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ARTICLE III.

RECENT WORKS BEARING ON THE RELATION OF SCIENCE TO RELIGION.

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III. — OBJECTIONS TO DARWINISM, AND THE REJOINDERS OF ITS ADVOCATES.

Gray (Professor Asa, M.D.). Darwiniana: Essays and Reviews pertaining to Darwinism. By Asa Gray, Fisher Professor of Natural History [Botany] in Harvard University. New York: D. Appleton and Co. 12mo. pp. 394.

This is mainly a collection of Articles previously published, but with a very valuable supplementary paper on "Darwinian Teleology."

Mivart (St. George). 1. "Specific Genesis," a reply, in the North American Review, Vol. cxiv. pp. 450–468, to Chauncey Wright's strictures on his "Genesis of Species."

2. Lessons from Nature as manifested in Mind and Matter. pp. 462. New York. 1876. This is largely a recast of review articles.

Max Müller. 1. Essays on Darwinism and Language. Frazer's Magazine for May, June, and July, 1873. Republished in Littell's Living Age.

2. Chips from a German Workshop. New York. 1876. Vol. iv. pp. 417–455, being a reply to Mr. Whitney's Essays in the North American as they were reproduced in the Contemporary Review for November 1874, by Mr. George Darwin.

Smith (John Cotton, D.D.). Miscellanies, Old and New. New York. 1876.

Whitney (Professor Wm. Dwight). 1. Articles in North American Review, Vol. cxiv. pp. 272–308; Vol. cxviii. pp. 61–88. The first a refutation of Steinthal's theory of the Origin of Language; the second of Max Müller's Essays on Darwinism and Language.

2. Language and the Study of Language. pp. 505. New York. 1868.

3. Oriental and Linguistic Studies (1st Series, pp. 416; 2d Series, pp. 431). New York. 1873, 1874. These two are largely a collection of review articles.[1]

THE period which has elapsed since the publication of the first edition of Darwin's Origin of Species, has not been un-

[1] For fuller list of books, see the Bibliotheca Sacra for July, pp. 448–453.

improved by its opponents. Of the relation of this theory to theology and the Bible we are to speak in future papers in this Journal. In the present number, we will confine ourselves to the points urged against the theory by men of science.

I. A Mere Theory.

The comprehensive objection to the view that species have been transmuted into one another mainly through the agency of natural selection is, that it is a mere theory, supported by some vague analogies and by very few facts. It is alleged that nearly all the facts upon which the view is based had been before the world for a half-century or more, and that it is not likely that so simple a clew to the maze as Mr. Darwin proposes would have escaped the notice of preceding naturalists. The objection is well taken, when urged against the sweeping generalizations of many who have espoused the doctrine. Very likely Mr. Darwin, even, with all his caution, has not escaped altogether the danger of being the servant, rather than the master, of his theory. It should, however, be remembered that Mr. Darwin was not in haste to publish, but, after he was recognized as among the most careful of scientific observers, worked assiduously, but silently, over his problem for twenty years. Furthermore, the publication was hastened by the circumstance that another scientific observer had been led independently to a similar, or even identical, theory.

However much value this objection of novelty might have had at the beginning, the theory has now been too long under discussion, and swept too many students of nature under its influence, to be lightly or sneeringly set aside. One thing is certain; it has not proved an easy task to disprove the theory altogether. Indeed, little has been attempted by the candid opponents of natural selection, except to set metes and bounds to its operation. As to the importance of the facts adduced, they must speak for themselves. The contemporaries of Newton derided him for taking notice of the analogy between the falling of an apple

and the motion of the moon. Comte, the father of what is called the "positive philosophy," spoke with contempt of those who, from the analogy between light and heat, endeavored to correlate their laws of action. It is to be remembered that there is analogy and analogy. The word covers a great range of meaning. It would be difficult to go into a forest of gigantic trees in California, and prove, except by analogy, that these princely forms were ever mere seedlings.

II. Abrupt Appearance of Species.

The fact that geological history can be divided into periods appears to militate against a gradual development of the species of one epoch into those of another. At first thought, it would seem that, upon the theory under discussion, there ought to be such a minute and continuous gradation of species from beginning to end of the geological formations that the divisions of the strata into Palaeozoic, Maesozoic, and Cainozoic should be altogether arbitrary. Innumerable forms of transition must have existed. Why have they disappeared? Why, in fact, are the beginnings of these periods so abrupt?

Barrande, one of the most eminent of living palaeontologists has pressed this objection with great force in his work on the Trilobites of the Silurian epoch. This widely extended family of Crustaceans appears suddenly and in a highly developed form. If we except the still controverted *Eozoon Canadense*, the Trilobite is one of the oldest forms of life whose remains have yet been discovered. Yet hundreds of species swarmed in the Cambrian and Silurian seas of Europe and America, and the remarkable eyes of these animals were apparently as well developed in the earlier, as in the later, periods of the existence of the family. If these species were transmuted from previously existing and lower organisms, why are there no premonitions of their approach in the epochs which immediately preceded? But there is no direct evidence that they had any ancestry.[1]

[1] See Summary of Barrande in Winchell, pp. 125–144.

Again; fishes appear with equal abruptness in the Devonian formation. Below the very uppermost divisions of the Silurian system not a single bone of any aquatic animal of the Vertebrate class has been detected. Yet in the Old Red Sandstone, immediately above the Silurian, there are found the fossil remains of more than a hundred species to which the anatomist would assign "by no means a low place in the Piscene class." [1]

Again, "The transition from the Palaeozoic to the Maesozoic forms of life was strongly marked in geological history." "At the close of the Carboniferous age there was a complete extermination of all living species." [2] In this step upward we have passed from the age of fishes to the age of reptiles with an abruptness that is somewhat startling to any theory of transmutation, and especially to a theory one of whose fundamental principles is that this transmutation has been by minute and slowly succeeding gradations. The transition from the Palaeozoic period to the Maesozoic is not a minute nor a local step, but a passage from water-breathing animals to air-breathing animals, like the Ichthyosaurus and his congeners, whose "long Greek names alone give us any idea of their main features."

Still again, the Tertiary period brings in abruptly a new order of things. The Cretaceous formation is a boundary line between the Maesozoic era and the Cainozoic. "No species of the European Cretaceous is known to occur in the Tertiary formation, and none of Asia or of Eastern North America. In the Rocky Mountain region some Cretaceous species and genera continue on, if the coal series is Tertiary; and yet the number now known is less than half a dozen. The vast majority of the species and nearly all the characteristic genera disappear. The facts do not authorize the inference that extermination was so complete as is implied

[1] See Lyell, Principles of Geology, Vol. i. p. 151 f. Also, Hugh Miller, Footprints of Creator.

[2] Dana, Manual of Geology (1st ed.), p. 403, 413. The second edition is much more guarded and omits this with many other like sweeping assertions.

in the above statement, although establishing that it was remarkable for its universality and thoroughness."[1]

"With the Tertiary epoch we are introduced to animal forms which, as the age progresses, are in increasing numbers identical with species that are now living." But in the case of man there is again a sudden leap forward; not so much, however, in the anatomical structure of his skeleton as in the size and office of his brain. "Not the first link below the level of existing man has yet been found. This is the more extraordinary, in view of the fact that, from the lowest limit in existing men there are all possible gradations up to the highest; while below that limit there is an abrupt fall to the ape level, in which the cubic capacity of the brain is one half less. If the links ever existed, their annihilation without a relic is so extremely improbable that it may be pronounced impossible. Until some are found, science cannot assert that they ever existed."[2]

Such are some of the leading objections to Darwinism drawn from the apparent abruptness of the introduction of the geological eras. We will present the rejoinders in inverse order.

In the case of man it has been said, that it will not break the force of the general argument to admit that he is exceptional, and that the characteristic and higher endowments of his nature were miraculously bestowed. Those who defend the occurrence of miracles do not suppose that thereby the belief in the ordinary uniformity of nature is disturbed. Miracles are extraordinary interventions, made for sufficient reasons. The reasons for divine intervention on the occasion of transforming an animal life into, or adding to that life the impress of, the divine image, are such as cannot be shown to exist at other stages of organic history.

