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MR. DARWIN'S "ORIGIN OF SPECIES"

by Thomas H. Huxley

Everyone knows that that superficial film of the earth's substance, hardly ten miles thick, which is accessible to human investigation, is composed for the most part of beds or strata of stone, the consolidated muds and sands of former seas and lakes, which have been deposited one upon the other, and hence are the older the deeper they lie. These multitudinous strata present such resemblances and differences among themselves that they are capable of classification into groups or formations, and these formations again are brigaded together into still larger assemblages, called by the older geologists, primary, secondary, and tertiary; by the moderns, palaeozoic, mesozoic, and cainozoic: the basis of the former nomenclature being the relative age of the groups of strata; that of the latter, the kinds of living forms contained in them.

Though but a film if compared with the total diameter of our planet, the total series of formations is vast indeed when measured by any human standard, and, as all action implies time, so are we compelled to regard these mineral masses as a measure of the time which has elapsed during their accumulation. The amount of the time which they represent is, of course, in the inverse proportion of the intensity of the forces which have been in operation. If, in the ancient world, mud and sand accumulated on sea-bottoms at tenfold their present rate, it is clear that a bed of mud or sand ten feet thick would have been formed then in the same time as a stratum of similar materials one foot thick would be formed now, and *vice versa*.

At the outset of his studies, therefore, the physical geologist had to choose between two hypotheses; either, throughout the ages which are represented by the accumulated strata, and which we may call *geologic time*, the forces of nature have operated with much the same average intensity as at present, and hence the lapse of time which they represent must be something prodigious and inconceivable, or, in the primeval epochs, the natural powers were infinitely more intense than now, and hence the time through which they acted to produce the effects we see was comparatively short.

The earlier geologists adopted the latter view almost with one consent. For they had little knowledge of the present workings of nature, and they read the records of geologic time as a child reads the history of Rome or Greece, and fancies that antiquity was grand, heroic, and unlike the present because it is unlike his little experience of the present.

Even so the earlier observers were moved with wonder at the seeming contrast between the ancient and the present order of nature. The elemental forces seemed to have been grander and more energetic in primeval times. Upheaved and contorted, rifted and fissured, pierced by dykes of molten matter or worn away over vast areas by aqueous action, the older rocks appeared to bear witness to a state of things far different from that exhibited by the peaceful epoch on which the lot of man has fallen.

But by degrees thoughtful students of geology have been led to perceive that the earliest efforts of nature have been by no means the grandest. Alps and Andes are children of yesterday when compared with Snowdon and the Cumberland hills; and the so-called glacial epoch—that in which perhaps the most extensive physical changes of which any record remaining occurred—is the last and the newest of the revolutions of the globe. And in proportion as physical geography—which is the geology of our own epoch—has grown into a science, and the present order of nature has been ransacked to find what, *hibernice*, we may call precedents for the phenomena of the past, so the apparent necessity of supposing the past to be widely different from the present has diminished.

The transporting power of the greatest deluge which can be imagined sinks into insignificance beside that of the slowly floating, slowly melting iceberg, or the glacier creeping along at its snail's pace of a yard a day. The study of the deltas of the Nile, the Ganges, and the Mississippi has taught us how slow is the wearing action of water, how vast its effects when time is allowed for its operation. The reefs of the Pacific, the deep-sea soundings of the Atlantic, show that it is to the slow-growing coral and to the imperceptible animalcule, which lives its brief space and then adds its tiny shell to the muddy cairn left by its brethren and ancestors, that we must look as the agents in the formation of limestone and chalk, and not to hypothetical oceans saturated with calcareous salts and suddenly depositing them.

And while the inquirer has thus learnt that existing forces—*give them time*—are competent to produce all the physical phenomena we meet with in the rocks, so, on the other side, the study of the marks left in the ancient strata by past physical actions shows that these were similar to

those which now obtain. Ancient beaches are met with whose pebbles are like those found on modern shores; the hardened sea-sands of the oldest epochs show ripple-marks, such as may now be found on every sandy coast; nay, more, the pits left by ancient rain-drops prove that even in the very earliest ages, the “bow in the clouds” must have adorned the palaeozoic firmament. So that if we could reverse the legend of the Seven Sleepers,—if we could sleep back through the past, and awake a million ages before our own epoch, in the midst of the earliest geologic times,—there is no reason to believe that sea, or sky, or the aspect of the land would warn us of the marvellous retrospection.

