ARTICLE VII.

RECENT BOOKS BEARING UPON THE RELATION OF SCIENCE TO RELIGION.

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No. I. — THE NATURE AND DEGREE OF SCIENTIFIC PROOF.

THE book[1] to whose guidance we willingly commit ourselves in this Article, is of exceptional value in this time so marked by fertile speculation and heated controversy. It covers a field which has been neglected entirely too much, by the interpreters both of nature and of the Bible. It may be of advantage to both parties, to be reminded that no facts are altogether foreign, either to science or religion, and that there is but one method by which to arrive at the truth, whether one call himself a scientist or a theologian. Logic is one; and holds alike all interpreters of facts to its rigorous postulates.

The authority of Christianity is not established by direct intuition; but as a conclusion of a syllogism, of which the objective facts contained in the Bible, and the circumstances attending its transmission to us, form the minor premise, and of which certain intuitions, which we will not here specify, compose the major premise.

The belief in the truths of physical science rests likewise on the conclusion of a similar syllogism, whose major premise is the same, and whose minor is a set of observations differing in many particulars from those in the other, but still similar to the others in this, that they are not proof, but only the basis of proof.

[1] The Principles of Science. A Treatise on Logic and Scientific Method. By W. Stanley Jevons, M.A., F.R.S., Fellow of University College, London, Professor of Logic and Political Economy in the Owens College, Manchester, England. 2 vols. 8vo. pp. 463, 480. London and New York: Macmillan and Co. 1874.

The central question of all reasoning is this: How do we join together the major and minor premise in a conclusion? Whence comes that new thought that is born neither of intuition alone, nor of observation? Has it the certainty of either? The defender of the Bible must answer, that he is not absolutely certain of its credibility and authority; for, from the nature of the case, one cannot be expected to establish these beyond a high degree of probability. But, on the other hand, is the physical philosopher able to do any better in his field? Is he able to eliminate all uncertainty from his conclusions regarding what are called the laws of nature? The author under review, who has made the physical sciences and their methods of proof a life-long study, answers, no; but expresses it as his "strong conviction that before a rigorous logical scrutiny, the 'reign of law' will prove to be an unverified hypothesis, the uniformity of nature an ambiguous expression, the certainty of our scientific inferences to a great extent a delusion." [1]

The distinguished reputation of Professor Jevons makes it worth while to notice his able and elaborate work upon the Principles of Science at some length. We can do this no better than by furnishing a connected series of extracts from its leading chapters, adding upon some allied topics, a few remarks of our own.

I. Nature of Scientific Inference.

"Science arises from the discovery of identity amid diversity. The process may be described in many different words, but our language must always imply the presence of one common and necessary element. In every act of inference or scientific method we are engaged about a certain identity, sameness, similarity, likeness, resemblance, analogy, equivalence, or equality apparent between two objects." [2] "It must be the ground of all reasoning and inference, that *what is true of one thing will be true of its equivalent*, and that under carefully ascertained conditions *nature repeats herself*." [3] "The fundamental action of our reasoning faculties consists in inferring, or carrying to a new instance of a phenomenon whatever we have previously known of its like, analogue, equivalent, or equal. Sameness or identity presents itself in all degrees, and is known under various names;

[1] Vol. i. Preface, p. ix. [2] Vol. i. p. 1. [3] p. 2.

but the great rule of inference embraces all degrees, and affirms that *so far as there exists sameness, identity, or likeness, what is true of one thing will be true of the other.* The great difficulty of reasoning doubtless consists in ascertaining that there does exist a sufficient degree of likeness or sameness to warrant an intended inference."[1]

In contrast to J. S. Mill, who held that all reasoning was really inductive, our author maintains the exact reverse.

"In a certain sense all knowledge is inductive. We can only learn the laws and relations of things in nature by observing those things. But the knowledge gained from the senses is knowledge only of particular facts, and we require some process of reasoning by which we may construct out of the facts the laws obeyed by them. Experience gives us the materials of knowledge; induction digests those materials, and yields us general knowledge." "In its ultimate origin or foundation, then, all knowledge is inductive, in the sense that it is derived by a certain inductive reasoning from the facts of experience. But it is nevertheless true — and this is a point to which insufficient attention has been paid — that all reasoning is founded on the principles of deduction. I call in question the existence of any method of reasoning which can be carried on without a knowledge of deductive processes. I shall endeavor to show that *induction* is really *the inverse process of deduction.* There is no mode of ascertaining the laws which are obeyed in certain phenomena, except we previously have the power of determining what results would follow from a given law..... An inverse process is the undoing of the direct process. A person who enters a maze must either trust to chance to lead him out again, or he must carefully notice the road by which he entered. The facts furnished to us by experience are a maze of particular results; we might by chance observe in them the fulfilment of a law, but this is scarcely possible, unless we thoroughly learn the effects which would attach to any particular law. Accordingly the importance of deductive reasoning is doubly supreme."[2]

II. Twofold Meaning of General Names.

"A name is said to *denote* the distinct object of thought to which it may be applied; it *implies*, at the same time, the possession of certain qualities or circumstances. The number of objects denoted, forms the *extent* of meaning of the term; the number of qualities implied forms the *intent* of meaning. ..... We increase the intent of meaning of a term by joining adjectives to it, and the removal of such adjectives, of course, decreases the intensive meaning. Now, concerning such changes of meaning the following all-important law holds universally true: *When the intent of meaning of a term is increased, the extent is decreased, and vice versa.* ..... Singular terms, which denote a single individual only, come under the

[1] Vol. i. p. 11. [2] pp. 14, 15.

same law of meaning as general names. They may be regarded as general names of which the meaning in extension is reduced to a mimimum. Logicians have erroneously asserted, as it seems to me, that singular terms are devoid of meaning in intension, the fact being that they exceed all other terms in that kind of meaning."[1]

"There is no distinction but that of degree between what is known as reasoning by *generalization* and reasoning by *analogy*. In both cases from certain observed resemblances we infer, with more or less probability, the existence of other resemblances. In generalization the resemblances have great extension and usually little intension, whereas in analogy we rely upon the great intension, the extension being of small amount."[2]

An important observation is made upon the indifference of logic to the order in which the adjectives which add intensive meaning to a term occur.

"A little reflection will show that knowledge in the highest perfection would consist in the *simultaneous* possession of a multitude of facts. To comprehend a science perfectly we should have every fact present with every other fact. We must write a book, and we must read it, successively, word by word; but how infinitely higher would be our powers of thought if we could grasp the whole in one collective act of consciousness Compared with the brutes, we do possess some slight approximation to such power; and it is just conceivable that, in the indefinite future, mind may acquire a vast increase of capacity, and be less restricted to the piecemeal examination of a subject. But I wish to make plain that there is no logical foundation for the successive character of thought and reasoning, unavoidable under our present mental conditions. The fact that we must think of one thing first, and another second, is a logical weakness and imperfection. We must describe metal as 'hard and opaque,' or 'opaque and hard,' but in the metal itself there is no difference of order; the properties are simultaneous and co-extensive in existence."[3]

These remarks connect themselves, in a later portion of the work, with others of much significance to metaphysicians, to the effect that the independence of space and time, appearing in logical relations, and in the algebraical formulae which represent in their variations certain curved lines in space, gives us a hint that space and time are not necessary conditions of every form of being.[4]

In our author's view, all logic rests on the principle of identity, and reasoning is the process of following the thread of identity through its multifarious transformations and

[1] Vol. i. pp. 31, 32. [2] Vol. ii. p. 244. [3] Vol. i. p. 41. [4] See below, p. 555.

combinations with other things and in other statements. Deductive reasoning, like going into a labyrinth, is comparatively easy; but the inductive process is beset with the perplexities of getting out of a maze without any clew. It is proposed, with some approach to success, to simplify the process by the application of mathematical formulae. Hamilton and some others have endeavored to accomplish this object by the use of geometrical figures, exhibiting the mutual inclusion or exclusion of propositions by the relations of circles to one another; the spaces intercepted in common by them representing the identity, and hence the limitations of the conclusion. But in logic, as in mathematics, figures in space are cumbrous, and must yield to the symbols of algebra. For the proposition All A is B, or, transposed, B includes A, substitute the formula A = B, meaning that A is identical with a portion of B. Now, if also B = C, then a portion of C must be identical with A. And you have the formula A = ABC, which means, when read in extension, A is an A which is a B, which is a C; each letter adding to the fold a more general term; or, read in intension, it means A is an A which possesses the additional meaning B plus the meaning of C.[1]

By introducing appropriate signs for negation, variation, and alternative propositions, and following simple rules of substitution, the whole mass of syllogisms, in all their moods and figures, is brought within the management of a few algebraical symbols. This enables our author to accomplish the same thing for logic which Mr. Babbage did in mathematics, namely, invent a machine which shall, when once the terms and propositions have been reduced to appropriate forms, dispense with the drudgery of the routine work, and lead to the conclusions which are involved in the premises.

We have not room here to give any adequate idea of this process, which is carefully elaborated by the author. We are not sure that we see all its advantages. It incorporates, however Hamilton's idea of quantifying the predicate, and

[1] See Jevons, Vol. i. pp. 15–194.

also that of inference being a mere explication of the concept of the subject of the minor premise. He does not, however, like De Morgan and others, make logic a branch of mathematics; but, on the contrary, calls mathematics a branch of logic, and places the law of identity at the foundation of the ordinary axioms of number and space.

III. The Process of Induction.

We come now to the vital point of interest: What degree of certainty can the inferences of induction have? According to our author,

"Inference never does more than explicate, unfold, or develop the information contained in certain premises or facts. Neither in deductive nor inductive reasoning can we add a tittle to our implicit knowledge, which is like that contained in an unread book or a sealed letter."[1] The question regarding this explication is, "Where does novelty of form begin?"[2]

The difficulties of explication increase in geometrical ratio with every ascending step of induction. The discovery of a new cause, or the appearance of a new connected phenomenon makes a fresh knot in the snarl we are disentangling. It is well to weigh the following sentences.

"Induction is the inverse operation to deduction."[3] "Induction is the decyphering of the hidden meaning of natural phenomena."[4] "We seldom observe any great law in uninterrupted and undisguised operation."[5] "It is now plain that induction consists in passing back from a series of combinations to the laws by which such combinations are governed."[6]

"The following table shows the extraordinary manner in which the number of possible logical relations increases with the number of terms involved.[7]

No. of Terms.	No. of possible Combinations.	No. of possible selections of combinations corresponding to consistent or inconsistent logical relations.
2	4	16
3	8	256
4	16	65,536
5	32	4,294,967,296
6	64	18,446,744,073,709,551,616"

The uncertainties regarding induction arise from the fact that, except in a few unimportant cases, it can never be perfect.

[1] Vol. i. p. 136, see also, pp. 171, 250. [2] p. 137. [3] p. 139.
[4] p. 143. [5] p. 145 [6] p. 154. [7] p. 163.

An unknown, but most important, factor in our calculations concerning the permanence of the laws of nature, by which we prognosticate the future, or form judgments regarding the past, is the purpose of the Creator. Or rather we should say that this is the thing which, in our processes of induction, we are always, with very imperfect data, attempting to determine. Thus our author:

"There is no fact which I shall more constantly keep before the reader's mind in the following pages, than that the results of imperfect induction however well authenticated and verified, are never more than probable. We never can be sure that the future will be as the present. We hang ever upon the will of the Creator; and it is only so far as he has created two things alike, or maintains the framework of the world unchanged from moment to moment, that our most careful inferences can be fulfilled. ..... No experience of finite duration can be expected to give an exhaustive knowledge of all the forces which are in operation. There is thus a double uncertainty; even supposing the universe as a whole to proceed unchanged, we do not really know the universe as a whole. ..... We cannot be sure, then, that our observations have not escaped some fact which will cause the future to be apparently different from the past; nor can we be sure that the future really will be the outcome of the past."

"As the creation of the universe is necessarily an act passing all experience and all conception, so any change in that creation, or, it may be, a termination of it, must likewise be infinitely beyond the bounds of our mental faculties. No science, no reasoning upon the subject, can have any validity; for without experience we are without the basis and materials of knowledge. It is the fundamental postulate, accordingly, of all inference concerning the future, that there shall be no arbitrary change in the subject of inference. Of the probability or improbability of such a change I conceive that our faculties can give no estimate."

"No net addition is ever made to our knowledge by reasoning; what we know of future events or unexamined objects, is only the unfolded contents of our previous knowledge, and it becomes less and less probable as it is more boldly extended to remote cases." [1]

It will thus be seen that doctors of science as well as of theology walk by faith, and not by sight. Physical science cannot divest itself of a metaphysical and theological basis. The scientist is searching after the ideas of God which are involved in both the past and the future of the material creation. At the very threshold he encounters the metaphysical

[1] Vol. i. pp. 168, 169, 170, 171. See also, pp. 250, 251.

questions concerning the wisdom, goodness, and veracity of God, and the data for interpreting the marks of these are obtained from his own mental experiences.

IV. Doctrine of Probabilities.

Professor Jevons rightly gives to the doctrine of probabilities a high place in inductive reasoning.

"As Butler truly said, 'Probability is the very guide of life.' ..... All our inferences concerning the future are merely probable; and a due appreciation of the degree of probability depends entirely upon a due comprehension of the principles of the subject. I conceive that it is impossible even to expound the principles and methods of induction as applied to natural phenomena, in a sound manner, without resting them upon the theory of probability. Perfect knowledge alone can give certainty; and in nature, perfect knowledge would be infinite knowledge, which is clearly beyond our capacities. We have therefore to content ourselves with partial knowledge — knowledge mingled with ignorance, producing doubt."[1]

By probability is not meant random casualty. Our author is far enough from taking the position that we are simply observers of hap-hazard evolutions of blind forces. The dice we use in induction are all loaded, and we have some idea which side is heavier. He squarely asserts that there is no such thing as chance in the phenomena of nature. The "probability belongs wholly to the mind."[2]

"The theory of probability deals with *quantity of knowledge.* ..... The theory consists in putting similar cases upon a par, and distributing equally among them whatever knowledge we may possess..... The theory comes into play when ignorance begins, and the knowledge we possess requires to be distributed over many cases."[3]

"It is just possible that some regular coincidences which we attribute to fixed laws of nature, are due to the accidental conjunction of phenomena in the cases to which our attention is directed. All that we can learn from finite experience is capable, according to the theory of probabilities, of misleading us, and it is only infinite experience that could assure us of any inductive truths. At the same time the probability that any extreme runs of luck will occur is so excessively slight, that it would be absurd seriously to expect their occurrence."[4]

"Certainty belongs only to the deductive process, and to the teachings

[1] Vol. i. p. 224. [2] See p. 225. [3] pp. 227, 228. [4] p. 236. See also, pp. 247, 248.

of direct intuitions; and as the conditions of nature are not given by intuition, we can only be certain that we have got a correct hypothesis, when, out of a limited number conceivably possible, we select that one which alone agrees with the facts to be explained."[1]

"Inductive inference might attain to certainty if our knowledge of the agents, existing throughout the universe, were complete; and if we were at the same time certain that the same power which created the universe would allow it to proceed without arbitrary change."[2]

"We, with our finite minds and short experience, can never penetrate the mystery of those existences which embody the will of the Creator, and evolve it throughout time..... The word 'cause' covers just as much untold meaning as any of the words, *substance*, *matter*, *thought*, *existence*."[3]

"Much has been said about the peculiar certainty of mathematical reasoning; but it is only certainty of deductive reasoning, and equally attaches to all correct logical deduction."[4]

It should be noted, at this point, that probability may approach so near to certainty as to be indistinguishable from it. And there is danger of under-estimating an argument because it is called "probable." For instance, Laplace estimated that the probability that the forty-three independent motions of the bodies in the solar system known in his day should coincide in direction by chance would be one half raised to the forty-second power: or "about 4,400,000,000,000 to 1 in favor of some common cause for the uniformity of direction." We have further to combine with this by multiplication the independent "probability that the sum of the inclinations of the planetary orbits would not exceed by accident the actual amount ([about one tenth] of a right angle for the ten planets known in 1801)" which is one tenth raised to the tenth power, or one ten billionth, i.e. the probability in favor of some common cause for these two sets of phenomena would be expressed by 44,000,000,000,000,000,000,000 to 1.[5] We may, or may not, agree with Laplace in adopting the nebular hypothesis; for we can plausibly reason that some idea of final cause has disturbed the orderly action of secondary causes. But when (not to pause here) we advance a step farther, and consider the uniformities resulting from the action of the geological, the molecular, the chemical, and

[1] Vol. i. p. 309. [2] pp. 274, 275. [3] p. 255. [4] p. 270. [5] See pp. 288, 289.

the vital forces we can affirm, from the doctrine of probabilities as applied to the material creation, that bald atheism is as near an absurdity as any supposition can well be. For we have sixty-four chemical elements. What is the probability that these should combine in an orderly manner by chance? The following calculations will give a faint idea of the problem. There are fifty-two cards in a pack. The number of hands of thirteen cards each which can be produced is 635,013,559,600.

"But in whist four hands are simultaneously held, and the number of distinct deals becomes so vast that it would require twenty-eight figures to express it. If the whole population of the world — say, one hundred thousand million persons — were to deal cards, day and night, for a hundred million of years, they would not in that time have exhausted one hundred-thousandth part of the possible deals. Now, even with the same hands, the play may be almost infinitely varied, so that the complete variety of games which may exist is almost incalculably great. It is in the highest degree improbable that any one game of whist was ever exactly like another, except by intention."[1]

When, furthermore, we think of the variety which might be produced from the original elements if combined in different numbers and proportions, and in higher orders of complexity, the conclusions are startling. We have, for example, twenty-six letters in our alphabet. From these we can by combination form several trillions of pronounceable words. From these words we can construct an indefinitely larger number of sentences. With these sentences we can fill an indefinitely larger number of books. Verily, of "making many books there is no end." And the variety of libraries that can be selected is indefinitely more numerous than that of the books that can be made. This last is what is called a combination of the fifth order. By combining two marks in all possible groups in similar ascending orders, the values would increase as follows:

First step, 2; next step, 4; third step, 16; fourth step, 65,536; fifth step, 65,536 *twos* multiplied together — a number "so great that we could not possibly compute it; the mere expression of the result requiring

[1] Vol. i. p. 217.

19,729 places of figures. But go one step more, and we pass the bounds of all reason. The sixth order of the powers of two becomes so great that we could not even express the number of figures required in writing it down, without using about 19,729 figures for the purpose."[1]

The fifth order of the powers of two is indefinitely greater than the number of molecules required to fill a globe extending to the stars of the sixteenth magnitude (hence with a radius of 33,900,000,000,000,000 miles), supposing the number of molecules in each cubic inch of solid or liquid substance to be 3×10^{26}.[2] The problem which undisguised atheism has on hand is to get the uniformities by which we live and move and have our being, from generation to generation, out of chance combinations when increased to infinite orders of the powers of infinity.[3] If a person denies design in the order and uniformity that reigns about him, and which he makes the basis of all his action, it is hardly worth while to reason with him, as Paley condescends to do, about the design manifest in a watch. Such condescension well merits the charge of being a leap from the sublime to the ridiculous. The uncertainties in science do not pertain to the question whether there is a design in nature, but to the very different question, How far is that design capable of interpretation by us, as to its ultimate and practical ends? A pure atheist is a rare product; and it is not strange that some — the Psalmist among them — question whether any who suppose themselves such are of a sound mind.

V. Hypothesis as an Organ of Induction.

Nothing is more interesting, and few things more startling, in these volumes, than the remarks which contrast the Baconian philosophy with that exemplified in the investigations of Newton. Our author — and we think with much reason — rates the Baconian method as very low, when compared with the Newtonian. The interpretation of nature is beset with difficulties analogous to those which attend the understanding of the verbal revelation of the Bible. Mere grammarians

[1] Vol. i. p. 221. [2] See p. 222. [3] See below p. 552.

and compilers of texts are not safe guides in the exposition of scripture, as the absurdities of many millennarians demonstrate. A true exegete must have, with his grammatical knowledge, a philosophical mind, which unifies and weighs the disconnected passages. The concordance and the multiplication table are not the only outfit which a student of the inspired record needs. Much that is said, in the following extracts, concerning the methods of the representatives of modern scientific thought applies also to the methods which are in vogue regarding the study of the Bible.

The question in exegesis is: How far shall the systematic theologian introduce what he knows from other sources of the general nature of the subject treated of, to modify and explain the particular passage under consideration? The present tendency in scientific investigation is exactly the reverse of that in biblical interpretation. Newton, Faraday, and Darwin, who represent the present predominant scientific tendency, insist on the right of rising above the mere enumeration of phenomena, and of giving superior weight to analogy, and of allowing — often without knowing it — enlarged views concerning questions of final causes to direct their investigations. That is, scientists are really turning themselves into metaphysicians and theologians, for what is called the positive philosophy has had its day; while there is a strange disinclination to the introduction of metaphysics into the pulpit, and a jealousy of the prominence which systematic theology has had in our methods of theological instruction. But to our extracts:

"Francis Bacon contributed to spread abroad the hurtful notion that to advance science we must begin by accumulating facts, and then draw from them, by a process of patient digestion, successive laws of higher and higher generality. In protesting against the false method of the scholastic logicians, he exaggerated a partially true philosophy until it became almost as false as that which preceded it. His notion of scientific method was that of a kind of scientific book-keeping. Facts were to be indiscriminately gathered from every source, and posted in a kind of ledger, from which would emerge, in time, a clear balance of truth. It is difficult to imagine a less likely way of arriving at great discoveries."[1]

[1] Vol. ii. p. 220.

"Newton did not less [than Bacon] found his method on experience; but he seized the true method of treating it, and applied it with a power and success never since equalled. It is wholly a mistake to say that modern science is the result of the Baconian philosophy; it is the Newtonian philosophy and the Newtonian method which have led to all the great triumphs of physical science; and I repeat that the 'Principia' forms the true 'Novum Organum.'"[1]

The importance of having a clew or a hypothesis to direct our observations, and at the same time a body of facts to correct our speculations, is illustrated in the experience of our leading investigators.

"As Faraday himself said, 'The world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy by his own severe criticism and adverse examination; that, in the most successful instances, not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized."[2]

Experiments at St. Helena showed that there was a tide in the atmosphere affecting the barometer, on the average, .00365, and even varying, according as the moon was farther or nearer from the earth, to the extent of .00056. Our author remarks upon this:

"It is quite evident that such minute effects could never be discovered in a purely empirical manner. Having no information but the series of observations before us, we could have no clew as to the mode of grouping them which would give so small a difference. In applying this method of means in an extensive manner, we must generally, then, have *a priori* knowledge as to the periods at which a cause will act in one direction or the other."[3]

It will be well to recall, in this connection, the famous but somewhat inconsistent passage from Sir William Hamilton upon the same general subject:

"This parital or one-sided cultivation is exemplified in three different phases. The first of these is shown in the exclusive cultivation of the powers of observation, to the neglect of the higher faculties of the understanding. Of this type are your men of physical science. In this department of knowledge there is chiefly demanded a patient habit of attention to details in order to detect phenomena; and, these discovered, their

[1] Vol. ii. pp. 228, 229. [2] p. 223. [3] Vol. i. p. 427.

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it may not be rendered highly probable, or even approximately certain, by a sufficient number of concordances. In fact the two best founded and most conspicuously successful theories in the whole range of physical science involve the most absurd suppositions. Gravity is a force which appears to act between bodies through vacuous space: it is in positive contradiction to the old dictum that nothing could act but through some intervening medium or substance. It is even more puzzling that the force acts in perfect indifference to all intervening obstacles..... The undulatory theory of light presents almost equal difficulties of conception. We are asked by physical philosophers to give up all our ordinary prepossessions, and believe that the interstellar space which seemed so empty, is not empty at all, but filled with *something* immensely more solid and elastic than steel. As Dr. Young, himself, remarked: 'The luminiferous ether, pervading all space, and penetrating almost all substances, is not only highly elastic, but absolutely solid!!!' Sir John Herschel has calculated the amount of force which may be supposed, according to the undulatory theory of light, to be exerted at each point in space, and finds it to be 1,148,000,000,000 times the elastic force of ordinary air at the earth's surface, so that the pressure of the ether upon a square mile of surface, must be about 17,000,000,000,000 pounds. Yet we live and move without appreciable resistance through this medium indefinitely harder and more elastic than adamant. All our ordinary notions must be laid aside in contemplating such an hypothesis; yet they are no more than the observed phenomena of light and heat force us to accept."[1]

VII. No Necessary Antagonism between Science and Theology.

"There are scientific men who assert that the interposition of providence is impossible, and prayer an absurdity, because the laws of nature are proved to be invariable. Inferences are drawn not so much from particular sciences as from the logical foundations of science itself, to negative the impulses and hopes of men. Now I may properly venture to state that my own studies in logic lead me to call in question all such negative inferences. Those so-called laws of nature are uniformities, observed to exist in the action of certain material agents, but it is logically impossible to show that all other agents must behave as these do. The too exclusive study of particular branches of physical science seems, in some cases, to generate an over-confident and dogmatic spirit. Rejoicing in the success with which a few groups of facts are brought beneath the apparent sway of laws, the investigator hastily assumes that he is close upon the ultimate springs of being. A particle of gelatinous matter is found to obey the ordinary laws of chemistry; yet it moves and lives. The world is therefore asked to believe that chemistry can resolve the mysteries of existence."[2]

[1] Vol. ii. pp. 144, 145.

[2] Vol. ii. p. 429.