Another mode of reply consists in a wholesale appeal to our ignorance of what has taken place in the unexplored parts of existing continents, and on lands that are now submerged by the ocean.

[1] Dana, Manual of Geology (2d ed.), pp. 487, 488.

[2] Dana, Manual of Geology (2d ed.), p. 603.

As this appeal to the imperfection of the geological record is on the one hand so often made by the Darwinians, and on the other as often spoken of with derision by their opponents, it is necessary to treat it at some length.

The Cretaceous formation, which separates the Maesozoic or Secondary period from the Cainozoic or Tertiary, represents a time when the continents best known were submerged in deep seas. The Pyrenees, the Alps, the Himalayas, the Andes, the Rocky Mountains, all give evidence of the long and deep submergence of the Cretaceous era.[1] The changes, if any, which were taking place at that time in the transformation of reptiles into Mammalia, would have occurred in regions which were then existing as dry land. When these sea-bottoms of the Chalk period again emerged, the sudden appearance of a range of species altogether different from those whose remains are found in the formation below would naturally be accounted for by migration. During the progress of the Cretaceous formation, time enough may have elapsed, and physical changes sufficiently extensive and profound have occurred, to allow of such a gradual transformation of species as is supposed. On this supposition, old forms of life had succumbed to the change of circumstances, as new and better adapted varieties had gradually taken their place. Under these circumstances, the sudden appearance of new species on the re-elevation of the continent would be more apparent than real, and might be attributed to the effect of *colonization*, rather than of *new creation*. The process can be better understood, if we imagine the bed of the Indian Ocean to be elevated till it becomes dry land. The new region would be at once supplied with plants and animals from adjacent continents. If we suppose the forms of life to have been undergoing gradual changes during all the period of subsidence, the transition from the species that peopled this hypothetical continent before the submergence to those that colonized it after would appear to have been sudden, whereas it was not.

Furthermore, the amount of denudation which may have

[1] See Dana, Manual of Geology (2d ed.), p. 480.

taken place between two strata that are in contact, is sometimes a very large and unknown quantity. It is obvious that successive geological formations were deposited from the debris of those that were of earlier origin. The sediment of the lake or lagoon is the "wash" of the hills. The removal, by sub-aerial agencies, of the continent to the sea is only a question of time. Deposition of sediment and denudation of material are correlative facts. Known instances of the immense amount of the former are easily matched by corresponding instances of the latter. For example, there are numerous places along the Apalachian chain of mountains where "faults" exist which show that many thousands of feet of material have been removed since the fracture occurred. A fault is a crack in the crust of the earth along which the strata on one side have been upheaved or thrown down on the other. According to Lesley, one such, twenty miles in length, occurs near Chambersburg, Pennsylvania, of which the eastern side "must have stood high enough in the air to make a Hindoo Koosh [at least twenty thousand feet]; and all the materials must have been swept into the Atlantic by the denuding flood. The evidence of this is of the simplest order, and patent to every eye. Portions of the Upper Devonian wall against the lowest portions of the Lower Silurian..... A man can stand astride across the crevice, with one foot on Trenton limestone, and the other on Hamilton slates."[1]

Should that region be submerged, and covered with a fresh deposition of material, two leaves of the geological book as far apart as the lower Silurian and the Post Tertiary would lie in contact, with all the vast intervening record removed. Sir Charles Lyell sets in strong light these and various other evidences of the incompleteness of the geological record. They afford the Darwinian large opportunity to account for the sudden appearance of groups of species in a new formation, on the hypothesis of migration.[2] It is by such suppo-

[1] See Dana, Manual of Geology (2d ed.), pp. 399.

[2] See Dana, Manual of Geology (2d ed.), pp. 600, 601, where the weight of this counter evidence is candidly discussed.

sitions only that he can work around the obstacles presented to his theory by the apparently abrupt changes of species on the introduction of the Tertiary (Cainozoic), the Secondary (Maesozoic), and the Silurian (Palaeozoic) eras. This appeal to the incompleteness of the geological record is not made by the Darwinians for the purpose of adducing positive argument, but to break the force of the negative arguments which their opponents array against them. By this means they attempt to give a rational explanation of the gaps that appear in their chain of positive evidence. It must be remarked, however, that these asserted hard-and-fast lines of demarcation between the geological eras are gradually disappearing before the advance of scientific discoveries. There is, for example, constantly increasing evidence that birds and marsupial quadrupeds existed in great numbers as early as the middle portion of the Secondary period.[1] "The *hiatus*, which, in the idea of most geologists, intervened between the close of the Cretaceous and the beginning of the Tertiary, appears to have had no existence so far as concerns the vegetation."[2]

The sudden appearance of groups of highly developed species, like the Trilobite, in the lowest fossiliferous strata is confessed by Mr. Darwin to remain as yet inexplicable; and he acknowledges that it "may be truly urged as a valid argument against his views"[3] At the same time, he presents an hypothesis "to show that it may hereafter receive some explanation." The reader should note carefully the character of Mr. Darwin's reasoning, as distinguished from the multitude of *a priori* evolutionists who have espoused his cause. His endeavor is to feel his way backwards from manifest present affinities along the converging lines of geological evidence, as far as they are tangible. He would claim that his positive analogies are sufficient to outweigh a large amount of merely negative evidence, and that it is only incumbent on him to show by hypothesis that the

[1] See Lyell, Principles of Geology, Vol. i. pp. 155–160.
[2] Count Gaston de Saporta, quoted by Gray, in Darwiniana, p. 197.
[3] Origin of Species, p. 287.

obstacles opposed by negative evidence are not insuperable. Nevertheless, it is incumbent on him to proceed with more and more caution as he gets away from his base of observation.

Mr. Darwin's method may be compared to that of astronomers in establishing the unlimited operation of the law of gravitation. It is a mistake to suppose that they have proved the general prevalence of this law with anything like mathematical accuracy. The planetary bodies do not yet all come around on time. No astronomer pretends that he has measured all the disturbing forces which determine the motions of the heavenly bodies. But, after having adduced a certain amount of positive evidence, it is sufficient for his purpose to show that unexpected aberrations could be accounted for on the hypothesis of disturbing powers such as are known to exist. It cannot by any means be said that the proof of the derivative origin of species has reached so high a degree of perfection as that of the theory of gravitation. It might more properly be compared to the condition of that theory just previous to the work of Laplace, who, by explaining a great number of apparent irregularities in the solar system, as the result of gravitation acting on masses of hypothetical size and density, and situated at hypothetical distances from each other, has established the theory beyond peradventure. Astronomy was a science before Laplace. Since his day it has merited the title of an "exact science."

The science of Tidology offers a comparison more nearly in point. The tides doubtless, are an effect of gravitation. But no mathematician can deductively work out the problem of those effects for all shores, and for every bay and inlet. The tide of each locality has a law of its own. All that can be done regarding abnormal instances, such, for example, as the enormous rise in the tide in the Bay of Fundy, is to show that they are not inconsistent with the theory of their being the effect of gravitation as conditioned by the changing positions of the earth and moon and sun acting on bodies of water, which are confined by shores that are but partially

surveyed, and which rests on a bottom whose character is to a still greater degree unknown.

Or, again, those who reconstruct the original text of our sacred scriptures do not pretend that they have a copy as it came from the hands of the authors. They, however, approach the central century, in which Christ and the apostles lived, on converging lines, some shorter, some longer; a few only reaching to the second or third century. By such a process it is believed that we are even more certain that we have the substance of gospel history and apostolic doctrine than we could be if we were supposed to have the original records. For it would be a more difficult matter to prove those alleged original documents to be original than it is to prove their substance from the manuscripts we have. For when manuscripts and versions with minor variations are traced along different lines toward a centre, we may rely on the aberrations of one class to correct those of another.

We hope this may not seem a digression; for the arguments of naturalists cannot be weighed without coming back repeatedly to the foundations on which all evidence reposes. It should be put to the credit of Mr. Darwin that, in the main, he tries to adhere to the canons of proof that are generally accepted in all sciences which deal with actual things.

