THE DOCTRINE OF EVOLUTION.

BY

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DOCTRINE OF EVOLUTION:

ITS DATA, ITS PRINCIPLES, ITS SPECULATIONS, AND ITS THEISTIC BEARINGS.

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NEW YORK:
HARPER & BROTHERS, PUBLISHERS,
FRANKLIN SQUARE.

PREFACE.

THE author of the following essay regrets to give it to the public in a state so inadequately representative of the science and philosophy which have contributed to modern discussions on the subject of Evolution. Yielding, however, to the judgment of others, he hopes there may be many intelligent readers who will receive his popular exposition of the theme as gladly as those who have already become acquainted with it.

As will be at once discerned, it has not been the author's aim either to defend or attack the doctrine, under any of its forms, but rather candidly to exhibit to the inquirer its strongest defenses and its weakest points. In the method of treatment he has endeavored to think for himself, though it may be doubted whether a single position has heretofore been omitted in the amplitude of the discussions on this question. The favoring arguments, it is to be presumed, have all been met by objectors, and the objections have all been handled by the supporters of evolution. Every one must have noticed, however, that the "handling"

of an adversary is not necessarily his eviction from a strong position; and so we iterate "objections" which have been a hundred times "answered."

Should the reader demand categorically whether the author holds to the doctrine of evolution or not, he replies, that this seems clearly the law of universal intelligence under which complex results are brought into existence. The existence and universality of a law operating upon materials so various, and under circumstances so diverse, but always evolving a succession of terms having the same values relatively to each other, is a fact which, to the ear of reason, proclaims intelligence more loudly than any possible array of isolated phenomena. But the diversity of the materials with which the law has to deal brings out a variety of special values for the general terms of the evolutionary series. Mechanical force acts with uniformity, symmetry, and always in one direction, producing results congeneric with itself; hence, in the world of mechanical force, the series are complete, calculable, and demonstrative. Or, if we penetrate to the rational element of all force, intelligent will, we should say that its self-imposed mode of activity in the mechanical world is one producing series which are complete, calculable, demonstrative. But obviously other modes of activity are possible and probable to intelligent will. When acting in the organic,

instead of the mechanical world, though conforming still to a fundamental law of evolution, its results may *not* present series which shall be complete, calculable, and demonstrative, but incomplete, contingent, and suggestive. Such seems to be the character of the succession of animals and plants. The series, as an evolution, lacks its first terms, and numerous intermediate terms; it presents regressions; it yields to the demands of physical correlations and ideal concepts; it betrays everywhere the activity of a force whose law is *not* that which dominates in the mechanical world. These modes of force take precedence of the modes producing mere physical results. The vital force subordinates chemistry and physics to ends beyond their compass. The intelligence of which vital force is a function, subordinates even physiological processes to the attainment of premeditated consummations. Thus the lungs of the tadpole are developed while it is yet a breather of water. Thus the perfect man is developed from the undistinguishable ovum. And thus it is possible to be (though we hold that it is not yet proven) that the process of reproduction, modified to suit special ends, has been employed by creative intelligence to raise organic types to their present status. But we can never believe that these results have been attained under any law but the supreme law of free intelligence. No

evidence can be stronger than that which convinces us that every effect must have its adequate cause, and that conformity to method and correlation of means to ends imply intelligence.

Mr. Spencer, in stating, in substance, that the efficient cause of evolution is a mode of the Unknowable, expresses our idea exactly in relegating this effect to a Power without the sphere of sensible things. But we differ from Mr. Spencer, *toto cœlo*, in respect to his dogma of the Unknowable, holding that the *Causa causarum* is revealed qualitatively to every rational being. The cause of evolution is, therefore, a mode or volition of the incomprehensible Mind.

The following essay was originally delivered, in the form of a couple of lectures, before the Drew Theological Seminary, on the 10th and 15th of December, 1873. This explains why we have appended to a scientific discussion an inquiry respecting the theological bearing of the positions of the disputants.

THE AUTHOR.

Syracuse University, February, 1874.

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EVOLUTION,

AND ITS

BEARING UPON THEISM.

EVOLUTION, in the language of Spencer, is the transformation of the homogeneous, through successive differentiations, into the heterogeneous.* The type of the process is the development of the embryo within the egg; but it is supposed to be exemplified in all progress, whether in the development of the earth, or of life upon the earth, or in the growth of society, government, manufactures, commerce, language, literature, science, or art. Evolution is thus a mode of succession of phenomena—a law of sequence. It is not a force, but a plan in accordance with which force acts. We may also say, it is the total result of the action of the evolving force.

No one can recognize the steps of an evolution without recognizing the operation of some force acting upon matter and producing motion. Evolution,

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* Spencer: *First Principles*, pp. 148, 149, 216, etc.

therefore, implies force. Hence the question which presents itself is twofold: 1. As to the *fact* of such a succession of phenomena as constitutes an evolution. 2. As to the nature and mode of action of the *force* causing evolution. The first question is to be settled by a collation of many facts. The answer must be either affirmative or negative. The second question must be discussed by appeals to facts, physical and biological principles, and metaphysics. The answers may be various, as they have been. First, the evolutionary force may be the Divine Will, or some force of matter or organization, or some force of whose nature nothing can be predicated—a mode of the unknowable. If the Divine Will, it may have been exerted initially, and then withdrawn; or it may have been exerted continuously. If a force of matter or of organization, it remains to determine which; also, whether the force be simple or complex; also, whether it be inherent or extrinsic; and, finally, whether it be ultimate or derivative.

It is a popular assumption, in regard to the doctrine and its implications, that it is a device for explaining the existence of phenomena by reference to forces whose origin is not traced to the Divine Mind. Its tendency is, therefore, supposed to be atheistic. As the phenomena of evolution are alleged to embrace the mental and moral class as well as the phys-

ical; and all phases of the evolutionary force are sometimes alleged to be equivalents of physical force, the doctrine of evolution is supposed to be materialistic in its tendency.

For these reasons, it is important to correctly understand the subject in its data, its principles, its speculations, and its theistic bearings. All these points we shall attempt to bring forward in a panoramic survey. It shall be an impartial, judicial citation of facts, principles, and theories, from which you shall be able to form your own opinions respecting the fact of evolution, and the theories which have been promulgated respecting the cause of evolution. In dogmatism and denunciation we shall not deal. If we are led to dissent from any phase of opinion, we shall remember that it has been defended by learned scientists, profound thinkers, honest hearts, and earnest lovers of the truth; and we shall continue to entertain a profound and sensitive respect for the honest opinions of every man laboring to enlarge the sphere of human knowledge.

It would not be necessary, even if time permitted, to survey the entire field of phenomena which have been supposed to fall under the operation of the law of evolution. The facts which lie before us in the physical and organic worlds will yield us adequate tests of the nature of the relationships which have

been set up in the system of existence. Cosmogony and organization, moreover, have been the fields on which the doctrine has waged its principal contests. We shall content ourselves, therefore, with a discussion of these two classes of facts.