"A law of nature, as I regard the meaning of the expression, is not a uniformity which must be obeyed by all objects, but merely a uniformity which is, as a matter of fact, obeyed by those objects which have come beneath our observation. There is nothing whatever incompatible with logic in the discovery of objects which should prove exceptions to any law of nature." [1] "I demur to the assumption that there is any necessary truth even in such fundamental laws of nature as the indestructibility of matter, the conservation of force, or the laws of motion." [2]

"Let us assume, for a time at least, as a highly probable hypothesis, that whatever is to happen must be the outcome of what is; there then arises the question, What is? Now our knowledge of what exists must ever remain imperfect and fallible in two respects: First, we do not know all the matter that has been created, nor the exact manner in which it has been distributed through space. Secondly, assuming that we had that knowledge, we should still be wanting in a perfect knowledge of the way in which the particles of matter will act upon each other..... To assume, then, that scientific method can take everything within its cold embrace of uniformity, is to imply that the Creator cannot outstrip the intelligence of his creatures, and that the existing universe is not infinite in extent and complexity, — an assumption for which I can see no logical basis whatever." [3]

"The original conformation of the material universe, was, so far as we can possibly tell, free from all restriction. There was unlimited space in which to frame it, and an unlimited number of material particles, each of which could be placed in any one of an infinite number of different positions..... The problem of creation was, then, what mathematicians would call an indeterminate problem, and it was indeterminate in an infinitely infinite number of ways..... Out of infinitely infinite choices, which were open to the Creator, that one choice must have been made which has yielded the universe as it now exists." [4]

"Life altogether is an exception to the simple phenomena of mineral substances, not in the sense of disproving those laws, but in that of superadding forces of new and inexplicable character. Doubtless no law of chemistry is broken by the action of the nervous cells, and no law of physics by the pulses of the nervous fibres, but something requires to be added to our sciences in order that we even explain these subtile phenomena." [5]

"It is a mere assumption that the uniformity of nature involves the unaltered existence of our own globe. There is no kind of catastrophe which is too great or too sudden to be theoretically consistent with the reign of law. For all that our sciences can tell, human history may be closed in the next instant of time. The world may be dashed to pieces against some intruding body; it may be involved in a nebulous atmosphere

[1] Vol. ii. p. 430. [2] p. 431. [3] p. 432. [4] pp. 434, 435. [5] p. 436.

of hydrogen to be exploded a few seconds afterwards; it may be scorched up or dissipated into vapor by some great explosion in the sun; there might even be within the globe itself some secret cause of disruption, which only needs time for its manifestation."[1]

"I am inclined to find fault with mathematical writers, because they often exult in what they can accomplish, but omit to point out that what they do is but an indefinitely, nay, an infinitely, small part of what might be done..... This may be excusable so far as the immediate practical result of their researches is in question; but the custom has the effect of misleading the general public into the fallacious notion that mathematics is a perfect science, which accomplishes what it undertakes in a complete manner. On the contrary, it may be said that if a mathematical problem were selected by pure chance out of the whole variety which might be proposed, the probability is infinitely slight that a human mathematician could solve it."[2]

"After two centuries of continuous labor, the most gifted men have succeeded in calculating the mutual effects of three bodies each upon the other, under the simple hypothesis of the law of gravity. Concerning these calculations we must farther remember that they are purely approximate, and that the methods would not apply where four or more bodies are acting, and all produce considerable effects each upon the other. There is every reason to believe that each constituent of a chemical atom must go through an orbit in the millionth part of the twinkling of an eye, in which it successively or simultaneously is under the influence of many other constituents, or possibly comes into collision with them. It is, I apprehend, no exaggeration to say that mathematicians have scarcely a notion of the way in which they could successfully attack so difficult a problem of forces and motions."[3]

"If we are to apply scientific method to morals, we must have a calculus of moral effects, a kind of physical astronomy, investigating the mutual perturbations of individuals. But as astronomers have not yet fully solved the problem of three gravitating bodies, when shall we have a solution of three moral bodies?"[4]

"A science of history, in the true sense of the term, is an absurd notion. A nation is not a mere sum of individuals whom we can treat by the method of averages; it is an organic whole, held together by ties of infinite complexity. Each individual acts and reacts upon his own smaller or greater circle of friends; and those who acquire a public position, exert an influence on much larger sections of the nation. There will always be a few great leaders of exceptional genius or opportunities, the unaccountable phases of whose opinions and inclinations sway the whole body, even when they are least aware of it. From time to time arise critical positions, battles,

[1] Vol. ii. p. 443. [2] p. 451. [3] p. 453. [4] p. 458.

delicate negotiations, internal disturbances, in which the slightest incidents may profoundly change the course of history. A rainy day may hinder a forced march, and change the course of a campaign; a few injudicious words in a despatch may irritate the national pride; the accidental discharge of a gun may precipitate a collision, the effects of which will last for centuries."[1]

"Theologians have dreaded the establishment of the theories of Darwin and Spencer, as if they thought that those theories could explain everything upon the purest mechanical and material principles, and exclude all notions of design. They do not see that those theories have opened up more questions than they have closed. The doctrine of evolution gives a complete explanation of no single living form. While showing the general principles which prevail in the variation of living creatures, it only points out the infinite complexity of the causes and circumstances which have led to the present state of things. Any one of Mr. Darwin's books, admirable though they all are, consists but in the setting forth of a multitude of indeterminate problems. He proves, in the most beautiful manner, that each flower of an orchid is adapted to some insect which frequents and fertilizes it; and these adaptations are but a few cases of those immensely numerous ones which have occurred throughout the life of plants and animals. But why orchids should have been formed so differently from other plants; why anything, indeed, should be as it is, rather than in some of the other infinitely numerous possible modes of existence, he can never show. The origin of everything that exists is wrapped up in the past history of the universe. At some one or more points in past time there must have been arbitrary determinations which led to the production of things as they are."[2]

"My purpose [in this concluding chapter] is the purely negative one of showing that atheism and materialism are no necessary results of scientific method. ..... I draw one distinct conclusion that we cannot disprove the possibility of Divine interference in the course of nature."[3]

"The same power which created material nature, might, so far as I can see, create additions to it, or annihilate portions which do exist. Such events are doubtless inconceivable to us in a certain sense; yet they are no more inconceivable than the existence of the world as it is. The indestructibility of matter, and the conservation of energy, are very probable scientific hypotheses; ..... but it would be a gross misconception of scientific inference to suppose that they are certain in the sense that a proposition in geometry is certain, or that any fact of direct consciousness is certain in itself. Philosophers, no doubt, hold that *de nihilo nihil fit;* that is to say, their senses give them no means of imaging to the mind how creation can take place. But we are on the horns of a trilemma; we must either deny that anything exists, or we must allow that it was created out of nothing, at

[1] Vol. ii. p. 459. [2] p. 463. [3] p. 465.

some determinate date, or that it existed from past eternity. The first alternative is absurd; the other two seem to me equally conceivable."[1]

"Go on as far as we will in the sub-division of continuous quantity, yet we never get down to the absolute point. Thus scientific method leads us to the inevitable conception of an infinite series of successive orders of infinitely small quantities. If so, there is nothing impossible in the existence of a myriad universes within the compass of a needle's point, each with its stellar systems, and its suns and planets, in number and variety unlimited. Science does nothing to reduce the number of strange things that we may believe. When fairly pursued it makes large drafts upon our powers of comprehension and belief."[2]

"Science will not deny the existence of things because they cannot be weighed and measured. It will rather lead us to believe that the wonders and subtilties of possible existence surpass all that our mental powers allow us clearly to perceive. The study of abstract logical and mathematical forms has seemed to convince me that even space itself, is no requisite condition of conceivable existence. Everything, we are told by materialists, must be here or there, nearer or farther, before or after. I deny this — and point to logical relations as my proof..... So far am I from accepting Kant's doctrine, that space is a necessary form of thought, that I regard it as an accident, and an impediment to pure logical reasoning. Material existences must exist in space, no doubt; but intellectual existences may be neither in space nor out of space; they may have no relation to space at all, just as space itself has no relation to time. For all that I can see, then, there may be intellectual existences to which both time and space are nullities."

"Now among the most unquestionable rules of scientific method is that first law, that whatever phenomenon is, is. We must ignore no existence whatever; we may variously interpret or explain its meaning and origin; but if a phenomenon does exist, it demands some kind of explanation. If, then, there is to be a competition for scientific recognition, the world without us must yield to the undoubted existence of the spirit within. Our own hopes and wishes and determinations are the most undoubted phenomena within the sphere of consciousness. If men do act, feel, and live as if they were not merely the brief products of a casual conjunction of atoms, but the instruments of a far-reaching purpose, are we to record all other phenomena and pass over these? We investigate the instincts of the ant and the bee and the beaver, and discover that they are led by an inscrutable agency to work towards a distant purpose. Let us be faithful to our scientific method and investigate, also, those instincts of the human mind, by which man is led to work as if the approval of a Higher Being were the aim of life."[3]

[1] Vol. ii. p. 466. [2] p. 467. [3] pp. 468–470.

ARTICLE IV.

RECENT WORKS BEARING ON THE RELATION OF SCIENCE TO RELIGION.

BY REV. GEORGE F. WRIGHT, ANDOVER, MASS.

NO. II.—THE DIVINE METHOD OF PRODUCING LIVING SPECIES.

In preparing our remarks on the subject named above, we have consulted the following works. We specify the editions to which we have particularly referred. We do not pretend that we include in our list all the works which have been published on the subject, but mention those only which we have examined.

Agassiz. 1. Principles of Zoölogy; touching the Structure, Development, Distribution, and Natural Arrangement of the Races of Animals, Living and Extinct. By Louis Agassiz and A. A. Gould. Revised edition. pp. 248. Boston. 1855.

2. Contributions to the Natural History of the United States of America [Essay on Classification]. Vol. i. pp. 232. Boston. 1857. Reviewed by Dana in American Journal of Science for March 1858. pp. 202–216; April, pp. 321–341.

3. Methods of Study in Natural History. pp. 318. Boston. 1871.

Argyll. 1. The Reign of Law. By the Duke of Argyll. First American from fifth London edition. pp. 462, xxvii. New York. 1868.

2. Primeval Man. An Examination of some Recent Speculations. pp. 200. New York. 1869.

3. Article in Contemporary Review, Vol. xxvi. pp. 352–376.

Chadbourne. Final Cause of Varieties. By P. A. Chadbourne, Professor in [now President] Williams College. Bib. Sac., Vol. xxi. pp. 348–362.

Chapman. Evolution of Life. Philadelphia. 1873.

Cope. Transactions of the American Philosophical Society, Vol. xiii. (1869). The Hypothesis of Evolution in Lippincott's Magazine. See also University Series, No. 4.

Dana. 1. Manual of Geology: Treating of the Principles of the Science; with special reference to American Geological History. By James D. Dana. Silliman Professor of Geology and Mineralogy in Yale College. 2d ed. pp. 828. New York. 1875.

2. Articles in Bibliotheca Sacra, Vol. xiii. pp. 80, 631; Vol. xiv. pp. 388, 461, 854. New Englander, Vol. xxii. pp. 283, 495. American Journal of Science for March 1858, pp. 202–216; April, pp. 321–341.

Darwin. On the Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life. By Charles Darwin, M.A., F.R.S., etc. 6th ed. pp. xxi, 458. London. 1873.

2. The Variation of Animals and Plants under Domestication. 2 Vols. pp. 494, 568. New York: Orange Judd and Co.

3. The Descent of Man, and Selection in Relation to Sex. New edition, revised and augmented. Complete in one volume. pp. 688. New York. 1875.

4. The Expressions of the Emotions in Man and Animals. pp. 374. London. 1872.

Dawson. 1. The Story of the Earth and Man. By J. W. Dawson, LL.D. pp. 493. New York. 1874.

2. Nature and the Bible. pp. 257. New York. 1875.

Foster, Rev. Randolph S., D.D.,LL.D., President of the Drew Theological Seminary, Madison, N. J. The Ingham Lectures. pp. 1–106. Cleveland, O. 1873.

Gray. 1. Natural Selection not inconsistent with Natural Theology. A Free Examination of Darwin's Treatise on the Origin of Species, and of its American Reviewers. By Asa Gray, M.D., Fisher Professor of Natural History in Harvard University. Reprinted from the Atlantic Monthly for July, August, and October, 1860. pp. 55. London. 1861.

2. Articles in the American Journal of Science and Arts for March 1860, pp. 153–184; Sept. 1860, pp. 226–239.

3. Articles in The Nation (New York), Vol. xviii. pp. 44–46 and 348–351.

4. An Address of Professor Asa Gray, President of the American Association for the Advancement of Science, Delivered at the Meeting held at Dubuque, Iowa, Aug. 1872.

5. Memoirs of American Academy of Arts and Sciences. Vol. vi. pp. 377–452. Boston. 1859.

Haeckel. 1. Generelle Morphologie der Organismen. Allgemeine Grundzüge der organischen Formen-Wissenschaft, mechanisch begründet durch die von Charles Darwin, reformirte Descendenz-Theorie, von Dr. Ernst Haeckel, Professor an der Universität Jena. Tzwei Bände, pp. 574, 462. Berlin. 1866.

2. Natürliche Schöpfungsgeschichte, etc. pp. 568. Berlin. 1868. A translation of this work has been published in two volumes by Appleton and Co.

Henslow. The Theory of Evolution of Living Things, and the Application of the Principles of Evolution to Religion, considered as Illustrative of the Wisdom and Beneficence of the Almighty. By the Rev. George Henslow, M.A., F.L.S., F.G.S. pp. 220. London. 1873.

Hodge. 1. Systematic Theology. By Charles Hodge, D.D., Professor in the Theological Seminary, Princeton, N. J. 3 Vols. pp. 648, 732, 880. New York. 1872, 1873.

2. What is Darwinism? pp. 178. New York. 1874.

Huxley. 1. On the Origin of Species; or, The Causes of the Phenomena of Organic Nature. A Course of Six Lectures to Working Men. By Thomas H. Huxley, F.R.S., F.L.S. pp. 150. New York. 1872.

2. Lay Sermons, Addresses, and Reviews, etc. pp. 344. London. 1872.

3. Critiques and Addresses. pp. 350. London. 1873.

Hooker. Flora of Tasmania. Introductory Essay, American Journal of Science (1860), Vol. xxix. pp. 1 ff., and 305 ff.

Hyatt (Professor Alpheus). Memoirs of the Boston Society of Natural History, Vol. i., part 2d (1867); American Naturalist, Vol. iv. pp. 230–277 (June 1870).

Jevons. The Principles of Science: a Treatise on Logic and Scientific Method. By W. Stanley Jevons, M.A., F.R.S. 2 Vols. pp. 463, 480. New York. 1874.

Le Conte. Religion and Science. By Joseph Le Conte, Professor of Geology and Natural History in the University of California. pp. 324. London. 1874.

Lyell. 1. Principles of Geology; or the Modern Changes of the Earth and its Inhabitants, considered as illustrative of Geology. By Sir Charles Lyell, Bart., M.A., F.R.S. Eleventh and entirely revised ed. 2 vols. pp. 671, 652. New York: D. Appleton and Co. 1873.

2. The Student's Elements of Geology. pp. 624. London. 1871.

3. Geological Evidences of the Antiquity of Man. Fourth ed., revised. pp. 572 and xix. London. 1873.

McCosh. Religious Aspects of the Doctrine of Development. By the Rev. James McCosh, D.D., LL.D., Princeton, N. J., President of the College of New Jersey. In Proceedings of the Evangelical Alliance, 1873, pp. 264–271.

Mill. A System of Logic, Ratiocinative and Inductive. Being a connected View of the Principles of Evidence and the Methods of Scientific Investigation. By John Stuart Mill. 8vo. pp. 600. New York. 1867.

Miller. The Footprints of the Creator. By Hugh Miller. pp. 337. Boston. 1854.

Mivart. 1. On the Genesis of Species. By St. George Mivart, F.R.S. pp. 296. London. 1871.

2. Contemporary Review, Nov. 1875. pp. 936–957.

Müller Max. Chips from a German Work-Shop. Vol. iv.

Murphy. Habit and Intelligence, in their Connection with the Laws of Matter and Force. A Series of Scientific Essays. By Joseph John Murphy. 2 vols. pp. 349, 240. London: Macmillan and Co. 1869.

Owen. 1. Palaeontology; or a Systematic Summary of Extinct Animals and their Geological Relations. By Richard Owen, F.R.S., Superintendent of the Natural History Department in the British Museum, etc. 2d ed. pp. 463. Edinburgh. 1861.

2. The Anatomy of the Vertebrates. 3d vol. pp. 915. London. 1868. The last chapter of Vol. iii. was republished in Silliman's Journal of Science, for January, 1869.

Peabody. 1. Christianity and Science. A Series of Lectures by Rev. A. P. Peabody, D.D., of Harvard College. pp. 287. NewYork. 1875.

2. Bearing of Modern Scientific Theories on the Fundamental Truths of Religion. Bib. Sac., Vol. xxi. pp. 710–724.

Parsons. On the Origin of Species. By Theophilus Parsons, Dane Professor of Law in Harvard University, Cambridge, Mass. American Journal of Science and Arts, July 1860. pp. 1–13.

Pfaff (Friederich, Professor der Geologie zu Erlangen), Die neuesten Forschungen und Theorieen auf dem Gebiete der Schöpfungsgeschichte. Frankfort. 1868.

Porter. 1. Science and Revelation; their Distinctive Provinces, etc. An Address by J. L. Porter, D.D., LL.D., Prof. of Biblical Criticism, Assembly's College, Belfast. pp. 38. Belfast. 1874.

2. Theological Colleges, etc. Opening Lecture, with special Reference to the Evil Tendencies of Recent Scientific Theories. pp. 24. Belfast. 1874.

Reusch. Bibel und Natur. Vorlesungen über die mosaische Urgeschichte und ihr Verhältniss zu den Ergebnissen der Naturforschung. Von Dr. F. Heinrich Reusch, Professor der Theologie an der Universität zu Bonn. Dritte, umgearbeitete Auflage. pp. 524. Freiburg. 1870.

Seelye. A Criticism of the Development Hypothesis. By Rev. Julius H. Seelye, D.D. 4to. pp. 16. Appendix to Vol. ii. of Johnson's Natural History. New York. 1874. See also Johnson's New Universal Cyclopaedia, under Darwinism.

Schmidt. The Doctrine of Descent and Darwinism. By Oscar Schmidt, Professor in the University of Strasburg. pp. 334. London. 1875.

Spencer. The Principles of Biology. By Herbert Spencer. 2 vols. pp. 492, 569. New York. 1871.

St. Clair. Darwinism and Design; or Creation by Evolution. By George St. Clair, F.G.S., M.A.I., etc. pp. 359. London. 1873.

Wallace. 1. Contributions to the Theory of Natural Selection. By A. R. Wallace. 2d ed. pp. 384. New York. 1871.

2. The Malay Archipelago, etc. pp. 638. New York. 1869.

Whewell. 1. History of the Inductive Sciences from the Earliest to the Present Time. 3d ed., with additions. 2 vols. pp. 566, 648. New York. 1870. First edition published in 1837; third and enlarged edition in 1857.

2. The Philosophy of the Inductive Sciences. By the Rev. William Whewell, B.D. 2 vols. pp. 586, 523. London. 1840.

Whitney (Professor W. D.) Darwinism and Language. Article in North American Review. Vol. cxix. pp. 61–88.

Winchell. The Doctrine of Evolution: Its Data, its Principles, its Speculations, and its Theistic Bearings. By Alexander Winchell, LL.D., Chancellor of Syracuse University, Author of Sketches of Creation, Geological Chart, etc., etc. pp. 148. New York. 1874.

Youmans. An Exposition of the Development Hypothesis. By Prof. E. L. Youmans, M.D., etc. 4to. pp. 35. Appendix to Vol. i. of Johnson's Natural History. New York. 1874. See also Johnson's New Universal Cyclopaedia, under Darwinism.

PERIODICAL LITERATURE BEARING ON THE SUBJECT.

American Theological Review. Vol. II. pp. 326–344, by Pres. D. R. Goodwin, D.D. Vol. II. pp. 496–518; Vol. IV. pp. 680–687; Vol. V. pp. 394–405, all by Prof C. Dewey.

American Presbyterian Review. Vol. III. (1871) pp. 347–379, by Prof. John Bascom.

Bibliotheca Sacra. Vol. XX. pp. 256–278, by Rev. J. M. Manning, D.D. Vol. XX. pp. 489–561, by Prof. Edward Hitchcock, D.D. Vol. XXIV. pp. 363–388, 429–481, by Prof. C. H. Hitchcock. Vol. XXVIII. pp. 654–685, by Prof. J. Bascom (on Instinct). Vol. XXIX. pp. 240–289, by Prof. F. Gardiner, D.D. See also in Catalogue of Authors, Dana, Chadbourne.

Baptist Quarterly. Vol. II. pp. 257–274, by Prof. Heman Lincoln. Vol. VI. pp. 1–29, by Charles E. Hamlin. pp. 129–146, by Samson Talbot. Vol. VII. pp. 69–87, 204–227, both by E. Nesbit, D.D. Vol. VIII. pp. 250–269; Vol. IX. pp. 48–74, 281–305, all three by Prof. L. E. Hicks, pp. 149–164, by S. H. Carpenter, LL.D.

Christian Examiner (for May 1860). pp. 449–464. One of the most spirited of the early protests.

Methodist Quarterly. Vol. XLIII. pp. 605–628, by Prof. W. C. Wilson. Vol. XLV. pp. 29–55, by Charles Martins, translated from the "Revue des Deux Mondes," pp. 175–179, editorial, pp. 181–204, by Henry M. Harmon, Esq. Vol. XLVII. pp. 29–49, 186–207, both from the "Revue des Deux Mondes," pp. 207–230, by Prof. Tayler Lewis, pp. 378–400, by John Johnston, LL.D. Vol. XLVIII. pp. 187–206, from the German of Dr. O. Föchler.

New Englander. Vol. XXVI. pp. 603–636, by Prof. W. N. Rice. Vol. XXX. pp. 464–471, by Rev. James B. Tyler. pp. 601–616, by Rev. G. F. Wright. Vol. XXXI. pp. 447–468, by Rev. Borden P. Bowne.

North American Review. Vol. XC. pp. 474–506, Vol. XCI. pp. 528–536. Vol. CVII. pp. 465–500, by H. B. Adams. Vol. CX. pp. 284–299, by

Rev. C. L. Brace. Vol. CXI. 282–311, Vol. CXIII. pp. 63–103, Vol. CXV. pp. 1–31, Vol. CXVI. pp. 245–310. These last four were by Chauncey Wright, of Cambridge, Mass. They are a defense of Darwinism against the attacks of Mivart; and were so much valued by Mr. Darwin that the first of the series was republished by him in pamphlet form.

North British Review. Vol. XXXII. pp. 455–487, Vol. XLVI. (June 1867) pp. 277–318. This last is anonymous, but is one of the ablest arguments against Darwinism that has appeared.

Princeton Review. Vol. XXXII. pp. 577–608, Vol. XXXIV. pp. 435–464, Vol. XLI. pp. 5–33, Vol. XLII. pp. 55–86.

It is neither necessary nor desirable for the understanding of the subject to peruse all the works here mentioned. A word of advice will doubtless be acceptable to those who have not unlimited time to spend upon the literature of the subject. The following books are indispensable to a just appreciation of the state of progress in Evolutionary Theories: Darwin's Origin of Species, 6th ed.; Descent of Man, 2d ed.; Animals and Plants under Domestication; Lyell's Principles of Geology, 10th or 11th ed.; Dana's Manual of Geology, 2d ed.; Agassiz on Classification, or Methods of Study in Natural History; Owen's Palæontology, and chap. 40 in Anatomy of the Vertebrates; Wallace on Natural Selection; Whewell, Mill, and Jevons on Inductive Logic.

Of the shorter treatises the articles of Prof. Gray, in the order named, should have the first place. They are marked equally by scientific accuracy, philosophical insight, metaphysical discrimination, and religious reverence. It is greatly to be regretted that they are not collected and published in a single volume. Huxley, Henslow, Schmidt, St. Clair, and Winchell give tolerably complete summaries of the arguments for the Darwinian Theory. Schmidt and Haeckel are too ready to reason upon the subject from *a priori* principles, and are offensively dogmatic. The weightiest objections to Darwinism are found best stated, first, in his own works, then in those of Agassiz, Argyll, Dawson, Mivart, Owen, and Wallace. Cope, Gray, Henslow, Hyatt, Mivart, Owen, St. Clair, Wallace, and Winchell are Evolutionists, without being altogether Darwinians. Hodge has so many misrepresentations that he furnishes much ground for the little esteem with which theological criticisms of scientific subjects are regarded by scientific men.[1]

[1] In confirmation of this assertion, which is not made recklessly, the reader is referred to the Bibliotheca Sacra, Vol. xxxi. pp. 788, 789, for one glaring instance of misapprehension. For a second, let the reader compare what Huxley really said with what Dr. Hodge, on page 16 of the 2d Vol. of his Theology makes him say. Huxley is made to say that he from the first regarded Darwin's "Origin of Species" as "the death-blow of teleology, i.e. of the doctrine of design and purpose in nature." We have no fondness for Professor Huxley,

Twenty-five years ago naturalists and theologians were in a heated discussion over the "Unity of the Human Race." The doctrine of the immutability of species was pushed by some to such an extreme, that they declared it incredible that the different races of men should have descended from a single pair. Professor Agassiz was an advocate of this view; and his name was, on that account, a terror to orthodox interpreters of the Bible. Even in 1872 Dr. Hodge makes the assertion that the unity of the human race is denied by "a large and increasing class of scientific men."[1] It would gratify a good deal of curiosity if the learned doctor had informed us from what ranks this "large class of scientific men," who disbelieve in the unity of the human race, is receiving so many recruits. For it seems to appear on the face of almost all recent works scientifically treating the subject of vegetable or animal life, that the question of the day is not whether the human races are of common origin, but

and should despair of success in any attempt to reconcile with one another, all of his crude and heated utterances; but even he should have his due. Professor Huxley did indeed write that "teleology, *as commonly understood*, had received its death-blow at Mr. Darwin's hands." Dr. Hodge, when he quotes Huxley on page eighty of his book on Darwinism, inserts the omitted phrase which we have italicized, but does not seem to see that it in any degree removes the curse from Professor Huxley, nor does he appear to have noticed the following significant sentences which occur in the very paragraph from which his quotation is drawn. "We [Huxley] should say that, apart from his [Darwin's] merits as a naturalist, he has rendered a most remarkable service to philosophical thought by enabling the student of nature to recognize, to their fullest extent, those adaptations to purpose which are so striking in the organic world, and which teleology has done good service in keeping before our minds, without being false to the fundamental principles of a scientific conception of the universe. The apparently diverging teachings of the teleologist and the morphologist are reconciled by the Darwinian hypothesis." — Lay Sermons (4th ed.), pp. 303, 304. London, 1872. Compare further, Dr. Hodge's quotation from, and comments upon, Professor Huxley's Article in the Academy (1869), with the full statement of Professor Huxley (republished in Critiques and Addresses, pp. 305–308), in which he says, p. 307, "The teleological and the mechanical views of nature are not, necessarily, mutually exclusive. On the contrary, the more purely a mechanist the speculator is, ... the more completely is he thereby at the mercy of the teleologist, who can always defy him to disprove that this primordial molecular arrangement was not intended to evolve the phenomena of the universe."

[1] Systematic Theology, Vol. ii. p. 77.

whether the whole animal kingdom may not have descended in unbroken chain from one progenitor.

I. Outline.[1]

This question we propose to discuss in the following order:

(1) We will present, as fully as our limits will allow, the argument in favor of the evolutionary origin of species.

(2) Give a summary of the objections to which these arguments are open, together with the rejoinders of those who advocate the origin of species through evolution.

(3) Treat of the analogies between Calvinism and the modern bent of scientific men.

(4) Make a provisional adjustment of evolutionary theories to the true doctrine of final cause or design in nature.

(5) Discuss more particularly the attitude of the Bible toward scientific discovery.

The present paper will be devoted to a statement of the argument in favor of the Origin of Species by Evolution.

II. Reasons for entering this Field of Discussion.

There is constant danger that misunderstanding should

[1] We beg leave to emphasize in the outset every term in the title of this Article. For we never mean to lose sight of these two postulates, both of which we shall defend at a later stage of the discussion. 1st. That scientific men deal only with the method that appears in the sequences of secondary causes. Even when treating of the origin of species, they do not, if they speak as scientific men, refer to the first and true causal origin. This is a problem of theology. But in scientific treatises reference is had solely to the order under which actual forces are seen or inferred to operate. 2d. Whatever the method may be, God is the author of it. God both makes the machine and operates it. The writer begs still farther leave to warn his readers that he must not be held to personal responsibility for the theories here discussed, and the arguments presented. This, and the succeeding paper in the series, are summaries of the arguments of others. It is best also here to emphasize the fact that if the theory of natural selection should be established in its general conclusions, it would not necessarily comprehend the essential characteristics of man in the scope of its operations. And on the other hand, the miraculous creation of man might no more disprove the general theory of natural selection than an ordinary miracle of Christ would disprove the general reign of natural law. The exception may even prove the rule. There would be no miracle if uniformity did not ordinarily prevail. There is, doubtless, miraculous interference with uniformities of nature when there is sufficient reason for it, and only then.

arise between the students of nature and the interpreters of the Bible. They who should dwell together in peace are too often at war with one another. It is our purpose to mediate between these parties, to show how asperities may be avoided, to reveal the body of truth which both hold in common, and more definitely to mark out the provinces in which each may have undisputed sway.