III. Absence of Intermediate Varieties.

In the preceding section we have spoken of the "sudden appearance of groups of allied species" at the beginning of the so-called geological eras. The present objection to Darwinism is closely allied to the previous one. It is alleged that, according to theory, there ought to be *in any single formation* an innumerable number of intermediate forms, shading into each other by imperceptible steps, and connecting the species which lived at the commencement with those living at the close of the period. But the links as best made out, when compared with those that must have actually existed, are few and disconnected.

The only reply that can be made is that the geological record, even in the best preserved sections, is poor and beggarly beyond description.[1] To get the force of this reply, one must conceive more fully the contingencies which attend the preservation of fossils.[2]

1. The "bird must be caught." The animal must die in a situation such that he shall be speedily imbedded in fine sediment. This is one contingency, and can occur only to a comparatively few individuals of a species.

2. The strata in which the fossil is deposited must be preserved from subsequent denudation.

3. "In order to get a perfect gradation between two forms in the upper and lower parts of the same formation, the deposit must have gone on continuously accumulating during a long period, sufficient for the slow process of modification; hence the deposit must be a very thick one, and the species undergoing change must have lived in the same district throughout the whole time."[3]

4. In order to have a record of gradations in a single formation, the life of the species must be shorter than the period in which the formation was deposited. Mr. Darwin closes his patient discussion of this objection with the remark that, "if there be some degree of truth" in the considerations he presents, "we have no right to expect to find in our geological formations an infinite number of those transitional forms which, on our theory, have connected all the past and present species of the same group into one long and branching chain of life. We ought only to look for a few links; and such, assuredly, we do find. ..... But I do not pretend that I should ever have suspected how poor was the record in the best preserved geological sections, had not the absence of innumerable transitional links between the species which lived at the commencement and close of each formation, pressed so hardly upon my theory."[4]

[1] See Origin of Species, Chaps. vi. and x. Lyell's Elements, p. 115; Principles, Vol. i. p. 341 f.; Vol. ii. p. 490.

[2] See Dana, Manual of Geology (2d. ed.), p. 600.

[3] Origin of Species, p. 277.

[4] Ibid. p. 282.

Professor Agassiz, in the very latest lines that fell from his pen, was proposing to show that we have a geological record which is vastly more complete than Mr. Darwin supposes; and that, "however broken the geological record may be, there is a complete sequence in many parts of it, from which the character of the succession may be ascertained."[1] But death cut him down before he had elaborated the proposition, and there has been no one else so competent to take it up."

IV. Lapse of Time insufficient for the Effects.

Though we be at the middle point of duration, the world has not existed in its present condition forever. The physical philosophers have something to say about the age of the world.[2] The earth is kept in its present condition by the interaction of a variety of correlated physical forces. Heat, light, electricity, chemical attraction, and motion are passing from one into the other in varying degrees of rapidity. Change can only occur where there is a disturbance of the equilibrium of these forces. To one effect all these modifications are tending, viz. an equilibrium that must be lifeless. The cosmos is running down like a clock. The heat of the world is dissipating. The earth is retarding its pace. Perpetual motion is as much an absurdity in a planetary system as in a human machine. "Nature no more works without friction than we can."

"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 the earth is equally limited." We are assured, however, on the highest authority, 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 vapor, which would extend over the whole planetary system and evaporate us entirely.[3] ..... Darwin's theory requires

[1] See Atlantic Monthly, Vol. xxxiii. p. 101.

[2] See North British Review, Vol. xlvi. pp. 294–305. [3] Ibid. pp. 297, 300.

countless ages during which the earth shall have been habitable. ..... 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. ..... Their [sun and earth] present state proves that they cannot remain forever 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 must 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."[1]

This sounds as if the way were preparing for a problem in the rule of three. And such is the case. Sir W. Thompson fixes the extreme limit in the past at which the heat of the earth's crust would have permitted the existence of life, at four hundred million years ago, and the probable limit as two hundred million years.[2] And now come the surmises regarding the rate of change which the theory of natural selection will allow. One says:

"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.[3] ..... Darwin would probably admit that ..... a million years would be no long time to ask for the production of a 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!"[4]

Mr. Murphy states the problem more precisely. If favorable variations in one organ occur once in a thousand times, and, to secure survival, ten organs should have to vary simultaneously in given directions, the probability of the occurrence is 1 to 10^{30}, a fraction the denomination of which is equal to "a number which is about ten thousand times as

[1] See North British Review, Vol. xlvi. p. 304.
[2] See Origin of Species, p. 286.
[3] North British Review, Vol. xlvi. p. 294.
[4] Ibid. p. 301.

great as the number of waves of light that have fallen on the earth since historical time began," i.e. $(189,216 \times 10^6)$ seconds $\times (535 \times 10^{12})$ undulations $= 101,230,560 \times 10^{18}$.[1]

This manner of statement is good for certain purposes, especially as showing there must be "a divinity shaping the ends" of organic life, let natural selection "rough hew them as it will." If there has been no appreciable progress in the development of species by natural selection since human history began, and if the limits to geological time as set by Sir W. Thompson are correct, that is an end of the matter. But the following line of rejoinder is open:

First; It is not proved that the rate of change among all wild species is imperceptible, even within the historic period. Such an inference has been made from the fact that man and certain domestic species of animals, as drawn on the earliest Egyptian monuments, are identical in their features with their descendants of the present day. Likewise, it is conceded that well-determined species do persist even through the whole length of vast geological periods. But these facts do not conflict with the supposition that, under favoring circumstances, variations may have branched off from the parent stock, and pursued their line of march in parallel lines with their genealogical ancestors. For very good reason, the record of wild varieties is not preserved, except in those analogies by which we infer their origin. On the other hand, varieties of marked and persistent characteristics have arisen since the historical era, under the direction of human selection. The amount of this domestic variation multiplied by tens of thousands would present a very large sum. He who believes in a providential Ruler can easily grant that the Creator, through the combination of the forces which produces a natural selection, may hasten the development of a variation even more rapidly and surely than man can do by his combination of these forces. So we cannot say

[1] See Habit and Intelligence, Vol. i. p. 320. The necessity of a simultaneous variation of different organs to secure preservation is so nearly akin to the subjects of sections vi. to x. that we have not given it separate treatment.

what the first member of our proportion is. The rate at which, under the ordinary operation of nature, a species may change has not been determined.

Secondly; Geologists are slow to grant the validity of mathematical calculations regarding the age of the earth. Both divisor and dividend are so indeterminate that the quotient must be still more conjectural. The amount of uncertainty is illustrated in the extreme limits which Sir W. Thompson sets for the date of the first consolidation of the earth's crust. It "can hardly have occurred less than twenty, nor more than four hundred, million years ago."[1]

V. Existing Difficulties of Classification Inevitable under any Hypothesis.[2]

This is not a direct objection to Darwinism, but is aimed at one of the prominent pillars of proof on which the theory rests. In this objection it is assumed only, first, that there "are different laws," under which "all existing substances or beings of which we have any scientific knowledge exist"; secondly, that there is a limited number of elements from which combinations can be made. With these self-imposed restrictions which the Creator has put upon his work in the material world, the problem of classification is one of permutations and combinations. "The limits to the possible number of combinations become more and more restricted, as we burden these combinations with laws more and more complicated."[3] For example, if it be required to find the number of words of five letters each which can be formed out of the English alphabet, and if there be no other restriction on the combinations than that there be five letters in each, we shall have the number 7,890,000. If, however, we insert the condition that no two of the combinations shall begin with the same letter, the number of possible words of five letters is reduced to twenty-six. If it be further stipulated

[1] Origin of Species, p. 286. See also Lyell, Principles of Geology, Vol. i. pp. 234, 235; also, Dana, Manual of Geology (1st ed.), p. 684.

[2] See North British Review, Vol. xlvi. pp. 305–313. [3] Ibid. p. 307.

that no two of the words shall have any letter in common, the number is reduced to five.