A.—EVOLUTION IN THE PHYSICAL WORLD.

Common familiarity with the facts embraced under this head renders it appropriate to confine ourselves to very condensed statements. We shall make a hasty reference to two classes of facts having a bearing on the question of evolution.

I. Facts of Co-existence.

The facts of co-existence which possess a bearing on the theory of evolution are such as sustain relations of affinity to each other, and suggest, through their common likeness, a common origin. Thus, the pebbles and sand accumulating along a sea-beach are identical in character and associations with those found in a railroad excavation, and suggest that inland deposits of pebbles—even those which have been consolidated into rocky beds—are products of littoral origin. The trachytic rocks of New Mexico and Arizona are so extremely similar to recent lavas erupted

from the throats of volcanoes, that every geologist feels compelled to conclude that these extensive deposits of trachyte are also of volcanic origin. The evidences of deep terrestrial heat revealed in volcanic eruptions are identical with the revelations of thermal springs, deep mines, and artesian borings; and all conspire to establish the conviction that such heat exists; and all these thermal indications together convince us that at some former period terrestrial heat exerted a melting agency over a great part of the earth's surface. Extending our observations in a similar manner to the aggregate of terrestrial phenomena, of the class denominated geological, and we find them bearing in common, and so legibly, the stamp of common forces and common modifications, that we can not forbear the conclusion that the whole physical aspect of the world has been wrought out as a single history. The conviction is equally clear that the agencies in the work have been physical; that they have operated in past times according to the same methods as in the present, and that the forces of fire and water have been gifted, in succession, with an intensity of energy which has not been witnessed in historic times.

If we lift our eyes to the heavens, we behold within the bounds of the solar system more that one hundred and fifty bodies executing motions around com-

mon centres, according to a system so well regulated that a collision of two of them is not only an accident which has never happened, but one which is impossible to happen. It is not necessary to enumerate the various circumstances of forms and motions to render it apparent, to persons of ordinary intelligence, that primaries, secondaries, and asteroids are controlled by one set of forces, and subsist under one physical dominion.

All that we have learned of the superficial features of the moon or of Mars—the two bodies nearest our earth—tends to exemplify still further the analogies among the members of the system, and confirm our conviction of a common physical government over them. The sun itself, while yielding visible obeisance to the controlling laws of form and motion, yields to the questioning of the spectroscope unexpected but emphatic testimony to a material constitution identical with that of our earth, and differing only in temperature and the conditions which depend upon it.

A further generalization from the sum of phenomena manifested in the solar system convinces us that its various members are characterized by no essential differences, except such as result from differences of existing temperature. It appears that from the largest body to the smallest is a wide and graduated range

of temperatures, and that each body at the highest temperature is approximating, through radiation, the temperature of some smaller and cooler body. These inductive conclusions respecting the relations of heat in the solar system remind us of our conclusion respecting the former thermal condition of our earth; and, combined with it, and other evidences which we will not take the time to adduce, go far toward a demonstration that all that common history revealed is nothing more than the record of a process of cooling.

If we raise our eyes still higher, the stellar universe presents us with a set of phenomena which greatly extends the analogies of our system. Uncultured opinion pronounces each star a sun; but the eye of science discerns profounder reasons for regarding each a globe of vast magnitude, subsisting at a temperature similar in intensity to that of our solar orb. The very contrasts in the colors of the stars suggest incandescence of different degrees of intensity. The telescope discerns some in a state of extraordinary tenuity, such as might result from an excessive temperature. It also brings to light the phenomena of orbital motions, and the presence of those forces to which orbital motions are due. In the next place, the spectroscope testifies unequivocally to three things respecting the stars: 1. That their physical state is generally that of an incandescent fog or gas enveloping

an incandescent liquid or solid nucleus—thus resembling the sun; 2. That the chemical substances which form the earth and sun build also stars and nebulæ; 3. That the different stars and nebulæ subsist at different temperatures. These are wonderful revelations, and almost inspire us with a belief that to possible knowledge no limits have been set.

Now, when we consider the evidence in our possession, that gravitation acts in the starry realm as it acts upon the earth, and that gyrations are actually in progress among the stars and nebulæ; that light finds free intercommunication between the remotest star and the earth, and thus testifies to the intervention of a common, pulsating ether; and that the stellar bodies subsist at intensely high but various temperatures, we can not exclude the further belief that the law of radiation is also operative in this common realm, and that, consequently, the process of cooling, which induction points out in the solar system, extends itself to the farthest limits of the firmament; and that, in short, throughout the utmost bounds of the visible creation, we witness the perpetual escape of heat, not only into the interstellar spaces, but also, and necessarily, into the unknown spaces beyond the bounds of the visible system of matter.

Here is an impressive and sublime generalization, the proofs of which compel the assent of modern sci-

ence, and out of which burst forth courses of reflection which carry our thoughts in many directions. Remembering, however, our main purpose, we shall confine ourselves to a brief statement of the great features of the historical panorama which is spread before us.

II. Facts of Succession.

We said that we look forth upon a universe in a state of change. The changes going forward are methodical and regulated. They tend constantly in one direction. We have no scientific ground for assuming that the direction of this tendency has ever been different, nor for denying that the movement has extended back into the past so far that each portion of cosmical matter has existed at the highest temperature of which we have any knowledge. That temperature reduces all matter to the state of an incandescent mineral fog, or, perhaps, a feebly luminous or non-luminous gas. Science does not answer the question of the higher antecedents of matter, nor of the authorship of those energies which she discovers resident in it, or, at least, active in it.

It may be regarded as a mere hypothesis which predicates this as the primordial state of cosmical matter, but this, at least, must be said: 1. It explains completely and beautifully the whole mass of astro-

nomical and geological phenomena; 2. There is no physical objection which can be scientifically urged against it; 3. Nearly all scientific men are in accord in sanctioning it; 4. The method by hypothesis is one of the logical methods for the discovery of truth. The laws of Kepler were hypotheses till similarly tested and sustained; and so was the law of gravitation. In fact, we may assert that tentative hypotheses are the usual methods of physical discovery. It disproves nothing to call a proposition a hypothesis; and you remain quite at liberty to style it a hypothesis after it has reached the status of an accepted doctrine, since, like many other physical doctrines, it will probably never admit of strict demonstration.

