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THE DARWINIAN HYPOTHESIS*

by Thomas H. Huxley

[footnote] *'Times', December 26th, 1850.

DARWIN ON THE ORIGIN OF SPECIES.

THERE is a growing immensity in the speculations of science to which no human thing or thought at this day is comparable. Apart from the results which science brings us home and securely harvests, there is an expansive force and latitude in its tentative efforts, which lifts us out of ourselves and transfigures our mortality. We may have a preference for moral themes, like the Homeric sage, who had seen and known much:--

"Cities of men
And manners, climates, councils, governments";

yet we must end by confession that

"The windy ways of men
Are but dust which rises up
And is lightly laid again,"

in comparison with the work of nature, to which science testifies, but which has no boundaries in time or space to which science can approximate.

There is something altogether out of the reach of science, and yet the compass of science is practically illimitable. Hence it is that from time to time we are startled and perplexed by theories which have no parallel in the contracted moral world; for the generalizations of science sweep on in ever-widening circles, and more aspiring flights, through a limitless creation. While astronomy, with its telescope, ranges beyond the known stars, and physiology, with its microscope, is subdividing infinite minutiae, we may expect that our historic centuries may be treated as inadequate counters in the history of the planet on which we are placed. We must expect new conceptions of the nature and relations of its denizens, as science acquires the materials for fresh generalizations; nor have we occasion for alarms if a highly

advanced knowledge, like that of the eminent Naturalist before us, confronts us with an hypothesis as vast as it is novel. This hypothesis may or may not be sustainable hereafter; it may give way to something else, and higher science may reverse what science has here built up with so much skill and patience, but its sufficiency must be tried by the tests of science alone, if we are to maintain our position as the heirs of Bacon and the acquitters of Galileo. We must weigh this hypothesis strictly in the controversy which is coming, by the only tests which are appropriate, and by no others whatsoever.

The hypothesis to which we point, and of which the present work of Mr. Darwin is but the preliminary outline, may be stated in his own language as follows:--"Species originated by means of natural selection, or through the preservation of the favoured races in the struggle for life." To render this thesis intelligible, it is necessary to interpret its terms. In the first place, what is a species? The question is a simple one, but the right answer to it is hard to find, even if we appeal to those who should know most about it. It is all those animals or plants which have descended from a single pair of parents; it is the smallest distinctly definable group of living organisms; it is an eternal and immutable entity; it is a mere abstraction of the human intellect having no existence in nature. Such are a few of the significations attached to this simple word which may be culled from authoritative sources; and if, leaving terms and theoretical subtleties aside, we turn to facts and endeavour to gather a meaning for ourselves, by studying the things to which, in practice, the name of species is applied, it profits us little. For practice varies as much as theory. Let the botanist or the zoologist examine and describe the productions of a country, and one will pretty certainly disagree with the other as to the number, limits, and definitions of the species into which he groups the very same things. In these islands, we are in the habit of regarding mankind as of one species, but a fortnight's steam will land us in a country where divines and savants, for once in agreement, vie with one another in loudness of assertion, if not in cogency of proof, that men are of different species; and, more particularly, that the species negro is so distinct from our own that the Ten Commandments have actually no reference to him. Even in the calm region of entomology, where, if anywhere in this sinful world, passion and prejudice should fail to stir the mind, one learned coleopterist will fill ten attractive volumes with descriptions of species of beetles, nine-tenths of which are immediately declared by his brother beetle-mongers to be no species at all.

The truth is that the number of distinguishable living creatures almost surpasses imagination. At least a hundred thousand such kinds of insects alone have been described and may be identified in collections, and the number of separable kinds of living things is under estimated at half a million. Seeing that most of these obvious kinds have their accidental varieties, and that they often shade into others by imperceptible degrees, it may well be imagined that the task of distinguishing between what is permanent and what fleeting, what is a species and what a mere variety, is sufficiently formidable.

