various species, and supposes all these differences, varying in degree only, to have been produced by the same causes; so that the subdivision into groups is, in this view, to a great extent arbitrary, but may be considered rational if the words variations, varieties, sub-species, species, and genera, be used to signify or be considered to express that the individuals included in these smaller or greater groups, have had a common ancestor very lately, some time since, within the later geological ages, or before the primary rocks. The common terms, explained by Darwin's principles, signify, in fact, the more or less close blood-relationship of the individuals. This, if it could be established, would undoubtedly afford a less arbitrary principle of classification than pitching on some organ in any degree similar. The application of the new doctrine might offer some difficulty, as it does not clearly appear what would be regarded as the sign of more or less immediate descent from a common ancestor, and perhaps each classifier would have pet marks by which to decide the question, in which case the new principle would not be of much practical use; yet if the theory were really true, in time the marks of common ancestry would probably come to be known with some accuracy, and meanwhile the theory would give an aim and meaning to classification, which otherwise might be looked upon as simply a convenient form of catalogue.

If the arguments already urged are true, these descents from common ancestors are wholly imaginary. 'How, then,' say the supporters of transmutation, 'do you account for our difficulty in distinguishing, *a priori* , varieties from species? The first, we know by experience, have descended from a common ancestor; the second you declare have not, and yet neither outward inspection nor dissection will enable us to distinguish a variety from what you call a species. Is not this strange, if there be an essential difference?'

No, it is not strange. There is nothing either wonderful or peculiar to organized beings, in the difficulty experienced in classification, and we have no reason to expect that the differences between beings which have had no common ancestor should be obviously greater than those occurring in the descendants of a given stock. Whatever origin species may have had, whether due to separate creation or some yet undiscovered process, we ought to expect a close approximation between these species, and difficulty in arranging them as groups. We find this difficulty in all classification, and the difficulty increases as the number of objects to be classified increases. Thus the chemist began by separating metals from metalloids, and found no difficulty in placing copper and iron in one category, and sulphur and phosphorus in the other. Now-a-days, there is or has been a doubt, whether hydrogen gas be a metal or no. It probably ought to be so classed. Some physical properties of tellurium would lead to its classification as a metal; its chemical properties are those of a metalloid. Acids and bases were once very intelligible headings to large groups of substances. Now-a-days there are just as finely drawn distinctions as to what is an acid, and what a base, as eager discussions which substance in a compound plays the part of acid or base, as there can possible be about the line of demarcation between animal and vegetable life, and any of the characteristics used to determine the group that shall claim a given shell or plant. Nay, some chemists are just as eager to abandon the old terms altogether, as Darwin to abolish species. His most advanced disciple will hardly contend that metals and metalloids are the descendants of organic beings, which, in the struggle for life, have gradually all their organs; yet is it less strange that inorganic substances should be hard to class, than that organic beings, with infinitely greater complexity, should be difficult to arrange in neat, well-defined groups? In the early days of chemistry, a theory might well have been started, perhaps was started, that all metals were alloys of a couple of unknown substances. Each newly discovered metal would have appeared to occupy an intermediate place between old metals. Alloys similarly occupied an intermediate place between the metals composing them; why might not all metals be simply sets of alloys, of which the elements were not yet discovered? An alloy can no more be distinguished by its outward appearance than a hybrid can. Alloys differ as much from one another, and from metals, as metals do one from another, and whole set of Darwinian arguments might be used to prove all metals alloys. It is only of late, by a knowledge of complicated electrical and other properties, that we could feel a certainty that metals were not alloys.