Now, if every astronomical body in the visible universe is in a progress of cooling, it is necessarily undergoing those transformations which accompany cooling processes before our eyes; and, on a still grander scale, in the physical aspects of the moon and our sister planets. The present condition of our world is one which has been assumed from an ancient state of igneous vapor. In the progress of its cooling it has existed in an infinity of intermediate states. At one time it was a fire mist, like the photosphere of the sun; then it was a globe of molten liquid, like the probable nucleus of the sun; incipient incrustation

succeeded, and, perhaps, at the same time or even earlier, solidification began at the centre; at a later period it was enveloped in clouds of watery vapor, and rains descended to fill a universal ocean; then primitive wrinkles in the crust emerged in continental germs. As cooling and shrinkage continued, the series of surface oscillations upraised mountains, developed continental germs into continents, and shaped, according to a persistent method, the long foreshadowed features of the lands. Some of these past stages of terrestrial life are pictured to human eyes in the existing conditions of other planets.

This terrestrial history diverged from that common history which involved all the bodies of our system in a common mass and more ancient vicissitudes. The process of planet genesis, through successive annulations, we need not describe. The annular phase is stereotyped in the single case of the Saturnian system; and it is set forth in the aspects of annular and spiral nebulæ in the more distant realm of space. From the most attenuated vapor to the habitable earth, and even the frozen and fossilized moon, all possible stages and conditions of cooling are grandly held forth to view in the aspects which the nightly firmament presents to the eye of science.*

* The author has discussed this branch of the subject more fully in a couple of papers in the *Methodist Quarterly Review* for April, 1873,

III. The Succession of Cosmical States an Evolution.

Is such a succession of cosmical states an evolution? If the succession and the successional correlation are such as we have indicated, no question can arise. It *is* an evolution. Our confidence in this proposition is measured only by our confidence in the interpretations which science has put upon the body of telescopic, spectroscopic, and geological facts. These phenomena are connected together by the relation of cause and effect. The so-called forces of matter are the causes. Condition has been physically evolved out of condition; and the conditions of today are determining the changed conditions of tomorrow. The common consent of scientists renders these conclusions inevitable. If they are inevitable we must not shrink from them. It is probable they represent truth. If so, it is God's truth; and the

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and January, 1874. See, also, his brochure, entitled "The Geology of the Stars," Estes & Lauriat, Boston, 1873. It is greatly to be regretted that Dr. Christlieb's late "Essay on Modern Infidelity" is marred by expressions of distrust of the method of reasoning from the uniformity of nature, and thus ascending toward a beginning of the earth's history (p. 61). We note here, also, the puerility and futility and detriment to theology of his attempted vindication of the Mosaic cosmogony (pp. 59–62). In other respects we regard the Essay a master-work.

truth of God it is man's religious duty to embrace. We are bound to admit the existence of a method of evolution in the physical world.

B.—EVOLUTION IN THE ORGANIC WORLD.

No determined opposition is likely to be manifested to the doctrine of evolution as applied to the physical world. At least, no such opposition is likely to come from well-read thinkers. We do not say it is impossible. It is within the domain of *organic nature* that the modern controversy chiefly exists; and from the application of the doctrine here that the most serious consequences are expected to flow. We had proposed to devote our discussion chiefly to this aspect of the subject.

In pursuance of this purpose, we shall present, first, a conspectus of the leading facts which bear upon the question of the derivative origin of species; then, having outlined the various theories which have been thrown before the world, we shall consider the leading arguments in support of them, and proceed to a comprehensive survey of the scientific difficulties in which they involve us. Finally, we shall inquire into the theistic bearings of the doctrine of evolution, whether as applied to the realm of inorganic or to that of organic nature.

I. Facts of Co-existence.

In glancing about us for the discovery of facts which may have a bearing on the question of the evolution of species, the phenomena of *types* and *archetypes* stand forth in great prominence. These bind groups of animals or plants together in relationships of profound significance, and establish such kinship as must subsist to render the doctrine probable, or even plausible. We find, for instance, that the whole animal kingdom ranges itself under four categories of fundamental structure. Within the limits of each category, myriads of animals and thousands of species are knit together by an extended and profound system of affinities. Every vertebrated animal resembles every other vertebrated animal in a hundred-fold more particulars than enter into its resemblance to a molluscous, or an articulated, or a radiated animal. These vertebrates are all constructed on a particular plan, insomuch that, differ as they may—as widely as a fish from a bird—we find limb answering to limb, cranium to cranium, bone to bone, and, to a great extent, nerve to nerve, and muscle to muscle. We see that all are but modifications of one; or, more strictly, that all are modifications of an ideal vertebrate—an *archetype*—embodying the essential and persistent structures of all individual vertebrates.

In the next place, we have class affinities, like those which unite the mammals in one, or the birds in one; and these bring individuals into a closer unity than the fundamental characters. Following these are ordinal, family, and generic characters, bringing individuals into successively closer relationships, though the size of the groups, as a rule, is successively diminished. It is this state of the facts which renders a classification possible. It is this state of the facts which has suggested to so many minds the possibility of a genetic relationship among all the animals of a single group. Whatever interpretation we put upon the phenomena of types and archetypes, we must confess that they demonstrate method, correlation, and, consequently, intelligence.

Another group of facts worthy of prominent consideration is that which embraces the *data of embryology.* The beetle, to a casual observer, shows little resemblance to the earth-worm; but the infant beetle, which is a grub, exhibits a relationship so close that the uninitiated regard it a real "worm." The infant, or embryo, frog is the fish-like tadpole. The chick in the egg assumes in succession the aspect of a fish, a snake, a bird of low degree, and, finally, the similitude of its parent. Even man possesses, at an early period, the branchial apertures of the fish, and assumes in succession the aspect of a seal, a quadru-

ped, a monkey, and a human being. These embryonic affinities reach out to animals of the same fundamental type, and strengthen the induction drawn from corresponding adult structures in reference to the unity which reigns in what are known as natural groups of animals; and they are even more suggestive than adult affinities of genealogical relationships among the species of a group.

The common *instincts* and the common *intellectual faculties*, especially of the higher animals, indicate close relationships between them; while the wide disparity which subsists between the mental faculties of man and the brutes next below him stands a yawning interval, which it would seem difficult for any developmental process to overpass; and the contrast of the moral natures renders the chasm still broader and deeper.

The facts illustrating the *variability of species* have a direct bearing upon the question of derivation. A certain amount of variability is a matter of universal observation; but what is its extreme limit, and under what influence is it brought about? Two causes of specific variation have presented themselves to the notice of every one. The first, which is perhaps rather an occasion than a cause, is the *physical environment* of the individual. No one doubts that climate, food, exposure, and other material conditions

occasion certain adaptive variations in the color, size, robustness, covering, or even the form of the animal. Under domestication animals and plants have wandered from their native types to such extent as we see exemplified in the races of pigeons, dogs, roses, or apples. One fact, however, needs to be particularly noted. Not a single known variation has extended so far as to produce, in essential respects, a new form which naturalists agree to regard as a new species. Variations produced spontaneously, under the influence of external conditions, so far as observation goes, amount to no more than varietal forms. Still more certainly do the confessedly more strongly-marked variations caused by domestication tend to revert to the original type, when the original surroundings and influences are restored. These, we say, are the teachings of the facts observed; and in this all naturalists and theorists are agreed. It is, of course, admissible to suppose that the long continuance of the changed conditions would augment the variation by insensible degrees, and create insuperable obstacles to a reversion to the original type, except through a reversal of the slowly acting outward conditions. But the difficulties of such a position are great, as will be shown.