Now, animals and plants are combinations of inorganic elements under conditions of almost inconceivable complexity. These elements are to be so arranged as to constitute an "eating, breathing, moving, feeling, self-reproducing thing."[1] How else than in a continuous series of combinations, each resembling its neighbor, could these elements be arranged under these conditions, if there were to be an indefinite number of individuals? Agassiz[2] seems to affirm that the possibilities of economical construction are exhausted in the four grand divisions of the animal kingdom — the Radiate, the Moluscan, the Articulate, and the Vertebrate. Mathematical laws determine that varieties, if they are made to exist, should be produced by incorporating minor changes upon these fundamental forms. The narrowness of the limits in which the creative power must move, unless the whole order of natural forces be changed, would compel such similarity in results as to create difficulties in classification. Such difficulties occur in the inorganic, as well as in the organic, world. Increase of knowledge has increased the difficulty of distinguishing metals from metalloids, and an acid from a base. In crystallography there are only a few fundamental forms; but these forms shade off into one another through insensible gradations. The patent office is a standing illustration of the difficulty of distinguishing objects which have originated in separate acts, but under similar mechanical laws, and for similar ends. For instance, there are three forms of bridges — suspension, girder, and arch. These forms are determined by mechanical laws. The girder is intermediate between the other two kinds, and innumerable varieties are possible and actual, which it is difficult to assign to their proper class. What one would call a "stiffened arch," another would denominate a "girder of a peculiar form"; "a third man calls a bridge a strengthened girder, which a fourth says differs

[1] See North British Review, Vol. xlvi. p. 308.

[2] See Methods of Study in Natural History, p. 36.

in no practical way from a suspension-bridge."[1] This intermingling of forms in the classification of bridges arises from the fact that "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." Lawyers have a similar difficulty in determining whether a "particular case falls under a particular statute," or "is ruled by this or that precedent." In so simple a matter as that of docketing letters, or cataloguing books the same perplexities arise. "How difficult it is to devise headings, and how difficult afterwards to know under what head to place your book."[2]

It must be confessed that this line of objection has great apparent force, as directed against one of the supposed positive arguments adduced in support of Darwinism. If the theory were largely dependent for its proof upon considerations of this nature, these objections would be more in point. But the Darwinian is free to say, first, that the considerations adduced above do not *disprove* his hypothesis. The gradations in the classifications of animals and plants are certainly not incompatible with the theory of their common descent. That hypothesis more *definitely* explains the gradation than any other; and the extent to which the Creator has restricted himself in the possible combinations of elementary matter is not known. Secondly, it is not the bare fact of gradation upon which reliance is had in proof of the Darwinian theory; but it is, rather, upon the method in which one group of species clusters around another group, together with the manner in which these are distributed both through time and space, and the tenacity with which organs remain as rudimentary after they have become useless.

VI. INDIVIDUAL VARIATIONS COUNTERACTED BY INTERCROSSING.[3]

A single individual, where he mingled freely with the

[1] North British Review, Vol. xlvi. p. 311. [2] Ibid. p. 312.

[3] See North British Review, Vol. xlvi. pp. 286–294; Mivart's Genesis of Species, pp. 57–60; Darwin's Origin of Species, pp. 70–79.

ordinary forms of his tribe, would have small chance of transmitting his peculiarities through many generations.

"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, for 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 favored of the negroes. Our white's qualities would certainly tend very much to preserve him to a good old age; and yet he would not suffice, in any number of generations, to turn his subjects' descendants white. ..... 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?"[1]

It will appear in all similar suppositions to be impossible for any "sport or accidental variation in a single individual" to transmit its advantages, even though they be manifest, to continually increasing numbers. In case the advantage were slight, the chance of continued transmission would be still more remote. The preponderating numbers of the ordinary herd constitute an advantage to them that is insurmountable by the single individual. The "sport" will be in the second generation but a drop in the bucket, and his strain will at each removal decrease in strength by a geomet-

[1] North British Review, Vol. xlvi. pp. 289, 290.

rical ratio. Mr. Darwin remarks that, until reading the Article from which we have quoted, he "did not appreciate how rarely single variations, whether slight or strongly marked, could be perpetuated;"[1] and strengthens the position by an illustration of his own:

"If, for instance, a bird of some kind could procure its food more easily by having its beak curved, and if one were born with its beak strongly curved, and which consequently flourished; nevertheless, there would be a very poor chance of this one individual perpetuating its kind to the exclusion of the common form; but there can hardly be a doubt, judging by what we see taking place under domestication, that this result would follow from the preservation during many generations of a large number of individuals with more or less strongly curved beaks, and from the destruction of a still larger number with the straightest beaks."[2]

This admission of Darwin is thought by Mivart "almost to amount to a change of front in the face of the enemy."[3] It certainly is the case that natural selection is powerless to preserve an advantage, except when a large number of individuals have simultaneously varied in the same direction. Natural selection does not originate advantages. Its office is to preserve those advantages that have arisen through the operation of the unknown cause of variation. Darwin says:

"There can be little doubt that the tendency to vary in the same manner has often been so strong that all the individuals of the same species have been similarly modified without the aid of any form of selection."[4]

To theists these concessions rob Darwinism of its sting; for large numbers of individuals do not vary at the same time and in the same direction, by chance; and the tendency to variation, which is itself the origin of the advantages (these becoming *fixed* only by natural selection), remains still among the mysteries of the Creator. In confronting that tendency we have reached the present length of our tether.

VII. Natural Selection and Specifc Stability Incompatible.

While the accurate observer of nature is impressed with

[1] Origin of Species, p. 71.
[2] Origin of Species, p. 72.
[3] Genesis of Species, p. 60.
[4] Origin of Species, p. 72.

the variability of many species, especially of domesticated animals and of cultivated plants, his attention is equally attracted by the persistent stability of other species, or of the same species in other circumstances. Drawings upon the monuments of Assyria and Egypt prove that many of the animals and plants of these countries have remained during three or four thousand years unchanged. For example, at that early period many of the present varieties of the dog were in existence, such as the greyhound, the common hound, the mastiff, the lapdog, and the turnspit.[1] Other still more striking instances of long-continued specific stability can be adduced. Some of the species found in the early Tertiary formation are still in existence, and hence have continued unchanged for a period of probably millions of years. A still more striking instance of specific stability appears in case of the Lingulae. Lingula is a genus of Mollusk, which appeared in the Palaeozoic age even as early as the Cambrian epoch.

"The Lingulae are especially interesting as examples of a type of beings continued almost from the dawn of life until now; for their shells as they exist in the Primordial are scarcely distinguishable from those of members of the genus which still live."[2]

It is plain that any theory of the origin of species by derivation must be broad enough to comprehend the indisputable and striking facts concerning the extremely long duration and unchanged condition of some species. Mr. Darwin supposes his theory to be sufficiently indefinite to allow it to shelter such diverse facts under its ample wings. For his hypothesis

"Includes no fixed law of development, causing all the inhabitants of an area to change abruptly, or simultaneously, or to an equal degree. ..... Whether such variations or individual differences as may arise will be accumulated through natural selection in a greater or less degree, thus causing a greater or less amount of permanent modification, will depend on many complex contingencies — on the variations being of a beneficial nature, on the freedom of intercrossing, on the slowly changing conditions

[1] See Darwin, Animals and Plants under Domestication, Vol. i. p. 29 f.