But is it not possible to apply a test whereby a true species may be known from a mere variety? Is there no criterion of species? Great authorities affirm that there is--that the unions of members of the same species are always fertile, while those of distinct species are either sterile, or their offspring, called hybrids, are so. It is affirmed not only that this is an experimental fact, but that it is a provision for the preservation of the purity of species. Such a criterion as this would be invaluable; but, unfortunately, not only is it not obvious how to apply it in the great majority of cases in which its aid is needed, but its general validity is stoutly denied. The Hon. and Rev. Mr. Herbert, a most trustworthy authority, not only asserts as the result of his own observations and experiments that many hybrids are quite as fertile as the parent species, but he goes so far as to assert that the particular plant 'Crinum capense' is much more fertile when crossed by a distinct species than when fertilised by its proper pollen! On the other hand, the famous Gaertner, though he took the greatest pains to cross the primrose and the cowslip, succeeded only once or twice in several years; and yet it is a well-established fact that the primrose and the cowslip are only varieties of the same kind of plant. Again, such cases as the following are well established. The female of species A, if crossed with the male of species B, is fertile; but, if the female of B is crossed with the male of A, she remains barren. Facts of this kind destroy the value of the supposed criterion.

If, weary of the endless difficulties involved in the determination of species, the investigator, contenting himself with the rough practical distinction of separable kinds, endeavours to study them as they occur in nature--to ascertain their relations to the conditions which surround them, their mutual harmonies and discordances of structure, the bond of union of their parts and their past history, he finds himself, according to the received notions, in a mighty maze, and with, at most, the dimmest adumbration of a plan. If he starts with any one clear conviction, it is that every part of a living creature is cunningly adapted to some special use in its life. Has not his Paley told him that that seemingly useless organ, the spleen, is beautifully adjusted as so much packing between the other organs? And yet, at the outset of his studies, he finds that no adaptive reason whatsoever can be given for one-half of the peculiarities of vegetable structure; he also discovers rudimentary teeth, which are never used, in the gums of the young calf and in those of the foetal whale; insects which never bite have rudimentary jaws, and others which never fly have rudimentary wings; naturally blind creatures have rudimentary eyes; and the halt have rudimentary limbs. So, again, no animal or plant puts on its perfect form at once, but all have to start from the same point, however various the course which each has to pursue. Not only men and horses, and cats and dogs, lobsters and beetles, periwinkles and mussels, but even the very sponges and animalcules commence their existence under forms which are essentially undistinguishable; and this is true of all the infinite variety of plants. Nay, more, all living beings march side by side along the high road of development, and separate the later the more like they are; like people leaving church, who all go down the aisle, but having reached the door some turn into

the parsonage, others go down the village, and others part only in the next parish. A man in his development runs for a little while parallel with, though never passing through, the form of the meanest worm, then travels for a space beside the fish, then journeys along with the bird and the reptile for his fellow travellers; and only at last, after a brief companionship with the highest of the four-footed and four-handed world, rises into the dignity of pure manhood. No competent thinker of the present day dreams of explaining these indubitable facts by the notion of the existence of unknown and undiscoverable adaptations to purpose. And we would remind those who, ignorant of the facts, must be moved by authority, that no one has asserted the incompetence of the doctrine of final causes, in its application to physiology and anatomy, more strongly than our own eminent anatomist, Professor Owen, who, speaking of such cases, says ('On the Nature of Limbs', pp. 39, 40): "I think it will be obvious that the principle of final adaptations fails to satisfy all the conditions of the problem."