Variation of species is also seen to be produced by *cross-breeding*. The sexual intercourse of two species

generally regarded as distinct is a thing of rare occurrence. Nature has established aversions to it which are difficult to overcome. As a rule, too, such unions are unproductive. When otherwise, we obtain a mule, which generally bears some of the specific characteristics of each of its parents. Were it possible to perpetuate these characteristics, we should obtain a form which all would recognize as a new species; but this is not possible. Two mules resulting from the cross between two species are incapable of continuing their like; and when recourse is had to an individual of the original stock, the new offspring manifests a tendency to revert to the form of the original stock. Thus the hybrid form disappears. Experience and observation have, therefore, shown that it is impossible to introduce through hybridism a genuine new specific form.

II. Facts of Succession.

The phenomena presented by the *geological succession of organic types* are interesting in themselves, and on account of their supposed bearing on the question of derivation. The first fact which impresses us, and one on which all evolutionists have rested with much stress, is the methodical graduation of the chronological series of animal and vegetal forms. The earliest animals and plants were comparatively low — very

low, in rank; and higher types have been introduced in gradual succession. First, supposing *Eozoön* to have been an animal, conscious life was ushered into existence in the form of an animated jelly. At a subsequent period, higher marine animals appeared, then reptilian air-breathers, and after them birds, quadrupeds, monkeys, and men. This is a very suggestive procession of organic forms, and ought to afford a most valuable lesson. A closer scrutiny of it is reserved for another connection.

The next great fact which arrests the attention of the paleontologist is the unmistakable *structural relationship* of older and newer forms. We have more than a gradually improving series; we have a gradually unfolding plan. The four fundamental types of structure which we find running through the existing world are seen to extend back through the whole history of life upon our planet. When the vertebrate structure first appeared in the skeleton of the fish, in that remote period when life had not yet been able to take possession of land and atmosphere, that skeleton, simple and unpromising as it was, embodied all the conceptions which have since been evoked into reality in the vertebrate sub-kingdom. Reptile, bird, mammal, and man existed potentially in the primitive fish. Modifications of certain bony elements have wrought out each type in an admirable

succession, and in the order of progressive derivation from the ichthyic type. The pectoral fin of the fish became the fore leg of the saurian, the wing of the pterodactyl and then of the bird, the fore leg of the fleet deer, the climbing squirrel, the digging mole, the paddling whale, the prehenso-locomotive arm of the monkey, and then the instrument to execute the behests of the intellect of man. Similar relationships of plan are seen running through the whole history of articulates, molluscs, and radiates. These facts, so compatible with theories of derivation, are strongly insisted upon by the defenders of those theories.

These historical affinities are brought out in a strong light by those geological types known as prophetic, retrospective, and comprehensive. It seems to have been the rule that some important features of a new type immediately impending in the future should be incorporated by anticipation among the characteristics of some of the types of the passing period. These are prophetic types. The class of reptiles afforded some striking instances. Before ever a bird had existed, the idea of flying vertebrates was expressed in flying reptiles. Before there was a whale or other mammal, the flippers and forms of cetaceans became the prophetic endowment of mesozoic enaliosaurs. Paleontologists cite many similar cases. But equally common has been the retention, in the forms of

the passing age, of some of the features of a dominant type of the preceding age. The forms which thus perpetuate reminiscences of the past may be styled retrospective. Of this kind is the earliest bird (*Archæopteryx*), which, emerging from the age and associations of reptiles, with a long vertebrated tail, bilaterally quilled, seems to reveal itself with the characters of reptiles still clinging to it. Prophetic and retrospective types have been conceived by Professor Dana as incident to the more general method of comprehensive types. A premeditated group of affiliated forms was usually heralded by a comprehensive form, embodying characters of higher forms not yet existent, together with characters of lower forms partly existent and partly future. In the progress of time the composite type became resolved: separate species or genera, representing the higher, intermediate, and lower forms. This view seems faithfully to represent the usual mode of succession of organic types; and it appears, consequently, that a close scrutiny reveals a series of partial retrodradations in the resultantly ascending scale of beings.

These general statements might be illustrated in great detail, but the information is readily accessible to every reader.

III. An Evolution of Ideas at least Exists.

It is believed, and generally admitted, that no reflecting person can survey the phenomena of paleontological history without being impressed by the conviction that the succession of forms is, in the main, such as constitutes a method of evolution. We make no reference here to the cause of this evolution. To assert a method of evolution is not to assert a method of derivation. We mean that, at least, this succession of forms typifies an *evolution of ideas.* The conception of the vertebrate archetype existed at the advent of fish-life. It was first expressed in its simplest outlines in the fish; then, with increased complications and differentiations, in the reptile; then, with further differentiations, successively in birds, mammals, and man. The successive ideas stand in the relation of an evolution. The successive forms also stand, in the main, in the relation of an evolution.

IV. Is there a Genetic Evolution of Organic Types?

1. *Theories of Development.*

But do we find these forms sustaining relations to each other so intimate, that it appears rational to suppose the whole line has come into existence by means of genetic processes alone, or by means of genetic

processes aided or controlled by other influences? We here reach the great question of the age—greater in the estimation of the timid than it is in the eyes of the independent thinker. Agassiz and others maintain that the only evolution pictured in the panorama of life is one of ideas; and that each successive typical form has assumed independent existence through creative energy, prompted by an all-comprehending intelligence. The meaning attached to the word creation by this naturalist, and by most others who employ it, is, origination by fiat, and with a certain degree of suddenness. Opposed to this idea is that of creation in accordance with natural laws, or the derivation of one organic form from another through some inherent or imparted tendency to variation, or some susceptibility of variation under external influences.

Among modern propounders of opinion on this subject, De Maillet* attributed the successive improvements of organic forms purely to the influence of external circumstances. The world having been originally covered with water, the later emergence of land was accompanied by the occasional transfer of marine creatures to the land, where changed conditions gradually transformed their organs into others

* De Maillet: *Telliamed.*

better adapted to the new situation. Lamarck* elaborated with the utmost care, and with profound learning, a theory of transmutation of species, which maintains that external conditions, giving direction to an inherent tendency to improvement, work out gradual variations of species, resulting in the ultimate development of new species, genera, orders, and classes. Thus, with an inherent appetency toward a more perfect adaptation to the external circumstances, an animal under the necessity of obtaining its food by browsing from the foliage of trees, would finally, through the continued effort to reach its food, develop the elongated muzzle of the elephant, or the lengthened neck and extensile tongue of the giraffe. Theories like those of Lamarck and De Maillet were wholly incompatible with the conception of final cause as endowing the animal with organs adapted to its situation; and also excluded, necessarily, the generally accepted doctrine of specific creation by fiat.