[2] Dawson, Story of the Earth and Man, p. 41. See Darwin, Origin of Species, pp. 169, 290–293.

of the country, on the immigration of new colonists, and on the nature of the other inhabitants with which the varying species come into competition."[1]

"Darwin clearly maintains — what the facts warrant — that the mass of a species remains fixed so long as it exists at all, though it may set off a variety now and then. The variety may finally supersede the parent form, or it may coexist with it; yet it does not in the least hinder the unvaried stock from continuing true to the breed, unless it crosses with it. The common law of inheritance may be expected to keep both the original and the variety mainly true as long as they last, and none the less so because they have given rise to occasional varieties. The tailless Manx cats, like the curtailed fox in the fable, have not induced the normal breeds to dispense with their tails; nor have the dorkings (apparently known to Pliny) affected the permanence of the common sort of fowl. As to the objection that the lower forms of life ought, on Darwin's theory, to have been long ago improved out of existence, and replaced by higher forms, the objectors forget what a vacuum that would leave below, and what a vast field there is to which a simple organization is best adapted, and where an advance would be no improvement, but the contrary. To accumulate the greatest amount of being upon a given space, and to provide as much enjoyment of life as can be under the conditions, is what Nature seems to aim at; and this is effected by diversification."[2]

The "many complex contingencies" which pertain to the theory in question afford theologians opportunities of wheeling it into line with a true theistic view of nature. It is to be deplored that more have not seen this, and so closed the mouths of the atheistical and deistical interpreters, who have been so ready to volunteer their services.

VIII. Natural Selection Inoperative in the Incipient Stages of Advantageous Variations.

Closely allied to the preceding objection is that urged at such length and with so much force by Mivart, viz. that *slight* variations could not give their possessors any appreciable advantage in the struggle for existence. Darwin's view is understood to be, that the progress of a species along a line of variation which is advantageous to it is by exceedingly minute steps, and that

"Natural selection acts only by the preservation and accumulation of

[1] Origin of Species, p. 291.

[2] Dr. Asa Gray, Natural Selection not Inconsistent with Natural Theology, pp. 53, 54. See Darwiniana, pp. 175, 176.

small inherited modifications, each profitable to the preserved being; and as modern geology has almost banished such views as the excavation of a great valley by a single diluvial wave, so will natural selection banish the belief of the continued creation of new organic beings, or of any great and sudden modification in their structure."[1]

"If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down."[2]

The writer in the North British Review already, quoted so freely, speaks of "the Darwinian theory of the gradual accumulation of infinitely minute differences of every-day occurrence and apparently fortuitous in character."[3] The line of Mr. Mivart's criticism is, that variations to be of advantage must be appreciable in extent. "Minute incipient variations" of an "infinitesimal degree in any special direction," would be valueless. In case of the supposed development of the mammary gland, or breast, he asks: "Is it conceivable that the young of an animal was ever saved from destruction by accidentally sucking a drop of scarcely nutritious fluid from an accidentally hypertrophied cutaneous gland of its mother?"[4] Is it not evident that the mammary gland must have come into existence by a variation that was distinctly marked before it could give the young of its possessor special advantage in the struggle for existence?

"The development of whalebone (baleen) in the mouth of the whale is another difficulty..... When the whale feeds it takes into its mouth a great gulp of water, which it drives out again through the intervals of the horny plates of baleen, the fluid thus traversing the sieve of horny fibres, which retains the minute creatures on which these marine monsters subsist. Now, it is obvious that if this baleen had once attained such a size and development as to be at all useful, then its preservation and augmentation within serviceable limits would be promoted by natural selection alone. But how to obtain the beginning of such useful development" is the question.[5]

Similar difficulties are supposed to arise, among other examples, in the preservation through natural selection of the

[1] Origin of Species, pp. 75, 76. [2] Darwin, Origin of Species, p. 146.

[3] North British Review, Vol. xlvi. p. 293. See Mivart, Genesis of Species, pp. 23–62.

[4] Genesis of Species, p. 47. [5] Genesis of Species, pp. 40, 41.

incipient stages in the development of the eye and the ear, and of the curious habits of mimicry characteristic of some species of insects. In case of the latter, imitation of the form, color, or motion of disagreeable objects, to be protective, must be well marked. If the counterfeit is only a slight approach to the original, it will be of no advantage. The ass must keep the lion's skin well pulled over his ears, or the fraud will be detected.

To this class of strictures Mr. Darwin has both replied at length himself,[1] and has commended the rejoinder of Mr. Chauncey Wright.[2] Making due allowance for the imperfection of a brief summary, the answer is this: first, that Mr. Darwin does not say so much about "infinitesimal beginnings" and "infinitely minute differences," as his reviewers are accustomed to suppose. The adjectives which Mr. Darwin has chosen are "slight," "small," "extremely gradual," as opposed to "great and sudden." He thinks it almost certain that many species "have been produced by steps not greater than those separating fine varieties."[3] The misunderstanding is similar to that which Sir Charles Lyell's views encountered. As already remarked[4] his theory of geological facts was denominated "uniformitarian," because he supposed past changes in geology had been produced by agencies such as are at work now in the world, and with no greater intensity of action than characterizes them at the present time. His real work, however, was to emphasize and set in its proper light the power of the geological agencies which we see still at work, and to show that these were neither trifling nor insignificant. So the standard of variability which Darwin assumes to account for the changes which have been produced in species is that which passes under our observation.

"That species have a capacity for change will be admitted by all evolutionists; but there is no need, as it seems to me, to invoke any internal force beyond the tendency to ordinary variability, which through the aid of selection by man has given rise to many well-adapted domestic

[1] Origin of Species (6th ed.), pp. 176–204.

[2] North American Review, Vol. cxiii. pp. 63–103.

[3] Origin of Species, p. 203. [4] See Bibliotheca Sacra for July, p. 490.

races, and which through the aid of natural selection would equally well give rise by graduated steps to natural races or species.[1] ..... Every one who believes in slow and gradual evolution will, of course, admit that specific changes may have been as abrupt and as great as any single variation which we meet with under nature, or even under domestication."[2]

Such an amount and kind of variation as will give its subject some advantage over its competitors is necessarily assumed. Natural selection cannot, of course, preserve an advantage till the species has got it to preserve. The choice is between reasoning from such data as observation has given us concerning the variability of races, and that of supposing a much stronger tendency to variation in the past than now exists. Darwin speaks of the "canon in natural history of 'Natura non facit saltum,'" as "somewhat exaggerated."[3] Huxley thinks Mr. Darwin's position might have been even stronger than it is if he had not embarrassed himself so much with this aphorism. Mr. Huxley believes that "nature does make jumps now and then," and that a "recognition of the fact is of no small importance in disposing of many minor objections to the doctrine of transmutation."[4]

IX. Independent Similarities of Structure.

We are indebted, also, to Mr. Mivart[5] for setting in order the important series of objections to Darwinism which fall under the present head. If there are any who view "variation" and "natural selection" as strictly fortuitous in their operation, they will, in the facts we are here considering, meet with a degree of improbability that is insurmountable. "The organic world supplies us with multitudes of examples of similar functional results being attained by the most diverse means." For example, birds and bats both fly; but their machinery of flight is constructed on very diverse patterns — so diverse that they must have had independent origin. In case of the bat, the bones of the hand are greatly elongated, and an expanse of naked skin forms the membrane of his wing. On the contrary, in case of the bird, the bones

[1] Origin of Species, p. 201. [2] Ibid. p. 201. [3] Ibid. p. 156.
[4] Lay Sermons, p. 297. [5] See Genesis of Species, pp. 63–96.

of the hand are excessively reduced, and the expanse of the wing is formed by feathers, which are an outgrowth of the skin. The "flying fish," the "flying dragon," and the pterodactyl, had each an independent and unique structure for securing aerial locomotion. A multitude of analogous instances could be cited. A mathematical calculation would, according to Mivart, show that chance variations which were not guided by some higher law than that of mere "natural selection" are entirely inadequate to such results. The probabilities are an "indefinitely great number to one against a similar series of variations occurring and being similarly preserved in any two independent instances."[1]

A still more remarkable instance is to be found in the independent development of the eye in different orders of animals. It "must have been perfected in three distinct lines of descent,"[2] viz. among Mollusks, as in cuttle-fish; among Articulates, as in spiders, crabs, trilobites; and among Vertebrates. These all existed, and were furnished with well-developed eyes, as early as the upper Silurian period. These orders of animals are so distinct that "it would be impossible to find a common ancestor without going back to some very simple form not yet provided with even the rudiments of vision."[3]

Mr. Mivart does not suppose that these facts bear against all doctrines of the derivative origin of species; for he has an evolutionary hypothesis of his own, which differs from that of Darwin mainly in making more prominent the influence of outward conditions in producing changes, and in the length of the leaps which nature is supposed at some times to take. We are glad to give Professor Huxley the credit of the following exposition of Mr. Darwin's views, which we suppose the latter would accept, and with which no theist need quarrel.