Such are the beliefs which modern physical geologists hold, or, at any rate, tend towards holding. But, in so doing, it is obvious that they by no means prejudge the question, as to what the physical condition of the globe may have been before our chapters of its history begin, in what may be called (with that licence which is implied in the often-used term “prehistoric epoch”) “pre-geologic time.” The views indicated, in fact, are not only quite consistent with the hypothesis, that, in the still earlier period referred to, the condition of our world was very different; but they may be held by some to necessitate that hypothesis. The physical philosopher who is accurately acquainted with the velocity of a cannon-ball, and the precise character of the line which it traverses for a yard of its course, is necessitated by what he knows of the laws of nature to conclude that it came from a certain spot, whence it was impelled by a certain force, and that it has followed a certain trajectory. In like manner, the student of physical geology, who fully believes in the uniformity of the general condition of the earth through geologic time, may feel compelled by what he knows of causation, and by the general analogy of nature, to suppose that our solar system was once a nebulous mass; that it gradually condensed, that it broke up into that wonderful group of harmoniously rolling balls we call planets and satellites, and that then each of these underwent its appointed metamorphosis, until at last our own share of the cosmic vapour passed into that condition in which we first meet with definite records of its state, and in which it has since, with comparatively little change, remained.

The doctrine of uniformity and the doctrine of progression are, therefore, perfectly consistent; perhaps, indeed, they might be shown to be necessarily connected with one another.

If, however, the condition of the world, which has obtained throughout geologic time, is but the sequel to a vast series of changes which took place in pre-geologic time, then it seems not unlikely that the duration of this latter is to that of the former as the vast extent of geologic time is to the length of the brief epoch we call the historical period; and that even the oldest rocks are records of an epoch almost infinitely remote from that which could have witnessed the first shaping of our globe.

It is probable that no modern geologist would hesitate to admit the general validity of these reasonings when applied to the physics of his subject, whence it is the more remarkable that the moment the question changes from one of physics and chemistry to one of natural history, scientific opinions and the popular prejudices, which reflect them in a distorted form, undergo a sudden metamorphosis. Geologists and palaeontologists write about the “beginning of life” and the “first-created forms of living beings,” as if they were the most familiar things in the world; and even cautious writers seem to be on quite friendly terms with the “archetype” whereby the Creator was guided “amidst the crash of falling worlds.” Just as it used to be imagined that the ancient world was physically opposed to the present, so it is still widely assumed that the living population of our globe, whether animal or vegetable, in the older epochs, exhibited forms so strikingly contrasted with those which we see around us, that there is hardly anything in common between the two. It is constantly tacitly assumed that we have before us all the forms of life which have ever existed; and though the progress of knowledge, yearly and almost monthly, drives the defenders of that position from their ground, they entrench themselves in the new line of defences as if nothing had happened, and proclaim that the *new* beginning is the *real* beginning.

Without for an instant denying or endeavouring to soften down the considerable positive differences (the negative ones are met by another line of argument) which undoubtedly obtain between the ancient and the modern worlds of life, we believe they have been vastly overstated and exaggerated, and this belief is based upon certain facts whose value does not seem to have been fully appreciated, though they have long been more or less completely known.

The multitudinous kinds of animals and plants, both recent and fossil,

are, as is well known, arranged by zoologists and botanists, in accordance with their natural relations, into groups which receive the names of sub-kingdoms, classes, orders, families, genera and species. Now it is a most remarkable circumstance that, viewed on the great scale, living beings have differed so little throughout all geologic time that there is no sub-kingdom and no class wholly extinct or without living representatives.

If we descend to the smaller groups, we find that the number of orders of plants is about two hundred; and I have it on the best authority that not one of these is exclusively fossil; so that there is absolutely not a single extinct ordinal type of vegetable life; and it is not until we descend to the next group, or the families, that we find types which are wholly extinct. The number of orders of animals, on the other hand, may be reckoned at a hundred and twenty, or thereabouts, and of these, eight or nine have no living representatives. The proportion of extinct ordinal types of animals to the existing types, therefore, does not exceed seven per cent.—a marvellously small proportion when we consider the vastness of geologic time.

Another class of considerations—of a different kind, it is true, but tending in the same direction—seems to have been overlooked. Not only is it true that the general plan of construction of animals and plants has been the same in all recorded time as at present, but there are particular kinds of animals and plants which have existed throughout vast epochs, sometimes through the whole range of recorded time, with very little change. By reason of this persistency, the typical form of such a kind might be called a “persistent type,” in contradistinction to those types which have appeared for but a short time in the course of the world’s history. Examples of these persistent types are abundant enough in both the vegetable and the animal kingdoms. The oldest group of plants with which we are well acquainted is that of whose remains coal is constituted; and as far as they can be identified, the carboniferous plants are ferns, or club-mosses, or Coniferae, in many cases generically identical with those now living!