The doctrine of the transmutation of species,† even

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* Lamarck: *Philosophie Zoologique*, 1809. These views were later maintained by Geoffroy St. Hilaire, and vigorously opposed by George Cuvier.

† Besides the authors cited in the text, a number of others, writing before Darwin, either explicitly avowed their belief in the doctrine of derivation of species, or indulged in dreams and conjectures on the subject. Among these may be mentioned Kant (1790), who, in § 79

at the hands of such valiant defenders as Lamarck and St. Hilaire, never succeeded in earning a large amount of acceptance. Its distinguished and convincing opponent was George Cuvier, the preceptor of the distinguished opponent of the later phase of the doctrine. The theory of the transmutation of species, accordingly, though feebly revived from time to time, was held in very general disrepute until the appearance of the memoirs of Darwin and Wallace,* in 1858, in which these two distinguished naturalists, laboring on opposite sides of the globe, arrived almost simultaneously at the same conclusion. They suggested that the *struggle for existence* among animals and plants, by causing the destruction of the feebler forms and the preservation of the stronger and higher, might probably, on the principle of the selection of the most perfect individuals to breed from, exert an improving influence on a specific type,

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of "Kritik der Urtheilskraft," speaks pretty clearly; Erasmus Darwin (1794), Oken (1802), Herbert (1822), R. E. Grant (1826), Geoffroy St. Hilaire (1830), the distinguished advocate of Lamarckianism; Goethe (1832), C. E. Bär (1834), Treviranus (1837), Freke (1841), Schleiden (1843), D'Omalius d'Halloy (1846), Unger (1852), Naudin (1852), Schaafhausen (1853), Carus (1853), Lecoq (1854), Büchner (1855), Baden Powell (1855).

* *Journal of the Linnean Society*, London, Zoology (1858), vol. iii., p. 45. The views of Mr. Wallace were foreshadowed in an article in the *Annals and Mag. of Nat. Hist.*, in September, 1855.

which, in a long course of generations, should cause it to present characters which naturalists would regard as specifically different. These learned theorists have subsequently elaborated their theories at length, and Darwinism is now as familiar as a household word.* It is Darwin's opinion, like Lamarck's, that man has not been an exception to the law of variation; while Wallace maintains that on the appearance of an animal endowed with mind, the forces of nature, instead of continuing to exert their wonted sway, were held in check and made subservient to the demands of his higher nature.†

The hypothesis of derivation by natural selection was heartily espoused by Dr. Hooker,‡ the distinguished English botanist; and our own distinguished botanist, Professor Asa Gray,§ gave the hypothesis a cautious adhesion at an early period. Professor Huxley is a valiant defender of Darwinism, with a visible

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* Darwin: *The Origin of Species by Means of Natural Selection; The Variation of Animals and Plants under Domestication*, 2 vols.; *The Descent of Man; The Expression of the Emotions in Man and Animals.* Wallace: *Contributions to the Theory of Natural Selection.* London and New York, 1870, p. 302.

† Wallace: *Natural Selection*, p. 324.

‡ Hooker: *Flora of Tasmania*, Introductory Essay; *Amer. Jour. Science* [2], xxix., pp. 1 and 305.

§ Gray: *Amer. Jour. Science* [2], xxix., p. 153. See, also, his later Address before the Amer. Assoc. Adv. of Science, Dubuque Meeting.

tendency to heresy, since he intimates that the advancing steps must, in some cases, have been rather abrupt—a result for which Darwinism pure and simple does not account.* He also admits the full force of sundry serious objections to the hypothesis.

One of the very ablest and most original of the defenders of the theory of Darwin is Professor Haeckel,† of the University of Jena. A vast body of facts and comparisons, interpreted from the Darwinian standpoint, is presented by Gegenbaur, in his celebrated works upon Comparative Anatomy.‡ In the English

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* Huxley: *Lay Sermons and Addresses*, Amer. edit., p. 312, etc. Compare, also, papers in his *Critiques and Reviews*, 1873.

† Haeckel, Dr. Ernst: *Natürliche Schöpfungs-Geschichte.* Berlin, 1868: Fourth edit., 1873. The theoretical positions of this author are laid down with an audacious degree of assurance; and he is sometimes as dogmatical as the dogmatists whom he takes so much pains to berate. One can not avoid amazement that Darwinism has never been opposed by a writer worthy of respectful mention, nor defended by one who is not worthy of it. The work lacks candor, and is garnished with an affluence of ridicule and hard names. See, also, Haeckel's *Generelle Morphologie*, 2 Bde. Berlin, 1866.

‡ Gegenbaur, Carl: *Untersuchungen zur Vergleichenden Anatomie der Wirbelthiere.* Also the very recent work, *Grundriss der Vergleichenden Anatomie.* Leipsic, 1874. A good text-book on the subject. Numerous other German writers have recently applied the theory of evolution to discussions in anthropology, biology, ethics, politics, and faith—as Carneri, Jaeger, Seidlitz, Spengel, Oscar Schmidt, Strauss, Von Hartmann, etc.

language, Dr. Chapman,* following in the footsteps of Haeckel, has presented a forcible array of pertinent facts and persuasive suggestions.

The doctrine called Darwinism, it will now be seen, is not co-extensive in its meaning with the doctrine of evolution, nor with that form of evolution through external influences known as "transmutation of species," or Lamarckianism. Darwinism is one theory respecting the nature of the forces which have caused an assumed divergence of species from their original forms. It assigns the principle of "natural selection," or "survival of the fittest," as the cause; while other speculators assign other causes of an assumed derivative origin of species.

There is a group of theories, differing from each other by slight, though essential, shades of divergence, which agree in attributing the derivation of species to some phase of action of the reproductive process. The author of the "Vestiges of Creation"† suggests that an exceptional *prolongation* of the term of embryonic development may give rise to a form somewhat in advance of the type of the parents. Mr. Alpheus Hyatt,‡ in 1867, suggested the idea that an

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* Chapman, Dr. Henry C.: *Evolution of Life.* Philadelphia, 1873.

† *Vestiges of the Natural History of Creation.* New York, 1845. *Explanations:* a sequel to the same. New York, 1846.

‡ Hyatt: *Memoirs Boston Soc. Nat. Hist.*, I., part ii. (1867); *Amer. Naturalist*, vol. iv., pp. 230–237 (June, 1870).

accelerated embryonic development would probably result in the production of improved forms, as a *retarded* development would give rise to an inferior form. These results might ensue without any material departure from the normal tenor of development. Acceleration or retardation of development would be promoted by favorable or unfavorable external conditions. Professor Edward Cope* soon afterward promulgated an identical theory, which, in several elaborate memoirs, he has most skillfully worked out.