Dr. Whewell,[1] in his chapter on the "Relation of Tradition to Palaetiology," has with great wisdom and candor discussed the relations that ought to subsist between theologians and men of science. He shows, in the first place, how the promulgators of religious truth are compelled to avoid reference to the more recondite matters of science, for fear of calling attention away from the weightier matters of the spiritual life that more personally concern men. He points out that the flexibility of the scriptures in adapting their teaching to scientific discoveries arises chiefly from this excellence, that their language is "adapted to the common state of man's intellectual development, in which he is supposed not to be possessed of science."[2] But from these facts there must arise trials of faith.

"The moral and providential relations of man's condition are so much more important to him than mere natural relations, that at first we may well suppose he will accept the sacred narrative, as not only unquestionable in its true import, but also as a guide in his views even of mere natural relations. He will try to modify the conceptions which he entertains of objects and their properties, so that the sacred narrative of the supernatural condition shall retain the first meaning which he had put upon it in virtue of his own habits in the usage of language."[3]

In the same chapter it is very well remarked that physical science can tell us nothing of the origin of things.

"The thread of induction respecting the natural course of the world snaps in our fingers when we try to ascertain where its beginning is. Since, then, science can teach us nothing positive respecting the beginning of things, she can neither contradict nor confirm what is taught by scripture on that subject.... The providential history of the world has its own beginning and its own evidence."[4]

[1] The Philosophy of the Inductive Sciences, Vol. ii. pp. 137–157.
[2] Ibid. p. 143. [3] Ibid. pp. 141, 142. [4] Ibid. p. 145.

Another fact of great interest is noticed by the same author.

"Scientific views, when familiar, do not disturb the authority of scripture.... When the language of scripture, invested with its new meaning, has become familiar to men, it is found that the ideas which it calls up are quite as reconcilable as the former ones were with the most entire acceptance of the providential dispensation. And when this has been found to be the case, all cultivated persons look back with surprise at the mistake of those who thought that the essence of the revelation was involved in their own arbitrary version of some collateral circumstance in the revealed narrative. At the present day we can hardly conceive how reasonable men could ever have imagined that religious reflections on the stability of the earth, and the beauty and use of the luminaries which revolve around it, would be interfered with by an acknowledgment that this rest and motion are apparent only. And thus the authority of revelation is not shaken by any changes introduced by the progress of science in the mode of interpreting expressions which describe physical objects and occurrences; provided the new interpretation is admitted at a proper season, and in a proper spirit; so as to soften, as much as possible, both the public controversies and the private scruples which almost inevitably accompany such an alteration."[1]

The question is then raised as to the proper time and spirit in which the "religious and enlightened commentator" is to make such changes in the current interpretation of sacred scripture as shall adjust it to new scientific theories. We may sum up his views in two or three easily remembered sentences. (1) Do not make scientific difficulties for the sake of adjusting scripture to them. The conservatism of religious feeling is of so much value that it is a crime to disturb it wantonly, or before there is a tolerably clear case of necessity. (2) Face the difficulties manfully when they appear, and show the same candor in your treatment of scientific men that you ask them to exhibit to you. Both theologians and men of science should remember, as Kepler says, that "it is for their common advantage to conciliate the finger and the tongue of God—his works and his word."[2] There is great loss in unreasonably delaying the concessions

[1] The Philosophy of the Inductive Sciences, Vol. ii. pp. 146, 147. See also, History of Inductive Science, Vol. i. p. 286.

[2] Quoted by Whewell, Philosophy of the Inductive Sciences, Vol. ii. p. 153.

which biblical interpreters must from time to time make to science.

In endeavoring to state and measure the scientific argument with which our discussion has to do, it may seem unfortunate that this is not a scientific periodical, and that the writer is not recognized as authority on any scientific subject. This, however, has its advantages. Unless a scientific theory is of such a nature, and is so far developed and established, that its leading points can be both apprehended and stated by the average religious teacher, the time has not arrived for religious teachers to pay much attention to it. Furthermore, we who make a special study of historical records and monuments can pass intelligent judgment on the credibility of witnesses who report scientific observations, and upon the bearing of their established facts upon a theory of causation. For scientific observers do not pretend to see the bond of secondary causation which unites similar things together. The existence of such a bond is, in any case, an inference. It is visible only to thought, and is discoverable only by the exercise of reason.

We must remember also, that the discussions upon which we are entering belong to the inductive sciences, in which it is unfair to demand demonstration. In this realm we must be satisfied with the highest attainable degree of probability. We must not overlook the distinction between a *theory* and a *theorem*. The first is of induction; the second of deduction. One is provisional; the other is absolute.

As religious teachers, dealing with the proofs of an external revelation, we are to be classed with inductive philosophers. The providential dispensation known as Christianity, is established by a rigorous application of the principles of induction. We are confident that the present bent of the scientific mind is favorable to that style of reasoning by which the credibility and authority of the Bible have been established. In the present endeavor to account for the origin of species, science is taking a higher aim than has heretofore been seriously entertained by any large number

of her votaries. Scientific men aim now to do far more than observe and classify. They are seeking the deeper meaning of the facts which they observe. They are endeavoring to trace out the bond of order which all believe to reign supreme in nature. This kind of intellectual endeavor is congenial to the theological mind. Because this work is both important and appropriate for us, we make bold to enter the arena.

III. Definition of Species.

It is necessary at the outset to ask the question, What is a species? Indeed our whole discussion will have regard to the true meaning of that word. With the limited space at our command, it would not be best to plunge into the deep mysteries of nominalism and realism. These mysteries, however, are more closely related to our subject than might at first be supposed. The definition of species given by Prof. Dana is sufficiently realistic.[1] "A species among living things, then, as well as inorganic, is based on *a specific amount or condition of concentrated force defined in the act or law of creation*," i.e. a species is a real unfolding of a real force, and by whatever act or law of creation defined, is the realization of a well-defined divine idea. But even this definition, distinct as it is in recognizing the creative act which is the initiatory cause of the species, does not determine the mode through which the creative impulse reaches its realization in natural forms. For anything given in this definition, we may suppose that the forces which became at last concentrated in the conditions of specific forms of life, may have run in devious and independent channels during all the time preceding their intersection and consequent production of what we call the species.

A prominent question involved in the study of natural history is, What part does inheritance play in giving to individuals that degree of likeness which constitutes them one species? The ordinary answer has been that the points of

[1] See Bibliotheca Sacra, Vol. xiv. p. 861.

likeness which characterize a species are the result of the law of inheritance; while the variations which constitute varieties and sub-varieties, are the result of the action of the diverse conditions of existence.

According to Linnaeus,[1] "Species tot sunt, quot diversas formas ab initio produxit Infinitum Ens; quae formae, secundum generationis inditas leges, produxere plures, at sibi semper similes." In the words of Professor Oliver, "All individual plants which resemble each other so nearly that it is consistent with experience to suppose that they may all have sprung from one parent stock, are regarded as belonging to the same species."[2] Agassiz insists that to bring in descent from one parent stock, as an element in the definition of species, is an entire begging of the question, and only serves to add perplexity to the subject;[3] for no one has ever preserved the genealogy of plant or animal. If the individuals of a species have a common pedigree, how is that to be proved? It is evident that aside from inferential proof, there is none. "*Individual plants* [or animals] *which resemble each other so nearly that it is consistent with experience to suppose that they may all have sprung from one parent stock*," are inferred to have a common ancestry. And for this reason; that inheritance is, in the case of plants and animals, a known cause of resemblance in operation around us on the most extended scale; and furthermore, it is the only known cause of such resemblance. It is by no false analogy that inheritance is brought in as the bond of unity in the constitution of a species. The bond, however, is usually inferential; and naturalists experience a vast amount of perplexity in determining how great a degree of unlikeness is compatible with descent from a common ancestry. The practical difficulty encountered in limiting species may be seen in a statement of Dr. Gray.

[1] Philosophia Botanica (1770), §157, p. 99. Quoted in Jevon's Principles of Science, Vol. ii. p. 415.

[2] Lessons in Elementary Botany. By David Oliver, F.R.S., F.L.S., etc. (3d ed., London, 1870), p. 122.

[3] See Essay on Classification, p. 163 ff.

"In a flora so small as the British, one hundred and eighty-two plants generally reckoned as varieties have been ranked by some botanists as species. Selecting the British genera which include the most polymorphous forms, it appears that Babington's Flora gives them two hundred and fifty-one species, Bentham's only one hundred and twelve; a difference of one hundred and thirty-nine doubtful forms. ... Illustrations of this kind may be multiplied to a great extent."[1]

Commenting upon these facts, the distinguished botanist from whom we quote farther remarks:

"They make it plain that whether species in nature are aboriginal and definite or not, our practical conclusions about them, as embodied in systematic works, are not *facts* but *judgments*, and largely fallible judgments. ... We are constrained by our experience to admit the strong likelihood, in botany, that varieties, on the one hand, and what are called closely-related species, on the other, do not differ except in degree. Whenever the wider difference separating the latter can be spanned by intermediate forms, as it sometimes is, no botanist long resists the inevitable conclusion. ... Whether we should continue to regard the forms in question as distinct species, depends upon what meaning we shall finally attach to that term; and that depends upon how far the doctrine of derivation can be carried back, and how well it can be supported."

But this question runs insensibly into others of a kindred nature. The foregoing and the two following sections are one problem in three forms of statement.

IV. Importance and Difficulty of Classification.

It is not optional with the scientific man whether he classify the facts of nature. He must classify or retire from the field. Unless he group things according to their prominent resemblances, disregarding, meanwhile, their minor differences, the man of science will be put to utter confusion by the interminable number of objects that come to his attention. Even as it is, the progress of science in enumerating so-called species is rapidly outstripping the power of retention which a single finite mind may possess. For example, botanists enumerate more than one hundred thousand species of phaenogamous plants; zoölogists, more than three hundred and fifty thousand species of animals. There are three hundred thousand species of the class articulata, and

[1] Silliman's Journal of Science, March, 1860, p. 168 f.

twenty-one thousand of vertebrata.[1] The elder De Candolle spent a long life on a descriptive catalogue of phaenogamous plants. His son took up the work, but has recently abandoned it in despair. It is estimated that nearly four hundred years would be required for one man to arrange and systematically describe them.[2] Between four and five hundred closely-printed octavo pages are required for their enumeration of the species of the Leguminous family,[3] and between sixteen and seventeen hundred for those of the great family of Compositae. Were it not for the fact that there is method in the relation of this vast multitude of species to one another, naturalists might well cease from the work of classification, and limit themselves to the contemplation of the individuals. But species do not have a hap-hazard existtence; they fall into a hierarchy of orders.

"It is a truly wonderful fact, the wonder of which we are apt to overlook from familiarity, that all animals and all plants throughout all time and space, should be related to each other in natural groups, subordinate to groups, in the manner which we everywhere behold, namely, varieties of the same species most closely related together; species of the same genus less closely and unequally related together, forming sections and sub-genera; species of distinct genera much less closely related; and genera related in different degrees, forming sub-families, families, orders, sub-classes, and classes. The several subordinate groups in any class cannot be ranked in a single file, but seem rather to be clustered round points, and these round other points, and so on in almost endless cycles."[4]

"According to the laws of botanical nomenclature adopted by the International Botanical Congress, held at Paris, August, 1867, no less than twenty-one names of classes[i.e. grades of relationship], are recognized, viz. Kingdom, Division, Sub-division, Class, Sub-class, Cohort, Sub-cohort, Order, Sub-order, Tribe, Sub-tribe, Genus, Sub-genus, Section, Sub-section, Species, Sub-species, Variety, Sub-variety, Variation, Sub-variation."[5]

V. Does a Species have more than one Centre of Dispersion?

It will be well at this point to consider more attentively

[1] See Dana's Manual of Geology (1st ed.), p. 575.

[2] See Popular Science Monthly, April, 1874. Also, Nation, Vol. xviii. p. 42.

[3] Lindley's Ladies' Botany, Vol. i. p. 122.

[4] Darwin's Origin of Species, pp. 135, 136.

[5] Jevon's Principles of Science, Vol. i. p. 417.

how a scientific man undertakes to solve the problem of an abnormal distribution of a species. When, for example, the same, or apparently the same species of animal or plant is found distributed over both England and the Continent, the question at once arises, how was this distribution effected? There are few intellectual operations more interesting than to observe the method of a naturalist as he attacks some of the more difficult of these problems concerning the distribution of the members of a single species. The law of parsimony, or of the continuity of nature, is of the highest importance in the inductive sciences. Hugh Miller thus emphasizes the necessity of insisting that members of the same species must have originated in the same centre.

"If members of the same species may exist through *de novo* production, without hereditary relationship, so thoroughly, in consequence, does the fabric of geological reasoning fall to the ground, that we find ourselves incapacitated from regarding even the bed of common cockle or mussel shells, which we find lying a few feet from the surface on our raised beaches, as of the existing creation at all. Nay, even the human remains of our moors may have belonged, if our principle of relationship in each species be not a true one, to some former creation, cut off from that to which we ourselves belong, by a wide period of death. All palæontological reasoning is at an end forever, if identical species can originate in independent centres, widely separated from each other by periods of time; and if they fail to originate in periods separated by time, how or why in centres separated by space?"[1]

Thus also Dr. Gray.

"The ordinary and generally-received view assumes the independent, specific creation of each kind of plant and animal in a primitive stock, which reproduces its like from generation to generation, and so continues the species. ... Whenever two reputed species are found to blend in nature, through a series of intermediate forms, community of origin is inferred, and all the forms, however diverse, are held to belong to one species. ... The orthodox conception of species is that of lineal descent: all the descendants of a common parent, and no other, constitute a species; they have a certain identity, because of their descent, by which they are supposed to be recognizable. So naturalists had a distinct idea of what they meant by the term species, and a practical rule, which was hardly the less useful because difficult to apply in many cases, and because its application was indirect, that is, the community of origin had to be inferred

[1] Footprints of the Creator, p. 255.

from the likeness; that degree of similarity, and that only, being held to be conspecific which could be shown or reasonably inferred to be compatible with a common origin."[1]

In accounting for the distribution of a species over both England and the Continent, it is readily seen to be no violent supposition that the island was formerly a part of the continent. But the following problem, to which Prof. Asa Gray[2] applied himself a few years ago, is far more intricate; yet it is extremely difficult, not to say impossible, for one to follow the steps of the reasoning and not assent to the conclusion. The facts are these: there is a remarkable degree of identity between the species of animals and plants in Japan and those of the Atlantic basin of the United States, though climatic and oceanic barriers now absolutely forbid migration. And still further, the flora of the Eastern United States much more nearly resembles that in Japan than either of those resembles the flora of Oregon and California. A threefold combination is required in the key that unlocks the problem; and this he produces. First comes the geological evidence of the existence of a warm climate, and of these species, or their representatives, in the lands that during the tertiary period clustered about the north pole. Secondly, there is the evidence of a succeeding glacial period which drove before it southward these inhabitants and their temperate climate, till at length all occupied corresponding lower latitudes on both sides of the Pacific Ocean. Thus we have the distribution and the similarity accounted for. Thirdly, there is the wide sweep of forces which produces similarity of climate on the eastern sides of the continents and a contrast between that of the eastern shores and that of the western. In these forces we have the sieve which sorts the species, and preserves similar species in Japan and on the Atlantic coast, while allowing a different class to maintain its foothold upon the Pacific slope of America.

It should be noted, however, that Professor Agassiz, as

[1] American Journal of Science, March, 1860, pp. 155, 157.

[2] See Memoirs of American Academy (1859), Vol. vi. pp. 377–452. Also, Dubuque Address.

Dr. Gray observes,[1] diverges from the ordinary views respecting species in exactly the opposite direction from Darwin.

"Agassiz discards the idea of a common descent as the real bond of union among the individuals of a species, and also the idea of a local origin; supposing, instead, that each species originated simultaneously, generally speaking, over the whole geographical area it now occupies or has occupied, and in, perhaps, as many individuals as it numbered at any subsequent period. Mr. Darwin, on the other hand, holds the orthodox view of the descent of all the individuals of a species, not only from a local birth-place, but from a single ancestor or pair; and that each species has extended and established itself, through natural agencies, whenever it could; so that the actual geographical distribution of any species is by no means a primordial arrangement, but a natural result. He goes farther, and this volume [Origin of Species] is a protracted argument intended to prove that the species we recognize have not been independently created, as such, but have descended, like varieties, from other species. Varieties, on this view, are incipient or possible species. Species are varieties of a larger growth and a wider and earlier divergence from the parent stock; the difference is one of degree, not of kind. ... The theory of Agassiz, referring as it does the phenomena both of origin and distribution directly to the divine will, ... may be said to be theistic to excess."

In pursuing the direct line of our argument, we take for granted, that there is an organic connection between members of the same species, however widely they may be separated either by time or space.[2] Until recently a specific

[1] Silliman's Journal of Science (March, 1860), pp. 155, 156.

[2] Agassiz, however, writes (Cont. to Nat. History, etc., Vol. i. pp. 39, 40). See also pp. 165, 166. "It was a great progress in our science, when the more extensive and precise knowledge of the geographical distribution of organized beings forced upon its cultivators the conviction, that neither animals nor plants could have originated upon one and the same spot upon the surface of the earth, and hence have spread more and more widely until the whole globe became inhabited. ..... All animals and plants have occupied, from the beginning, those natural boundaries within which they stand to one another in such harmonious relations. Pines have originated in forests, heaths in heathers, grasses in prairies, bees in hives, herrings in schools, buffaloes in herds, men in nations! I see a striking proof that this must have been the case in the circumstance that representative species, which as distinct species, must have had from the beginning a different and distinct geographical range, frequently occupy sections of areas, which are simultaneously inhabited by the representatives of other species which are perfectly identical over the whole area. ..... Facts lead, step by step, to the inference that such birds as the Mallard and the Scaup originated simultaneously and separately in Europe and in America; and that all animals

difference was regarded by scientific men as necessitating separate original creation; the species of a genus being always regarded as of independent origin. The genus, and all higher orders, were supposed to be altogether ideal, with no connecting bond of physical causation between their subordinate members.

We come now to the facts which seem to force upon us the higher problem of accounting, by natural means, for the origin and dispersion of allied species and genera.

VI. Distribution of Species in Space.

In studying the distribution of living animals and plants, we are impressed with the existence of natural barriers which prevent the present intermingling of species. The rule is, that in proportion as the barriers which separate provinces are impassable, the contrasts are greater throughout the whole range of organic life. For example, the larger part of the dry land of the globe lies in the northern hemisphere, and is nearly contiguous in the arctic zone. Furthermore, geological evidence is abundant, that during the tertiary period a warm climate extended far up towards the pole. Fossil animals and plants are found in Greenland and adjacent lands like those which now cannot endure anything colder than a warm temperate climate. Thus it is plain that during a recent geological period the insuperable barriers which now prevent the migration of plants and animals from Europe and temperate Asia to America were not in existence.

originated in vast numbers; indeed, in the average number characteristic of their species, over the whole of their geographical area, whether its surface be continuous or disconnected by sea, lakes, or rivers, or by differences of level above the sea, etc. The details of the geographical distribution of animals exhibit, indeed, too much discrimination to admit for a moment that it could be the result of accident, that is, the result of the accidental migrations of the animals or of the accidental dispersion of the seeds of plants. The greater the uniformity of structure of these widely distributed organized beings, the less probable does their accidental distribution appear. I confess that nothing has ever surprised me so much as to see the perfect identity of the most delicate microscopic structures of animals and plants from the remotest parts of the world."

This fact is significant when viewed in connection with the close similarity of the faunas throughout the temperate regions of the northern hemisphere.

"The fauna of Europe is very closely related to that of the United States proper.*... Notwithstanding the immense extent of country embraced, the same stamp [of animal life] is everywhere exhibited. Generally the same families, frequently the same genera, represented by different species are found."[1]

On the other hand, as we proceed on either continent through the torrid and south temperate zones, where the oceanic and climatic barriers are, and doubtless for a long time have been, vastly greater;

"Instead of that general resemblance, that family likeness which we have noticed between all the faunas of the temperate zone of the northern hemisphere, we find here the most complete contrasts. Each of the three continental peninsulas which jut out southerly into the ocean represents, in some sense a separate world. The animals of South America, beyond the tropic of Capricorn, are in all respects different from those of the southern extremity of Africa."[2]

But this dissimilarity of native animals and plants does not arise solely from dissimilarity in the physical conditions in those regions; for foreign plants when introduced have often flourished in a remarkable degree. For example, in New Zealand the Norwegian rat has extirpated the native rat, and is to be found everywhere. The progeny of the pigs which Captain Cook and other navigators left with the natives run wild in such a way that it is impossible to destroy them. There are large tracts of country where they reign supreme. In South America the horse has with equal facility increased in a wild state. Among plants we may mention the Scotch thistle, briar, rose, plantains, and docks, which have all become noxious weeds in South Africa and Australia.[3]

Lyell pertinently remarks, that if we reject the generally received doctrine of specific centres of creation and natural barriers to distribution,

[1] Principles of Zoölogy, by Agassiz and Gould, pp. 200, 203.

[2] Buffon, quoted in Lyell's Principles of Geology, Vol. ii. pp. 329, 332.

[3] See Hooker, in Popular Science Review (London), Vol. vi. p. 131 ff. Republished in The Eclectic Magazine (New York), for July, 1867.

"The fact that not a single native quadruped is common to Australia, the Cape of Good Hope, and South America, can in no way be explained by adverting to the wide extent of ocean, or to the sterile deserts, or the great heat or cold of the climates, through which each species must have passed, before it could migrate from one of those distant regions to another. It might fairly be asked of one who talked of impassable barriers, why the same kangaroos, rhinoceroses, or llamas should not have been created simultaneously in Australia, Africa, and South America? The horse, the ox, and the dog, although foreign to these countries until introduced by man, are now able to support themselves there in a wild state; and we can scarcely doubt that many of the quadrupeds at present peculiar to Australia, Africa, and South America might have continued in like manner to inhabit all the three continents, had they been indigenous in each, or could they once have got a footing there as new colonists."[1]

VII. Species arranged in Clusters.

Notwitstanding the great dissimilarity between the products of life on the southern extremities of the three continents, there is a striking similarity between the species inhabiting these several peninsulas and those found upon the islands adjacent to each. The islands are, in their forms of life, the satellites of the nearest continents. One of the most striking illustrations of this principle is found in the relation of the fauna and flora of the Galapagos Archipelago to those of South America. These islands lie nearly on the equator, five hundred miles west of the main land. They are of volcanic origin, and in their soil, elevation, and climate differ greatly from the neighboring coast. In these natural respects they very much resemble the Cape de Verde Islands, which are situated in the same latitude, and about the same distance to the west of Africa that the Galapagos are west of South America. The environment, or the conditions of life, are very much alike on the Galapagos and on the Cape de Verde Archipelago; while the conditions of life on each of these Archipelagos are in great contrast to those which surround the faunas and floras of their adjacent continents. The species of birds, reptiles, and plants found on the Galapagos are, for the most part, such as exist nowhere else in the

[1] Lyell, Principles of Geology, Vol. ii. p. 333.

world. On the ordinary view, naturalists would say they must have been created there. But according to Mr. Darwin,[1] — and it was this fact which turned his mind into the channel of speculation which has made him so justly famous, —

"Nearly all [these species] bore an American stamp. In the song of the mocking-thrush, in the harsh cry of the carrion-hawk, in the great candlestick-like opuntias, I clearly perceived the neighborhood of America, though the islands were separated by so many miles of ocean from the main land, and differed much from it in their geological constitution and climate. Still more surprising was the fact that most of the inhabitants of each separate island in this small Archipelago were specifically different, though most closely related to each other."

The animals and plants on the Cape de Verde Islands have a corresponding affinity to those of Africa. The problem is to find, if possible, the bond of secondary causation which shall join together these complex phenomena. It must account for the similarity under diverse conditions, and the diversity under similar conditions. Mr. Darwin believes that it is idle for us to search here for a "final cause." So far as there is truth in his remark it is, in our opinion, partially owing to the inadequate views now current regarding the doctrine of final causes. Mr. Darwin supposes he has found a natural mode of accounting for the similarities and the difference of representative species, in the effect of diversity of condition acting on the descendants of a common ancestry. According to him, the facts delineated with regard to the relationship between the forms of life on the islands and those on the adjoining continental areas, point to community of descent in comparatively recent time. No one can deny that there is great plausibility in this explanation.

In further illustration similar facts may be adduced regarding the island of Madagascar, where all the species of animals but one, and nearly all the genera, are different from those on the continent of Africa.[2] Yet these genera

[1] "Animals and Plants under Domestication," Vol. i. p. 21. See also "Origin of Species," pp. 353–356.

[2] Lyell's Principles of Geology, Vol. ii. p. 347.

and species resemble those in Africa more than they do those of any other province.

The direction and character of the boundary line between the fauna of Australia and that of Asia is still more impressive. The Philippine Islands, with Sumatra, Java, and Borneo, are in a sea that is nowhere more than six hundred feet deep. So that with an elevation of the Malay Archipelago to that amount, the continent of Asia would extend as far southeast as the island of Java, or twelve degrees of latitude beyond the Malay peninsula. Beyond a line drawn from the southeast end of Java, to the southernmost of the Philippine Islands, the depth of the ocean is more than six hundred feet. According to Mr. Wallace,[1] the line of soundings of six hundred feet, marking the termination of shallow seas, between the Indo-Malayan and the Austro-Malayan regions, is also the boundary between Australian and Asiatic genera of plants and animals, though in one instance the islands of these different zoölogical provinces are within sight of each other. The animals and plants of Asia are supposed to have migrated to the farthest islands in the shallow seas of the Malay Archipelago when they were continuously connected by land now moderately submerged; while the Marsupials of Australia maintained their ground on the islands that are now, and probably have been from a very remote period, surrounded by deep water. The principle is pretty well established that, with little regard to natural conditions, the fauna of islands is more nearly allied to that of the nearest continent than to that of any other region, and that the deeper the sea between them the more diverse is the fauna.

This class of facts receives explanation on the supposition that the Creator has given to the life-principle a power co-ordinate with that of the conditions of existence. The changes in the forms of life follow a long way behind the changes in the physical conditions. The islands surrounded

[1] See "The Malay Archipelago," pp. 20–31. Also Lyell's Principles of Geology, Vol. ii. pp. 349, 350.

by deep water are supposed to have retained the earlier forms of life because they have been longer isolated, and the conditions have there been more uniform, and there has been less room for competition between varieties.