Other examples may be given, and will hereafter be given, of analogous difficulties of classification; but let us at once examine what expectations we might naturally form, *a priori* , as to the probable ease or difficulty in classifying plants and animals, however these may have originated. Are not animals and plants combinations, more or less complex, of a limited number of elementary parts? The number of possible combinations of a given number of elements is limited, however numerous these elements may be. The limits to the possible number of combinations become more and more restricted, as we burden these combinations with laws more and more complicated, —insisting, for instance, that the elements shall only be combined in groups of threes or fives, or in triple groups of five each, or in *n* groups, consisting respectively of *a* , *b, c* , *d, . . . n*elements arranged each in a given order. But what conceivable complexity of algebraic arrangement can approach the complexity of the laws which regulate the construction of an organic being out of inorganic elements? Let the chemist tell us the laws of combination of each substance found in an organized being. Let us next attempt to conceive the complexity of the conditions required to arrange these combinations in a given order, so as to constitute an eating, breathing, moving, felling, self-reproducing thing. When our mind has recoiled baffled, let us consider whether it is not probable, nay certain, that there should be a limit to the possible number of combinations, called animals or vegetables, produced out of a few simple elements, and grouped under the above inconceivably complex laws. Next, we may ask whether, as in the mathematical permutations, combinations, and arrangements, the complete set of possible organized beings will not necessarily form a continuous series of combinations, each resembling its neighbour, even as the letters of the alphabet grouped say in all possible sets of five each, might be arranged to as to form a continuous series of groups, or sets of series, according as one kind of resemblance or another be chosen to guide us in the arrangement. It is clear that the number of combinations or animals will be immeasurably greater when these combinations are allowed to resemble each other very closely, than when a condition is introduced, that given marked differences shall exist between them. Thus, there are upwards of 7,890,000 words or combinations of five letters in the English alphabet. These are reduced to 26 when we insert a condition that no two combinations shall begin with the same letter, and to 5 when we stipulate that no two shall contain a single letter alike. Thus we may expect, if the analogy be admitted, to find varieties of a given species, apparently, though not really, infinite in number, since the difference between these varieties is very small, whereas we may expect that the number of well-marked possible species will be limited, and only subject to increase by the insertion of fresh terms or combinations, intermediate between those already existing. Viewed in this light, a species is the expression of one class of combination; the individuals express the varieties of which the class is capable.

It may be objected that the number of elements in an organized being is so great, as practically to render the number of possible combinations infinite; but unless infinite divisibility of matter be assumed, this objection will not hold, inasmuch as the number of elements or parts in the germ or seed of a given animal or plant appears far from infinite. Yet it is certain that differences between one species and another, one variety and another, one individual and another, exist in these minute bodies, containing very simple and uniform substances if analysed chemically. Probably, even fettered by these conditions, the number of possible animals or plants is inconceivably greater than the number which exist or have existed; but the greater the number, the more they necessarily resemble one another.

It may perhaps be thought irreverent to hold an opinion that the Creator could not create animals of any shape and fashion whatever; undoubtedly we may conceive all rules and all laws as entirely self-imposed by him, as possibly quite different or non-existent elsewhere; but what we mean is this, that just as with the existing chemical laws of the world, the number of possible chemical combinations of a particular kind is limited, and not even the Creator could make more without altering the laws he has himself imposed, even so, if we imagine animals created or existing under some definite law, the number of species, and of possible varieties of one species, will be limited; and these varieties and species being definite arrangements of organic compounds, will as certainly be capable of arrangement in series as inorganic chemical compounds are. These views no more imply a limit to the power of God than the statement that the three angles of a triangle are necessarily equal to two right angles.

It is assumed that all existing substances or beings of which we have any scientific knowledge exist under definite laws. Under any laws there will be a limit to the possible number of combinations of a limited number of elements. The limit will apply to size, strength, length of life, and every other quality. Between any extremes the number of combinations called animals or species can only be increased by filling in gaps which exist between previously existing animals, or between these and the possible limits, and therefore whatever the general laws of organization may be, they must produce results similar to those we observe, and which lead to difficulty in classification, and to the similarity between one species or variety and another. Turning the argument, we might say that the observed facts simply prove that organisms exist and were created under definite laws, and surely no one will be disposed to deny this. Darwin assumes one law, namely, that every being is descended from a common ancestor (which, by the way, implies that every being shall be capable of producing a descendant like any other being), and he seems to think this is the only law which would account for the close similarity of species, whereas any law may be expected to produce the same result. We observe that animals eat, breathe, move, have senses, are born, and die, and yet we are expected to feel surprise that combinations, which are all contrived to perform the same functions, resemble one another. It is the apparent variety that is astounding, not the similarity. Some will perhaps think it absurd to say that the number of combinations are limited. They will state that no two men ever were or will be exactly alike, no two leaves in any past or future forest; it is not clear how they could find this out, or how they could prove it. But as already explained, we quite admit that by allowing closer and closer similarity, the number of combinations of a fixed number of elements may be enormously increased. We may fairly doubt the identity of any two of the higher animals, remembering the large number of elements of which they consist, but perhaps two identical foraminiferae have existed. As an idle speculation suggested by the above views, we might consider whether it would be possible that two parts of any two animals should be identical, without their being wholly identical, looking on each animal as one possible combination, in which no part could vary without altering all the others. It would be difficult to ascertain this by experiment.