Professor Theophilus Parsons,† in July, 1860, advanced the theory that ordinary generation might occasionally result in the production of a form advanced by the whole difference between two species, beyond the status of its parents. New species, he supposed, came into existence by means of occasional *extraordinary births*. A theory almost identical was independently propounded by Professor Richard Owen,‡ in 1868; and it is also the theory of Galton.§ Professor A. Kölliker,‖ of Germany, in 1864, in equal

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* Cope: *Transactions Amer. Phil. Soc.*, xiii. (1869); *The Hypothesis of Evolution*, in Lippincott's Magazine and "University Series," No. 4. Also, *On the Origin of Genera.*

† Parsons: *Amer. Jour. Science* [2], xxx., p. 1.

‡ Owen: *Anatomy of Vertebrates*, chap. xl.; Amer. Jour. Science [2], xlvii., p. 33.

§ Galton: *Hereditary Genius.* An inquiry into its laws, etc.

‖ Kölliker: *Ueber die Darwin'sche Schöpfungstheorie;* ein Vortrag. Leipsic, 1864.

independence of Parsons, conjectured, in antagonism to the theory of Darwin, that the development of species is conducted through the normal processes of generation. Professor St. George Mivart,* however, has presented this view with the greatest degree of fullness, candor, and ability. Finally, "partheno-genesis," so called, or virginal births, has been advanced by Ferris as an adequate explanation of the essential phenomena of derivation.

The following is a systematic conspectus of the several existing theories of the origin of species:

Conspectus of Theories of the Origin of Species.

IMMEDIATE CREATION:

In single pairs ..... Popular opinion.

In colonies ..... AGASSIZ.

DERIVATION (MEDIATE CREATION):

Through a force, which is a mode of the Unknowable ..... } SPENCER.

Through external forces.

Physical surroundings (*Transmutation*) ..... DE MAILLET.

Conflicts of individuals, or "Natural Selection."

Embracing the mental and moral nature.

By insensible gradations (*Variative*) ..... } DARWIN, HAECKEL, CHAPMAN, GEGENBAUR, etc.

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* Mivart: *On the Genesis of Species;* Amer. edit., 1871. Also, *Man and Apes;* Amer. edit., 1874.

With occasional leaps (*Saltative*).....HUXLEY.

Excluding the mind and body of man.....WALLACE.

Through an internal force, influenced by external Conditions.

Perpetual effort to improvement (*Conative-variative*..... } LAMARCK, ST. HILAIRE, etc.

Genetic processes exclusively (*Filiative*).

Prolonged development of embryo (*Variative-filiative*)..... } "Vestiges."

Accelerated development (*Variative-filiative*) { HYATT AND COPE.

Extraordinary births (*Saltative-thaumogene*..... } PARSONS, OWEN, KÖLLIKER, MIVART.

Partheno-genesis (*Saltative-filiative*)....FERRIS, KÖLLIKER.

2. *Leading Arguments for Genetic Relationship of the Terms of the Evolution.*

It will be sufficiently obvious that the great leading facts of the organic world, to which brief reference has already been made, must be the chief reliance of those who maintain that the paleontological succession of animals is in the order of a true evolution, and that organisms existing to-day are the last terms of a series which extends for a greater or less distance into the past. The classes of facts to which appeal is made in support of the *fact* of an evolution are, briefly: 1. The graduated succession of organic forms in geological history; 2. The graduated relationships of animal and vegetal types in the existing

world; 3. The correspondence of this gradation with the successive phases presented by embryos in the progress of their evolution.

As to the causes of this evolutionary relationship of organisms, all those who maintain that specific forms are derivative find countenance for their belief in the admitted fact that, while species are generally true to their lineage, they do vary, to a certain extent, so as to give rise to the phenomena of races and varieties. If the variation is a definable amount in brief periods, it may result in a wide divergence in the course of a thousand generations; and thus the origin of new specific forms become referable to the action of those forces which we see in action under ordinary circumstances. The idea of derivation of species, the one from the other, is further countenanced by the existence of typical plans of structure running through the history of extinct forms and through the world of living organisms.

Those who maintain that the evolution proceeds from the influence of physical conditions make appeal, 1. To the universal and admirable correspondence which we witness between the organs of animals and plants and the situations in which they live; 2. To the obvious and undisputed modifications produced in individuals and even races under the influence of climate, food, and physical circumstances; 3. The ex-

treme variations often witnessed in domesticated animals subjected to artificial food, lodgings, and treatment.

Darwinism, so called, while holding to the sufficiency of external influences to account for the derivation of species, relies rather upon the conflicts of individual with individual in the struggle for existence, the result of which is the survival of the fittest. The consequent slow deviation of the specific form is, therefore, the resultant effect of all the physical forces brought into play in the prosecution of the struggle. It is not the direct impression of physical influences upon the organism; it is not an innate active impulsion to deviation, but a sort of residual effect. Darwinism as holding, 1. To the fact of an evolutionary relationship of organic phenomena; 2. To the derivative character of each term of the series, must appeal primarily, as it does, to the same classes of facts, as we have already instanced. It appeals further, as a distinctive theory, 1. To the well-known laws of increase in the number of individuals of a species; 2. To the consequent and undoubted rivalry between them, tending to the destruction of those least fitted to survive; 3. To the assumed probability that hybridism, or cross-breeding, would occasionally give rise to forms better suited than either of the parents to the surrounding conditions, and therefore more like-

ly to survive than other forms which adhere to the specific type; 4. To a certain amount of improvement of the species resulting from the natural selection of the best to perpetuate it; 5. The hypothesis that this variative improvement is capable of being continued indefinitely; 6. To the phenomena of affiliated forms and fundamental plans of structure in the existing world and in the geological record, as evidence that the variative improvement *has been* carried on to an indefinite extent.

Here, it will be seen, are two hypotheses or assumptions incorporated into a body of sound facts: 1. That improved self-perpetuating types may result from hybrid connections; 2. That the graduated relationships of animals and plants in time and space are genetic. This is the very thing, and the only thing, which the theory is called upon to prove. To this and other difficulties we shall return.*

Those who maintain that the evolution of species

* Haeckel summarizes the inductive evidences of Darwinism as follows: 1. The Paleontological series (Phylogeny); 2. Embryological development of the individual (Ontogeny); 3. The correspondence in the terms of these two series; 4. Comparative Anatomy (Typical forms and structures); 5. Correspondence between comparative anatomy and ontogeny; 6. Rudimentary organs (Dysteleology); 7. The natural system of organisms (classification); 8. Geographical distribution (Chorology); 9. Adaptation to the environment (Œcology); 10. The unity of biological phenomena (*Natürl. Schöpfungsgesch.*, pp. 643–5).

is caused wholly or partly by an inherent tendency to improvement, or appetency to conform to the surrounding conditions, regard this hypothesis favored by the mutual relations between the organs of animals and their environment, and the probability that when the outward conditions become less favorable, beings in which we discover so many provisions for their best welfare would be provided with a tendency toward organic changes corresponding to the changes in external conditions.