Darwin[1] makes good use also of the fact that there are "no [native] Batrachians and terrestrial Mammals on oceanic islands."[2] There are only bats, whose presence can be accounted for by their power of flight. But the absence of frogs and Mammals is not due to lack of adaptations to the conditions; for often, when introduced, they thrive in a remarkable manner. Frogs have become a nuisance in Madeira and the Azores.[3] The full bearing of these facts cannot be seen till they are joined with two or three other coordinate series of phenomena. We proceed, therefore, to speak

VIII. Of the Distribution of Species in Time.

As long ago as 1844, Professor Owen enunciated the law "that with extinct as with existing Mammalia, particular forms were assigned to particular provinces, and that the same forms were restricted to the same provinces at a former geological period as they are at the present day."[4] In 1861, he adds:

"That period was the more recent Tertiary one. In carrying back the retrospective comparison of existing and extinct Mammals to those of the Eocene and Oölitic strata, in relation to their local distribution, we obtain indications of extensive changes in the relative position of sea and land during these epochs, in the degree of incongruity between the generic forms of the Mammalia which then existed in Europe and any that actually exist on the great natural continent of which Europe now forms part. It would seem, indeed, that the further we penetrate into time for the recovery of extinct Mammalia, the further we must go [from Europe] into space to find their existing analogies. To match the Eocene Palaeo-

[1] Origin of Species, p. 351.

[2] Origin of Species, p. 350. See also Lyell's Principles of Geology, Vol. ii. pp. 406–436.

[3] Ibid. p. 416.

[4] Quoted from Transactions of the British Association, 1844, in Owen's Palaeontology, p. 433.

theres and Lophiodons we fetch Tapirs from Sumatra or South America, and we must travel to the antipodes for Myrmecobians, the nearest living analogues to the Amphitheres of our Oölite strata."

The law of the distribution of species in time and space has been stated by Professor Dana thus:[1]

"The Orient has always been the continent of progress. From the close of the Palaeozoic its species of animal life have been three times as numerous as those of North America, and more varied in genera. In the early Tertiary its flora in the European portion had an Australian type, and there were Marsupials and Edentates there. In the middle and later Tertiary it represented recent North America in its flora. But from this condition it emerged to a higher grade. In the Post-tertiary it became the land of the Carnivores, while North America was the continent as distinctly of Herbivores — an inferior type; South America of Edentates — still lower; Australia of the lowest of quadrupeds — the Marsupials. In the closing creations Australia remained Marsupial, though with dwindled forms; South America was still the land of Edentates, but of smaller species, and with inferior Carnivores and the inferior type of monkeys, or Quadrumana; North America of Herbivores, also small compared with the Post-tertiary; while the Orient, besides its new Carnivores, received the highest of Quadrumana. Thus the Orient has successively passed through the Australian and American stages, and, leaving the other continents behind, it stood in the forefront of progress."[2]

Dawson emphasizes the same point:

"It thus appears that the Miocene flora of Europe resembles that of America at present, while the Eocene flora of Europe resembles that of Australia, and the Eocene [Pliocene?] flora of America, as well as the modern, resembles the Miocene of Europe. In other words, the changes of the flora have been more rapid in Europe than in America, and probably slowest of all in Australia. The eastern continent has taken the lead in rapidity of change in the tertiary period, and it has done so in animals as well as in plants."[3]

IX. Connecting Links between Species.

The argument in favor of the affinity of species cannot be adequately set forth, until attention has been called to the general unities of anatomical structure which pervade the species, genera, and orders of each of the four departments

[1] Manual of Geology (1st ed., Philadelphia, 1863), p. 585.

[2] See also Principles of Zoölogy, by Agassiz and Gould, p. 235.

[3] Story of the Earth and Man, pp. 259, 260.

of the animal kingdom, and which serve as the basis upon which they are grouped together in classes. We will attend to these deeper unities a little later; restricting ourselves in this section to what may more properly be called intermediate links between species that are now reckoned as distinct.

It is a fact, commented on at length by Dana and Agassiz, that the species which appear earlier in the history of the globe are of a more comprehensive type than those which appear later. The earlier forms are not so specialized in their structure as the later. The earlier types are spoken of as prophetic. Their structure contains intimations of what the peculiarities of future species are to be. All palaeontologists admit that as the present is approached there is progress in the geological record of life. The grade of life indicated in a geological formation is, in a general way, intermediate between that of the formation above and that below. Numerous transitional forms are found between the various classes and genera of vertebrate animals. Reptiles are anatomically intermediate between fishes and birds. The passage from the water-breathing class of Vertebrates to an air-breathing class, is "by close transitional steps."[1] The affinities of reptiles while they are close, in vertebral structure, with the ganoid fishes, are equally close with birds and mammals. The archaeopteryx was half reptile and half bird. It had the vertebrate tail of the reptile, which was, at the same time, supplied with the true feathers of the bird. Its foot had no characteristics that would distinguish the class to which it would belong. Professor Marsh[2] has found in the Cretaceous strata of Nebraska birds possessing teeth. In the Dinosauria the reptile class is allied more closely to the mammals. The Marsupials are midway between the oviparous Vertebrates and the placental Mammalia. Between the mastodon and the elephant there are many transitional species.[3]

[1] See Owen, Palaeontology, p. 320.

[2] See American Journal of Science for October, 1872, and January, 1873; also American Naturalist for October, 1875.

[3] Owen's Palaeontology, p. 376.

There are numerous intermediate forms joining together the rhinoceros and the horse, the bear and the wolf, the hyena and the civet, and even forms so diverse as the hog and the camel.[1]

Professor Owen remarks[2] that when the transmutation theories of the early part of the century were under discussion by Cuvier, with whom he was then studying, in opposition to these theories reliance was chiefly placed on the absence of intermediate species, especially the lack of intermediate forms between the Palaeotherium of the early Eocene and the hoofed quadrupeds of the present age. But adds:

"The progress of Palaeontology since 1830 has brought to light many missing links unknown to the founder of the science.... The discovery of the remains of the *Hipparion* supplied one of the links, required by Cuvier, between the Palaeotherium and the horse of the present day; and it is still more significant of the fact of filiation of species that the remains of such three-toed horses are found only in deposits of that Tertiary period which intervene between the older palaeotherian one and the newer strata in which the modern horse first appears to have lost its lateral hooflets. ... Other missing links of this series of species have been supplied; as, e.g. by the Paloplotherium of the newer Eocene of Hordwell, Hants; by the *Palaeotherium aurelianense* from the 'molasse marine' of Orleans, and by the *Palaeotherium hippoïdes* of the lacustrine calcareous beds of Sansan, all which deposits are Miocene, or are transitional between Eocene and Miocene." In the two last examples, "the whole foot is longer and more slender, with a longer and thicker middle toe, than in the older Eocene type-genus, whence the generic name *Anchitherium*, applied to them by von Meyer."

Prof. Marsh has since found a very complete gradation of fossil horses in America, some with three hoofs on each foot, others with a main hoof and two hooflets, and others in which the fingers are all rudimental, except the middle one which bears the hoof.[3] The general law, that intermediate geological formations contain intermediate species, was thus announced by Prof. Agassiz:

"Each formation contains remains peculiar to itself, which do not extend into the neighboring deposits above or below it. Still there is a

[1] See Wallace, Con. Theory. Nat. Selec., pp. 299, 300.

[2] Anatomy of the Vertebrates, Vol. iii. pp. 789–792. See also Dana, Manual of Geology (2d edition), pp. 503–520.

[3] American Journal of Science (March, 1874), pp. 247–258. See also Dana, Manual of Geology, p. 505.

connection between the different formations more strong in proportion to their proximity to each other. Thus the animal remains of the Chalk, while they differ from those of all other formations, are, nevertheless, much more nearly related to those of the Oölitic formation, which immediately precedes, than to those of the Carboniferous formation, which is much more ancient; and, in the same manner, the fossils of the Carboniferous group approach more nearly to those of the Silurian formation than to those of the Tertiary."[1]

Thus it must be admitted that the broken lines of life upon which we stumble in the geological record are not parallel; but they lie in directions radiating from a well-defined centre. There is more interlacing of these lines than we have been accustomed to admit. Life is a web.

X. Homologous and Rudimental Structures.

Vertebrate animals are all variations of one type of structure. A significant unity pervades the whole department. Even generic distinctions are founded upon "minor peculiarities of anatomical structure, such as the number, disposition, or proportions of the teeth, claws, fins, etc. ... Thus the lion, tiger, leopard, and cat are put into the same genus because they agree in the structure of their feet, claws, and teeth;" while the dog, fox, jackal, and wolf have another and different peculiarity of these parts of their bodies.[2] The species is formed upon less important distinctions, such as color, size, proportions, sculpture, etc.

The persistent and fundamental unity of structure throughout the vertebrata is extremely remarkable. For example, in the class of mammals the cervical vertebrae are constant in their number throughout all genera. The long neck of the giraffe has the same number of vertebrae with the short neck of the whale or the elephant. For all practical purposes the whale or elephant might as well have but one bone each in their necks; but each has seven, so small, and crowded so closely together, that they are in effect but one.

Limbs that are used for very different purposes have

[1] Principles of Zoölogy, p. 221.

[2] See Principles of Zoölogy, by Agassiz and Gould, p. 18.

frequently a structure that is anatomically the same. The bones of the human arm and hand have their homologues in the legs and feet of all quadrupeds, in the wings of all birds, and in the pectoral fin of the fish, and the flipper of the seal. The hoof of the horse is on his middle finger; the other phalanges are rudimental, though all present. The carpal and metacarpal bones are also partially represented in the legs of the horse; so also is the radius, though these bones are now rudimentary and useless.

Among other rudimentary structures may be mentioned the foetal teeth of whales and of the front part of the jaw of ruminant quadrupeds.

"These foetal structures are minute in size, and never cut the gum; but are reabsorbed without ever coming into use, while no other teeth succeed them or represent them in the adult condition of those animals. The mammary glands of all male beasts constitute another example, as also does the wing of the apteryx, — a New Zealand bird utterly incapable of flight, and with the wing in a quite rudimentary condition (whence the name of the animal). Yet this rudimentary wing contains bones which are miniature representatives of the ordinary wing-bones of birds of flight."[1]

Is there in all this any meaning which the human mind can interpret? Do these facts have any natural correlation to those innate tendencies of the mind on which beliefs are based? Is their glimmer of light in any degree trustworthy, and if so, to what degree? Or are they altogether like Will-o'the Wisps going before us but to deceive? Mr. Darwin's comparison has the merit of being clear, if not cogent.

"Rudimentary organs may be compared with the letters in a word, still retained in the spelling, but become useless in the pronunciation, but which serve as a clue for its derivation. On the view of descent with modification, we may conclude that the existence of organs in a rudimentary, imperfect, and useless condition, or quite aborted, far from presenting a strange difficulty, as they avowedly do on the old doctrine of creation, might even have been anticipated in accordance with the views here explained."[2]

[1] See Mivart, Genesis of Species, pp. 7, 155–187.

[2] Origin of Species, p. 402.

XI. Embryology.

Another class of facts presenting peculiar difficulties to the ordinary hypothesis of special creation, relates to the process of development through which the young animal passes in its embryonic condition. We quote again from the elementary work on Zoölogy by Professor Agassiz.

"As a general result of the observations which have been made up to this time [1855] on the embryology of the various classes of the animal kingdom, especially of the Vertebrates, it may be said, that the organs of the body are successively formed in the order of their organic importance, the most essential being always the earliest to appear. In accordance with this law, the organs of vegetative life, the intestines and their appurtenances, make their appearance subsequently to those of animal life, such as the nervous system, the skeleton, etc.; and these, in turn, are preceded by the more general phenomena belonging to the animal as such. ... Hence the embryos of different animals resemble each other more strongly when examined in the earlier stages of their growth. We have already stated that, during almost the whole period of embryonic life, the young fish and the young frog scarcely differ at all; so it is also with the young snake compared with the embryo bird." [1]

"This similarity of members of the same great class, in their embryonic condition, — the embryo, for instance, of a mammal, bird, reptile, and fish being barely distinguishable," is pronounced by Darwin "the most wonderful fact in the whole round of natural history." [2] That the embryos of the higher vertebrates should in their development pass through all the stages of the lower orders of their class, taking upon them at successive stages the peculiarities that characterize the order, the family, the genus, the species, and the individual; that this order coincides with the distribution of species in time; and that rudimentary organs are often developed at particular stages of the growth, and then partially or wholly re-absorbed, are certainly coincidences which it is hard to accept as accidental or meaningless. But on the theory of a common descent with modifications, all these facts come in harmoniously, this element of descent

[1] Principles of Zoölogy, p. 153.

[2] Animals and Plants under Domestication, Vol. i. p. 24.

being the hidden bond of connection which naturalists, in their efforts at classification, have been seeking, under the term of the natural system.[1]

XII. Analogous Variation.

An argument is also drawn from the facts of analogous variation. For instance, distinct breeds, like those of the domestic pigeon, which are now very unlike, tend to vary in a similar manner, resembling one wild species from which they are supposed to have descended. The slaty-blue color and the black bars across the wings of the original rock pigeon are occasionally assumed by individuals of all the varieties, though when kept pure they usually breed true and have no trace of those colors. When, however, different breeds are crossed, the tendency of these black bars and this blue color to appear is greatly increased, and the peculiarities of the crossed birds disappear.

Similar facts afford proof of the affinity of the horse and the ass to the zebra. By a wide induction, Darwin has shown that the appearance of the stripes which characterize the zebra are sometimes seen on every variety both of the horse and of the ass. And furthermore, that the mule, which is a cross between the horse and the ass, is much more likely than either to display those characteristic stripes, especially when young. Upon this Darwin remarks:[2]

"He who believes that each equine species was independently created, will, I presume, assert that each species has been created with a tendency to vary, both under nature and under domestication, in this particular manner, so as often to become striped like other species of the genus; and that each has been created with a strong tendency, when crossed with species inhabiting distant quarters of the world, to produce hybrids resembling in their stripes, not their own parents, but other species of the genus. To admit this view is, as it seems to me, to reject a real for an unreal, or at least for an unknown, cause. It makes the works of God a mere mockery and deception. I would almost as soon believe with the old and ignorant cosmologists that fossil shells had never lived, but had been created in stone, so as to mock the shells living on the sea-shore."

[1] See Origin of Species, pp. 381, 396 and 403. [2] Origin of Species, p. 130.

XIII. Summary of Facts.

Before proceeding to an explanation of these phenomena, we will briefly recapitulate. If in the animal kingdom we take one of the departments, Vertebrata, for instance, we find that all the individuals are characterized by certain fundamental likenesses, and are distinguished by varying degrees of unlikeness. Upon the bond of the similarity characterizing the grand division, the differences are superimposed which designate the more specific stages of our advancement in classification. There is a natural order of classification, so that starting along certain lines of divergence, and passing through more and more restricted clusters of likenesses, we reach a system of species and varieties and individuals, branching off from a common point, in which there is no intermingling and little ground for confusion.

Theories of evolution have in their favor the analogies of the known mode of the production of individuals. So far as we know, individuals are born and developed; not produced by a direct act of creation, or by spontaneous generation. "Every life is from an egg." So constant is this law that the supposed production of a living thing without a cell for its origin is strong proof either of the incompetence of the observer's method or of the imperfection of his instruments.

The natural system of classification corresponds in general with the embryonic development of each individual. The more generic characters of the animal appear first in the developing embryo. The specific characters are superinduced from time to time, as the period of birth approaches, or, indeed, long afterwards, in the post-natal development.

In the distribution of animals in time the same order of development is observable. The earlier forms of life that are studied in fossil remains are, as a rule, more generalized in their structure than the later forms. Classes of animals, like birds, reptiles, and fishes, were not so clearly distinguishable in the early Tertiary and in the Maesozoic times as now.

Again, in space animals and plants are separated by natural

barriers. The farther you recede from the continental hemisphere of the earth the more diverse the existing forms of life are from each other, and the nearer they resemble the more generalized forms of past time. Also the forms of life on islands are, as a rule, conformed not so much to the existing conditions of soil and climate as to the type of animal life on the nearest continental area.

XIV. Proper to Speculate upon the Problem.

The foregoing are the more important of the facts that press upon us for an explanation. It is not in accordance with what we specially value in the modern habits of thought to cut the Gordian knot with the assertion, "so God has made it," and set that up as the Ultima Thule of our investigation. Such a course would be suicidal to all scientific thought, and would endanger the rational foundation upon which our proof even of revelation rests. It is superstition, and not reverence, that leads us to avoid the questions concerning the order and mode of divine operations.

It is a principle never to be forgotten in any department of study that we are to press known secondary causes as far as they will go in explanation of facts. We are not to resort to an unknown cause for explanation of phenomena till the power of known causes has been exhausted. If we cease to observe this rule there is an end to all science and all sound sense.

In viewing the complicated movements of the heavenly bodies, it would relieve us from much labor, if we should simply register the phenomena, and attribute them directly to the divine activity. Newton, however, was not satisfied till he had interpreted the laws under which these movements proceed. He believed that in the peculiarities of planetary movements God permitted us to read the method of his operations. By a most successful application of the law of parsimony all that variety of movement in cycle and epicycle was traced to the effects of two forces, centripetal and centrifugal; the one constant, the other varying as the square of the distance between the attracting objects.

Through a generalization of this nature Mr. Darwin has, with greater success than any previous naturalist, approached the exceedingly complex phenomena exhibited in the organization of living forms. As Newton left the nature of the centrifugal and centripetal forces with the mysteries of the creation, so Darwin can leave where they belong the forces that have moved and directed the development of life upon the earth. Human pride may not boast too confidently of having sounded any of the deep things of God. The genuine man of science does not use the word 'explanation' with reference to the final solution of the problems of nature. In this respect Mr. Darwin is much more cautious than some of his followers. In the main he contents himself with viewing the unknown in the light of the known, and refrains from speculating upon the nature of the ultimate facts of observation. It should be remembered that, in the highest sense, it is no adequate explanation of the movements of the moon to show that it is to be classed with those of an apple as it falls from a tree. To any thoughtful mind the absolute mystery is rather increased than explained by such classification. And it may well be said that scientific explanation, such as it is, intensifies rather than diminishes our admiration of divine power. If the undevout astronomer be mad, it would in still greater degree be true that the irreverent disciple of Darwin is mad.

XV. Darwin's Method of Solution.

Darwin starts with two or three principles derived from our observation of living individuals and varieties of species, and tries to see how far there are indications that these principles have had sway in past times. The lamp by which he guides his feet among the scattered fragments of the creation is the fundamental axiom of all science, that similarity of effect indicates similarity of cause.

It is a matter of common observation that while it is true, in a loose sense, that "like begets like," — that plant and animal beget after their kind, — this law is co-ordinated by

another, just as centrifugal is co-ordinated with centripetal force. The progeny is never just like the parent. There is no dead level of uniformity in organic beings. Not even two peas are exactly alike. The law of heredity in animals and plants is a resultant of two tendencies; the one to likeness, the other to variation. The tendency to variation revolves around the tendency to uniformity. One force is centripetal, the other centrifugal. This is a general truth about which there is no dispute. It remains for the more accurate and extended observation of scientific men to determine the orbit of this revolution and the limits of this oscillation.

Is there such degree of plasticity in species that the orbit of one may break into that of another? This question we cannot hope to settle by direct observation. But we are permitted to determine very few things by direct observation. We never see the curve of the orbit of a star. We see it at different points of its orbit, and supply the rest of the curve on the ground of our confidence in intuitive principles. We go beyond observation whenever we try to prove anything. We believe that Biela's comet was drawn out of its orbit by the force of the attraction of the planet Jupiter. The proof of it is an exercise of mind far nobler than that of watching a vaporous disk in the glass of a telescope. The conformity of certain facts to principles established by broader observation and more intricate calculations may involve the veracity of God as absolutely as the agreement of a signature with a business man's known hand-writing may connect the two together, and prove the genuineness of the document. In this light let us try to answer the question, Are species transmuted into other species?

XVI. Elasticity of Species.

That species are in some degree plastic is evident to all, in the fact that varieties exist and that individuals are distinguishable from one another. Under the guidance of man, both animals and plants vary to a remarkable extent. Such

variations are produced in the vegetable world, that botanists are much averse to pronouncing upon the species of a domestic plant. Plants may be made to vary in almost any part of their structure.

There are several hundred varieties of our American grapes, with fruit ranging from the small acrid berry that grows wild on our river banks, to the luscious Catawba that would not ripen in Northern New England out of a conservatory. Yet they all range under three or four species.[1]

The strawberry was confined a hundred years ago to a very small number of varieties. While now, principally through the skill of gardeners within the last sixty years, the varieties are innumerable.[2] Potatoes, cabbages, apples, roses, and numerous other cultivated plants, are synonymes for variability in different parts of their organism.

In the animal creation too, every one is familiar with facts indicating a great amount of variability in domestic breeds. Indeed, the word breed indicates the fact. Horses have probably all descended from what would be called one species. Yet what a contrast between a dray-horse and an English race-horse! Or between Black-hawk and a Canadian pony! Whatever might be said about the original diversity of the wild varieties of the cow and the sheep, which have been domesticated, there is no doubt that the skill of breeders has produced additional and most important changes.

It is almost demonstrable that domestic pigeons are descended from one parent species, — the rock-pigeon. But now they have been transformed by fanciers to the strange forms of the pouter, fantail, carrier, barb, tumbler, and a hundred other varieties that breed true and have been named. These are made to differ in various points of anatomical structure more than is often required to establish a difference of species, or even of genus.[3]

The changes in domestic animals and plants take place under the directing agency of man. Man does not produce

[1] See Darwin, Animals and Plants under Domestication, Vol. i. p. 400 f., which, however, chiefly relates to European varieties.

[2] Ibid. p. 423.

[3] Ibid. p. 194.

the variation. He only uses it when for some unknown reason it appears. The tendency to variation has its origin in a cause that is mysterious; though change of circumstances increases the tendency. The agency of man is confined to accumulating by selection the variations that appear in a certain line. Without his interference, the tendencies to vary in opposite directions would, where communication was unrestricted between individuals, counteract each other, and keep the species uniform. Hence, it might occur that when a skilful breeder passed away, the breed would pass away with him, from lack of his skill in selecting the animals from which to propagate the variety. How far this process of variation may proceed in a particular line is still undetermined. Indeed, that is the question under consideration. With pigeons it has gone so far that the varieties if found in a wild state would be called species. The difficulties of classification are evidence of a great plasticity in species. It repeatedly occurs that what have been classed as distinct species are, by the subsequent discovery of intermediate forms grouped together as varieties of a single species. In such cases the divergence of the varieties from the type of the species measures the known degree of the elasticity of the species.

The changes which man secures in animals and plants by systematically selecting for propagation the individuals that possess qualities subservient to human want or caprice, are in one sense superficial, since they are made blindly. A variety is chosen for propagation because of peculiarities that can be seen, in ignorance of their correlated relation to profounder anatomical or physiological changes that simultaneously occur. Still farther, man protects his animals from the effect of deficient food or shelter, and so may preserve a peculiarity of structure which would be fatal to the existence of the animal if in a natural state.

If we go beyond the reach of the directing agency of man it would seem that there could be no analogous force able to enlarge indefinitely the orbit of individual variability.

XVII. Natural Selection.

But Mr. Darwin must have the credit of presenting in a new light, if not of discovering, a natural power of selection which is marvellous in its possibilities and probabilities. In the first place, the physical agencies that produce the succession of the seasons and the distribution of heat and moisture, and which so powerfully influence the animal and vegetable world, are in a state of unstable equilibrium. The seasons vary in periods that are of unequal duration, and that are dependent on far-reaching causes. If we extend our observation through the long ages of geologic record, we have brought to view alternations from temperate to frigid, and from frigid to torrid, climates, that are as extensive as the globe. In the alternate contraction and expansion of the continental areas, through the elevation and depression of the land, there are brought to light other important changes in the conditions to which animal and vegetable life have been subjected. At one time Europe is an archipelago of scattered islands. At another time England is joined to Ireland and to the continent by a continuous belt of land. During these periods of contraction, and at those times when drouth or winter was creeping over the world, there must have been a struggle for existence between the various individuals that were living at the time, in which the weakest would die first. At one time the survival would depend on the nature of the instinct, at another on the fleetness or size, at another on the ability to withstand extremes of heat and cold. In some of these conditions increase of size would be an advantage to the individual, in others it would be a disadvantage. In time of scarcity of food increase of size would make more food necessary, and perhaps bring more food within reach.

It is evident that these extraordinary trials would sift out those least fitted to the conditions, and leave behind those best fitted. "Animals, like men, are tried in the fire of affliction. The hay, wood, and stubble are burned, and the gold is left." In Darwin's system, however, "gold" does not mean necessarily a higher organism, but those peculiarities of the

organism that protect one from present physical evils, whether it be peculiarities that indicate progression or retrogression. Indeed, the very opposite qualities might secure immunity from destruction. A large dog might jump over a fence where a small one would go through, and only the medium sized be kept in by it. A nervous animal might live where a stupid one would die, and vice versa.

XVIII. The Struggle for Life.

In enumerating these changes in external nature, we have brought before us only one of the known agencies which serve as a crucible in which to test the tenacity of the life of any organic form. Whatever may be the ultimate explanation of it, it is a fact that the "whole creation groaneth and travaileth together in pain until now." There is a constant state of warfare in the organic world. The grub is trying to kill the tree, and the woodpecker is seeking, with exquisite instruments, to take the life of the grub; the parasite is worrying the life of the woodpecker, and so on through the whole story of the house that Jack built.

The Malthusian law of the tendency of all living things to increase through reproduction in geometrical ratio, while the stores from which they feed and the houses in which they live are limited by definite measurements, becomes in Darwin's hands a mighty power. If slow breeding man were not limited by many unavoidable evils from increasing and multiplying according to his natural instincts, there would in a few thousand years be so many people in the world that standing-room could not be found for them. If a plant should produce two seedlings a year, and its two produce each two more, and so on, there would in twenty years be a million plants. Mr. Darwin says:[1] "The elephant is reckoned to be the slowest breeder of all known animals, and I have taken some pains to calculate its probable minimum rate of natural increase; it will be under the mark to assume that it breeds when thirty years old, and goes on breeding till ninety years

[1] Origin of Species (5th ed.), p. 51.

old, bringing forth three pairs of young in this interval; if this be so, at the end of the fifth century there would be alive fifteen million elephants, descended from the first pair." When now we come to consider the rapidity with which innumerable other organisms tend to increase, we shall have before us a faint idea of the power that is here brought into the equation. We may safely assume that plants produce every year a million times as many seeds fitted for growth, as ever come to perfection. So that the ground of a forest is year by year literally covered with seedlings that are destined to die from lack of room and want of access to the elements necessary to their growth. Of the smaller plants we know that the ground is full of their seeds. Turn up the ground where you will, and it will be found that there are germs of life in it, or that they will lodge on it, and cover it very speedily with a rank vegetation. A few rank weeds, like the burdock or the thistle, delight to lord it over their weaker brethren. Infanticide and oppression are, in a figure, practised to an alarming extent throughout the vegetable kingdom. "Plants do not grow where they like best, but where other plants will let them."