But, if the doctrine of final causes will not help us to comprehend the anomalies of living structure, the principle of adaptation must surely lead us to understand why certain living beings are found in certain regions of the world and not in others. The palm, as we know, will not grow in our climate, nor the oak in Greenland. The white bear cannot live where the tiger thrives, nor 'vice versa', and the more the natural habits of animal and vegetable species are examined, the more do they seem, on the whole, limited to particular provinces. But when we look into the facts established by the study of the geographical distribution of animals and plants it seems utterly hopeless to attempt to understand the strange and apparently capricious relations which they exhibit. One would be inclined to suppose 'a priori' that every country must be naturally peopled by those animals that are fittest to live and thrive in it. And yet how, on this hypothesis, are we to account for the absence of cattle in the Pampas of South America, when those parts of the New World were discovered? It is not that they were unfit for cattle, for millions of cattle now run wild there; and the like holds good of Australia and New Zealand. It is a curious circumstance, in fact, that the animals and plants of the Northern Hemisphere are not only as well adapted to live in the Southern Hemisphere as its own autochthones, but are in many cases absolutely better adapted, and so overrun and extirpate the aborigines. Clearly, therefore, the species which naturally inhabit a country are not necessarily the best adapted to its climate and other conditions. The inhabitants of islands are often distinct from any other known species of animal or plants (witness our recent examples from the work of Sir Emerson Tennent, on Ceylon), and yet they have almost always a sort of general family resemblance to the animals and plants of the nearest mainland. On the other hand, there is hardly a species of fish, shell, or crab common to the opposite sides of the narrow isthmus of Panama. Wherever we look, then, living nature offers us riddles of difficult solution, if we suppose that what we see is all that can be known of it.

But our knowledge of life is not confined to the existing world. Whatever their minor differences, geologists are agreed as to the vast thickness of the accumulated strata which compose the visible part of

our earth, and the inconceivable immensity of the time of whose lapse they are the imperfect, but the only accessible witnesses. Now, throughout the greater part of this long series of stratified rocks are scattered, sometimes very abundantly, multitudes of organic remains, the fossilized exuviae of animals and plants which lived and died while the mud of which the rocks are formed was yet soft ooze, and could receive and bury them. It would be a great error to suppose that these organic remains were fragmentary relics. Our museums exhibit fossil shells of immeasurable antiquity, as perfect as the day they were formed, whole skeletons without a limb disturbed--nay, the changed flesh, the developing embryos, and even the very footsteps of primieval organisms. Thus the naturalist finds in the bowels of the earth species as well defined as, and in some groups of animals more numerous than, those that breathe the upper air. But, singularly enough, the majority of these entombed species are wholly distinct from those that now live. Nor is this unlikeness without its rule and order. As a broad fact, the further we go back in time the less the buried species are like existing forms; and the further apart the sets of extinct creatures are the less they are like one another. In other words, there has been a regular succession of living beings, each younger set being in a very broad and general sense somewhat more like those which now live.

It was once supposed that this succession had been the result of vast successive catastrophes, destructions, and re-creations 'en masse'; but catastrophes are now almost eliminated from geological, or at least palaeontological speculation; and it is admitted on all hands that the seeming breaks in the chain of being are not absolute, but only relative to our imperfect knowledge; that species have replaced species, not in assemblages, but one by one; and that, if it were possible to have all the phenomena of the past presented to us, the convenient epochs and formations of the geologist, though having a certain distinctness, would fade into one another with limits as undefinable as those of the distinct and yet separable colours of the solar spectrum.

Such is a brief summary of the main truths which have been established concerning species. Are these truths ultimate and irresolvable facts, or are their complexities and perplexities the mere expressions of a higher law?

A large number of persons practically assume the former position to be correct. They believe that the writer of the Pentateuch was empowered and commissioned to teach us scientific as well as other truth, that the account we find there of the creation of living things is simply and literally correct, and that anything which seems to contradict it is, by the nature of the case, false. All the phenomena which have been detailed are, on this view, the immediate product of a creative fiat and consequently are out of the domain of science altogether.