The Lamarckian theory of inherent appetency is little insisted on at the present day, and unmodified Darwinism, it may be added, has fallen into a widespread disrepute. Neither Huxley, nor Parsons, nor Mivart, nor even Wallace, one of its original propounders, accepts the doctrine in its integrity; while they all maintain that the principle of natural selection is a true conditioning cause of a certain amount of variation; or, at least, a means of preserving in existence an improved form, when making its appearance through any cause whatever. The most popular and plausible views respecting the efficient cause of specific derivation are certain phases of the belief in the sufficiency of natural generation for the purpose. That is, assuming the fact of a derivative origin of species, the derivation of species from species is not the result of the impression made by the envi-

ronment of the organism, nor the result of the struggles between weaker and stronger; nor the effect of an inherent tendency to change to perfect the adaptations of the organism, but the result of extraordinary incidents of the process of generative reproduction. These views receive countenance in the fact that the successive stages of embryonic development of higher animals represent the adult stages of lower animals, showing that the serial relation is a developmental one, and also a relation of generative development.

The theory that a prolongation of the period of embryonic development may lead to more highly perfected forms, is based by the author of the "Vestiges" on, 1. The fact that the period of embryonic development is a period of progress from lower to higher; 2. That the higher animals are characterized, as a rule, by the longest periods of embryonic development; 3. That the period is known in some cases to become prolonged beyond the norm for the species. These recognized facts are supplemented by the hypothesis that, in cases of prolonged development, the *rate* of development is as rapid as in cases of normal duration; for, if the rate fall short of the norm in as great a ratio as the lengthening of the term, the status reached by the matured embryo would be no more advanced, notwithstanding the prolonged development. The theory, in addition to this, supposes that

the improvement which takes place *after* birth is not diminished in amount by the extraordinary prenatal development.

The hypothesis of Hyatt and Cope that the births of superior forms are the result of an accelerated, rather than a prolonged embryonic development, and that an acceleration may be effected through the influence of improved conditions of vitality, is grounded upon such facts as the following: 1. An acceleration or retardation of development, either with or without an alteration of the period, is known to take place under circumstances of the kind alleged; as in the case of the ova and tadpoles of frogs and other batrachians, in which the rate and period both depend upon temperature, and, in the case of tadpoles, also upon the supply of food; 2. Certain other batrachians —notably *Siredon lichenoides**—under seemingly unfavorable conditions of existence, have been practically arrested in their development, and their larvæ have reached a kind of reproductive maturity, and have been described as adult forms, while, under changed, and probably improved conditions, the development of other specimens has been continued, without interruption, to a conclusion which presents

* See Professor O. C. Marsh's observations in *American Journal of Science*. Also, *Tribune Extra*, No. 8.

an adult which, without a knowledge of these facts, would be taken, not only for a distinct species, but for a distinct genus, family, and even order. This hypothesis assumes that acceleration and retardation are phenomena so general as to impress the whole of organic nature. It also assumes, as an implication, that there is no specific limit beyond which such embryonic variations can not pass, or to which, if they do pass it, there is no tendency in the offspring to revert. That is, it denies all constancy in species, and asserts that every species is liable to slight, continued, unrestrained, and irremediable fluctuations through the accident of accelerated or retarded development.

The idea suggested by Parsons, and, independently, by Owen, and adopted by Mivart, that the derivative origin of species comes through occasional abnormal births, rests, as a specialty, chiefly on the known occurrence of such births, and the occasional hereditary transmission of their characteristics, especially in the state of domestication. The theory assumes that this cause of variation works out its results by perceptible rather than imperceptible steps; and that, consequently, each specific form remains, as a rule, constant. It depends upon the influence of natural selection to preserve in existence such extraordinary births as possess improved fitness to survive. Its most vulnerable point is the assumption that extraor-

dinary births are so frequent and general, and their peculiarities so transmissible, as to alter by degrees the whole aspect of the organic world.

The suggestion by Ferris and Kölliker that the phenomena of so-called "partheno-genesis" afford examples of a kind of specific derivation which may have been sufficiently common and general to impress and mould the whole aspect of organic nature, rests upon the fatal mistake of regarding as adults certain extraordinary larval forms—like the intermediate stages (misnamed "generations") of *Cercaria* and certain *Aphides*. The idea of partheno-genesis is a contempt of the universal law of life; and the assumed facts are *not* facts, since the succession of forms returns in all cases to an original form, which is the only one to which genesis can be ascribed.

3. *Prominent Objections to Theories of Specific Derivation.*

(1.) *In the Field of the Facts.*—It becomes our next duty, whether favorably or unfavorably impressed by the doctrine of specific derivation, to examine candidly the difficulties which it encounters both in the field of the facts and in the field of physiological force. The great stubborn fact which every form of the theory encounters at the very outset, is that, notwithstanding variations, we are ignorant of a single

instance of the derivation of one good species from another. The world has been ransacked for an example, and occasionally it has seemed for a time as if an instance had been found of the origination of a genuine species by so-called natural agencies; but we only give utterance to the admissions of all the recent advocates of derivative theories when we announce that the long-sought *experimentum crucis* has not been discovered.

According to common observation, while every specific type manifests a certain degree of flexibility under the influence of physical conditions, this is absolutely restricted within fixed limits. This proposition has been amply illustrated by Sir Charles Lyell,* whose reasoning, though subsequently disavowed, was framed in a more candid mood than the disavowal. Sir Charles has also convincingly shown that so much variation as is possible may be generally effected in brief intervals of time, and that thereafter the variety can be no further modified in the same direction. It is also a matter of common observation that the divergent form, when relieved of the physical constraint, rapidly reverts to its original type.

These statements are as true of divergencies resulting from hybridity as from the influence of domesti-

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* Lyell: *Principles of Geology*, eighth edit., pp. 573–577.

cation or other external agencies. Neither have we such a knowledge of the persistence of forms resulting from extraordinary births, as to be able to assert that the tendency to reversion is not so dominant as to prevent the perpetuation of accidental features which should impress whole faunas and floras, and transmute whole assemblages of species.