Among animals, instances of the same kind may be found in every sub-kingdom. The *Globigerina* of the Atlantic soundings is identical with that which occurs in the chalk; and the casts of lower silurian *Foraminifera*, which Ehrenberg has recently described, seem to indicate the existence at that remote period of forms singularly like those which now exist. Among the corals, the palaeozoic *Tabulata* are constructed on precisely the same type as the modern millepores; and if we turn to molluscs, the most competent malacologists fail to discover any generic distinction between the *Craniae*, *Lingulae* and *Discinae* of the silurian rocks and those which now live. Our existing *Nautilus* has its representative species in every great formation, from the oldest to the newest; and *Loligo*, the squid of modern seas, appears in the lias, or at the bottom of the mesozoic series, in a form, at most, specifically different from its living congeners. In the great assemblage of annulose animals, the two highest classes, the insects and spider tribe, exhibit a wonderful persistency of type. The cockroaches of the carboniferous epoch are exceedingly similar to those which now run about our coal-cellars; and its locusts, termites and dragon-flies are closely allied to the members of the same groups which now chirrup about our fields, undermine our houses, or sail with swift grace about the banks of our sedgy pools. And, in like manner, the palaeozoic scorpions can only be distinguished by the eye of a naturalist from the modern ones.

Finally, with respect to the *Vertebrata*, the same law holds good: certain types, such as those of the ganoid and placoid fishes, having persisted from the palaeozoic epoch to the present time without a greater amount of deviation from the normal standard than that which is seen within the limits of the group as it now exists. Even among the *Reptilia*—the class which exhibits the largest proportion of entirely extinct forms of any one type,—that of the *Crocodilia*, has persisted from at least the commencement of the mesozoic epoch up to the present time with so much constancy, that the amount of change which it exhibits may fairly, in relation to the time which has elapsed, be called insignificant. And the imperfect knowledge we have of the ancient mammalian population of our earth leads to the belief that certain of its types, such as that of the *Marsupialia*, have persisted with correspondingly little change through a similar range of time.

Thus it would appear to be demonstrable, that, notwithstanding the great change which is exhibited by the animal population of the world as a whole, certain types have persisted comparatively without alteration, and the question arises, What bearing have such facts as these on our notions of the history of life through geological time? The answer to this

question would seem to depend on the view we take respecting the origin of species in general. If we assume that every species of animal and of plant was formed by a distinct act of creative power, and if the species which have incessantly succeeded one another were placed upon the globe by these separate acts, then the existence of persistent types is simply an unintelligible irregularity. Such assumption, however, is as unsupported by tradition or by Revelation as it is opposed by the analogy of the rest of the operations of nature; and those who imagine that, by adopting any such hypothesis, they are strengthening the hands of the advocates of the letter of the Mosaic account, are simply mistaken. If, on the other hand, we adopt that hypothesis to which alone the study of physiology lends any support—that hypothesis which, having struggled beyond the reach of those fatal supporters, the Telliameds and Vestigiarians, who so nearly caused its suffocation by wind in early infancy, is now winning at least the provisional assent of all the best thinkers of the day—the hypothesis that the forms or species of living beings, as we know them, have been produced by the gradual modification of pre-existing species—then the existence of persistent types seems to teach us much. Just as a small portion of a great curve appears straight, the apparent absence of change in direction of the line being the exponent of the vast extent of the whole, in proportion to the part we see; so, if it be true that all living species are the result of the modification of other and simpler forms, the existence of these little altered persistent types, ranging through all geological time, must indicate that they are but the final terms of an enormous series of modifications, which had their being in the great lapse of pregeologic time, and are now perhaps for ever lost.

In other words, when rightly studied, the teachings of palaeontology are at one with those of physical geology. Our farthest explorations carry us back but a little way above the mouth of the great river of Life: where it arose, and by what channels the noble tide has reached the point when it first breaks upon our view, is hidden from us.

The foregoing pages contain the substance of a lecture delivered before the Royal Institution of Great Britain many months ago, and of course long before the appearance of the remarkable work on the “Origin of Species” just published by Mr. Darwin, who arrives at very similar conclusions. Although, in one sense, I might fairly say that my own views have been arrived at independently, I do not know that I can claim any equitable right to property in them; for it has long been my privilege to enjoy Mr. Darwin’s friendship, and to profit by corresponding with him, and by, to some extent, becoming acquainted with the workings of his singularly original and well-stored mind. It was in consequence of my knowledge of the general tenor of the researches in which Mr. Darwin had been so long engaged; because I had the most complete confidence in his perseverance, his knowledge, and, above all things, his high-minded love of truth; and, moreover, because I found that the better I became acquainted with the opinions of the best naturalists regarding the vexed question of species, the less fixed they seemed to be, and the more inclined they were to the hypothesis of gradual modification, that I ventured to speak as strongly as I have done in the final paragraphs of my discourse.

Thus, my daw having so many borrowed plumes, I see no impropriety in making a tail to this brief paper by taking another handful of feathers from Mr. Darwin; endeavouring to point out in a few words, in fact, what, as I gather from the perusal of his book, his doctrines really are, and on what sort of basis they rest. And I do this the more willingly, as I observe that already the hastier sort of critics have begun, not to review my friend’s book, but to howl over it in a manner which must tend greatly to distract the public mind.