Whether this view prove ultimately to be true or false, it is, at any rate, not at present supported by what is commonly regarded as logical proof, even if it be capable of discussion by reason; and hence we consider ourselves at liberty to pass it by, and to turn to those views

which profess to rest on a scientific basis only, and therefore admit of being argued to their consequences. And we do this with the less hesitation as it so happens that those persons who are practically conversant with the facts of the case (plainly a considerable advantage) have always thought fit to range themselves under the latter category.

The majority of these competent persons have up to the present time maintained two positions,--the first, that every species is, within certain defined or definable limits, fixed and incapable of modification; the second, that every species was originally produced by a distinct creative act. The second position is obviously incapable of proof or disproof, the direct operations of the Creator not being subjects of science; and it must therefore be regarded as a corollary from the first, the truth or falsehood of which is a matter of evidence. Most persons imagine that the arguments in favour of it are overwhelming; but to some few minds, and these, it must be confessed, intellects of no small power and grasp of knowledge, they have not brought conviction. Among these minds, that of the famous naturalist Lamarck, who possessed a greater acquaintance with the lower forms of life than any man of his day, Cuvier not excepted, and was a good botanist to boot, occupies a prominent place.

Two facts appear to have strongly affected the course of thought of this remarkable man--the one, that finer or stronger links of affinity connect all living beings with one another, and that thus the highest creature grades by multitudinous steps into the lowest; the other, that an organ may be developed in particular directions by exerting itself in particular ways, and that modifications once induced may be transmitted and become hereditary. Putting these facts together, Lamarck endeavoured to account for the first by the operation of the second. Place an animal in new circumstances, says he, and its needs will be altered; the new needs will create new desires, and the attempt to gratify such desires will result in an appropriate modification of the organs exerted. Make a man a blacksmith, and his brachial muscles will develop in accordance with the demands made upon them, and in like manner, says Lamarck, "the efforts of some short-necked bird to catch fish without wetting himself have, with time and perseverance, given rise to all our herons and long-necked waders."

The Lamarckian hypothesis has long since been justly condemned, and it is the established practice for every tyro to raise his heel against the carcass of the dead lion. But it is rarely either wise or instructive to treat even the errors of a really great man with mere ridicule, and in the present case the logical form of the doctrine stands on a very different footing from its substance.

If species have really arisen by the operation of natural conditions, we ought to be able to find those conditions now at work; we ought to be able to discover in nature some power adequate to modify any given kind of animal or plant in such a manner as to give rise to another kind, which would be admitted by naturalists as a distinct species. Lamarck imagined that he had discovered this 'vera causa' in the admitted facts that some organs may be modified by exercise; and that modifications,

once produced, are capable of hereditary transmission. It does not seem to have occurred to him to inquire whether there is any reason to believe that there are any limits to the amount of modification producible, or to ask how long an animal is likely to endeavour to gratify an impossible desire. The bird, in our example, would surely have renounced fish dinners long before it had produced the least effect on leg or neck.

Since Lamarck's time, almost all competent naturalists have left speculations on the origin of species to such dreamers as the author of the 'Vestiges', by whose well-intentioned efforts the Lamarckian theory received its final condemnation in the minds of all sound thinkers. Notwithstanding this silence, however, the transmutation theory, as it has been called, has been a "skeleton in the closet" to many an honest zoologist and botanist who had a soul above the mere naming of dried plants and skins. Surely, has such an one thought, nature is a mighty and consistent whole, and the providential order established in the world of life must, if we could only see it rightly, be consistent with that dominant over the multiform shapes of brute matter. But what is the history of astronomy, of all the branches of physics, of chemistry, of medicine, but a narration of the steps by which the human mind has been compelled, often sorely against its will, to recognize the operation of secondary causes in events where ignorance beheld an immediate intervention of a higher power? And when we know that living things are formed of the same elements as the inorganic world, that they act and react upon it, bound by a thousand ties of natural piety, is it probable, nay is it possible, that they, and they alone, should have no order in their seeming disorder, no unity in their seeming multiplicity, should suffer no explanation by the discovery of some central and sublime law of mutual connexion?