Animals have feeling, which plants have not. But of compassion the animal kingdom is utterly devoid. The equilibrium of the animal world is maintained not merely by preparation for war, but by actual and unceasing conflict. Almost every species of animal is pressing beyond the limits of its means of subsistence. There are low forms of animals that produce millions of young every season. Yet the number of progeny which survive may not be at all in proportion to that which comes into existence. The mishaps that befall a young trout are far more numerous than those to which a whale is liable. "The condor lays a couple of eggs, and the ostrich a score; and yet in the same country the condor may be the more numerous of the two. The fulmar petrel lays but one egg, yet it is believed to be the most numerous bird in the world." It is plain that the number of individuals of a species that are found in existence is not at all

in proportion to their natural tendency to increase, but is rather dependent on their ability to contend against forces, both organic and inorganic, which oppose them after they are brought into existence. The great difficulty to be overcome in the continual existence of a species is that of adjusting itself to the other forms of life that crowd in upon it.

There is a constant oscillation in the comparative numbers of different classes of animals. As the food of herbivorous animals for any cause increases, the law of geometrical increase soon fills the enlarged possibility of subsistence, and individuals of this order are in competition again with each other. But the increase of Herbivora is soon followed by that of the Carnivora who feed upon them till these two orders are again in sharp competition, and the Carnivora contend with a diminishing relative supply of food.

When the animals are superabundant upon which the Carnivora feed, the weakest and most clumsy of that order could supply himself with food, and it would be the most helpless of the Herbivora that would be devoured. But when the balance was restored and the competition commenced again, the fleetest or strongest of the Herbivora, or those that had some other advantage, would be preserved; only the more favored of the Carnivora could then take or overcome them. The unfortunate of both orders would perish, and the more favored ones of both survive. Somewhat thus must be the internal contest among the animals which are food one for the other. When the struggle is in the same family with lessening amount of food, either absolute or relative, or with changing climate, analogous results must follow. In both cases, those variations from the type of the species that occur in every individual are the centrifugal force tending to divergence, counteracted, when nothing else interferes to augment it, by the law of inheritance and by the inter-crossing of individuals with opposite variations.

The external power in nature which supplies the place of man's agency as seen in domesticating animals, is the varying conditions of life which arise from changes in climate,

in temperature, in the extent of territory open for the range of the species, together with the encroachment of other species upon their domain. In this complicated environment we have a power which Darwin personifies as "Natural Selection." He speaks, we suppose, of power in the secondary sense, as when we use similar language regarding the force of gravity. He proceeds to trace the action of this secondary cause with reference to the production of species, as geologists would try to account for the features of a river valley by the erosive action of flowing water; or as the mathematician verifies the law of gravitation by the solutions it affords to the complicated observations of the astronomer. Or yet again, the problem is similar to that of the historian who sits in judgment on the documents before him, and pronounces them true or false according as they conform or not, to the known action of the human mind under the stress of given motives.

It should be remembered in this connection that the limits which we have set to the liberty of variation inherent in species is altogether arbitrary. It is perfectly proper for any person to proceed according to the law of parsimony from what is actually known of the variability of species and of the power of "Natural Selection," and see how far these factors will account for all the changes that are apparent. To the theologian the question regards the mode of the divine operations in nature. Darwin's law of "Natural Selection" only furnishes a natural bond for what Agassiz calls the ideas of God that were realized in innumerable special creations, and during countless periods of past time.

The theologian stands in no more need of miracles for the production of species than he does for that of the planets and their movements. Direct providential interposition is not for the irrational creation, but for the rational. So we may divest ourselves of theological prepossessions of any kind in reference to the material machinery by which the diversity of animal and vegetable life has been produced. But of these points we will speak farther on.

XIX. Time as a Factor in the Equation.

The rate at which changes may proceed through "natural selection" is an indeterminate quantity. If natural selection be the secondary cause that has determined the development of species, then its speed must have been inversely as the time in which it has operated. If time has been short, natural selection must either have been incompetent for the results, or have worked the faster. We do not know that any clue has been given as to the rapidity with which, in favorable circumstances, changes may proceed in species. Mr. Darwin insists, too strenuously perhaps, upon a very slow rate of variation. By a singular misnomer the school in geology led by Lyell, and of which Darwin's is the complement in natural history, was called uniformitarian, whereas both these distinguished authors emphasize not so much the uniformity of the past as the instability of the present. Time can easily be eliminated when cause and effect are brought into line. It must be admitted that geological measures of time are very indefinite and unsatisfactory.

Without dispute, however, geology opens up an expanse of time through which plants and animals have lived that is ample enough for almost any purpose. The geological succession of the earth's strata extends the present order of things back to a point that is far out of sight. Darwin may with confidence claim one hundred million years, and without much fear of contradiction, five times that period, as a field in which his law may have operated. As near as we can ascertain, we are in the middle of duration, and God has been no more pressed for time in which to do his work in the past than he is to be for the future. God is as prodigal of time as of space, and to appearance has shown himself as little concerned about the fate of the mere forms of life that have in succession inhabited the world, as about the quantity of dirt it has required to make the world; though doubtless, before divine omniscience, every hair of each minutest insect has its place in the general scheme of organic development, and every grain of sand on the surface has been weighed.

As a single illustration of the demands which geology makes upon us for time, it is enough to refer to the great gorge of the Colorado.[1] "This Cañon is three hundred miles long, and has walls of rock three thousand to six thousand feet high. The walls are sections of nearly horizontal strata, ranging for the principal part of their extent from the granite to the top of the carboniferous, and higher up the stream to the top of the cretaceous; and the whole bears undoubted evidence, according to Newberry, that it was made by running water. The granite has been excavated in some places to a depth of nearly one thousand feet; above this there are two thousand to two thousand five hundred feet of Palaeozoic sandstones, shales, and limestones, one thousand feet of probably subcarboniferous limestone, and one thousand two hundred feet of Carboniferous sandstones and limestones." This enormous gorge must have been principally worn out since the beginning of the Tertiary period, for very little progress could have been made before the elevation of the mountains of that region which bear upon their shoulders the Cretaceous formation. If we suppose the erosion to have proceeded at the rate of one inch a year, it would place the beginning of the Tertiary period more than twenty million years ago. That is, this period would have elapsed since there are known to have existed a number of species of animals (Palaeothere, Lophiodon) closely allied to the horse and the hog (Hieracothere, Chaeropotamus), also those that partook of characteristics between the Pachyderms and the stag among Ruminants (as the Anoplothere and Dichobune). "There were also monkeys, bats, deer, and opossums in England and France, although in the present age there are no opossums out of America, and monkeys are confined to the tropical zones." It is evident that the rate of change required to pass during such a period from the Palaeotherium to the horse and from Chaeropotamus to the hog might be very slow. Reflection on the vastness of these pre-historic ages does much to smooth the way for the acceptance of such a

[1] Dana's Manual of Geology (1st ed.), p. 569. The account is not materially different in the 2d edition.

theory as that of Darwin. Time is one factor; change is another. To produce a given result each would vary inversely as the other. As we pass into the period preceding the Tertiary the vistas of time recede in increasing ratio to the beginning of organic existence. During this period positive evidence concerning the plasticity of the existing species diminishes, while there is a corresponding increase of the unknown element of time and physical change. The more cautious scientific men pause before venturing far into the mazes of primordial time.

XX. Conspectus.

Setting out from that period when the Creator first breathed life into one, or, more probably, four or five, distinct forms, Mr. Darwin supposes the development to have been something as follows:

A vast, extremely complicated, and inscrutable environment of physical forces has furnished both material and limits to the development of organic life. The generic thread of life has been continuous from its introduction to the present day. Species in every part of their organism were endowed with an indefinite and imperfectly understood power of variability. Those variations which were best fitted to the changing conditions of their existence have of course survived. The conditions favoring the existence of a divergence from the type may continue so long that new species shall result. The qualities required to give a new variety the advantage in the struggle for life are as varied as the whole range of organic functions, of animal impulse, and of social instinct. "Utility" has as broad a meaning in Darwin's law of natural selection as "desire" has in systems of ethics or political economy. Desire ranges from the brutal instincts of the savage to the loftiest aspiration of the philosopher or the Christian martyr. The conclusions of the science of political economy are as indefinite as its basis of desire is broad. In like manner the superstructure of Darwin's evolutionary hypothesis must be as indeterminate as its base of utility is comprehensive. The preservation of a divergent

variety may depend on its own absolute completeness for the struggle, or on the comparative weakness of its competitors. It may depend on gigantic stature or diminutive littleness, on endurance or alertness, on boldness or timidity, on acuteness or stupidity. The range of social and sexual instinct is also exceedingly wide. We give the logical chain according to Wallace,[1] Organisms tend to a rapid increase, while the total number of individuals is stationary: this induces a struggle for existence, which combined with "heredity and variation," results in the "survival of the fittest"; this, combined with "unceasing change of external conditions," secures changes of organic forms, of such degree and permanency that they are called specific; thus *Species* may originate.

On the supposition of a preponderance of land during an early period in the Southern hemisphere, analogous to that which now exists in the Northern, many of the anomalous facts of the distribution of species, and the retention of old forms of life in the isolated centres of the South, will approach solution.

Through the discovery of connecting links, and fresh investigation of the facts bearing upon the distribution, gradation, and variability of species, much presumptive proof of the evolution of species has accumulated. What was required, and what "natural selection" has to some extent supplied, was not so much additional positive arguments, as the production of a theory which should not in its mode of operation do violence to the facts pointing so strongly in an opposite direction. A secondary cause, known to operate within certain limits, and which may have operated through the whole extent of organic life, and bound all species of an order into a united whole is brought to light. It is endeavored thus to put the advocates of the independent creation of species on the defence, and to throw the burden of proof upon those who deny the organic unity of the animal and vegetable creation. Of the defences put forth for the old-time view of the manner of the production of species we will speak in a succeeding Article.

[1] Con. Theory Nat. Selec., p. 302.

ARTICLE III.

RECENT WORKS BEARING ON THE RELATION OF SCIENCE TO RELIGION.

BY REV. GEORGE F. WRIGHT, ANDOVER, MASS.

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 Palæozoic 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 $\times$ (535×10^{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 Frazer'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. 386.

ARTICLE VI.

RECENT WORKS BEARING ON THE RELATION OF SCIENCE TO RELIGION.[1]

BY REV. GEORGE F. WRIGHT, ANDOVER, MASS.

No. IV. — CONCERNING THE TRUE DOCTRINE OF FINAL CAUSE OR DESIGN IN NATURE.

Birks (Thomas R.). Modern Physical Fatalism and the Doctrine of Evolution. 12mo. Macmillan.

Cocker (Prof. B. F., D.D., LL.D.). Theistic Conception of the World. An Essay in Opposition to certain Tendencies of Modern Thought. pp. 426. New York. 1875.

Bowen (Professor Francis). Lowell Lectures on the Application of Metaphysical and Ethical Science to the Evidences of Religion. pp. 465. Boston. 1849. In Lectures viii. and ix. of the First Course, pp. 155–198, the "Argument from Design" is judiciously and powerfully presented, though of course without special reference to the peculiar problems of the present time.

Cook (Rev. Joseph). Monday Lectures delivered in Boston in the Fall and Winter of 1876 and 1877. Published with the author's revision in the Daily Advertisers of the Tuesdays or Wednesdays following. Especially the Lectures on the Concessions of Evolutionists. Oct. 9, 16, 23, 30, 1876.

Dawson (J. W., LL.D.). An Address before the American Association for the Advancement of Science at Detroit, Michigan. August, 1875. pp. 26. Montreal. 1875.

Article in International Review for Jan. 1877, in Review of Huxley's New York Lectures. pp. 17.

Elam (Charles, M.D.). Winds of Doctrine: being an Examination of the Modern Theories of Atomatism and Evolution. Reprinted from Contemporary Review for Sept., Oct., and Dec., 1876. pp. 163. London: Smith, Elder, and Co. 1877.

Fiske (Prof. John). Outlines of Cosmic Philosophy, based on the Doctrine of Evolution. 2 vols. pp. 465, 523. Boston. 1875.

Article in North American Review for Jan. 1877. pp. 90–106.

[1] The list of books and articles given here is supplementary to that given in the two previous papers. See Bibliotheca Sacra for July and October, 1876. We regret that through oversight Mesozoic was incorrectly spelled in the October Article. It was correctly spelled in the manuscript.

Hickok (Laurens P., D.D., LL.D.). The Logic of Reason, Universal and Eternal. pp. 192. Boston: Lee and Shepard. 1875.

Hill (Thomas, D.D., LL.D.). A Statement of the Natural Sources of Theology; with a Discussion of their Validity and of Modern Sceptical Objections; to which is added an Article on the First Chapter of Genesis. Reprinted from the Bibliotheca Sacra. pp. 139. Andover: W. F. Draper. 1877.

Huxley (Thomas H., F.R.S., F.L.S.). Lectures on the Theory of Evolution, delivered in New York. Published in Tribune Extra. No. 36, also, with the author's revision, in the Popular Science Monthly for Nov. and Dec. 1876, Jan. 1877.

2. Article on Biology in the ninth edition of Encyclopaedia Britannica.

Jackson (Rev. William, M.A., F.S.A.). The Philosophy of Natural Theology. An Essay in Confutation of the Scepticism of the Present Day, which obtained a prize at Oxford, Nov. 26, 1872. pp. xviii. and 398. New York: A. D. F. Randolph and Co. 1875.

LeConte (Dr. John L.) Address before the American Association for the Advancement of Science at Detroit, Michigan, August, 1875. pp. 18. Salem. 1875.

Martineau (James, D.D., LL.D.). Modern Materialism in its Relations to Theology and Religion. With an Introduction by Henry W. Bellows, D.D. 18mo. pp. 211. G. P. Putnam's Sons. 1877.

Maxwell (Prof. Clerk). In Article on "Atoms" in the ninth edition of the Encyclopaedia Britannica. He argues the absurdity of "pangenesis," from mathematical calculations regarding the size of atoms.

Morse (Professor Edward S.). Paper read before the American Association for the advancement of Science at Buffalo, N. Y. Aug. 1876. Published in Popular Science Review for Nov. and Dec. 1876. pp. 1-16. 181-198.

McCosh (James, D.D., LL.D., President of Princeton College). The Development Hypothesis: Is it Sufficient? 12mo. pp. 104. New York: Robert Carter and Brothers. 1876.

The earlier works of the same author should by no means be neglected. The more important are:

The Method of the Divine Government, Physical and Moral. pp. 547. Especially Book II. pp. 75-257. Edinburgh. 1855.

Typical Forms and Special Ends in Creation. pp. 556. Edinburgh. 1857.

The Intuitions of the Mind Inductively Investigated. Revised edition. pp. 448. London. 1865.

Porter (President Noah, D.D., of Yale College). The Human Intellect, etc. pp. 693. Especially Chapter v. of the Fourth Part, on "Design, or Final Cause." New York. 1869.

Smith (Prof. Goldwin). "The Ascent of Man." Article in Macmillan's Magazine for Jan. 1877. pp. 10. Republished in Eclectic Magazine for March.

Socrates. Reported in Xenophon's Memorabilia. Book I. chap. 4 and Book IV. chap. 3. This author is not very recent, neither are the Bridgewater Treatises, to which the reader should be referred, fully up to date, but there is as much meaning in them now as ever, and, as modern science is trying to show, a little more.

Wallace (Alfred Russell). The Geographical Distribution of Animals, with a Study of the Relations of Living and Extinct Forms as Elucidating the Past Changes of the Earth's Surface. 2 vols. 8vo. pp. 503, 607. New York: Harper and Brothers. 1876.

Address at the Glasgow Meeting of the British Association. Published in the American Journal of Science and Arts for Nov. 1876. pp. 354–85.

Weismann (Prof. August). Studien zur Descendenz-Theorie. II. Uber die letzten Ursachen der Transmutationen, Mit fünf Farbendrucktafeln. 8vo. pp. 336. Leipzig. 1876.

Wilder (Rev. M. A.) Natural Law and Spiritual Agency. Article in New Englander, Vol. xxxiii. (Oct. 1874). pp. 674–702. This is a very satisfactory vindication of the general doctrine of Mind in Nature.

I. *Is there Design in Nature?*

If on shaking a quantity of type in a basket it should appear that some of the pieces stuck together, when they fell, in such order as to compose the story of Moses in the bulrushes, could we resist the conclusion that these particular types were loaded with the design of composing that story, on condition that they were well shaken? Indeed, should we not see more design in type thus endowed than in ordinary "pie," from which an intelligible sentence can be formed only by the direct efforts of a highly skilled workman?

We read the design in the complicated and intelligible adaptation of the final result. It is no prejudice to our conclusion to show that the forces producing this delicate adaptation have passed through a variety of transformations, and that their origin is out of sight. Whatever that might prove, it would in no manner disprove origination in an intelligent designer. The atmosphere of modern speculation is not inimical to the Paleyan argument when properly understood, but is rather a positive supporter of it.

We hear much about the conservation of force. Energy may be cast down from one seat and another, but it cannot be destroyed. It is protean in its forms. There is a principle of continuity in nature. Lines of force which we see in operation in present phenomena may be traced backward into more indefinite, because less known, forms; but they cannot be run so far back as to project behind adequate causation. It is precisely so with the evidence of design in complicated adaptations of nature. Chance produces nothing *definite* and *orderly*.[1] Nature "conserves" design as much as it does force, and in much the same manner.

"One day at Naples," says a French writer, "a certain person in our presence put six dice into a dice-box, and offered a wager that he would throw *sixes* with the whole set. I said that the chance was possible. He threw the dice in this way twice in succession; and I still observed, that possibly he had succeeded by chance. He put back the dice into the box for the third, fourth, and fifth time, and invariably threw *sixes* with the whole set. 'By the blood of Bacchus,' I exclaimed, '*the dice are loaded*'; and so they were.

"Philosophers, when I look at the order of nature that is constantly reproduced, its fixed laws, its successive changes, invariably producing the same effect, — when I consider that there is but one chance which can preserve the universe in the state in which we now see it, and that this always happens, in spite of a hundred millions of other possible chances of perturbation and destruction,—I cry out, '*Surely, Nature's dice are also loaded.*"[2]

The adaptations which we behold in such profusion in nature, may each of them, with respect both to their secondary causes and their final causes, be compared to a river like the Mississippi, flowing past our doors. We shall not be able to dispense with the idea of design in the location of the river by showing that the channel was not dug by the

[1] How little sense there is in attributing orderly manifestations to chance, especially such adaptations as those by which we live and move and have our being, we have shown in previous Articles. See Bib. Sac., Vol. xxxii. pp. 544–547; also Vol. xxxiii. pp. 669, 674, 676, and 687; see also, Hill's Natural Sources of Theology, p. 77 f.; J. S. Mill's Inductive Logic, Book iii., chapters 17 and 18; Bowen, on Metaphysical and Ethical Science, pp. 165–171; Jevons's Principles of Science, Vol. i. p. 225 ff.

[2] The Abbé Galiani in discussion with Diderot, translated and quoted by Bowen from Dugald Stewart's notes.

use of spades, and the material removed on wheelbarrows; for that is only one way, and is not God's way, of forming a canal. The nature of the instrument used in accomplishing an object has nothing whatever to do with the fact of *a* design. We may, if we please, trace the Mississippi back through all its numerous tributaries to the raindrops and the skies, but we are still in a charmed and closed circle of "principles of order," combining for definite results. We never in our investigations get within sight of chaos. What is science but a study of orderly operations? Where order seems to cease, the scientific investigator pauses in bewilderment. "Principles of order" compass his "path and his lying down," they beset him "behind and before." If he "ascend up into heaven they are there; if he take the wings of the morning and dwell in the uttermost parts of the sea, even there shall they lead him."

In any case of secondary causation we do not care, so far as the argument for the existence of an intelligent designer is concerned, at how many, or at what points, the various elements of design entered. The inference of design in nature is drawn from complexity and niceness of adaptation. This inference need not be affected by any new view of the mode of origination, and cannot be rebutted, except by assigning a sufficient physical cause, irrespective of intelligence. If any one asserts that these adaptations arise from necessity, he is bound to show by what necessity. Until that is shown, the inference of an intelligent cause is as good as it ever was, however much our conception of nature's intricate machinery may be enlarged. Man is himself a designer. The hypothesis that the adaptations of nature had their origin in design is, to say the least, more intelligible than that which ascribes them to necessity. Certainly it devolves upon those who deny or refuse to recognize design in organic complexity, to do more than push back one step, or one hundred steps, the point at which the designing impulse may have been given. They must draw lines of circumvallation around the whole field, and cut off every avenue of approach, or the argument

for design will enter with all its force in spite of them. Sober-minded naturalists do not undertake this task. We do not envy the success of those philososphers who have undertaken it. For, it is as hard to banish the idea of final cause as of efficient causation, and for precisely the same reason.

In the case referred to, of type arranging itself to compose the story of Moses, there is an accumulation of particular designs. In type set up by a printer, a very large part of the particular design enters through his work. But he did not design the type, nor did the type-founder design the story. In this case the skill of the type-setter is called into requisition because the type-maker had not the power or the inclination to go farther in his design than to get the material in readiness for the more specific designs of the printer. But if this type, when shaken sufficiently by horse power in the cellar, would in a square box become Milton's "Sonnet on his Blindness," in a round one the "Lord's Prayer," in a tin pan the "Sayings of Poor Richard," and in a rush basket the story of Moses, we have not lost the design because an animal furnished the power which did the shaking. We grant that the animal did not of his own will add anything to the evidence of the design,—perhaps he was only trying to get at an ear of corn on a stick before him. But design entered in adjusting the forces to make the mill go. We grant, also, that a person of less skill than a printer could set the mill in operation. But so far as the argument for design is concerned, you have, in bringing forward these considerations, only transferred more of the designing activity to this extraordinary type-founder. The evidence of design is not obscured.

II. *Paley did not Reason in a Circle.*

Paley, in the second chapter of his Natural Theology, considers the case of one watch being produced from another in a regular series; and shows that such a discovery would only increase our "admiration of the contrivance," and our "conviction of the consummate skill of the contriver."

Paley, in company with all the scientific investigators of his day, was ignorant of the considerations which are now forcing upon the world the question of the derivative origin of species as well as that of individuals. But he was not so short-sighted as to base his argument on the mode of origination. When one individual gives birth to another, it is only "in some sense the maker" of it.

He is "asking for the cause of that subserviency to a use, that relation to an end, which we have remarked in the watch before us. No answer is given to this question by telling us that a preceding watch produced it."[1]

Still farther on in the chapter Paley contends that supposing one watch to have been produced from another watch, and "that from a former, and so on indefinitely," "does not, even though we go ever so far," "bring us any nearer to the least degree of satisfaction on the subject." The difficulty is not diminished by removing it farther back.

"A chain composed of an infinite number of links can no more support itself than a chain composed of a finite number of links. And of this we are assured, though we never *can* have tried the experiment, because, by increasing the number of links, from ten, for instance, to a hundred, from a hundred to a thousand, etc., we make not the slightest approach, we observe not the smallest tendency, towards self-support."[2]

In the case of one watch being produced by another, Paley denies that "we have [in that fact] any cause whatever ..... for the design, the contrivance, the suitableness of means to an end."[3] The real effect of discovering such an origin would be to "increase beyond measure our admiration of the skill which had been employed in the formation of such a machine."[4] But, while Paley satisfactorily disposed of the objections to his argument on the ground that individuals are propagated from each other, it could not be expected that he should altogether anticipate a somewhat different line of objection, subsequently arising out of a belief that living *species* have a genetic connection with one another. If individuals are endowed not merely with the power of producing other individuals exactly after their kind, but of producing them

[1] Paley's Natural Theology, chap. ii., sec. 3.
[2] Ibid., sec. 4.
[3] Ibid., sec. 4.
[4] Ibid., sec. 5.

with variations of such a kind, and so correlated to their environment, that there shall be improvement in the organization, this, as Professor Gray early contended, compels an extension of the Paleyan argument for a designer.

We are fully aware of a remarkable passage, in which Paley is thought by some to assert that he would throw up his whole style of reasoning if such an hypothesis as that of Mr. Darwin should be established. The passage is as follows:

"There is another answer which has the same effect as the resolving of things into chance, which answer would persuade us to believe that the eye, the animal to which it belongs, every other animal, every plant, indeed every organized body which we see, are only so many out of the possible varieties and combinations of being which the lapse of infinite ages has brought into existence; that the present world is the relic of that variety; millions of other bodily forms and other species having perished, being, by the defect of their constitution, incapable of preservation, or of continuance by generation."[1]

If Paley had written in our day, he would no doubt have guarded his phraseology with more care. But even as it is, the section, as a whole, plainly indicates that the Lucretian theory of fortuitous development was in view. For in his more explicit statement, on the following page, we read:

"The hypothesis teaches, that every possible variety of being hath, at one time or other, found its way into existence, — by what cause or in what manner is not said, — and that those which were badly formed perished; but how or why those which survived should be cast, as we see that plants and animals are cast, into regular classes, the hypothesis does not explain; or, rather, the hypothesis is inconsistent with this phenomenon."

Now, Mr. Darwin, in our day, has brought forward an hypothesis which purports to be consistent with this phenomenon. On this hypothesis, — suggested by observation, — of a wide range of variability, correlated to a complicated series of changing conditions which do not neutralize the effect of the tendency to variation, but direct and intensify it, naturalists are attempting to account for the definite direction in which species have progressed, and the "regular classes" in which they are cast. Yet this can be no hap-hazard process,

[1] Natural Theology, chap. v., sec. 4.

however concealed from our plodding intellects. No one can suppose that all possible events have occurred. The farthest one could go in that direction would be to surmise that all events possible under the present system of nature had come to pass; but that would be a very different thing. Like all illustrations, the one we are now going to bring forward is very unsatisfactory in some respects; but it is truthful to the main point. Each single variation in the hypothesis of Mr. Darwin is like an explosion of gunpowder, determinate in its tendency only as there is a gun-barrel to direct its force.

Had the modern speculations concerning the derivative origin of species been promulgated when Paley wrote, there can be little doubt that our American naturalist would have been anticipated in his supposition of the watch whose immemediate descendants produced better watches, and whose remote descendants gave birth to a chronometer and a town clock. The question in natural theology raised by Darwinism does not disturb the argument for an intelligent designer, but pertains only to the times and modes in which the forces of design are introduced. It also modifies in some degree the interpretation of that design. How little the students of natural theology have to fear this theory of the origin of species, will appear when attention is directed to the contrivance and foresight of a higher power demanded by this theory, not so apparently in the construction of each particular part of the organic and balanced whole, when taken singly, as in the construction and preservation of the whole itself, which should *incorporate* and *retain* these contrivances and adaptations among its parts.

If Paley is open to criticism in one point more than in another, it is in this: that he does not make sufficiently prominent the *a fortiori* nature of his argument. To come down from the "Cosmos" to a watch, to find design, seems like labor lost, since the one is so infinitely inferior to the other. Furthermore, the watch reveals two separate things which we are likely to confound, namely, design, and man's

method of executing design. Making such a comparison prominent incurs the danger of encouraging conceptions of God which are too *anthropomorphic*, both as to the narrowness of the design contemplated and as to the means of attaining the end.

III. *Life does not exist or continue by Necessity.*

The profoundly mysterious power of life, somehow introduced into the world, is adjusted on the Darwinian hypothesis to the other forces which have operated co-ordinately with it. We can easily conceive that at any time since its introduction, changes in these co-ordinate powers might have altogether extinguished life itself. The theory of pangenesis, which is derided by some as absurd, has only that degree of absurdity that pertains to any attempt to state in comprehensive, material figures of speech the marvellous facts concerning the manifestations of life.