No one will be better satisfied than I to see Mr. Darwin’s book refuted, if any person be competent to perform that feat; but I would suggest that refutation is retarded, not aided, by mere sarcastic misrepresentation. Every one who has studied cattle-breeding, or turned pigeon-fancier, or “pomologist,” must have been struck by the extreme modifiability or plasticity of those kinds of animals and plants which have been subjected to such artificial conditions as are imposed by domestication. Breeds of dogs are more different from one another than are the dog and the wolf; and the purely artificial races of pigeons, if their origin were unknown, would most assuredly be reckoned by naturalists as distinct species and even genera.

These breeds are always produced in the same way. The breeder selects a pair, one or other, or both, of which present an indication of the peculiarity he wishes to perpetuate, and then selects from the offspring of them those which are most characteristic, rejecting the others. From the selected offspring he breeds again, and, taking the same precautions as before, repeats the process until he has obtained the precise degree of divergence from the primitive type at which he aimed.

If he now breeds from the variety thus established for some generations, taking care always to keep the stock pure, the tendency to produce this particular variety becomes more and more strongly hereditary; and it does not appear that there is any limit to the persistency of the race thus developed.

Men like Lamarck, apprehending these facts, and knowing that varieties comparable to those produced by the breeder are abundantly found in nature, and finding it impossible to discriminate in some cases between varieties and true species, could hardly fail to divine the possibility that species even the most distinct were, after all, only exceedingly persistent varieties, and that they had arisen by the modification of some common stock, just as it is with good reason believed that turnspits and greyhounds, carrier and tumbler pigeons, have arisen.

But there was a link wanting to complete the parallel. Where in nature was the analogue of the breeder to be found? How could that operation of selection, which is his essential function, be carried out by mere natural agencies? Lamarck did not value this problem; neither did he admit his impotence to solve it; but he guessed a solution. Now, guessing in science is a very hazardous proceeding, and Lamarck's reputation has suffered woefully for the absurdities into which his baseless suppositions led him.

Lamarck's conjectures, equipped with a new hat and stick, as Sir Walter Scott was wont to say of an old story renovated, formed the foundation of the biological speculations of the "Vestiges," a work which has done more harm to the progress of sound thought on these matters than any that could be named; and, indeed, I mention it here simply for the purpose of denying that it has anything in common with what essentially characterises Mr. Darwin's work.

The peculiar feature of the latter is, in fact, that it professes to tell us what in nature takes the place of the breeder; what it is that favours the development of one variety into which a species may run, and checks that of another; and, finally, shows how this natural selection, as it is termed, may be the physical cause of the production of species by modification.

That which takes the place of the breeder and selector in nature is Death. In a most remarkable chapter, "On the Struggle for Existence," Mr. Darwin draws attention to the marvellous destruction of life which is constantly going on in nature. For every species of living thing, as for man, "*Eine Bresche ist ein jeder Tag.*"—Every species has its enemies; every species has to compete with others for the necessaries of existence; the weakest goes to the wall, and death is the penalty inflicted on all laggards and stragglers. Every variety to which a species may give rise is either worse or better adapted to surrounding circumstances than its parent. If worse, it cannot maintain itself against death, and speedily vanishes again. But if better adapted, it must, sooner or later, "improve" its progenitor from the face of the earth, and take its place. If circumstances change, the victor will be similarly supplanted by its own progeny; and thus, by the operation of natural causes, unlimited modification may in the lapse of long ages occur.

For an explanation of what I have here called vaguely "surrounding circumstances," and of why they continually change—for ample proof that the "struggle for existence" is a very great reality, and assuredly *tends* to exert the influence ascribed to it—I must refer to Mr. Darwin's book. I believe I have stated fairly the position upon which his whole theory must stand or fall; and it is not my purpose to anticipate a full review of his work. If it can be proved that the process of natural selection, operating upon any species, can give rise to varieties of species so different from one another that none of our tests will distinguish them from true species, Mr. Darwin's hypothesis of the origin of species will take its place among the established theories of science, be its consequences whatever they may. If, on the other hand, Mr. Darwin has erred, either in fact or in reasoning, his fellow-workers will soon find out the weak points in his doctrines, and their extinction by some nearer approximation to the truth will exemplify his own principle of natural selection.

In either case the question is one to be settled only by the painstaking, truth-loving investigation of skilled naturalists. It is the duty of the general public to await the result in patience; and, above all things, to discourage, as they would any other crimes, the attempt to enlist the prejudices of the ignorant, or the uncharitableness of the bigoted, on either side of the controversy.

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* “Macmillan’s Magazine,” December 1859.

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