Questions of this kind have assuredly often arisen, but it might have been long before they received such expression as would have commanded the respect and attention of the scientific world, had it not been for the publication of the work which prompted this article. Its author, Mr. Darwin, inheritor of a once celebrated name, won his spurs in science when most of those now distinguished were young men, and has for the last 20 years held a place in the front ranks of British philosophers. After a circumnavigatory voyage, undertaken solely for the love of his science, Mr. Darwin published a series of researches which at once arrested the attention of naturalists and geologists; his generalizations have since received ample confirmation, and now command universal assent, nor is it questionable that they have had the most important influence on the progress of science. More recently Mr. Darwin, with a versatility which is among the rarest of gifts, turned his attention to a most difficult question of zoology and minute anatomy; and no living naturalist and anatomist has published a better monograph than that which resulted from his labours. Such a man, at all events, has not entered the sanctuary with unwashed hands, and when he lays before us the results of 20 years' investigation and reflection we must listen even though we be disposed to strike. But, in reading his work it must be confessed that the attention which might at first be dutifully, soon becomes willingly, given, so clear is the author's

thought, so outspoken his conviction, so honest and fair the candid expression of his doubts. Those who would judge the book must read it; we shall endeavour only to make its line of argument and its philosophical position intelligible to the general reader in our own way.

The Baker-street Bazaar has just been exhibiting its familiar annual spectacle. Straight-backed, small-headed, big-barrelled oxen, as dissimilar from any wild species as can well be imagined, contended for attention and praise with sheep of half-a-dozen different breeds and styes of bloated preposterous pigs, no more like a wild boar or sow than a city alderman is like an ourang-outang. The cattle show has been, and perhaps may again be, succeeded by a poultry show, of whose crowing and clucking prodigies it can only be certainly predicated that they will be very unlike the aboriginal 'Phasianus gallus'. If the seeker after animal anomalies is not satisfied, a turn or two in Seven Dials will convince him that the breeds of pigeons are quite as extraordinary and unlike one another and their parent stock, while the Horticultural Society will provide him with any number of corresponding vegetable aberrations from nature's types. He will learn with no little surprise, too, in the course of his travels, that the proprietors and producers of these animal and vegetable anomalies regard them as distinct species, with a firm belief, the strength of which is exactly proportioned to their ignorance of scientific biology, and which is the more remarkable as they are all proud of their skill in 'originating' such "species."

On careful inquiry it is found that all these, and the many other artificial breeds or races of animals and plants, have been produced by one method. The breeder--and a skilful one must be a person of much sagacity and natural or acquired perceptive faculty--notes some slight difference, arising he knows not how, in some individuals of his stock. If he wish to perpetuate the difference, to form a breed with the peculiarity in question strongly marked, he selects such male and female individuals as exhibit the desired character, and breeds from them. Their offspring are then carefully examined, and those which exhibit the peculiarity the most distinctly are selected for breeding, and this operation is repeated until the desired amount of divergence from the primitive stock is reached. It is then found that by continuing the process of selection--always breeding, that is, from well-marked forms, and allowing no impure crosses to interfere,--a race may be formed, the tendency of which to reproduce itself is exceedingly strong; nor is the limit to the amount of divergence which may be thus produced known, but one thing is certain, that, if certain breeds of dogs, or of pigeons, or of horses, were known only in a fossil state, no naturalist would hesitate in regarding them as distinct species.

But, in all these cases we have 'human interference'. Without the breeder there would be no selection, and without the selection no race. Before admitting the possibility of natural species having originated in any similar way, it must be proved that there is in nature some power which takes the place of man, and performs a selection 'sua sponte'. It is the claim of Mr. Darwin that he professes to have

discovered the existence and the 'modus operandi' of this natural selection, as he terms it; and, if he be right, the process is perfectly simple and comprehensible, and irresistibly deducible from very familiar but well nigh forgotten facts.