We are aware that at this point we are likely to be told that there is no more propriety in speaking of the "power of life" and "vitality" than in speaking of the "power of aquosity" in water. For the sake of the argument we are willing to grant it. But certainly the "power of aquosity" is something. Water is not a necessary existence, even when all the elements in its composition abound. Oxygen and hydrogen are not water, till other and a whole congeries of powers have brought them in to a particular relation to each other; and then they are held in that relation only so long as certain conditions are preserved. The word "aquosity" because superfluous, is not senseless. But no one would contend that there is not a far greater manifestation of power, and an inconceivably more delicate adjustment of conditions required in the production and perpetuation of living organisms, especially those of a higher grade, than in the production of water. As water is more than oxygen and hydrogen, so a living organism is more than oxygen, hydrogen, nitrogen, carbon, and whatever other chemical elements enter into it. If any one says that living organisms exist in nature by virtue

of necessity, we ask by what necessity? Chance knows no necessity. There can be no necessity in the outcome of Nature except such as is put into her operations. The reasoner never can get so far back in the chain of secondary causation that he is not compelled to posit a nature and conditions which involve in their operations all present phenomena. We by no means admit that philosophers have reduced, or ever can reduce, all phenomena to two or three elementary forms of motion. But if they should do so, they will not have reduced the amount of intelligence necessary to work out of these so-called simple motions the present complicated results and adaptations; for since the days of Aristotle we have rather heard that wisdom was most manifest in the power of accomplishing wonderful results by simplest means.

Let us now look more closely at the Darwinian hypothesis, and see if it in any manner excludes design.

Life is not, according to this hypothesis, a product of the present conditions of existence. It comes down from the past through a mysterious power of propagation. Life is a power co-ordinate with the other natural forces, and clothes itself in material forms which accord both with the nature of the inner principles and of the conditions. A living principle, capable, to a limited extent, of transforming other material powers, is set in motion. To maintain its existence this principle has to run the gauntlet of all the changes that take place in such a world as this. This power of life may be compared to a rove of cotton, and the conditions of life to the spinning-jenny and the combined machinery of a cotton-mill. The nature of the product depends on a vast complication of movements and adaptations, from those of the water-wheel to those which secure the proper tension of the thread. All these movements are independently adjusted with reference to the nature of the cotton. Too much tension will break the thread, too little would loop it.

The Darwinian supposition is, that life has been so adjusted to the changing conditions of the material forces of the

world, that for a period of one hundred million years, more or less, it has been continuous. That surely makes a demand for a Contriver who is omniscient as well as omnipotent. For, the conditions through which that plastic principle has passed have been changeable and trying. Time and again, land and water have shifted place, and transferred the scene for organic development from one portion of the globe to another. The alternations of climate have been extreme between distant periods of time. Now an arctic climate has crept slowly down far towards the equator, to give place in due season to ameliorating influences that should dispel even the rigor of the frigid zones. Volcanoes have at times belched forth their fires in almost every portion of the world, and earthquakes have everywhere shaken her solid foundations. Vast regions have sunk beneath the sea; while elsewhere plains as vast, and bearing mountain chains on their summits, were rising towards the sky. Amid all these changes, however slowly they may have occurred, the equation of life has had continually to re-adjust itself not only to forces outside, but to its own inherent tendencies. Race has warred on race, and individual has been brought into sharp competition with his fellow. The mystery is that the higher forms of life have been preserved at all. The hand of Providence certainly is not dispensed with, but rather called for. The Providence of the Darwinian resembles a far-seeing capitalist, who like the ant lays up his store in the summer season; while that of the catastrophist is like the day-laborer, whose family lives from hand to mouth. It is the inability of our imaginations to cross the cycles of time and its secondary causes, which makes it so difficult for us to recognize the similarity of contrivance from eternity with that which is originated to-day. There is convincing force in the remarks of Whewell, when applied to the subject in hand, as well as to that upon which he was writing.

"The adaptation of the bones of the skeleton to the muscles, the provision of the fulcrums, projecting processes, channels, so that the motions and forces shall be such as the needs of life require, cannot possibly become less

striking and convincing from any discovery of general analogies of one animal frame with another, or of laws connecting the development of different parts. Whenever such laws are discovered we can only consider them as the means of producing that adaptation which we so much admire. Our conviction that the artist works intelligently is not destroyed, though it may be modified and transferred, when we obtain a sight of his tools. Our discovery of laws cannot contradict our persuasion of ends; our morphology cannot prejudice our teleology. ..... The assertion appears to be quite unfounded that, as science advances from point to point, final causes recede before it, and disappear one after the other. The principle of design changes its mode of application, indeed, but it loses none of its force. We no longer consider particular facts as produced by special interpositions; but we consider design as exhibited in the establishment and adjustment of the laws by which particular facts are produced. We do not look upon each particular cloud as brought near us that it may drop fatness on our fields; but the general adaptation of the laws of heat and air and moisture to the promotion of vegetation does not become doubtful. We do not consider the sun as less intended to warm and vivify the tribes of plants and animals because we find that, instead of revolving round the earth as an attendant, the earth, along with other planets, revolves round him. We are rather, by the discovery of the general laws of nature, led into a scene of wider design, of deeper contrivance, of more comprehensive adjustments. Final causes, if they appear driven farther from us by such extension of our views, embrace us only with a vaster and more majestic circuit. Instead of a few threads connecting some detached objects, they become a stupendous network, which is wound round and round the universal frame of things."[1]

IV. *Difficulties in the way of an Exhaustive Interpretation of God's Designs in Nature.*

It may be well to recur to our opening illustration of types possessed in some way of the capacity of sticking together according to an intelligible plan. Suppose, now, that after the amount of shaking, more or less, which brought out the story of Moses we should find a large quantity of "types," "leads," "spaces," and "quads" still jumbled together according to no discernible order: would that disprove the positive testimony we already had of intelligent design? We will not insult our readers by answering so plain a question for them, but may bring to their attention a pertinent remark of Paley on the point:

[1] The Philosophy of the Inductive Sciences, Vol. ii. pp. 88–94. London, 1840.

"True fortitude of understanding consists in not suffering what we know to be disturbed by what we do not know. If we perceive a useful end, and means adapted to that end, we perceive enough for our conclusion. If these things be clear, no matter what is obscure. The argument is finished..... A just reasoner removes from his consideration not only what he knows, but what he does not know, touching matters not strictly connected with his argument, that is, not forming the very steps of his deduction. Beyond these, his knowledge and his ignorance are alike relative."[1] [That is to say, are *irrelative* to the matter in hand.]

But by the seeming waste and the apparent failures and imperfections of nature, we are brought to face a difficulty regarding the power, wisdom, and goodness of its Designer. We come now to the more important and difficult question of *interpreting* the designs of the Creator. The position which we defend is, that though his ways are as much higher than our ways, and his thoughts than our thoughts, as the heavens are higher than the earth, still, his name is something better than the "Unknowable." We do know something about the heavens. The heavenly bodies are set for the dividing of times and seasons. The fugitive and the sailor know something, though far less than the astronomer, about the north star. "We may find God, though we can never find him out." One may endeavor to point out the means of rescuing the doctrine of final causes from the general disrepute into which it has fallen in some quarters; and from certain objections, supposed to be new, arising in connection with Darwinism.

There are, indeed, few subjects upon which there has been so much loose speculation as upon that of the interpretation of the reasons which have actuated the Divine Mind in the creation of particular things. The arrogance of our short-sighted wisdom in pronouncing upon the ultimate reason why certain things are brought into existence has often been so manifest and so offensive, that it is not surprising that some philosophers have gone to the other extreme, and pronounced the ways of God absolutely unknowable. But it is surprising and somewhat discouraging that authors of the

[1] Natural Theology, chap. v., sec. 7.

calibre and breadth of Hamilton and Mansel should have landed in such a suicidal and self-stultifying position. The error has been in failing to consider the universe as a whole. We have cut nature up into parts, and discussed the meaning of these in their isolation. We have brought an atom within the field of the microscope, and reasoned about it as though it were the centre of the universe, as it is of our vision. Whatever thing was useful it has been assumed was made for that special purpose, with no farther thought of its relation to other objects. The bill of a mosquito is doubtless useful to its possessor, but it is a torment to the rest of the animal creation. The tail of the cow is of advantage to the cow chiefly as it is a terror to the mosquito.

There is no disguising the fact that a constant state of warfare exists between the members of the animal kingdom, in which the weakest go to the wall. Carnivorous animals live by depredations upon the herbivorous, and the more favored of the herbivorous live by snatching the food from the mouths of their less favored brethren, and subjecting them to slow starvation. The carnivora, too, struggle between themselves as well as with their more peaceable neighbors. The very need of many of the contrivances necessary for the preservation of the lives of plants and animals is created by the existence of antagonistic elements in surrounding nature. For example, some individual fishes produce millions of young every year; but the adverse conditions are so numerous and destructive that, on the average, not over one or two survive to maturity. It has been adduced as evidence of the care of the Deity for the welfare of these fishes that since the elements are so adverse to the survival of their young they are compensated by the power of producing so great a number, so that the species may not be lost. But then the rocks are full of evidences that numberless species have at last succumbed and become extinct.

> "From scarped cliff and quarried stone
> She cries 'A thousand types are gone.'"

Where is the benevolent wisdom in these facts, when con

sidered in themselves, apart from the general system in which they are introduced? The truth is, that the rose-colored views of many of the evolutionists, and of still more of the pietistic interpreters of natural theology, are built upon a very narrow basis of facts, to the exclusion of another class of facts which abound in startling number. Much of what is ascribed to God as benevolence, displays as much confusion of mind on the part of those who adduce it, as did certain laws of Massachusetts for the protection of fish. Among other statutes on the subject, there was one making the lives of *pickerel* sacred at certain times of the year. The legislators did not consider that the lives of the more valuable fishes were in greater danger from the voracity of one hungry pickerel than from the depredations of half a score of fishermen.

V. *The Doctrine of Second Causes involves Difficulties analogous to those in the Doctrine of Final Causes.*

In stating the doctrine of secondary causation, logicians have found it necessary to disencumber themselves of many old-time distinctions between causes and conditions. In the realm of secondary causes nothing is the product of a single cause. As Hamilton remarks:

"Of second causes, there must almost always be at least a concurrence of two to constitute an effect. Take the example of vapor. Here, to say that heat is the cause of evaporation is a very inaccurate, at least a very inadequate, expression. Water is as much the cause of evaporation as heat. But heat and water together are the causes of the phenomenon. Nay, there is a third concause which we have forgot — the atmosphere. Now, a cloud is the result of these three concurrent causes or constituents; and, knowing this, we find no difficulty in carrying back the complement of existence, which it contains prior to its appearance. But on the hypothesis that we are not aware what are the real constituents or causes of the cloud, the human mind must still perforce suppose some unknown, some hypothetical, antecedents, into which it mentally refunds all the existence which the cloud is thought to contain."[1]

According to Stuart Mill:

"The statement of the cause is incomplete, unless in some shape or

[1] Lectures on Metaphysics, chap. xl., pp. 554, 555. Boston, 1859.

other, we introduce all the conditions. A man takes mercury, goes out of doors, and catches cold. We say, perhaps, that the cause of his taking cold was exposure to the air. It is clear, however, that his having taken mercury may have been a necessary condition of his catching cold; and, though it might consist with usage to say that the cause of his attack was exposure to the air, to be accurate we ought to say that the cause was exposure to the air while under the effect of mercury..... Every condition of the phenomenon may be taken in its turn, and with equal propriety in common parlance, but with equal impropriety in scientific discourse, may be spoken of as if it were the entire cause. And in practice that particular condition is usually styled the cause whose share in the matter is superficially the most conspicuous, or whose requisiteness to the production of the effect we happen to be insisting upon at the moment. So great is the force of this last consideration that it often induces us to give the name of cause even to one of the negative conditions. We say, for example, 'the cause of the army's being surprised was the sentinel's being off his post.' ..... Since, then, mankind are accustomed, with acknowledged propriety, so far as the ordinances of language are concerned, to give the name of cause to almost any one of the conditions of a phenomenon, or any portion of the whole number, arbitrarily selected, without excepting even those conditions which are purely negative and in themselves incapable of causing anything; it will probably be admitted, without longer discussion, that no one of the conditions has more claim to that title than another, and that the real cause of the phenomenon is the assemblage of all its conditions..... The cause, philosophically speaking, is the sum total of the conditions, positive and negative, taken together."[1]

We would not care to be held by all the phraseology of Mill, nor would we speak disrespectfully of those logicians and philosophers who, for special purposes, have endeavored to make accurate and intelligible distinctions between causes of various kinds and conditions. It is sufficient for our purpose that there is a word "concause": and its idea in a very comprehensive sense is indispensable to any proper understanding of the true doctrine of secondary or efficient causation. A difficulty which is always encountered by the men of science is to keep hold of all the threads of physical causation which centre in a given phenomenon. Some are invariably lost, and there is necessarily an apparent dissipation of

[1] Logic, p. 198 ff. See also President Edwards' definition of cause, in "Freedom of the Will," Part ii., sec. 3.

energy. The doctrine of the conservation of energy is not one of perfect experiment, but is one of thought; it is a belief which goes beyond experiment.[1] The students of natural theology, or of design in nature, encounter in their field difficulties altogether analogous to, but we apprehend no greater than, those just referred to as experienced by scientific men. The students of natural theology are endeavoring to harmonize in one principle the imperfect evidences of apparently conflicting designs which appear in nature. The universe is a compromise, in which subordinate ends are but imperfectly realized. Justice and mercy are not the only principles which coalesce with difficulty. There are paradoxes other than those presented by the co-existence in the human will of freedom and certainty. There is a nature of things which presents obstacles even to Omnipotence; for Omnipotence has relation only to such things as are the proper objects of power. Two hills cannot exist without a valley between. It is easy to conceive that two or more ends, desirable in themselves, may be so related as to require an indirect process for their accomplishment. For example, the perfection of the whole and the perfection of the part, are in a manner exclusive of each other, except as the mutual adaptation is an element of the perfection. It may not be derogatory to the divine wisdom to affirm that the eye is an imperfect optical instrument, because the securing of the power of sight is only one of the many ends to be accomplished in such an organism. Vision as an end is correlated with other objects of design. As each writer has his style, so God has his chosen mode of operations. The style of God's workmanship may be as essential in its correlation to the intellect of his creatures, as light is to the eye. If God has infinite ends in view, it is fitting, that in accomplishing these ends, he move along the curve of an infinite circle. The manner in which a thing is done, is a part of the thing itself. If it be impossible to penetrate far into the designs of the Creator,

[1] See an instructive paper, by Prof. Leebody in British and Foreign Evangelical Review, for Oct. 1876.

it is equally impossible to comprehend to any great extent, the method of his operations.

In the comprehensive theory of virtue elaborated by President Edwards and his successors, the "good of being" is made the ground of obligation. "The creation, taken not distributively, but collectively, as a system raised to a high degree of happiness," constitutes "the declarative glory of God."[1] God, in his infinite benevolence, must have sought, in the creation as a whole, the "good of being," in the most comprehensive sense of that phrase, including himself. Here comes the practical difficulty of interpretation; when we attempt to follow out the lines of this design as they radiate from the divine activity; or (to speak more properly) when we pick up a few loose strands of this infinite web, we soon plunge into mysteries and encounter paradoxes. But it ill becomes scientific men to magnify those difficulties in comparison with their own. The scientific fraternity had trouble, not long since, with a guild popularly styled "positivists," who well nigh classified science to death, and insisted that philosophers were to take no step beyond actual observation and experiment. From that folly Darwin has happily delivered them. So have we had, in the ethical field, those called "utilitarians," who insisted that there was no virtue except in such acts as have a tendency to promote happiness, — the *promotion* of happiness being the foundation of obligation. But that is too narrow a view of virtue, since man cannot tell absolutely what actions will, on the whole, promote happiness; he must accept the testimony of God as seen in the construction of human nature and in providence and in revelation. To the question what is Virtue; the Edwardean answers, Virtue consists in choosing the "good of being"; and that involves, on the part of a finite creature only such conformity of executive action in attaining the general object as corresponds to the light he has regarding the correlation of means to the end. Where there is a willing mind, God takes care of the results. But when we rise above the region of

[1] See Edwards' Works [The Younger], Vol. i. p. 481. Boston, 1854.

human infirmity, and speculate concerning the designs of infinite wisdom, we see that with God the choice and the action must coalesce. The general becomes particular, and the individual choice becomes universal. Doubtless, the universe is "all of a piece" both as to second causes and as to final causes. No part of the creation can be fully interpreted, either as to efficient cause or as to final cause, without regard to every other part. We may say, then, of any object in nature, that in the divine idea the final cause of its creation is the sum of all the uses to which it is ever to be put. This should introduce us to a very broad view of design, comprehending the principle of correlation, which has regard to negative use as well as positive, and bringing to view the whole question regarding the dignity of human nature, and the requisites for its mental and moral development. Even then there is an unknown range of possible intelligence, different from our own and perhaps above it, which will make us cautious about expressing negative conclusions regarding the wisdom of any work of God. With some of these questions, as they have been met both in the field of science and in that of theology, we shall deal in a future paper; so we will touch lightly upon them here. Doubtless there is in the mind of God a "sufficient reason" for the existence of each particular thing in the creation. But the full interpretation of this sufficient reason, like the complete comprehension of the doctrine of the "continuity of nature," lies beyond our capacity. Still, we are not in either department complete "agnostics"; we do know something. Let us see what, and about how much, it is.

VI. *How fully can the Human Mind interpret the Design in Nature?*

To get a proper understanding of the true doctrine of final causes, we must endeavor to shift the point of view from that in which we see things singly and disconnected to a position from which they shall be seen as parts of an organic whole. The reason for the existence of any part of the

creation cannot be fully understood except in its relations to all the other parts. The final cause of the least part of the universe can be interpreted only from a proper understanding of the final cause of the whole. The part must be merged in the whole before it can be exhaustively interpreted. As each particle of matter feels the attraction of every other particle, so all lines of design are deflected by the requirements of each subordinate element. We have not insisted enough upon the distinction between the chief end of creation and what is subsidiary or incidental to it. Each incidental good, however, comes in as a part of that whole which constitutes the chief end. The comprehensive end of the creation is, as we have said, the "highest good of being in general." We can conceive that this is secured in a variety of co-ordinate lines centering in that one generalization. The sensational happiness of all organic creatures, from the lowest animalcule to that of the most highly organized animal form, is an element to be considered in that general good of being. The pleasurable sensations of the intellect, investigating and interpreting the ways of God as displayed in the creation, is likewise a part of that good included in the end for which all things were made. The interchange of sympathy and love and admiration and gratitude which accompanies the development of moral character amid the trials of life, forms also a part of that object for which all things exist. But, aside from the satisfaction which we may suppose God to have himself in his own work and its results, we must, perhaps, in estimating the material creation's "value in use," give the foremost place to the probability that intelligent beings throughout all future time and in all space will need a clew by which to unravel and rightly interpret the scheme of God. The intellectual and moral emotions dependent upon the adaptability of the works of God to being understood may form the chief part of finite good. In other words, it may reasonably be supposed that it is of more account to God's creatures as a whole that the universe be capable of interpretation, and that the method of God in his works

be manifested, than that any amount of temporary good should occur during the earlier stages of the process of development. The happiness occurring now may be only such as can be worked in incidentally to the greater good that is to supervene in the consummation of all things. And even now it may be of more account to us to be assured that we have some conception of God's general plan of operations with reference to us, than it would be to know the full meaning and object of any part of his creation; just as it is of more importance that a child should be certain that the command is from his parent than that he should understand the reason of the command.

The use to which we may put a thing is never more than a fragment of the final cause of its existence.

We may illustrate this by the reasons that prevail in the establishment of a manufactory at a particular place. We will suppose it is a saw-mill, the main object of whose construction is the production of lumber. A combination of reasons, no single one of which may have been sufficient alone, accounts for the existence of each particular saw-mill. The price of labor, the facility to a market for the principal production, the obstacles to be overcome in getting the raw materials to the mill, and, finally, the use that can be made of the refuse, or incidental production of the establishment, may, any one of them, come in as the determining reason. All the profits of the mill may be in the sale of the slabs and scantling, or in economizing these as fuel. The uses the miller's children may make of the refuse for play-houses, and the miller's wife for kindling, are none of them so insignificant as not to be taken into account. The children very naturally, might at a certain age, fix upon their incidental advantage as the main object, or final cause, for which the mill existed. And their error may not be half so ludicrous as that we make in assigning the temporary advantages we derive from them as the exhaustive reason for the existence of the several parts of the universe that come within the range of our limited observation. Indeed we may well

suppose that the highest conception we can compass with our imagination of the perfection and design of the divine workmanship, is but a partial appreciation of the utility of the chips that have fallen off incidentally in the process of rearing the walls of the city of God. We are living in the quarry, and are concerned with the fragmentary pieces of emerald and sardonyx and topaz that are scattered thickly about the region where God's hand is at work. This view is suggested by the last three pages in the work of Darwin on "Animals and Plants under Domestication"; which are worthy of the most careful study of the theologian.

"In accordance with the views maintained by me in this work and elsewhere, not only the various domestic races, but the most distinct genera and orders within the same great class; for instance, whales, mice, birds, and fishes, are all the descendants of one common progenitor, and we must admit that the whole vast amount of difference between these forms of life has primarily arisen from simple variability. To consider the subject under this point of view is enough to strike one dumb with amazement. But our amazement ought to be lessened when we reflect that beings, almost infinite in number, during an almost infinite lapse of time, have often had their whole organism rendered in some degree plastic, and that each slight modification of structure which was in any way beneficial under excessively complex conditions of life, will have been preserved, whilst each which was in any way injurious will have been rigorously destroyed. And the long continued accumulation of beneficial variations will infallibly lead to structures as diversified, as beautifully adapted for various purposes, and as excellently co-ordinated, as we see in the animals and plants all around us. Hence I have spoken of selection as the paramount power, whether applied by man to the formation of domestic breeds, or by Nature to the production of species. I may recur to the metaphor given in a former chapter; if an architect were to rear a noble and commodious edifice, without the use of cut stone, by selecting from the fragments at the base of a precipice wedge-formed stones for his arches, elongated stones for his lintels, and flat stones for his roof, we should admire his skill and regard him as the paramount power. Now, the fragments of stone, though indispensable to the architect, bear to the edifice built by him the same relation which the fluctuating variations of each organic being bear to the varied and admirable structures ultimately acquired by its modified descendants.

Some authors have declared that natural selection explains nothing, unless the precise cause of each slight individual difference be made clear. Now, if it were explained to a savage utterly ignorant of the art of build-

ing, how the edifice had been raised stone upon stone, and why wedge-formed fragments were used for the arches, flat stones for the roof, etc.; and if the use of each part and of the whole building were pointed out, it would be unreasonable if he declared that nothing had been made clear to him, because the precise cause of the shape of each fragment could not be given. But this is a nearly parallel case with the objection that selection explains nothing, because we know not the cause of each individual difference in the structure of each being.

The shape of the fragments of stone at the base of our precipice may be called accidental, but this is not strictly correct; for the shape of each depends on a long sequence of events, all obeying natural laws; on the nature of the rock, on the lines of deposition or cleavage, on the form of the mountain, which depends on its upheaval and subsequent denudation, and, lastly, on the storm or earthquake which threw down the fragments. But in regard to the use to which the fragments may be put, their shape may be strictly said to be accidental. And here we are led to face a great difficulty, in alluding to which I am aware that I am travelling beyond my proper province. An omniscient Creator must have foreseen every consequence which results from the laws imposed by Him. But can it be reasonably maintained that the Creator intentionally ordered, if we use the words in any ordinary sense, that certain fragments of rock should assume certain shapes, so that the builder might erect his edifice? If the various laws which have determined the shape of each fragment were not predetermined for the builder's sake, can it with any greater probability be maintained that He specially ordained for the sake of the breeder each of the innumerable variations of our domestic animals and plants, — many of these variations being of no service to man, and not beneficial, far more often injurious to the creatures themselves? Did He ordain that the crop and tail-feathers of the pigeon should vary in order that the fancier might make his grotesque pouter and fantail breeds? Did He cause the frame and mental qualities of the dog to vary in order that a breed might be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport? But if we give up the principle in one case, if we do not admit that the variations of the primeval dog were intentionally guided in order that the greyhound, for instance, that perfect image of symmetry and vigor, might be formed, no shadow of reason can be assigned for the belief that variations, alike in nature and the result of the same general laws, which have been the ground-work through natural selection of the formation of the most perfectly adapted animals in the world, man included, were intentionally and specially guided. However much we may wish it, we can hardly follow Professor Asa Gray in his belief 'that variation has been led along certain beneficial lines, like a stream, along definite and useful lines of irrigation.' If we assume that each particular variation was from the beginning of all time pre-ordained, the plasticity of

organization, which leads to many injurious deviations of structure, as well as that redundant power of reproduction which inevitably leads to a struggle for existence, and, as a consequence, to the natural selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything and foresees everything. Thus we are brought face to face with a difficulty as insoluble as is that of free-will and predestination."

This remarkable passage really raises, as Mr. Darwin evidently perceives, no new questions regarding final causes, but such as have already been raised by Copernicus and the geologists, and indeed by theologians in their discussions of the doctrine of general providence. That structure of rock to which he refers, as rendering it fit for building purposes, whether quarried by human tools, or by the powers of nature, is certainly adapted to meet the wants of man: and its general diffusion presents a remarkable correlation to the infirmities of man's bodily condition and to the range of his mental powers. Likewise the capacity for variation in animals, offering such a wide range of uses subservient to the purposes which men may cherish, whether benevolent or otherwise, is adapted to the capacity which man really possesses: and affords material, upon which man's character may impress itself in tangible shape. We may not fully comprehend the extent of the necessary limitations of any particular plan of creation. Into that question theologians have ventured, and have to venture, much farther than any other class of reasoners. But any one can see that this adaptation of nature to the use of man, does not exist from any necessity other than is involved in the conditions which we are compelled to postulate before we reason at all upon the matter. Nature is made for a long time; what is not of present use, perhaps has been of use, or will be. To have things lying around loose, so that a being with man's freedom of choice and abundant infirmities, will run upon them is an element of value in them. To have them preserve marks such that the geologist, or the naturalist, can interpret their scientific meaning, is, perhaps, the highest of all the uses to which they are ever put.

Dr. Asa Gray's pertinent suggestions[1] concerning the purpose which is served by much of the seeming waste in nature, lay open a very wide subject. Some make the apparrent waste in nature an argument against the wisdom of the Creator. But, as Professor Gray remarks, if there seems to be a superabundance, for example, of pine pollen, we must remember that "wind carriage is cheap"; and there is no wasteful excess when both the end — cross-fertilization — and the means of transportation are taken into account. So we can say of all mere material mechanism and of the lower forms of life, as of dirt, that they are exceedingly cheap. Our chief arguments in natural theology are drawn from the intellectual and moral constitution of man, as he is related to the complex system of nature. We might easily premise with regard to the adaptations suitable to man, that it would usually be much easier, and far better, to make Mohammed go to the mountain than to bring the mountain to Mohammed. What else should we expect of such a far-seeing capitalist as Nature, but that she should have laid by in store the tools and materials and means of intellectual and moral advancement which man, her crowning work, would need? The man of science does well in exalting to the highest degree of importance man's capacity for discerning truth. It is an inspiring and ennobling thought that man can

> "Find tongues in trees, books in the running brooks,
> Sermons in stones, and good in everything."