It is very curious to see how man's contrivances, intended to fulfill some common purpose, fall into series, presenting the difficulty complained of by naturalists in classifying birds and beasts, or chemists in arranging compounds. It is this difficulty which produces litigation under the Patent Laws. Is or is not this machine comprised among those forming the subject of the patent? At first sight nothing can be more different than the drawing in the patent and the machine produced in court, and yet counsel and witnesses shall prove to the satisfaction of judge, jury, and one party the suit, that the essential part, the important organ, is the same in both cases. The case will often hinge on the question, What is the important organ? Just the question which Darwin asks; and quite as difficult to answer about a patented machine as about an organic being.

This difficulty results from the action of man's mind contriving machines to produce a common result according to definite laws, the laws of mechanics. An instance of this is afforded by the various forms of bridge. Nothing would appear more distinct that the three forms of suspension-bridge, girder, and arch; the types of which are furnished by a suspended rope, a balk of wood, and a stone arch; yet if we substitute an iron-plate girder of approved form for the wooden balk, and then a framed or lattice girder for the plate-iron girder, we shall see that the girder occupies an intermediate place between the two extremes, combining both the characteristics of the suspension and arched rib, —the upper plates and a set of diagonal strutts being compressed like the stones of an arch, the lower plates and a set of diagonal ties being extended like a suspended rope. Curve the top plates, as if often done, and the resemblance to an arch increases, yet every member of the girder remains. Weaken the bracing, leaving top and bottom plates as before, the bridge is now an arched bridge with the abutments tied together. Weaken the ties gradually, and you gradually approach nearer and nearer to the common arch with the usual abutments. Quite similarly the girder can be transformed into a suspension-bridge by gradual steps, so that none can say when the girder ends and the suspension-bridge begins. Nay, take the common framed or lattice girder, do not alter its shape in any way, but support it, first, on flat stones, like a girder, then wedge it between sloping abutments like an arch, and lastly, hang it up between short sloping links like those of a suspension-bridge, attached to the upper corners at the end, —you will so alter the strains in the three cases that in order to bear the same load, the relative parts of the framework must be altered in their proportions in three distinct ways, resembling in the arrangement of the strongest parts, first a girder, next an arch, and finally a suspension-bridge. Yet the outline might remain the same, and not a single member be removed.

Thus we see, that though in three distinct and extreme cases it is easy to give distinctive names with clear characteristics, it is very difficult as the varieties multiply to draw distinct lines between them. Shall the distribution of strains be the important point? Then one and the same piece of framework will have to be included under each of three heads, according to the manner in which it is suspended or supported. Shall form be the important point? We may construct a ribbed arch of string, of a form exactly similar to many compressed arches, we may support this from below, and yet the whole arch shall be in tension, and bear a considerable load. Shall the mode of support be the important point? It would be an odd conclusion to arrive at, that any stiff beam hung up in a particular way was a suspension-bridge. Nor is this difficulty simply a sophistical one invented for the occasion; the illustration was suggested by a practical difficulty met with in drawing up a patent; and in ordinary engineering practice, one man will call a certain bridge a stiffened arch, while another calls it a girder of peculiar form; a third man calls a bridge a strengthened girder, which a fourth says differs in no practical way from a suspension-bridge. Here, as in the case of animals or vegetables, when the varieties are few, classification is comparatively easy; as they are multiplied it comes difficult; and when all the conceivable combinations are inserted it becomes impossible. Nor must it be supposed that this is due to the suggestion of one form by another in a way somewhat analogous to descent by animal reproduction. The facts would be the same however the bridges were designed. There are only certain ways in which a stream can be bridged; the extreme cases are easily perceived, and ingenuity can then only fill in an indefinite number of intermediate varieties. The possible varieties are not created by man, they are found out, laid bare. Which are laid bare will frequently depend on suggestion or association of ideas, so that groups of closely analogous forms are discovered about the same time; but we may *a priori*assert that whatever is discovered will lie between the known extremes, and will render the task of classification, if attempted, more and more difficult.

Legal difficulties furnish another illustration. Does a particular case fall within a particular statute? Is it ruled by this or that precedent? The number of statutes or groups is limited; the number of possible combinations of events almost unlimited. Hence, as before, the uncertainty which group a special combination shall be classed within. Yet new combinations, being doubtful cases, are so, precisely because they are intermediate between others already known.