Who, for instance, has duly reflected upon all the consequences of the marvellous struggle for existence which is daily and hourly going on among living beings? Not only does every animal live at the expense of some other animal or plant, but the very plants are at war. The ground is full of seeds that cannot rise into seedlings; the seedlings rob one another of air, light and water, the strongest robber winning the day, and extinguishing his competitors. Year after year, the wild animals with which man never interferes are, on the average, neither more nor less numerous than they were; and yet we know that the annual produce of every pair is from one to perhaps a million young,--so that it is mathematically certain that, on the average, as many are killed by natural causes as are born every year, and those only escape which happen to be a little better fitted to resist destruction than those which die. The individuals of a species are like the crew of a foundered ship, and none but good swimmers have a chance of reaching the land.

Such being unquestionably the necessary conditions under which living creatures exist, Mr. Darwin discovers in them the instrument of natural selection. Suppose that in the midst of this incessant competition some individuals of a species (A) present accidental variations which happen to fit them a little better than their fellows for the struggle in which they are engaged, then the chances are in favour, not only of these individuals being better nourished than the others, but of their predominating over their fellows in other ways, and of having a better chance of leaving offspring, which will of course tend to reproduce the peculiarities of their parents. Their offspring will, by a parity of reasoning, tend to predominate over their contemporaries, and there being (suppose) no room for more than one species such as A, the weaker variety will eventually be destroyed by the new destructive influence which is thrown into the scale, and the stronger will take its place. Surrounding conditions remaining unchanged, the new variety (which we may call B)--supposed, for argument's sake, to be the best adapted for these conditions which can be got out of the original stock--will remain unchanged, all accidental deviations from the type becoming at once extinguished, as less fit for their post than B itself. The tendency of B to persist will grow with its persistence through successive generations, and it will acquire all the characters of a new species.

But, on the other hand, if the conditions of life change in any degree, however slight, B may no longer be that form which is best adapted to withstand their destructive, and profit by their sustaining, influence; in which case if it should give rise to a more competent variety (C), this will take its place and become a new species; and thus, by 'natural selection', the species B and C will be successively derived from A.

That this most ingenious hypothesis enables us to give a reason for many apparent anomalies in the distribution of living beings in time and space, and that it is not contradicted by the main phenomena of life and organization appear to us to be unquestionable; and so far it must be admitted to have an immense advantage over any of its predecessors. But it is quite another matter to affirm absolutely either the truth or falsehood of Mr. Darwin's views at the present stage of the inquiry. Goethe has an excellent aphorism defining that state of mind which he calls 'Thatige Skepsis'--active doubt. It is doubt which so loves truth that it neither dares rest in doubting, nor extinguish itself by unjustified belief; and we commend this state of mind to students of species, with respect to Mr. Darwin's or any other hypothesis, as to their origin. The combined investigations of another 20 years may, perhaps, enable naturalists to say whether the modifying causes and the selective power, which Mr. Darwin has satisfactorily shown to exist in nature, are competent to produce all the effects he ascribes to them, or whether, on the other hand, he has been led to over-estimate the value of his principle of natural selection, as greatly as Lamarck overestimated his vera causa of modification by exercise.

But there is, at all events, one advantage possessed by the more recent writer over his predecessor. Mr. Darwin abhors mere speculation as nature abhors a vacuum. He is as greedy of cases and precedents as any constitutional lawyer, and all the principles he lays down are capable of being brought to the test of observation and experiment. The path he bids us follow professes to be, not a mere airy track, fabricated of ideal cobwebs, but a solid and broad bridge of facts. If it be so, it will carry us safely over many a chasm in our knowledge, and lead us to a region free from the snares of those fascinating but barren Virgins, the Final Causes, against whom a high authority has so justly warned us. "My sons, dig in the vineyard," were the last words of the old man in the fable; and, though the sons found no treasure, they made their fortunes by the grapes.

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