In his search for truth in nature the man of science is not discarding final causes. He is but reading the hand-writing of God, and, consciously or unconsciously, paying deference to the highest end for which nature exists, namely, that of revealing the glory of the Creator's ways. The doctrine of final causes has been too often associated with low forms of utilitarianism. The paleontologist, for example, finds the cast of a trilobite in the bed of what was an old Silurian sea. The purpose of that low organism is by no means exhaustively explained when we have taken a measure of

[1] See Darwiniana, pp. 375–378.

the sensational happiness he derived from his monotonous existence. The light so well adapted to his marvellous eyes, the agreeable temperature of the waters, the slimy food on which he lived, all this, and more, brought him some degree of pleasure; and that is to be considered a part of the final cause of his existence. But a far higher purpose is served in the adaptation of his complicated organism, and the position of his tomb in a sedimentary deposit, to arrest the attention and direct the reasoning of a scientific observer. The pleasure of one lofty thought is worth more, and so more fitted to be with the Creator an object of design, than a whole herd of sensational pleasures. A page of Darwin has, to a single reader, more "value in use" than all the elements had, to the whole race of the trilobites in Silurian seas. Yet the latter, with their marks in the rocks,—what are present as well as what are absent,—when correlated with general laws of production and preservation, may have been necessary before ever the thought which illuminates the page of the naturalist could have been engendered. This leads us to the real question of the doctrine of final causes, a question that also lies at the foundation of the authority of conscience. And here the modern bent of the scientific mind allies itself with Theism as opposed to Deism, and with the intuitional theory of morals as opposed to the utilitarian.

VII. *The Revelation of God is the Highest End of Nature.*

With those modern men of science who give attention to the philosophy which really underlies their processes of thought, the combination of marks in the organic world pointing to the affinity of all species with each other, is held to be of the very highest value as God's hand-writing. The men of science would live "not by bread alone, but by every word that proceedeth out of the mouth of God." The temporal uses to which the various incidents of the development were put, are of infinitely less account than the purpose they serve in revealing the eternal glory of the Creator.

The very doctrine of final causes which leads us, as theolo-

gians, to look for occasional miracles in the administration of God's moral system, would, perhaps, persuade us not to look for them previous to the establishment of that system. In the true doctrine of final causes the wants of rational creatures must be supposed to be the principal object kept in view by the Creator. "How much better is a man than a sheep"? "Are ye not of more worth than many sparrows"? And of the wants of such beings the most imperious is that of a means of communication with each other and with the Creator. Thus the persistent adherence of the Creator to a definite plan of operations, and the trustworthiness of the marks revealing the style of his workmanship and hand-writing, become essential elements in the well-being of a progressive and immortal race. It is confidence in this uniformity of manifestation as involving the veracity of supreme goodness, that renders it possible to have communion and fellowship either with our fellow creatures or with our Creator. It is this intuition of the value to us of uniformity in the ordinary operation of divine power, which makes a miracle miraculous, and therefore an instructive attestation; i.e. which makes a break in the appareut uniformity for moral ends conceivable and cognizable.

The theistic hypothesis which acknowledges the need of the revelation of the Bible has this special merit, that it brings into prominence the inscrutability of the ways of God. A prominent assumption at the bottom of the reasoning of theists regarding the revelation given in the Bible, is that we have less power to interpret, in the narrow sense, the final causes of existing things, than we have to discern the marks of God's veracity in revealing a law of conduct for us. Indeed, this revelation of a law of duty to us, is a large part of the final cause of all things. Our faith in Scripture rests on the intuition that, with the conscious limitations of power and experience belonging to human reason, it is easier for us to recognize the authenticity of the hand-writing of God, than it is to interpret the ultimate end which a particular part of the creation is designed to serve. The veracity of God in his dealings with

us flows more directly from his goodness than any other of his moral qualities. Confidence in the marks of his veracity as guides of our conduct is what constitutes faith. In these marks of God's veracity in revealing himself to us, we have a provisional guide in practical morality. The instincts of our nature have thus a certain amount of authority from God. And with reference to the Bible, though its revelations are beyond the reach of reason, and are many of them profoundly mysterious, yet the veracity of God is so bound up in the evidence of its genuineness, and of its authority on moral subjects, that we accept it as a rule of action, with all there is in it to stagger the reason.

It is upon the same department of our reasoning powers that the present scientific habit of thought makes its demands. It denies our power exhaustively to interpret the final cause of the narrow fields of nature which we explore. It says, in the true spirit of theism, the full meaning of this is above our sight, and we do not attempt to comprehend it. We will acknowledge to the fullest extent the uses to which all these contrivances are and may be put. But we still hold that there are irrefragable evidences that these uses are but incidental in working out a master scheme, whose law of development we dimly discern. We transfer you from the narrow and delusive study of the final cause of the things as isolated and in themselves, to contemplate the final cause of the whole scheme of nature. In that infinite scheme, — so the thoughtful man of science must say — we believe that the good which may come from being able to discover the truth in the works of God and to enlarge our conceptions of his plans, may be far greater than that possible to arise in connection with the transient sensational uses which a contrivance is allowed to serve. That is, God has taken more pains to reveal to us his methods and laws, than to reveal his particular ends. It is the supremest mark of design that the method of God should be so admirably correlated to the capacity of our understanding. The revelation of God himself is the larger part of the final cause of creation.

It is in place to remark here that a question altogether similar to the foregoing has to be considered when we seek for the ground of the authority of conscience. Is conscience guided by a direct perception of the utility of its commands, or by an indirect belief that certain impulses and intuitions are infallible guides to utility? The latter is most certainly the case. Man cannot refrain from acting till he has demonstrated the utility of his choice. He obeys certain impulses, and intuitions, and tendencies of mind, as being the voice of God. Within certain limits he does not discern the utility of purity or honesty, but accepts obedience to the voice of God as infallibly leading to the highest utility. General principles have more weight in sanctioning moral action than a narrow circle of visible results. There is the same distinction as this between the prevailing scientific interpretation of final causes and the ordinary method.

To prevent misapprehension it may be well, in conclusion, to state more explicitly our position. The universe is made for happiness of one sort or another. There is no happiness in the universe, not even that of the smallest insect, but such as was designed by the Creator. The system, however, was chosen as a whole. The prospective pleasure of the worm had *some* power as an element determining to the creation as it is, — it was a part of that sufficient reason which moved the divine being to creative activity in the modes which we witness. But there are grades of happiness, and hierarchies of being. The same impulse of the designing mind which leads to a provision for the sensational happiness of the oyster, leads also to the subordination of the oyster to the higher orders of being. The welfare of oysters, of birds, and of men, were elements in the final cause which led to the creation as it is. But for the sake of the oysters, God would have made the world somewhat different from what it is. But for the sake of the birds, he would have made it still more different. Had it not been that man was to be incorporated in the scheme, the plan would have been very different indeed. It is important, for both men of science and

theologians to occupy that median position, where the truth lies; on the one hand avoiding the presumption which aspires by searching to "find out" God, and on the other hand, shunning that false humility which disowns our divine birthright of reason, — a birthright which enables us to penetrate to some extent into the realm of both final and secondary causes, and to partially answer the two inseparable questions, how does God work? and what does he work for?

It may have been observed that the order announced for the treatment of the subjects in this series of papers has been departed from in the present discussion. What was announced as the fifth, is given as the fourth of the series. This was partly due to the desire to present first, the subjects which were least theological; though to some, this paper may seem theological enough. What follows, however, in succeeding Articles must be still more deeply tinctured with theology. But we beg our scientific readers, if we have any, to be patient with us, as we have been with them. Theology, even more than science, suffers from fragmentary treatment. If the men of science object to the petty criticisms, and narrow judgments, of those who have only a superficial acquaintance with the problems presented in nature; so may students of theology complain, if the system of thought to which the great body of Christendom has given its assent is set aside without being adequately understood. "We be brethren," all of us, gathering pebbles along the shore of the same illimitable ocean.

ARTICLE II.

RECENT WORKS BEARING ON THE RELATION OF SCIENCE TO RELIGION.

BY REV. GEORGE FREDERICK WRIGHT, ANDOVER, MASS.

NO. V. — SOME ANALOGIES BETWEEN CALVINISM AND DARWINISM.

SINCE the publication (April 1877), of the fourth Article in this series, the following books bearing upon the general subject in hand have come under our notice. Where they have already been reviewed in this Quarterly the date is indicated in brackets. Over the signature "S." a list (with brief notices), of twenty-five recent German works bearing upon the subject of Evolution may be found in the number for July 1877, and of several other German and French books, Jan. and July 1878.

Bowne (Professor Borden P.). Studies in Theism. [Oct. 1879]. pp. 444. New York. 1879.

Fiske (Professor John). Darwinism and other Essays. [Oct. 1879]. pp. 283. London. 1879.

Flint (Professor Robert). Anti-Theistic Theories; being the Baird Lecture for 1877. [Oct. 1879]. pp. 557. Edinburgh. 1879.

Haeckel (Professor Ernst). The Evolution of Man; A Popular Exposition of the Principal Points of Human Ontogeny and Philogeny. [Oct. 1879]. 2 vols. pp. 467, 522. New York. 1879.

Freedom in Science and Teaching. With Prefatory Note by F. H Huxley. [Oct. 1879]. pp. xxxi, 121. New York. 1879.

Le Conte (Professor Joseph). Elements of Geology: A Text-Book for Colleges and for the General Reader. [Jan. 1879]. pp. 588. New York. 1878.

Newcomb (Simon, LL.D.). Popular Astronomy. [April 1879]. pp. 571. New York. 1878.

Quatrefages (Professor A. De). The Human Species. [Oct. 1879]. pp. 498. New York. 1879.

Shields (Professor C. W., D.D.). The Final Philosophy, or System of Perfectable Knowledge issuing from the Harmony of Science and Religion. [April 1878]. pp. 609. New York. 1877.

Smyth (William Woods). The Bible and the Doctrine of Evolution. Being a Complete System of their Truth, and giving a sure Scientific Basis for the Doctrine of Scripture. pp. 390. London. 1873.

Wallace (A. R.). The Geographical Distribution of Animals. With a Study of the Relations of the Living and Extinct Faunas as elucidating the Past Changes of the Earth's Surface. [July 1877]. 2 vols. pp. 607, 503. New York. 1876.

Winchell (Alexander, LL.D.]. Reconciliation of Science and Religion. [Oct. 1877]. pp. 403. New York. 1877.

We may also mention a book by the writer of this Article, just published by W. F. Draper, on the "Logic of Christian Evidences," which in its first and second parts incidentally treats the topics under discussion in this Series.

I. *Introductory Cautions.*

To those who believe that the material creation, the mind of man, and the Bible are all the productions of one author, it will not be unexpected if attention reveal internal evidence of this community of origin. It need not surprise such to find a thread of analogy running through the sciences which treat of nature as embodied in matter and mind, and that revelation of the supernatural which more fully unfolds the unseen and the future. The interpreters of these three departments of divine revelation should have many principles in common. It may not, therefore, be irreverent to join together, for purposes both of comparison and contrast, the names of Paul, Augustine, and Darwin—the first, an inspired apostle; the second, a profound philosopher and theologian; the third, a painstaking modern interpreter of nature. It would, indeed, be irreverent to place these names together as standing in anything like the same rank of importance or authority. Therefore let it be expressly understood, at this stage of our discussion, that the names, as representing different systems of thought, are brought together for purposes of contrast as well as of comparison.

The inspired theologian is limited only by the extent of eternity. The third heaven was within the reach of his clarified vision. The theologian is a philosophical interpreter of the apostle, and does for the fragmentary records of inspiration what the palaeontologist does with the scattered remains of extinct animals. By careful study of the conformation and articulation of a few bones the com-

parative anatomist can determine what other bones, and what sinews and muscles, and what hairy covering and digestive organs are complements to the parts discovered. So the philosophic theologian is ever at work upon the typical facts of verbal revelation, arranging around them their natural clothing of flesh and blood, showing how present experiences and newly-discovered facts in other fields of science spring out of and adjust themselves to the pregnant utterances of the inspired writers. The systematic theologian is an exegete, drawing out of the Bible and human history the material from which to construct a system of unending hopes and of eternal aspirations. The naturalist chooses a much humbler sphere for his investigations, and walks by a much dimmer light. With the flickering lamp of experience he gropes his way, between daylight and dark, along the surface of the earth, and stumbles about over the *débris* that is scattered upon it. The naturalist does not concern himself either with the beginning of things or with the end of things. That is work for the philosopher and the theologian. The naturalist studies, with what light he has, the *order* of divine operations within the range of what is visible. The *phenomena of physical nature* are to the man of science what the *words* of the Bible and the phenomena of *human* nature are to the Christian theologian. The axioms and intuitions concerning the divine nature and the authority of evidence are the common property of both.

So far as the present discussion is concerned, it may or it may not be true, that species are of derivative origin, and that natural selection is the main guiding force operative in their derivation from one another. It is sufficient for the purposes of this discussion that the theory has at present a firm hold upon the scientific world. As students of theology we ask: How does this theory, whether true or false, adjust itself to that comprehensive system of theological speculation of whose correctness, in the main, we are persuaded by a variety of cogent evidence.

II. *Salient Features of Calvinism.*

The mantle of Augustine fell upon the theologian of Geneva. But "theologians are still divided on the question as to what constitutes the peculiarity of the Reformed [Calvinistic] church."[1] Much in this Article that is styled Calvinistic or Augustinian, might with equal propriety be labelled "evangelical." The most distinctive point of Calvinism relates to the divine "purposes." As it is desirable to draw comparisons between that distinctive trait and the bent of modern science, we retain the word "Calvinistic," instead of the less explicit and intensive word "evangelical." We fear that those who are merely evangelical will not get the full benefit of some of our analogies. We may further premise that in this discussion we have nothing to do with the mere *minutiae* of the doctrines either of science or of theology. It is only in their broader aspects, in which distinguished men have become representative teachers, that we are viewing the subject. We therefore shall use the word "Calvinism" interchangeably with "Augustinianism," and shall be careful not to make Darwinism responsible for everything Mr. Darwin and his coadjutors have written.

The scientific theory under consideration has already been presented with sufficient fulness.[2] The theological system is familiar, but for present purposes may be epitomized as follows: God only is self-existent. The universe is his work, and is the embodiment and unfolding of his eternal ideas. The foreknowledge of God comprehends all things. "Known unto God are all his ways from the beginning." Not only is the providence of God concerned in the sparrow's fall and in the fate of each particular hair of our heads, but, paradoxical as it seems, the fore-ordaining providence of God has also comprehended the actions of the free-will of man. And furthermore, notwithstanding the knowledge of all the parts of the universe and the fore-ordination of the system

[1] Hagenbach's History of Doctrines. Translated by C. W. Buch (New York, 1862), Vol. ii. p. 160.

[2] Bib. Sac., Vol. xxxiii. pp. 448–493, and 656–694; Vol. xxxiv. 355–385.

as a whole (and in logical consequence of this fore-ordination, foreknowledge of all) the goodness of God is held to be consistent with the creation of a condition of things in which sin enters in such degree and extent that some of its subjects will be consigned thereby to endless punishment; so that the Author of all things himself can say of some persons, when considered with reference to themselves, it had been better for them if they had never been born.

According to this system, also, the scheme of the universe is so vast that it is unsafe to assume that the happiness of particular individuals, or generations even, much less of animals, is a prominent object of the existing order of things. Calvinism is opposed to utilitarianism as a theory of virtue. The chief end of man is not to seek his own happiness, but the glory of God. The authority of obligation to particular duties is not the perceived bearing of our actions upon the happiness of being, but the perceived evidence that God enjoins the course of action. God's ways, though not absolutely unknown, are often inscrutable, compelling man to walk by faith, and not by sight.

III. *The Ground of Opposition to Calvinism.*

This system of theology is vigorously opposed in many quarters with the objections that it narrows to the smallest sphere, if it does not wholly obliterate, the self-determining power of man's will; that it belittles the true dignity of human nature; that it leaves no ground for the intervention of mercy; that it represents God as at once unfeeling, unjust, and remote from the world and its affairs.

A popular preacher of the radical school exclaims: "The faults [of Calvinism] come from its peculiar doctrine. . . . . It makes God dark and awful. . . . . He is the Draco of the universe, the author of sin. . . . . This system degrades man. It deprives him of freedom. It does not tell of God now near at hand, but a long while ago." [1]

[1] Theodore Parker. A Discourse of Matters Pertaining to Religion. (Boston, 1842), pp. 455–456.

A leading defender of Arminian theology thus addresses a select audience of Sabbath-school teachers: "Calvin, in whose mind the logical faculty was predominant, and who never hesitated to follow out his own accepted premises to their legitimate conclusion, at length developed a complete system of philosophical theology, which so exalted the divine sovereignty in grace and providence as to leave no room for the action of any creature, except as moved and actuated by the power of God. Whatever might occur must, therefore, be interpreted as the outcome of the will of God, whether of righteousness or of sin, eternal life or eternal death. The only possible laws in the universe were the divine decrees, from which there could be no departure; the actions of all creatures were subject to his hands, in both their inception and their execution; and the whole universe, physical and spiritual, was subject to a complete order of predestination. As a piece of machinery, the system was organically complete and sublimely effective; but, at the same time, to ordinary minds it seemed utterly heartless and cruel as destiny itself. ..... This system proceeds upon the assumption of such a real and practical or administrative sovereignty in God over every man and his eternal destiny that the whole thing admits of neither conditions nor qualifications. The ordering of the affairs of the universe is an eternal and unalterable decree, complete in the divine mind from eternity, and unfolding in part in the form of events within the realms of time. ..... It is, in its logical outcome, simply fatalism, substituting the name of its God for the mythological Jupiter or Zeus, or the philosopher's fate or chance or destiny — names that designate the unknown force that sustains and directs the course of affairs in lofty disregard of the weal or woe of the intelligent and sensitive beings that are evolved in its resistless movement. But its God is not that 'Father of the spirits of all flesh,' of whom and of whose abounding mercies the Bible tells us." [1]

Now if the Darwinian can show that his theory of the

[1] Rev. Daniel Curry, D.D. Chatauqua Address, Aug. 12, 1879.

origin of species is, from a theological point of view, open only to these same and analogous objections, then he may shelter himself behind Calvinism from charges of infidelity. The student of natural history who falls into the modern habits of speculation upon his favorite subject may safely leave Calvinistic theologians to defend his religious faith. All the philosophical difficulties which he will ever encounter, and a great many more, have already been bravely met in the region of speculative theology. The man of science need not live in fear of opprobious epithets; for there are none left in the repertory of theological disputants which can be specially aimed at the Darwinian advocate of continuity in nature. The Arminian, the Universalist, and the Transcendentalist long ago exhausted their magazine in their warfare against the lone camp of the Calvinist.

The Calvinist has long stood in the breach, and defended the doctrine that order is an essential attribute of the divine mind, and that whatsoever proceeds from that mind conforms to principles of order; God "hath fore-ordained whatsoever comes to pass." The doctrine of the continuity of nature is not new to him. In extending his conception of the reign of law, the modern man of science is but illustrating the fundamental principle of Calvinism.

Proceeding with the analogy, we notice first, that

IV. *Darwinism is not a Theory of Universal Progression.*

Darwinism conforms to the facts both of nature and of the Bible in not being a theory of invariable and progressive development. The organisms that succeed each other under the action of natural selection are not necessarily always of a higher or of a better kind. There may be, by the action of this law, either advancement or degradation. The condition necessary to secure the continued existence of a form of life is, not that the form is the best that *could* be prepared for its position, but that it is the best which could be secured under the actual scheme of operations. For example: Darwin is careful not to say that we are descended

from apes, but takes pains to speak of our progenitor as being an ape-*like* creature;[1] from which, according to his theory, the apes may have branched off as far in one direction as we in the other. On his theory an organ or an instinct that might be of great advantage in one condition of things may in another be indifferent, or actually disadvantageous, and so may become rudimentary, or wholly aborted. Then, on return of the former circumstances and with fresh competition, the animal, or organ, would succumb, and the race become extinct. So this theory comprehends *extinction* of species and organs as well as their production, and *degradation* as well as advancement. Indeed the advancement of some is sure to be accompanied by the degradation of others; and the extinction of the more generalized forms of life is the very reason why we have the present diversity.

In this respect the theory, in its application to the human species, may well consist with the teaching of the Catechism, that man was made in the beginning upright, but fell from his first estate; and has in his fall, not unlikely, involved all nature to a certain extent with him. That new and superior moral element, which was added when man became man, and which constitutes his distinctive characteristic, is capable of being a hinderance as well as a help in the career of progress.

No organ is an advantage in itself. An organ can be of advantage only as it is in harmony with its environment. In nature the environment is undergoing constant change, which necessitates as constant adaptation on the part of the organism, in order to have its peculiarities continuously advantageous to it. The imposition of a moral faculty upon man's physical organism brought in a double source of danger. Through the perversion of that spontaneity which we call moral freedom, the high endowments of the human race became an active source of disharmony. In the moral world, sin, as to its effects, may be considered a maladjust-

[1] Descent of Man, Vol. i. pp. 131, 148, 151, 153, 226; Vol. ii. pp. 312, 345, 366.

ment of the soul to the conditions of its best existence. The soul must reap the wages of such voluntary maladjustment in bearing as a burden what, properly used, would be a help. The conscience of a sinner is an impediment. The moral powers of a rebellious race are a burden to it. They may become rudimentary. It is a question of revealed theology whether they ever become wholly abortive and the soul itself annihilated. A being with a moral nature ill used is of all creatures most miserable. It impedes him in his search for happiness, as the antlers of a stag, however useful in their place, interfere with his progress through a jungle.

Weight is of advantage to the elephant for certain purposes, but is a manifest disadvantage when searching for food in miry ground or where the wild goats pasture. So the very greatness of man's endowments are a source of misery to him so long as he persists in trying to stand on slippery places. Man's desires greatly outstrip the earthly means of gratification. His worldly ambition is often as much out of proportion to the provision made for its satisfaction here, as is the unwieldy form of the mastodon to the scant vegetation of an arctic summer. Indeed, it is a serious question whether civilization may not end in the destruction of itself. The strength and present safety which result from political union and the division of labor tend to diminish the power of the individual to care for himself. Civilization produces changes in the human constitution analogous to those produced in brute animals by domestication. The balance and harmony of the individual are disturbed by the enormous development of particular capacities. Why should an ox want to weigh a thousand pounds? Why should a horse wish to be bred into the shape of a greyhound? Why should a man desire to unfit himself for everything else for the sake of acquiring facility in making the fifteenth part of a pin? Through the action of natural selection in the human race, the social and political organism is likely to be developed at the expense of the individual. The individual, as a social force, is already becoming a mere

rudiment. He is in danger of becoming an organ rather than a being.

V. *The Organic Connection of the Human Race.*

The Calvinistic doctrine of the spread of sin from Adam to his descendants has also its illustrative analogies in the Darwinian doctrine of heredity.

The Calvinist holds that Adam's sin insured that of the whole race. Corruption was transmitted from Adam to all his descendants. The Calvinist cannot regard mankind as a loose aggregation of individuals, with nothing but an ideal bond of connection; but in a most profound sense the children of Adam compose an organic whole. Adam was not merely a "progenitor, but, as it were, a root," by whose corruption "the whole human race was vitiated." When Adam corrupted himself "he transmitted the contagion to all his posterity." From the "corrupt root of our first known progenitor corrupt branches proceeded, which transmitted their corruption to the saplings which sprang from them." "The children, being vitiated in the parent, conveyed the taint to the grandchildren; and so the corruption commencing in Adam is by perpetual descent conveyed from those preceding to those coming after them." Calvin calls this viciousness of human nature "natural, to prevent any one from supposing that each individual contracts it by depraved habit, whereas all receive it by a hereditary law."[1]

We must, however, pause, even in the midst of this exposition, to remark that notwithstanding the hereditary transmission of sinful tendencies, Calvin thinks he sees his way clear to absolve God from *direct* responsibility for sin. "The blame of our ruin rests with our own carnality, not with God; its only cause being our degeneracy from our original condition..... It is plain that this wound was inflicted by sin; and therefore we have no ground of complaint except against ourselves."[2] We confess that it is difficult to give logical

[1] See Calvin's Institutes of the Christian Religion, Book ii. chap. 1, sects. 5, 6, 7, 8 and 11.

[2] Ibid., sec. 10.

consistency to this language, except we adopt either the so-called New School theory, or resort to traducianism in explanation of the origin of the soul.

The New School party do not maintain that sin itself, or sinful qualities, are transmitted, but only that depraved conditions are transmitted to such extent that sin does infallibly occur in the soul which is the subject of these conditions. The σάρξ, or, in modern language, the whole automatic machinery of our nature, is disarranged; and the disarrangement is transmitted from generation to generation.

The New School Calvinists, however, would not accept, without qualification, the saying of their master that "our whole nature is a seed-bed of sin, and therefore can but be odious and abominable to God."[1] They cut the Gordian knot, and say man's fallen nature is a "seed-bed of temptation," and the *character* which *certainly*, but not *necessarily*, develops in those conditions is odious, — a distinction which those who cannot see the difference between a *moral* motive and a locomotive are slow to recognize.

On the other hand, the traducianist, by introducing a counter mystery, analogous to that entertained by the Darwinians, pushes the original problem respecting transmitted sin a little farther back and out of sight. The creationist says, with Calvin, that the responsible soul is in every case breathed fresh from God, but in the case of man is at once joined to an infected body. While the traducianist contends that the soul, in all its length and breadth, is propagated by natural generation. The language of the Westminster Catechism is, "All mankind, descending from him [Adam] by ordinary generation sinned in him, and fell with him in his first transgression."[2] Professor Shedd[3] maintains with great spirit that this means "that all men were, in some sense, co-existent in Adam"; "that all men were, in some sense, co-agents in Adam"; that "the will of Adam was not the will of a single

[1] Institutes, Bk. ii. chap. 1, sec. 8.

[2] Larger Catechism, Question xxvi.