"I apprehend that the foundation of the theory of natural selection is the fact that living bodies tend incessantly to vary. This variation is

[1] See Genesis of Species, p. 67.
[2] Ibid. p. 76.
[3] Lyell, Principles of Geology, Vol. ii. p. 498.

neither indefinite nor fortuitous, nor does it take place in all directions, in the strict sense of these words. Accurately speaking, it is not indefinite, nor does it take place in all directions, because it is limited by the general characters of the type to which the organism exhibiting the variation belongs. A whale does not tend to vary in the direction of producing feathers, nor a bird in the direction of developing whalebone. In popular language, there is no harm in saying that the waves which break upon the sea-shore are indefinite, fortuitous, and break in all directions. In scientific language, on the contrary, such a statement would be a gross error, inasmuch as every particle of foam is the result of perfectly definite forces, operating according to no less definite laws. In like manner, every variation of a living form, however minute, however apparently accidental, is inconceivable, except as the expression of the operation of molecular forces or 'powers' resident within the organism. And as these forces certainly operate according to definite laws, their general result is doubtless in accordance with some general law which subsumes them all..... If I affirm that 'species have been evolved by variation, including under this head hereditary transmission (a natural process the laws of which are for the most part unknown), aided by the subordinate action of natural selection,' it seems to me that I enunciate a proposition which constitutes the very pith and marrow of the first edition of the Origin of Species."[1]

X. Infertility of Hybrids.

For the purpose of testing an hypothesis, it is customary to resort to what is called a "crucial experiment." Newton's attempted demonstration that the motion of the moon conformed to his hypothesis of gravitation was such a test. His success in the effort swept away at once a host of objections, and silenced almost all critics. Had he failed to demonstrate the conformability of his law to that crucial test, the best he could have done would be to show that the data were not such as could make it a determinate case; proving that, he then would have been at liberty to seek some other case more satisfactory.

An attempt has been made to set up the fertility of individuals with one another as the test of their community of descent. On this view, it is the manifest and oft-repeated objection to the filiation of species, that hybrids are not continuously fertile. If we concede that "the fundamental idea

[1] Critiques and Addresses, pp. 298, 299.

of species is that of a chain of which genetically-connected individuals are the links,"[1] it seems to some unscientific to infer unity of origin in any case in which a present cross is proved to be infertile. Close inter-breeding in the same variety produces sterility. The crossing of varieties with one another is favorable to fertility. On the contrary, when the divergence has become a little greater, and is such as would be called specific, intercrossing produces sterility. "He who explains the genesis of species through purely natural agencies should assign a natural cause for this remarkable result; and this Mr. Darwin has not done."[2] Professor Gray, however, now (June 1876) informs us that among plants there are known hybrids of unlimited fertility, and that there are almost all degrees between this and sterility; that Dr. Engelmann, in a recent memoir upon North American oaks, enumerates six unquestionable hybrids as well known to him, of which those that have been tested are fully fertile, although these plants belong to very distinct species, and that this is also true of the other probable hybrid oaks of this country.

Several methods are open by which to parry these objections; and at present not much more can be done. First, the differences separating one species from another are the same, through whatever process they may have originated. If degree of unlikeness be the cause of infertility, it would be a cause whether secured at once by direct creation, or by the accumulation of smaller and successive steps of divergence. So that the existence of the fact of infertility of crosses does not really bear on the question of community of origin. A possible test which would be of great value is suggested by Professor Gray.[3] If naturalists could adduce an instance in which two varieties have diverged enough from the parent stock to bring about some sterility in the

[1] See Dr. Asa Gray's Darwiniana, p. 201.

[2] See Dr. Asa Gray's Darwiniana, p. 51. See also Huxley on the Origin of Species, pp. 140–143; also, Lay Sermons, etc., pp. 271–277; also Mivart, Genesis of Species, pp. 123–126.

[3] Darwiniana, p. 51. See also Huxley on Origin of Species, p. 141.

crosses, this would be a complete and satisfactory answer to the objection. But this no one has yet done. It should be observed, however, that there is, on this point, great danger of reasoning in a circle, and naming the race "species" when the cross is sterile, and calling the species "a race" when the individuals freely interbreed. Darwin attempts to break the force of the objection by adducing a parallel case in the effect of a change of condition. Slight changes of circumstances are beneficial to both plants and animals, and increase their fertility. Extreme changes, like those involved in the confinement of wild animals, are deleterious and productive of sterility. Still further, we are in danger of forgetting that if fertility of intercrossed varieties be accepted as proof of specific unity, an important point is gained with reference to the degree of unlikeness that is acknowledged as compatible with descent from a common ancestry. In that case we should have acknowledged a genetic connection between the several varieties of the horse, as well as of the cow, the dog, the hen, the pigeon, and of the human race. Each of these names represents a group of varieties physiologically one, but morphologically so distinct that many naturalists have insisted on calling the varieties species. Agassiz, for instance, insisted that man was not of one, but of several, species.

XI. Agassiz on the Significance of Embryology.

In 1863, Agassiz writes as follows:

"One important truth already assumes great significance in the history of the growth of animals; namely, that whatever the changes may be through which an animal passes, and however different the aspect of these phases at successive periods may appear, they are always limited by the character of the type to which the animal belongs, and never pass that boundary. Thus the Radiate begins life with characters peculiar to Radiates, and ends it without assuming any feature of a higher type. The Mollusk starts with a character essentially its own, in no way related to the Radiates, and never shows the least tendency to deviate from it, either in the direction of the Articulate or the Vertebrate types. This is equally true of the Articulates; ..... [and] emphatically true of the Vertebrates. ..... These results are of the highest importance at this moment, when men of authority in science are attempting to renew the

theory of a general transmutation of all animals of the higher types out of the lower ones. If such views are ever to deserve serious consideration, and be acknowledged as involving a scientific principle, it will only be when their supporters shall have shown that the fundamental plans of structure characteristic of the primary groups of the animal kingdom are transmutable, or pass into one another, and that their different modes of development may lead from one to the other. Thus far embryology has not recorded one fact on which to base such doctrines."[1]

The argument here is somewhat misstated. Darwin's principal point is to prove that each of these types or classes has developed into their various orders, genera, and species. Back to that point at which the characteristics of the class appear, the analogical argument from embryology is very strong. Previous to that stage of development Darwin would only go so far as the momentum of his analogical argument at the beginning of the classes would carry him. If, however, a naturalist has been brought by plain analogies to believe in only four distinct lines of genealogical descent, it is difficult to stop there, although there may be no further accessible facts upon which to base a positive argument, just as in the realm of astronomy we can hardly help applying our general conclusions to regions of space beyond the reach of the telescope. Unless there is counter-evidence, we may sometimes extend our generalizations a long way beyond the bare facts, and throw the burden of proof upon those who deny such extension. This is akin to the argument known in mechanics as the method of proof by gradual approach.

XII. Natural Selection Incompetent to Produce Beauty of Form and Color.

Nothing in nature is more striking than the beauty with which organic forms are clothed. Solomon in all his glory is not arrayed like the lily of the field. It is difficult to say which is most graceful in form and exquisite in coloring, — the humming-bird, or the flower before which he balances himself in the air, and from which he sips the nectar. No

[1] Methods of Study in Natural History, by G. L. Agassiz. pp. 302–303. Boston. 1871.

painter can equal the beauty of color and delicacy of shading that appear in the plumage of the peacock or of the bird of paradise; nor can any designer improve upon the pattern of the every-day dress in which these birds clothe themselves. Even the fish of the sea revel in gorgeous colors; and the shells of marine Molusca, both those now existing and those of past ages, are exceedingly beautiful, both in form and in surface ornament.