It might almost be urged that all the difficulties of reasoning, and all differences of opinion, might be reduced to difficulties of classification, that is to say, of determining whether a given minor is really included in a certain major proposition; and of discovering the major proposition or genus we are in want of. As trivial instances, take the docketing of letters or making catalogues of books. How difficult it is to devise headings and how difficult afterwards to know under what head to place your book. The most arbitrary rule is the only one which has a chance of being carried out with absolute certainty.

Yet while these difficulties meet us wherever we turn, in chemistry, in mechanics, in law, or mere catalogues of heterogeneous objects, we are asked to feel surprise that we cannot docket off creation into neat rectangular pigeon-holes, and we are offered a special theory of transmutation, limited to organic beings, to account for a fact of almost universal occurrence.

To resume this argument: —Attention has been drawn to the fact, that when a complete set of combinations of certain elements is formed according to a given law, they will necessarily be limited in number, and form a certain sequence, passing from one extreme to the other by successive steps.

Organized beings may be regarded as combinations, either of the elementary substances used to compose them, or of the parts recurring in many beings; for instance, of breathing organs, apparatus for causing blood to circulate, organs of sense, reproduction, etc., in animals. The conclusion is drawn that we can feel no reasonable surprise at finding that species should from a graduated series which it is difficult to group as general, or that varieties should be hard to group into various distinct species.

Nor is it surprising that newly discovered species and varieties should almost invariably occupy an intermediate position between some already known, since the number of varieties of one species, or the number of possible species, can only be indefinitely increased by admitting varieties or species possessing indefinitely small differences one from another.

We observe that these peculiarities require no theory of transmutation, but only that the combination of the parts, however effected, should have been made in accordance with some law, as we have every reason to expect they would be.

In illustration of this conclusion, cases of difficult classification are pointed out containing nothing analogous to reproduction, and where no struggle for life occurs.

Observed Facts supposed to support Darwin's Views. — The chief argument used to establish the theory rest on conjecture. Beasts may have varied; variation may have accumulated; they may have become permanent; continents may have arisen or sunk, and seas and winds been so arranged as to dispose of animals just as we find them, now spreading a race widely, now confining it to one Galapagos island. There may be records of infinitely more animals than we know of in geological formations yet unexplored. Myriads of species differing little from those we know to have been preserved, may actually not have been preserved at all. There may have been an inhabited world for ages before the earliest known geological strata. The world may indeed have been inhabited for an indefinite time; even the geological observations may perhaps give most insufficient idea of the enormous times which separated one formation from another; the peculiarities of hybrids may result from accidental differences between the parents, not from what have been called specific differences.

We are asked to believe all these maybe's happening on an enormous scale, in order that we may believe the final Darwinian 'maybe,' as to the origin of species. The general form of his argument is as follows: —All these things may have been, therefore my theory is possible, and since my theory is a possible one, all those hypotheses which it requires are rendered probable. There is little direct evidence that any these maybe's actually *have been* .

In this essay an attempt has been made to show that many of these assumed possibilities are actually impossibilities, or at the best have not occurred in this world, although it is proverbially somewhat difficult to prove a negative.

Let us now consider what direct evidence Darwin brings forward to prove that animals really are descended from a common ancestor. As direct evidence we may admit the possession of webbed feet by unplumed birds; the stripes observed on some kinds of horses and hybrids of horses, resembling not their parents, but other species of the genus; the generative variability of abnormal organs; the greater tendency to vary of widely diffused and widely ranging species, certain peculiarities of distribution. All these facts are consistent with Darwin's theory, and if it could be shown that they could not possibly have occurred except in consequence of natural selection, they would prove the truth of this theory. It would, however, clearly be impossible to prove that in no other way could these phenomena have been produced, and Darwin makes no attempt to prove this. He only says he cannot imagine why unplumed birds should have webbed feet, unless in consequence of their direct descent from web-footed ancestors who lived in the water; that he thinks it would in some way be derogatory to the Creator to let hybrids have stripes on their legs, unless some ancestors of theirs had stripes on his leg. He cannot imagine why abnormal organs and widely diffused genera should vary more than others, unless his views be true; and he says he cannot account for the peculiarities of distribution in any way but one. It is perhaps hardly necessary to combat these arguments, and to show that our inability to account for certain phenomena, in any way but one, is no proof of the truth of the explanation given, but simply is a confession of our ignorance. When a man says a glowworm must be on fire, and in answer to our doubts challenges us to say how it can give out light unless it be on fire, we do not admit his challenge as any proof of his assertion, and indeed we allow it no weight whatever as against positive proof we have that the glowworm is not on fire. We conceive Darwin's theory to be in exactly the same case; its untruth can, as we think, be proved, and his or our own inability to explain a few isolated facts consistent with his views would simply prove his and our ignorance of the true explanation. But although unable to give any certainly true explanations of the above phenomena, it is possible to suggest explanations perhaps as plausible as the Darwinian theory, and though the fresh suggestions may very probably not be correct, they may serve to show that at least more than one conceivable explanation may be given.