[3] See Essay on the "Doctrine of Original Sin," in Christian Review, No. 67. Reprinted in Discourses and Essays (Andover, 1862), pp. 218–271.

isolated individual merely; it was also, and besides this, the will of the human species — the human will generically"; that "each individual of the human race is in some mysterious, but real manner a responsible partaker in Adam's sin — a guilty sharer, and, in some solid sense of the word, co-agent in a common apostasy." Professor Shedd maintains that Augustine, Luther, John Owen, and President Edwards were advocates of this view. What should really be said of Augustine and President Edwards, however, is, that according to Professor Shedd's logic they *ought* to be advocates of his view in order to be consistent in maintaining, as both did, the doctrines of free-will, original sin, and total depravity. Edwards uses the following language: "There is no sure ground to conclude that it must be an absurd and impossible thing for the race of mankind truly to partake of the *sin* of the first apostasy, so that this in reality and propriety shall become their sin; by virtue of a real *union* between the root and branches of mankind (truly and properly availing to such a consequence) established by the Author of the whole system of the universe; to whose establishments are owing all propriety and reality of union in any part of that system; and by virtue of the full *consent* of the hearts of Adam's posterity to that first apostasy. And therefore the sin of the apostasy ..... is truly and properly theirs."[1] The italics are his. This language probably loses its value to the traducianist by virtue of the peculiar views Edwards elsewhere advances regarding the relation of God to the creation. The significant thought is that Edwards's conception of the presence of God in creation does not interfere with his conception of him as creating by law and through an "established course of nature." This is his language in another place: "It is true that God by his own almighty power creates the *soul* of the infant, and it is also true that God by his immediate power forms and fashions the *body* of the infant in the womb; yet he does both according to that *course of nature* which he has been pleased to establish." He says that by

[1] Treatise on "Original Sin." Part iv. chap. 3.

nature "no more is meant than an established method and order of events, settled and limited by divine wisdom." [1]

Passing, now, back to Augustine, we find that he devotes a special treatise to the question of the origin of the soul.[2] In this, while he does not advocate traducianism, he does, with great vigor defend it from the charge of heresy, and insists that, at any rate, it is an open question. In saying that God created all breath, the Scriptures do not — so Augustine contends — commit themselves to any metaphysical theory regarding the *mode* of creation. It may as well be indirect as direct. "'I have created all [or every] breath,' is undoubtedly spoken of each individual soul. Well; but God also creates the entire body of man; and, as nobody doubts, he makes the human body by the process of propagation. It is therefore, of course, still open to inquiry concerning the soul (since it is evidently God's work), whether he creates it, as he does the body, by propagation, or by inbreathing, as he made the first soul." [3] "All our question is as to the *mode* of the formation. Now, let us take the eye of the body, and ask, Who but God forms it? I suppose that he forms it not externally, but in itself, and yet, most certainly, by propagation. Since, then, he also forms the human spirit or soul, in itself, the question still remains, whether it be derived by a fresh insufflation in every instance, or by propagation." [4]

In reading these discussions it is plain to see that theologians are as much puzzled to form a satisfactory conception of the *origin of each individual soul* as naturalists are to conceive of the *origin of species*. Their difficulties are, indeed, nearly identical. In both instances they are forced to take hold of the old questions so hotly disputed between the nominalists and the realists. Let us be warned by the fruitlessness of these discussions to recognize the limits of human thought, and learn to be content with such partial knowledge of the

[1] Treatise on "Original Sin." Part iv. cap. 2. [2] De Anima.

[3] De Anima, Lib. i. c. 21.

[4] De Anima. Lib. i. c. 22. In further confirmation of this view of Augustine's position, see in the same work, Lib. i. cc. 6, 13, 16, 18, 19, 26, 28, 33; Lib. ii. cc. 10 and 20; Lib. iv. cc. 2, 15, 38.

divine methods of activity as our minds can really compass. It would have been well if on some of these insoluble questions theologians had maintained either the dignified reserve of Scripture, or had displayed the caution of Mr. Darwin in his speculations concerning pangenesis, which he expressly labels a "provisional hypothesis." It is unjust to blame Mr. Darwin, as Professor Bowen does,[1] for modestly limiting himself to a consideration of the Creator's method in the production of vital phenomena, instead of extending his speculation so as to cover the method of creation in general The naturalist, as such, is not compelled to be a theologian.

VI. *Evolution, Correlation, Design, Fore-ordination, and Free-Will.*

The adjustment of the doctrines of fore-ordination and free-will occasion perplexity to the Calvinist in a manner strikingly like that experienced by the Darwinian in stating the consistency of his system of evolution with the existence of manifest design in nature. The doctrine of free-will stands in as much danger of being strangled by the encircling coils of fore-ordination, as the doctrines of final cause and particular providence do by evolution.

The most puzzling question which theologians have to deal with is that which concerns God's responsibility for the existence of sin. It will not do to say that God is in no way responsible for the existence of sin, since his foreknowledge must have comprehended all things, and no sin could have existed without the creative fore-ordination of a system that was known to include sin and suffering among its incidents. Nor can it be correct to say that God is the direct author of sin [evil], for that would contradict the clearest affirmations of our consciousness concerning personal guilt. It would also destroy the idea of any degree of finite freedom of will, and compromise the goodness of God. These apparently contradictory ideas are reconciled in our systems

[1] Modern Philosophy, p. 124.

of theology by making a distinction between the ordaining and the permissive decrees of divine power. God *permits* many things to occur which are not in the *direct range* of his original design.

This method of statement amounts to the same thing as changing the point of view from the circumference of the system to its centre. From the centre we do not look upon each part singly, but view the parts in their relation to the whole. From this point of view the narrow sphere of human freedom is encircled in the more comprehensive folds of the system as a whole. Sin and its consequent evil occur as incidents to that measure of freedom which it has been thought best to give a portion of the creation. In stating the theological problem we do not say that the final cause for the creation of a particular sinner is that he may commit sin and be punished for it. But the reason for his existence resolves itself into the more comprehensive one of the nature of all things, and the relations of the parts of the creation to the whole. The Calvinist assumes that the highest good of the whole is consistent with that constituted order of things in which sin is allowed to exist, and in which the freedom that makes sin possible and actual may be put to good use, and even the wrath of man be made to praise God. It is not difficult to see that in these speculations theologians are struggling with problems concerning final causes far deeper than those which face the scientific evolutionist. The problem of the theologian is as much deeper than that of the man of science as the nature of a moral being is more profound than that of an irrational creature; or to the extent that eternity surpasses time.

The Darwinian hypothesis, in like manner with the Calvinistic, would regard creation from the centre instead of from the circumference, and insists on viewing the parts in their proper perspective. The sphere of one is the moral world, the sphere of the other the physical. In both, the main discussion of the question of final causes gathers about the constitution of the system as a whole, rather than about that

of the parts taken singly. The perfection of the parts is not absolute, but relative. Absolute perfection only resides in the whole, and the parts can be perfect only as related to the whole. The Darwinian refuses to accept as exhaustive that interpretation of design which limits the final cause to the narrow sphere of the immediate uses to which a form of organized matter is put by its possessor. In his sphere he makes the same distinction with the Calvinist between what is designed and what is incidental.

The scientific world is familiar with the so-called principle of correlation. In living organisms the parts are all *interdependent.* Any change in one part must be correlated by adaptive changes in other parts, or the harmony is destroyed. To use the standard illustration of Mr. Spencer: The Irish elk has horns weighing a hundred pounds. If these have been acquired through natural selection an extended series of changes must have simultaneously occurred in other portions of the skeleton, in order to render such enormous antlers serviceable. They are used for purposes of offence and defence. But an increase of size can only be advantageous when there is an increased development of the supporting bones and muscles. The skull must be thickened; the vertebrae of the neck must be increased in size; the ligaments and muscles which move these must be enlarged; the upper vertebrae of the back must be strengthened. Like changes must take place in the shoulders. "Still more there must be a simultaneous development of the bones and muscles of the fore leg, since each of these extra growths in the horns, in the skull, in the neck, in the shoulders, adds to the burdens which the fore legs have to bear." All these changes necessarily involve *disabilities.* The increased size of the animal makes a demand for more food. The branching horns are likely to impede the flight of the animal through the forest. And this whole circle of advantageous development is correlated to the antagonistic development in some other animal. Where there are no enemies there is no call for means of defence. The danger is first created and then the way of escape devised.

Through the perpetual recurrence of such correlations in nature the naturalist is brought to face the deep questions concerning omnipotence, and may discern the true solution of the problem of evil. The divine power seems to be limited by the nature of things. At any rate the author of nature has limited himself in regard to the creation. A creation in space and time is compelled to conform to the nature of space and time. There cannot be two hills without a valley, nor a *before* without an *after*. It would be an absurdity to construct a physical organism which did not conform to the laws of gravity and chemical combination in the system into which it was introduced. To impeach the wisdom of any part of a system we must understand the reason of the whole. A system, like an organism, is designed as a whole. The parts are correlative. The supposition of a universe in which the parts do not limit each other is a logical contradiction. Limitation is a necessary incident of creation. In defining God's omnipotence as "ability to do whatever is an object of power," we do not limit the divine power by any intractable and eternal substance. We only say that omnipotence is not a power which can transcend the law of logical contradiction; and that God has made matter what it is for reasons best known to himself. Such limitations to power as appear in the organic world are analogous to those revealed in the moral system of which Calvinism gives the completest summary and the soundest interpretation.

For example, the Calvinist need not say that the character of Judas was designed for what it is in itself. He might say a general system was designed in which Judas's crime was permitted as an incident which could be put to good use. The Calvinist need not say that the final cause of the creation of the wicked was their reprobation. But the reprobation of the wicked may come in as a circumstance subsidiary to the general ends of the moral system that is created. It was better to have the system as a whole, notwithstanding that perversion of freedom, than not to have the system at all.

Thus the character of God may be shielded from the imputation of direct responsibility for sin; since his omniscience enables him to look beyond incidental evils to an ulterior good, and to make use in his general system of the perverted powers of those who sin against him. The happiness of the individual creature would seem at first sight to be the reason for his creation. But the Calvinist learns so to exalt the principles of justice and holiness, and the ideas of law and the glory of God, that the happiness of the individual retires to a very subordinate place among the reasons that justify his creation and continuance. As it is said: "In very deed for this cause have I raised thee up, for to show in thee my power; and that my name may be declared throughout all the earth" (Ex. ix. 16; Rom. ix. 17).

Not only is the Calvinist accustomed to look with submissive spirit upon the misery of the wicked on account of the requirements of the general system; he is also led by comparison to speak disparagingly of the value of the happiness of the obedient. The elect are not led to believe that they are chosen for good in themselves that distinguishes them from other men, nor because they have greater capacity for happiness than others, but, before divine wisdom, their election depends upon the general requirements of the moral system chosen, and the ulterior uses to which they may be put. It is this idea that makes self-sacrificing missionary zeal so constant an outgrowth of Calvinism. Calvinistic preachers use this thought with powerful effect in securing the virtues of humility and self-forgetfulness. The reason for giving the elect more privileges than others does not lie in any antecedent personal superiority over others. They were all alike vessels of wrath; and some of them were the chief of sinners. But the reason for the choice of them to become vessels of mercy lay in their relations to the all-comprehensive divine plan.

In the language of political economy, the Calvinistic conception of the Christian scheme, while keeping in prominence two distinct elements of worth in a soul, viz. the value in

use and the value in *exchange*, seems unduly to emphasize the latter. The first of these is the value of the being to himself, or his personal capacity for happiness. The second is his value to the universe as he fills a particular place in the general scheme of creation. The redemptive agencies which are set at work by an allwise Creator must keep in view both these elements of value. Wisdom cannot permit one to be swallowed up by the other. We are not at liberty to put asunder what God has joined together. The salvation of a soul is both an end and a means. In the evangelical conception neither of these considerations stands alone. Christ would save a soul, but only in such a manner as will not (in the existing order of things) interfere with his saving other souls, and in such manner as will allow him (in the existing order of things) to reveal all sides of his own character, and all the hazards of moral freedom. It passes our powers to estimate the amount of happiness secured to the apostle Paul by his redemption. But, in the broader outlook, the transcendent gain secured in his conversion is to be found in the transmitted effects of his conversion as he became a preacher of righteousness to the Gentiles, an illustrious example of self-devotion to subsequent generations, a systematizer of theology, and a monument of the power of divine grace to transform the heart of an obdurate man. The universe will doubtless derive indefinitely more of good from its acquaintance with the life and writings of Paul, and from the direct influence transmitted through him to them than Paul himself will ever derive from getting to heaven.

The reasons for the continuance of the saints in the earth have more warrant from the use to which they may be put in revealing the glory of God, than from any capacity they may have for individual enjoyment. Calvinism is opposed utterly to all low forms of utilitarianism, and exalts ideal good and remote results to the highest degree of importance.

Now, if Darwinism has any difficulty with the subject of final causes, the problem is solved on principles analogous to those which underlie Calvinism. In his attempts to construct

a system of theology out of the facts of history and revelation, the Calvinist is dealing with the profoundest questions of design. There is something truly sublime in the boldness with which he faces the dark question of reprobation, and attempts to reconcile this doctrine with the apparently antagonistic doctrines of the power, the wisdom, and the goodness of the Creator.

The resoluteness with which the Calvinist propounds the doctrine of election, with all its humiliating consequences to human pride, is likewise heroic. But in charging Calvinists, as some do, with having exalted God and his glory at the expense of due recognition of the importance of the happiness of the individual man, they are charging them with the acceptance of a truth of the very widest application. Scientific investigations are constantly raising analogous (and, so far as we can see, not essentially different) questions to these that have long been discussed in speculative theology. But certainly the men of science can by no possibility have any more staggering phenomena to deal with than the revealed facts concerning sin, freedom, election, and foreknowledge. The schemes of the physical philosopher stop far short of attempting to comprehend eternity, past or future. They only consider a section of time. They but touch the surface of problems in causation and design which theologians are compelled to probe to the core. They drop their lines only in the shallows of the great ocean of which theologians must sound the depths. But there are for the true man of science, as well as for the profound theologian, glimpses of a higher and more comprehensive design than appears in the immediate uses to which an advantageous circumstance is put.

To the student of natural history there are so many things which indicate the genetic relation of succeeding species with one another, that when he essays to interpret the ultimate designs of the Creator he is compelled to assume that the revelation of *method* and *order* in nature is a higher end, and so a more important factor in the final cause of the creation,

than the passing advantages which the organic beings derive from it as the scheme of nature is unfolding. The Darwinian view of the life of organized beings is, that they are pilgrims and strangers, all of them, and have to put up with such accommodations as the reign of general laws and the requirements of their fellow-travellers will allow. He does not find, and, like the Calvinist, he is not bound to find, absolute perfection in each individual; but only such perfection as is consistent with the requirements of the general scheme.

It is the glory of the Creator to accomplish a variety of objects by simple means. This "law of parsimony" so commends itself to our reason that we cannot well refuse assent to it. Infinite wisdom would not be infinite wisdom, unless it accomplished its ends by the simplest means, and reached them by the shortest method. That is certainly true. But there is always the underlying question, What is the end to be accomplished? If, for example, it be a canal for transportation, a straight canal is the shortest means to the end. But if the design of irrigation be added, a very crooked canal may be the most economical contrivance. If the design had been to get Israel from Egypt to the promised land in the shortest time, there was a direct road, and (in the opinion of the evangelical theologian) there was unlimited power to perform miracles. But if there was the added design of such discipline for the chosen people as should adjust them into a vast scheme by which God is controlling a moral universe, then the shortest road may well be a very round-about one, and the wanderings in the desert may be the straightest path to the complete fulfilment of their mission.

De Quincey said that he did not tell the tragic story of his life for the sake of the story, but for the flowers and foliage which clustered about it. The story was but the support, around which a vine should twine. To a creature of mere sensation, the foliage, the flowers, the fruit, and the shade might appear to exhaust the useful qualities of the vine. But to reasoning man there is all this, with the addition of a still nobler element of use, viz. the revelation in its struc-

ture, of its law of growth, and of its generic affinities. What if we have opened to us evidence not only of the continuity of a single vine or species, but of whole genera and families and classes and orders in the animal and vegetable kingdoms! Is anything too hard for the Lord? Is it impossible for him to give us bread and to satisfy our reason in the same substance? Far be it from us to say that this is impossible. The true and full statement of the doctrine of final cause involves, as we have already shown,[1] the recognition of all the uses which the object serves in the total plan of the Creator. That is its sufficient reason for existence.

The tendency of mind which leads us to seek for the bond of unity and order which appears in similar and analogous phenomena is among the noblest impulses and the highest endowments of the soul. The gratification of that tendency *must* constitute an important part of the reason of our existence. The adaptation of the creation to this tendency of our minds is among the most impressive and important of the contrivances apparent in nature. This introduces us to our next comparison.

VII. *The Limits of the Speculative Reason which appear in the Calvinistic and the Darwinian Hypotheses.*

The philosophical student cannot fail to be impressed by the analogy between the Calvinistic rule defining the attitude of reason toward the revelation of the Bible, and that guiding the modern naturalist in his interpretation of nature.

Without pausing to consider how much of approval it implies, the theological opponents of Darwinism sometimes say that Darwinism is not *proved*, but it may be a very good *working hypothesis*. This opens the way to some remarks upon the common ground regarding the nature of proof, occupied by both the defenders of a positive revelation of the Bible and systematic naturalists. They are both alike

[1] See Bib. Sac., Vol. xxxv. pp. 374–381. Also the Author's Logic of Christian Evidences, Part ii. chap. i. pp. 104–122.

opposed to what may be called the expectation of an absolute and exhaustive knowledge of divine things. Neither expects or requires demonstration. Both content themselves with what is called probable or moral evidence.[1]

The proof of an hypothesis is that it works well. You can make discoveries by it. It explains or co-ordinates complicated phenomena which otherwise are confused and unintelligible. The hypothesis furnishes the clew by which we thread our way through the phenomenal labyrinth. The proof that we have the right clew is the extent to which it leads us through a complicated mass of phenomena. Christianity, considered as an external revelation, is a mass of purported historical facts. We have first to prove that the phenomena really appeared. In proof that the history is true we proceed to apply a variety of hypotheses, and to eliminate those which are unsatisfactory.

To begin with, we are at liberty to suppose that this purported body of facts are fables or myths or pure fabrications. It is not necessary here to explain on what ground these hypotheses are rejected. Suffice it to say that the only hypothesis which has worked well, — i.e. which has not raised more difficulties than it has explained — is, that the Bible is true history, and that the writers of it were competent witnesses as to what they saw and heard, and as to the value of the documents which they used.

Now, in order to explain these historical phenomena we have to make a still farther use of hypothesis. Are these facts *natural* or *supernatural?* Here, too, demonstration is out of the question. It is not a subject of abstract logic, but of inductive evidence. The belief of the writers that they were inspired, and of the actors that they were for special purposes and seasons endued with supernatural power, coupled with their manifest sobriety and sanity; the contrasts between this system of purported revelation and other systems that have been presented for the consideration of the world; the effects of this system in the development of history and

[1] See Logic of Christian Evidences, Part i.

on the individual believer, — these and a great number of other concurring facts are so harmonized by the hypothesis of supernatural intervention that few well-balanced minds who have fully considered the evidence can resist assent to the theory that a supernatural factor is present. The hypothesis of inspiration and miraculous intervention works so well, and the hypothesis of imposture and delusion works so ill, that a heavy burden of proof comes upon him who denies inspiration and miracle. The reasoning is not such as can be compressed into the hard and fast forms of a syllogism. For no two persons can ever have the same conception of the major premise. It is cumulative evidence, depending for its force upon a variety of considerations, including the personal experience of a sense of dependence arising from a feeling of guilt and of the natural limitations to the development of our capacities, and including also the success and diligence with which we have studied the Bible and given attention to the problems of human history.

The so-called evangelical school of theology emphasizes our dependence upon a positive revelation of God which is outside of nature, and rejects "absolute" religion. It insists upon our anchoring our speculations to a solid body of facts. This rule has been well stated as follows:[1] "The province of human reason in interpretation is to ascertain what the Scriptures teach; to put its varied teachings in systematic form; to construe them so as to shun obvious contradictions with each other and with the indisputable testimony of sense and of unperverted reason; and humbly to bow to them when ascertained and determined, however incomprehensible, unwelcome, or irreconcilable with our feelings, judgments, or predilections. This gives reason a very high office in ascertaining and accepting the teachings of revelation, a very humble office as an original authority touching any matters in regard to which God speaks in his word. ..... Reason soars beyond its true level when it assumes to judge what can or cannot be true or possible relative to the infinite God

[1] Prof. Atwater of Princeton College, N. J., in Bib. Sac., xxi. p. 70.

— what, therefore, he cannot mean to declare, although he seems to declare it, in his word. Human reason is competent to no such office. It cannot span infinity."

The devout believer in inspiration finds no insuperable difficulty in accepting the mysteries that are revealed in the Bible, such as those relating to the mode of the divine existence, and those concerning the manner of the transmission of moral character from Adam to his posterity. For these mysteries pertain to questions of ontology, and have only that amount of difficulty which belongs to everything which we really try to fathom.'

In a similar manner, the Darwinian says that his theory is not to be rejected simply on the ground of its mystery; for that belongs essentially to all facts and to any system that tries to unify them. Darwinism does not propose to explain ultimate facts, but only to interpret their significance regarding the mode or laws of the Creator's action. Thus Mr. Darwin, in his provisional hypothesis of pangenesis, presents some of the acknowledged facts concerning the multiplication of gemmules, as of small-pox and rinderpest, and endeavors to use them in formulating a theory of the proximate cause of the facts of inheritance and reversion. The most obvious objection to this hypothesis is, that it makes such extreme demands upon our imagination in trying to conceive the minuteness of the atoms. In reply he sagaciously remarks, " that a cod-fish has been found to produce 4,872,000 eggs, a single ascaris about 64,000,000, and a single orchidaceous plant probably as many million seeds. In these several cases the spermatozoa and pollen grains must exist in considerably larger numbers. Now, when we have to deal with numbers such as these, which the human intellect cannot grasp, there is no good reason for rejecting our present hypothesis on account of the assumed existence of cell-gemmules a few thousand times more numerous." [1]

[1] Animals and Plants under Domestication, Vol. ii. p. 453 f. See *per contra*, J. Clerk Maxwell in Article on Atoms in the ninth edition of the Encyclopaedia Britannica.

At the same time, Darwinism is a powerful protest against unrestricted *a priori* methods. Darwin does not propose, after the free manner of some, to sail into the open sea: he intends never to be out of sight of land. He does not, indeed, hug the continuous shore of a continent; nobody can do that; but he threads his way through an archipelago. When he gets to the end he stops, or thinks he does. He will, for example, at present, have nothing to do with theories of spontaneous generation. We do not, by any means, give assent to all Mr. Darwin's conclusions. Neither, on the other hand, do we accept all the interpretations that have been put upon the Bible. How could we? For the interpreters, not being inspired, have made many grievous mistakes. But it is a point of great value and significance that the best modern representatives of science, as well as the best theologians, alike recognize the importance of keeping their feet upon the ground, and are willing to fetter themselves with the objective facts of creation and revelation. They both accept the humble *role* of the interpreter of God's revealed systems — the one of organic nature, the other of human nature. The naturalist finds himself in the midst of a vast and accumulating mass of observations. The theory that species are genetically connected gives order and consistency to the facts, and brings in an element of purpose to much that otherwise seems purposeless. The growing difficulties of classification through the discovery of intermediate forms: the distribution of species through space and time as though they were genetically connected; the arrangement of species in clusters, like planets and their satellites; the persistent anatomical similarity in all species of the same class, even to the existence of the useless rudiments of aborted organs, together with the analogy of embryological development, convince him. If these facts do not point to community of descent in the species connected, then, so far as the revelation of the divine purpose is concerned, the universe seems unskilfully made. In the case of such complicated similarities, "to reject a real for an unreal, or at

least an unknown, cause," Mr. Darwin cogently argues, is to make "the works of God a mere mockery and deception. I would," he continues, "almost as soon believe, with the old and ignorant cosmogonists, that fossil shells had never lived, but had been created in stone so as to mock the shells living on the sea-shore."[1]

VIII. *The Reign of Law.*

A further point of analogy between the Darwinian view of nature and the scheme of revelation defended by Calvinists relates to the method in which the Creator has transmitted his action during successive periods of time. Under both representations of the actions of the Creator law reigns supreme, and the main reliance for the dissemination of the divine influence is upon what are called natural means. The revelation of God in the Bible is progressive, and in general is by means of natural instrumentalities, with only occasional miracles. The revelation to Adam was very dim; that to Noah, and later to Abraham, was still far short of what appeared in the prophetic era of Jewish history; while the least in the kingdom of heaven, after Christ had come and the Holy Spirit had been poured out, was greater than John the Baptist. Thus through thousands of years, notwithstanding all the pressing exigencies of human history, the special revelation of God, by which alone we believe the world is to be saved, was left to run in a very contracted current, through a single family and their descendants. The *family* is chosen as the centre from which these influences are to spread. And still, even now the vast majority of the human race have not caught sight of a single beam of that light which radiates from Calvary. This reliance of an Almighty God upon human activity for the dissemination of that knowledge of him which reveals his brightest glory, and upon which depend the highest personal interests of mankind, is a mystery of infinite wisdom which we cannot hope to solve. It is a most inspiring truth of revelation that "the same Lord over

[1] Origin of Species, p. 130.

all is rich unto all that call upon him. For whosoever shall call upon the name of the Lord shall be saved" (Rom. x. 12, 13). But the next sentence of the inspired word throws us adrift, with nothing to support us but our faith in the sovereign wisdom of God. "How, then, shall they call upon him in whom they have not believed? And how shall they believe in him of whom they have not heard? And how shall they hear without a preacher? And how shall they preach except they be sent?"

It is also instructive, in this connection, to think of the means by which the evidence of the genuineness of the Scriptures is preserved. The providence that has preserved monuments and manuscripts and fragments of historical writers has not been what is called a particular, but a general providence. We have no miraculous proof of miracles. We have no inspired interpreters of inspiration. Use has been made of the caprices of the human mind (even of the peculiarities of the hand-writing, and the unwise monastic habits of misguided believers) to establish the credibility of the Bible. The very desolation that has come over the seats of early civilization has preserved from destruction the monuments confirmatory of the Scriptures. The thread of natural causes which leads us by a process of induction back through the unfolding stages of the revelation of the Bible has nowhere been absolutely broken by miracle. Miracle and special providence have only come in to incorporate new fibres with the lengthening thread. And we are wont to say that now the day of miracles is past; and have always acknowledged that these special interpositions have been limited to well-defined epochs of history.

This *gradual development of revelation* and its spread by natural agencies, which are so evident in the providential history of the scheme of redemption, fall in with the expectations of that scientific bent of mind which has constructed the Darwinian theory. Miracles are neither to be introduced to explain phenomena, nor expected for human deliverance, unnecessarily. Clearly, there is a reason for their

use in a providential government of moral beings, which does not exist previous to the creation of such beings. Miracles are for moral ends, and without positive evidence we have no reason to look for them in the developments of an irrational creation. It is no more inconsistent with the goodness of God that he did not interfere with organic life by special creation for many million years before the appearance of man, than that he has interfered so little by miraculous manifestations with the spread of the gospel. If he has relied in so large degree upon natural means for the dissemination of the moral forces of his spiritual kingdom, there is no *a priori* presumption against his having relied wholly upon such means in the development of the lower kingdoms of organic life.

But the limitations of space, rather than the lack of material, compel us to close. The conclusions which we have endeavored to make evident are as follows. If Calvinism is a foe to sentimentalism in theology, so is Darwinism in natural history. If Darwinism in its philosophy naturally allies itself to "realism" so does the theology of Augustine. If Darwinism appears to banish design from nature, and to be fatalistic, it is only because it is liable to the same class of misunderstandings against which Calvinism has had so constantly to contend. Are Christian apologists satisfied with *moral evidences*, and ready to rest their case on *probabilities?* Darwinians are often *more than ready* to accept similar evidence in natural history. Finally, a plan of development, in which there appears "first the blade, then the ear, after that the full corn in the ear," is as manifest in *human* history as in *natural* history; and we may conclude that, not improperly, Darwinism has been styled the "Calvinistic interpretation of nature." Through philosophic study both of the system of nature and of grace we come back at length to the central throne of God, from whose all-comprehensive ideas streams of creating and directing power flow across the gulf of time in continuous and orderly measure.