Mr. Darwin[1] admits that if it could be proved that "structures have been created for the sake of beauty, to delight man, ... or for the sake of mere variety," it would be absolutely fatal to his theory. He admits, however, as fully as any one, the extent to which beauty abounds in nature; but he remarks, (*a*) "That the sense of beauty obviously depends on the nature of the mind" which perceives it.[2] (*b*) That beauty existed in the early geological ages, and now exists in countless microscopical animals that are never visible to man.

> "Full many a flower is born to blush unseen,
> And waste its fragrance on the desert air."

(*c*) We cannot deny to the lower animals the capacity of being attracted by the beautiful, and so, through their agency in sexual selection and in fertilizing and distributing the seeds of plants having highly colored flowers, much of the beauty in those objects may owe its origin to their instrumentality. He infers that a "nearly similar taste for beautiful colors and for musical sounds runs through a large part of the animal kingdom."[3]

> "How the sense of beauty in its simplest form — that is, the reception of a peculiar kind of pleasure from certain colors, forms, and sounds — was first developed in the mind of man and of the lower animals is a very obscure subject. ..... There must be some fundamental cause in the constitution of the nervous system in each species."[4]

It will be perceived here, as frequently elsewhere, that the circle is not closed so as to exclude the directing agency of

[1] Origin of Species, pp. 159, 160.
[2] Ibid. p. 160.
[3] Origin of Species, p. 161.
[4] Ibid. p. 162.

the Creator. Even after the machinery of nature is set going, there are abundant arrangements by which the Engineer can control its movements.[1]

XIII. Natural Selection Accounts for the Preservation of Varieties, but not for their Origin.

The thought with which we closed the preceding section will be still more prominent in this. The ultimate causes is never reached by Mr. Darwin. At the best, the naturalist does no more than grope along the periphery of an infinite circle, the centre of which is far out of his sight. The cause of the phenomena of heredity and of variation are alike inscrutable to him. The most he can propose is to catch here and there a few glimpses of the orbit along which the bodies propelled by them move. The criticism which is the subject of review in this section is neatly presented by the Duke of Argyll:[2]

"Natural selection can do nothing except with the materials presented to its hands. It cannot select except among the things open to selection. Natural selection can originate nothing; it can only pick out and choose among the things which are originated by some other law. Strictly speaking, therefore, Mr. Darwin's theory is not a theory on the origin of species at all, but only a theory on the causes which lead to the relative success or failure of such new forms as may be born into the world."

It will appear, we think, that so elastic a principle as natural selection, as Mr. Darwin defines it, cannot be particularly dangerous to theism. In appreciation of its being extremely indeterminate as a cause, Darwin remarks:[3]

"Several writers have misapprehended or objected to the term 'natural selection.' Some have even imagined that natural selection induces variability, whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life..... The variability which we almost universally meet with in our domestic productions is not directly produced, as Hooker and Asa Gray have well remarked, by man. He can neither originate varieties nor prevent their occurrence; he can only preserve and accumulate such as do occur."

[1] See this question discussed by Argyll, Reign of Law, pp. 188–194. Darwin, Descent of Man, pp. 413, 427–443.

[2] Reign of Law, p. 219.

[3] Origin of Species, pp. 63, 62.

A careful study of each sentence in the following extract from Darwin will serve in a measure to dispel the fears which any may have had regarding the omnipotence of natural selection.

"I have now recapitulated the facts and considerations which have thoroughly convinced me that species have been modified during a long course of descent. This has been effected chiefly through the natural selection of numerous successive, slight, favorable variations; aided in an important manner by the inherited effects of the use and disuse of parts; and in an unimportant manner — that is, in relation to adaptive structures, whether past or present — by the direct action of external conditions, and by variations which seem to us, in our ignorance, to arise spontaneously. ..... As my conclusions have lately been much misrepresented, and it has been stated that I attribute the modification of species exclusively to natural selection, I may be permitted to remark that in the first edition of this work, and subsequently, I placed in a most conspicuous position — namely, at the close of the Introduction — the following words: 'I am convinced that natural selection has been the main, but not the exclusive, means of modification.'"[1]

To realize how indeterminate the problem of the origin of species is, even after Mr. Darwin leaves it, we need to combine the indefinite quantities which are assumed. First, variation is produced by action of the "conditions of life" (a term as complex as all nature) upon the "individual organism" (another term of equal complexity). This raises our quantity to the second power. Secondly, we must introduce "natural selection" (a term as broad as that of both the others combined). In considering any specific result in nature, we find ourselves in the presence of an indefinitely large indetermination, raised to the fourth power. In other words, we cannot tell deductively what variations will arise, unless we know all about the constitution of the individual, and all about the outward circumstances that act upon it to produce variation; and we cannot know what variations will be perpetuated till we know how each is related to the whole system of nature. It would seem that such an hypothesis left God's hands as free as could be desired for contrivances of whatever sort he pleased. At every point of this discus-

[1] Origin of Species, p. 421.

sion the conviction recurs that naturalists are no nearer than ever to obtaining "any insight into the nature of the forces by which a higher grade of organization or instinct is evolved out of a lower one, by becoming acquainted with a series of gradational forms or states, each having a close affinity to the other."[1] Still the "mystery of creation" is as great and as much beyond the domain of science as ever.

Lyell further remarks[2] that the real question at issue

"Is not whether we can explain the creation of species, but whether species have been introduced into the world one after the other, in the form of new varieties of antecedent organisms, and in the way of ordinary generation, or have been called into being by some other agency, such as the direct intervention of the First Cause. Was Lamarck right ..... in supposing that the changes of the organic world may have been effected by the gradual and insensible modification of older pre-existing forms? Mr. Darwin, without absolutely proving this, has made it appear in the highest degree probable, by an appeal to many distinct and independent classes of phenomena in natural history and geology, but principally by showing the manner in which a multitude of new and competing varieties are always made to survive in the struggle for life. The tenor of his reasoning is not to be gainsaid by affirming that the causes or processes which bring about the improvement or differentiation of organs, and the general advance of the organic world from the simpler to the more complex, remain as inscrutable to us as ever. ..... The more the idea of a slow and insensible change from lower to higher organisms, brought about in the course of millions of generations according to a preconceived plan, has become familiar to men's minds, the more conscious they have become that the amount of power, wisdom, design, or forethought required for such a gradual evolution of life, is as great as that which is implied by a multitude of separate, special, and miraculous acts of creation."

XIV. Natural Selection subject to Peculiar Limitations when applied to Man.

This objection might well have been treated under the second or third sections, when we were speaking upon the abrupt appearance of many species, and the absence of intermediate varieties. But it is worthy of special attention at this stage of the discussion. Wallace[3] has devoted a

[1] Lyell, Principles of Geology, Vol. ii. pp. 496, 497. [2] Ibid. pp. 499, 500.
[3] See Cont. Nat. Selection, pp. 332–362.

chapter to the proof of the proposition that natural selection cannot account for the development of man. His points are,

1. That the brain of the savage man is much beyond his actual requirements in the savage state. It is a remarkable fact "that the average cranial capacity of the lowest savages is probably not less than *five sixths* of that of the highest civilized races, while the brain of the anthropoid apes scarcely amounts to *one third* that of man — in both cases taking the average."[1] The average internal capacity of the cranium in the Teutonic races and the Bushmen respectively is ninety-four and seventy-seven cubic inches, while we drop at once to thirty inches in the highest of the apes. "The savage possesses a brain capable, if cultivated and developed, of performing work of a kind and degree far beyond what he ever requires it to do."[2] If this be the case, natural selection could not have produced it, since that preserves only such variations as are of positive service at the time of their occurrence.

2. The absence of hair from the back of the human species could not have arisen through natural selection. For with the lower animals the hairy covering of the back is of very great service, and gives them an advantage which could not well be dispensed with. Just where hair is of special service as a covering it is absent in man. Of course a natural selection of advantages could not secure a great disadvantage.