It is a familiar fact that certain complexions go with certain temperaments, that roughly something of a man's character may be told from the shape of his head, his nose, or perhaps from most parts of his body. We find certain colours almost always accompanying certain forms and tempers of horses. There is a connexion between the shape of the hand and the foot, and so forth. No horse has the head of a cart-horse and the hind-quarters of a racer; so that, in general, if we know the shape of most parts of a man or horse, we can make a good guess at the probable shape of the remainder. All this shows that there is a certain correlation of parts, leading us to expect that when the heads of two birds are very much alike, their feet will not be very different. From the assumption of a limited number of possible combinations or animals, it would naturally follow that the combination of elements producing a bird having a head very similar to that of a goose, could not fail to produce a foot also somewhat similar. According to this view, we might expect most animals to have a good many superfluities of a minor kind, resulting necessarily from the combination required to produce the essential or important organs. Surely, then, it is not very strange than an animal intermediate by birth between a horse and ass should resemble a quagga, which results from a combination intermediate between the horse and ass combination. The quagga is in general appearance intermediate between the horse and ass, therefore, *a priori* , we may expect that in general appearance a hybrid between the horse and the ass will resemble the quagga, and if in general it does resemble a quagga, we may expect that owing to the correlation of parts it will resemble the quagga in some special particulars. It is difficult to suppose that every stripe on a zebra or quagga, or cross down a donkey's back, is useful to it. It seems possible, even probable, that these things are the unavoidable consequences of the elementary combination which will produce the quagga, or a beast like it. Darwin himself appears to admit that correlation will or may produce results which are not themselves useful to the animal; thus how can we suppose that the beauty of feathers which are either never uncovered, or very rarely so, can be of any advantage to a bird? Nevertheless those concealed parts are often very beautiful, and the beauty of the markings on these parts must be supposed due to correlation. The exposed end of a peacock's feather could not be so gloriously coloured without beautiful colours even in the unexposed parts. According to the view already explained, the combination producing the one was impossible unless it included the other. The same idea may perhaps furnish the clue to the variability of abnormal organs and widely diffused species, the abnormal organ may with some plausibility be looked upon as the rare combination difficult to effect, and only possible under very special circumstances. There is little difficulty in believing that it would more probably vary with varying circumstances than a simple and ordinary combination. It is easy to produce two common wine-glasses which differ in no apparent manner; two Venice goblets could hardly be blown alike. It is not meant here to predicate ease of difficulty of the action of omnipotence; but just as mechanical laws allow one form to be reproduced with certainty, so the occult laws of reproduction may allow certain simpler combinations to be produced with much greater certainty than the more complex combinations. The variability of widely diffused species might be explained in a similar way. These may be looked on as the simple combinations of which many may exist similar one to the other, whereas the complex combinations may only be possible within comparatively narrow limits, inside which one organ may indeed be variable, though the main combination is the only possible one of its kind.

We by no means wish to assert that we know the above suggestions to be the true explanation of the facts. We merely wish to show that other explanation than those given by Darwin are conceivable, although this is indeed not required by our argument, since, if his main assumptions can be proved false, his theory will derive no benefit from the few facts which may be allowed to be consistent with its truth.