3. The origin of the moral sense is inexplicable on natural principles. The ideas of right and wrong are independent of the utility of the action. "So those faculties which enable us to transcend time and space, and to realize the wonderful conceptions of mathematics and philosophy, or which give us an intense yearning for abstract truth, ... are evidently essential to the perfect development of man as a spiritual being, but are utterly inconceivable as having been produced through the action of a law which looks only, and can look only, to the immediate material welfare of the individual or

[1] See Cont. Nat. Selection, p. 338.
[2] Ibid. p. 340.

the race."[1] This latter point, as it arises in connection with theories of the origin of language, has been discussed at length by Professor Max Müller.[2]

"No animal has ever spoken." The step from a non-speaking animal to a speaking animal is a long one — long enough, in fact, to be called a leap. The characteristic point of distinction in man, however, is not articulate speech; for the parrot can utter almost every sound of which man is capable. The voice is but an instrument. Emotional language, such as interjections and other simple sounds which express simple feelings, man shares, also, with the brute creation. Nor can we deny that animals may have some degree or kind of conceptual thought. But man alone "realizes his conceptual thought by means of words derived from roots." The study of comparative philology reveals the fact that in the Aryan group of languages a few hundred "roots" constitute the elements from which the diversified structure of these languages are built. These "roots" are the ultimate facts in the analysis of language. Doubtless they had their origin in the tendency to use interjectional and imitative sounds.

How the vast number of complicated concepts which man employs could have been packed away for use in the simple sounds to which he gives utterance surpasses our comprehension. The creative power of mind which has given origin to the material machinery of the nineteenth century must take a very humble place beside that of the men who first put thought and words together. The former harnessed heat and electricity; the latter made available the true Promethean fire. The question chiefly concerns a mental power. The child of the lowest savages can learn the most cultivated language, while the highest of the animals cannot learn any language.

Not to multiply words, it is sufficient to remark, that here,

[1] Cont. Nat. Selection, pp. 358, 359.

[2] See Essays on Darwinism and Language, in Fraser's Magazine for May, June, and July 1873, republished in Littell's Living Age. Also Chips from a German Workshop, Vol. iv. pp. 417–455. On the contrary, see Prof. W. D. Whitney in North American Review, Vol. cxiv. pp. 272–309; Vol. cxix. pp. 61–88.

as everywhere else, something certainly is added whenever there is a step taken in advance. The question under discussion does not necessarily concern the source from which the additions come, but rather the rapidity with which they accumulate. Are Nature's steps all of corresponding length? How long a step would be called a leap? This, perhaps, depends upon the magnifying power of the lens through which we look. At any rate, the same amount of power is required to raise a given amount to a given height with slow velocity, as with rapid. Doubtless the divine power is competent to move in natural operations by long strides; but he is not compelled to move in that manner. The question under consideration is to determine by evidence what relation the steps of nature sustain to human powers of reason. A closing extract from Professor Müller will show how little the naturalist, the linguist, and the theist need come in conflict with each other.

"Let us suppose, then, that myriads of years ago there was, out of myriads of animal beings, one, and one only, which made that step which in the end led to language, while the whole rest of the creation remained behind. What would follow? That one being, then, like the savage baby now, must have possessed something of his own — a germ very imperfect, it may be, yet found nowhere else; and that germ, that capacity, that disposition, — call it what you like, — is, and always will remain, the specific difference of himself and all his descendants. It makes no difference whether we say it came of itself, or it was due to environment, or it was the gift of a Being in whom we live and move..... Language is something; it presupposes something; and that which it presupposes, — that from which it sprang, — whatever its pre-historic, pre-mundane, pre-cosmic state may have been, must have been different from that from which it did not spring. People ask whether that germ of language was 'slowly evolved' or 'divinely implanted'; but if they would but lay a firm grip on their words and thoughts, they would see that these two expressions, which have been made the watchwords of two hostile camps, differ from each other dialectically only."[1]

XV. Conclusion.

Of those who have taken the trouble to read the foregoing

[1] Chips from a German Workshop, Vol. iv. pp. 453, 455. Compare remarks of Sir Charles Lyell, above, p. 688.

paper, and its predecessor in the July number of the Bibliotheca Sacra, doubtless some will be disappointed that we have not mentioned the objections to a derivative origin of species which seem to them most cogent; while others will think the presentation of the argument in favor of such origin deficient in many particulars. But there are limits to all things in time and space, and especially to the pages of this Journal and the patience of its readers. While it would be easy to multiply objections, it would not be difficult to strengthen the argument. So far as we have gone we have endeavored to state the case fairly. An exhaustive treatment of the subject, as at present developed, would involve the reproduction of several octavo volumes. Nevertheless, an outline map may be of service where a Johnston's atlas would be cumbrous and confusing. Two or three conclusions have forced themselves upon us in this investigation.

First, that Darwin's hypothesis has attained to such a degree of probability that it deserves dignified treatment. Sneers and ridicule are no longer sufficient to overthrow it.

Secondly, protracted study of the subject in its various aspects has allayed many of the fears with which, as a practical expounder of the sacred scriptures, we approached the investigation. This may, we admit, arise from the fact that error, no less than

> "Vice, is a monster of so frightful mien,
> As, to be hated, needs but to be seen;
> Yet seen too oft, familiar with her face,
> We first endure, then pity, then embrace."

The writer would not, however, put himself forward as a disciple of Mr. Darwin, or as a champion of his theory. Instead of pausing to discuss the irrelevant, and comparatively unimportant question concerning Mr. Darwin's personal attitude to theism, we have thought it more incumbent upon us to consider the logical relation of his principles to the system which without peradventure sets God on a throne of supreme authority. Our object in the preceding pages has been, by careful study of the subject, to get such a knowledge of it

that we could understandingly discuss its relation to natural and revealed theology. We have by that means been led to a well-assured conviction that there is no more reason now than at any previous time why the scientific "leopard" and the theological "kid" should not lie down together, and there is nothing in recent developments to hinder the lion from "eating straw like the ox."

There has been an exaggerated fear of the embarrassments which the establishment of a derivative origin of species was likely to bring to a theistical view of the universe, and especially to the reverent interpretation of the Bible. This has been fostered, on the one hand, by the hasty and heated attacks of some ill-informed theologians, and, on the other hand, by the crude and over-confident metaphysical speculations of some members of the scientific guild; for many of these have been more than ready to forsake the tedious processes of natural history, and to put themselves forward as authoritative interpreters of the deepest mysteries of existence.

At this stage of our discussion it is not in place to set forth in detail the position which can be occupied in common by the sober-minded naturalist and the Christian believer. Intimations of our views have already appeared at various stages in the progress of this paper. We may, however, briefly remark that, on the scientific side, deliverance can easily come from two quarters:

(1) From the expansive nature of the principle of natural selection. This is a personification of such a general nature that it necessarily leaves the whole question of ultimate causation just where it was before; and it is so indeterminate that providential interpositions for adequate reasons are in no manner excluded. As before remarked, "utility" is a word of the very broadest significance.

Regarded from a dogmatic evolutionist's point of view, Mr. Darwin's caution in stating this principle seems timidity; while to those who are unaccustomed to the methods of inductive reasoning, the hypothetical nature of much of his discussion seems an evasion of the real question. Not without

some reason has Mr. Darwin's theory (and we could speak in much the same strain concerning the theory of gravitation) been described as a series of "loopholes" and "may-bes"; since difficulties in it are explained by reference to such things as "reversion," "correlation," "use and disuse of parts," "direct action of external conditions," and "spontaneous" variation.

The believer in transmutation

> "... 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."[1]

(2) Moreover, as Professor Gray well remarks,[2] natural selection is only a directing agency. It is "the rudder which by friction, now on this side, and now on that, shapes the course" of the vessel, i.e. which acts in virtue of a movement already induced. The propelling agency is "variation," which proceeds from an unknown power within the organism itself. It is "not physical, but physiological." With these remarks, we must leave the subject for the present, hoping in due time to complete, according to our humble ability, the edifice of which we have hitherto but laid the foundation and drawn the plan.

[1] North British Review, Vol. xlvi. p. 293. [2] See Darwiniana, p. 396.