The peculiarities of geographic distribution seem very difficult of explanation on any theory. Darwin calls in alternately winds, tides, birds, beasts, all animated nature, as the diffusers of species, and then a good many of the same agencies as impenetrable barriers. There are some impenetrable barriers between the Galapagos Islands, but not between New Zealand and South America. Continents are created to join Australia and the Cape of Good Hope, while a sea as broad as the British Channel is elsewhere a valid line of demarcation. With these facilities of hypothesis there seems to be no particular reason why many theories should not be true. However an animal may have been produced, it must have been produced somewhere, and it must either have spread very widely, or not have spread, and Darwin can give good reason for both results. If produced according to any law at all, it would seem probable that groups of similar animals would be produced in given places. Or we might suppose that all animals having been created anywhere or everywhere, those have been extinguished which were not suited to such climate; nor would it be an answer to say that the climate, for instance, of Australia, is less suitable now to marsupials than to other animals introduced from Europe, because we may suppose that this was not so when the race began; but in truth it is hard to believe any of the suppositions, nor can we just now invent any better, and this peculiarity of distribution, namely, that all the products of a given continent have a kind of family resemblance, is the sole argument brought forward by Darwin which seems to us to lend any countenance to the theory of a common origin and the transmutation of species.

Our main arguments are now completed. Something might be said as to the alleged imperfection of the geological records. It is certain that, when compared with the total number of animals which have lived, they must be very imperfect; but still we observe that of many species of beings thousands and even millions of specimens have been preserved. If Darwin's theory be true, the number of varieties differing one from another a very little must have been indefinitely great, so great indeed as probably far to exceed the number of individual which have existed of any one variety. If this be true, it would be more probable that no two specimens preserved as fossils should be of one variety than that we should find a great many specimens collected from a very few varieties, provided, of course, the chances of preservation are equal for all individuals. But this assumption may be denied, and some may think it probable that the conditions favourable to preservation only recur rarely, at remote periods, and never last long enough to show a gradual unbroken change. It would rather seem probable that fragments, at lest, of perfect series would be preserved of those beings which lead similar lives favourable to their preservation as fossils. Have any fragments of these Darwinian series been found where the individuals merge from one variety insensibly to another?

It is really strange that vast numbers of perfectly similar specimens should be found, the chances against their perpetuation as fossils are so great; but it is also very strange that the specimens should be so exactly alike as they are, if, in fat, they came and vanished by a gradual change. It is, however, not worth while to insist much on this argument, which by suitable hypotheses might be answered, as by saying, that the changes were often quick, taking only a few myriad ages, and that then a species was permanent for a vastly longer time, and that if we have not anywhere a gradual change clearly recorded, the steps from variety to variety are gradually being diminished as more specimens are discovered. These answers do not seem sufficient, but the point is hardly worth contesting, when other arguments directly disproving the possibility of the assumed change have been advanced.

These arguments are cumulative. If it be true that no species can vary beyond defined limits, it matters little whether natural selection would be efficient in producing definite variations. If natural selection, though it does select the stronger average animals, and under peculiar circumstances may develop special organs already useful, can never select new imperfect organs such as are produced in sports, then, even though eternity were granted, and no limit assigned to the possible changes of animals, Darwin's cannot be the true explanation of the manner in which change has been brought about. Lastly, even if no limit be drawn to the possible difference between offspring and their progenitors, and if natural selection were admitted to be an efficient cause capable of building up even new senses, even then, unless time, vast time, be granted, the changes which might have been produced by the gradual selection of peculiar offspring have not really been so produced. Any one of the main pleas of our argument, if established, is fatal to Darwin's theory. What then shall we say if we believe that experiment has shown a sharp limit to the variation of every species, that natural selection is powerless to perpetuate new organs even should they appear, that countless ages of a habitable globe are rigidly proven impossible by the physical laws which forbid the assumption of infinite power in a finite mass? What can we believe but that Darwin's theory is an ingenious and plausible speculation, to which future physiologists will look back with the kind of admiration we bestow on the atoms of Lucretius, or the crystal spheres of Eudoxus, containing like these some faint half-truths, marking at once the ignorance of the age and the ability of the philosopher. Surely the time is past when a theory unsupported by evidence is received as probable, because in our ignorance we know not why it should be false, though we cannot show it to be true. Yet we have heard grave men gravely urge, that because Darwin's theory was the most plausible known, it should be believed. Others seriously allege that it is more consonant with a lofty idea of the Creator's action to suppose that he produced beings by natural selection, rather than by the finikin process of making each separate little race by the exercise of Almighty power. The argument such as it is, means simply that the user of it thinks that this is how he personally would act if possessed of almighty power and knowledge, but his speculations as to his probable feelings and actions, after such a great change of circumstances, are not worth much. If we are told that our experience shows that God works by laws, then we answer, 'Why the special Darwinian law?' A plausible theory should not be accepted while unproven; and if the arguments of this essay be admitted, Darwin's theory of the origin of species is not only without sufficient support from evidence, but is proved false by a cumulative proof.

References

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