According to the hypothesis of derivation, the varieties of domesticated animals and plants are to be regarded as incipient species capable of diverging further and further from their original types. Varieties ought, therefore, occasionally to come into existence so divergent from the primitive stock that the phenomena of hybridity should be possible between them —*i. e.*, the joint offspring of the variety and the original stock, or two different varieties of the original stock, should be incapable of generation. Such a phenomenon has not yet arisen, and the Darwinists admit the fact with concern. Professor Huxley says:* "I do not know that there is a single fact which would justify any one in saying that any degree of sterility has been observed between breeds absolutely known to have been produced by selective breeding from a common stock." Though he asserts that it may be possible, he says: "If it could be demonstra-

* Huxley: *On the Origin of Species*, p. 141.

ted that it is impossible to breed selectively from any stock a form which shall not breed from another produced from the same stock; and if we were shown that this must be the necessary and inevitable result of all experiments, I hold that Mr. Darwin's hypothesis would be utterly shattered."

But, it is readily answered, our observations have been confined to a period of time too brief to authorize us to set the limits to the possibility of variation. To which we reply by appealing to the records of the past. During the French occupation of Egypt under the first Napoleon, extensive collections of specimens of natural history were made, including thousands of mummied examples of animals existing in Egypt two or three thousand years ago. These were studied and reported upon by a committee of naturalists appointed by the Academy of Sciences. These eminent authorities were so impressed by the evidence which the mummied remains presented of the absolute constancy of specific forms, that they add: "It seems as if the superstition of the ancient Egyptians had been inspired by Nature, with the view of leaving a monument of her history." * Among the animals thus pre-

* "Il semble que la superstition des anciens Egyptiens ait été inspiré par la Nature, dans la vue de laisser un monument de son histoire," etc. *Annales du Museum d'Histoire Naturelle*, tom. i., pp. 235, 236. Lamarck: *Philosophie Zoologique*, tom. i., p. 69.

served were the ape, the ichneumon, the crocodile, and the ibis, besides many other wild quadrupeds, birds, and reptiles, which are thus certified to have remained constant during a period sufficiently long, one would suppose, to have wrought sufficient change, if total transmutation were possible, to be discernible by a body of zoological experts, one of whom, at least, would have been greatly gratified by such discovery.* But the strongest testimony of all to the permanence of species was shown in the mummies of domestic animals; for here were found abundant examples of the bull, the dog, and the cat; and such was the conformity of all these species to those now living, that there was no more difference, says Cuvier, between them than between the human mummies and the embalmed bodies of men of the present day. And yet these species have since been transported to all parts of the world, have endured the influences of all climates and all circumstances. The bearing of such facts can not be gainsaid, and it is to be regretted that Professor Huxley's candor has not prevented him from passing them by with the contemptuous assertion that they are "battered and hackneyed."†

Perhaps the animals contemporary with man in

* The committee consisted of MM. Cuvier, Lacépède, and Lamarck.

† Huxley: *Lay Sermons, Addresses, and Reviews.*

Europe during the Stone Age of that continent, do not reach back to a higher than Egyptian antiquity; but it is worthy of mention that the bison, the reindeer, the dog, sheep, cat, and other primitive animals have undergone no perceptible alteration in the interval between prehistoric and recent times.

Some light may be thrown on the possibility of important change in the psychic characters of brutes by contrasting their fixed intelligence with the progressive intelligence of man. What progress has man made in intellectual, æsthetical, moral, and religious development since the period when he was a dweller in the caves of Europe, or a "mighty hunter" in the primitive forests of Assyria! But the domestic animals which have kept him company, and been the witnesses of all his advance, have gathered no new stores of intellectuality or knowledge. We detect no tendency to develop toward the intellectual standard of their master. Should we grant that the lack of articulate speech is the bar to their progress, we grant and claim thereby the impossibility of climbing up to man till that bar is removed. But have they given any surer signs of learning to articulate than they have of learning to think? If not, then the bar remains. This absolute fixity for a period of three or four thousand years, and this absolute, unchanged, organic incapacity to take a step forward in intelligence, while

man is demonstrating the possibility of great movements in brief periods, must be regarded as affording little countenance to the hypothesis that any speechless, unreasoning pair of brutes has ever departed from the norm so many times and so greatly as to have become a speaking, reasoning, conscience-stricken Adam and Eve.

But, in promising to make an appeal to the records of the past, we did not propose to restrict ourselves to an interval of two, three, or five thousand years. This, affirms Lamarck, is too brief a period to suffice for the slow transmutation of species; we rely upon the prolonged influence of geologic cycles. Well, we will cite a few examples of that influence. American geologists are very familiar with a couple of species of brachiopods which turn up under all lithological conditions, and through a wide vertical range of formations. *Atrypa reticularis* of Dalman, ranges from the Clinton Group, near the bottom of the Upper Silurian, through the Niagara Shale and Limestone, the Salina Group, the formations of the Lower Helderberg, the Oriskany Sandstone, the Corniferous and Onondaga Limestones, the formations of the Hamilton Group, the Portage and Chemung Groups, making its last appearance in the Marshall Group, within the bounds of the Carboniferous System. Geologists may well re-examine the evidences of the continuity

of the same species through so vast an interval of time; but though Mr. Whitfield* has suggested the probability of more than one species, the fact is, that paleontologists have generally recognized but one; and even if Whitfield's suggestions were confirmed, the endurance of an unaltered specific form through time would still be so great as to convey a vivid impression of the constancy of species; and we should still have no evidence that the later form was derived from the earlier. Another species—*Strophomena rhomboidalis* of Wahlenberg—has an equal, or even greater, range in time, while similar doubts have not been expressed of the strict identity of the earlier and later forms. It should also be stated that both these species have a very wide geographical range, having been first discovered and named in Europe, where the diverse conditions did not stamp upon them an aspect specifically different from the American forms.

We could cite from paleontology numerous instances of the persistence of specific types; while the persistence of well-restricted generic types, through even greater intervals, is a fact of the same purport, and probably of equal weight. Thus, among exist-

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* Whitfield: Nineteenth Report New York Regents on the State Cabinet.

existing genera, we find *Nautilus*, which reaches back probably to Lower Silurian time; *Lingula*, which penetrates even to the beginning of the Silurian; *Rhynchonella*, which dates from the Lower Silurian; *Terebratula*, which comes down from the middle Devonian; *Ostrea*, which commences in the older Carboniferous. Of similar import is the persistence of family and ordinal types, like ganoid fishes and crinoidea, from remote ages to the present.*

We may also cite the parallelism of the lines of descent of closely allied species, through long intervals of geological history. The hypothesis of derivation implies the probability that at least some of these affiliated species should have had a common origin, and must have been descending along divergent lines; but no such divergences have been pointed out.

The unavoidable conclusion from this class of objections is, that whereas the theory of variative derivation requires that every species should be capable of assuming, by insensible degrees, not only specific characters, but even generic, family, ordinal, and class characters not originally belonging to it—thus presenting, at successive times, totally changed categories

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* See a candid admission of such facts by Huxley in *Critiques and Addresses*, pp. 184–186.

of structure of all grades—the facts only show that individuals are capable temporarily of exhibiting considerable, though definitely restricted, variations wholly within the limits of the specific type.

Another set of facts which it concerns the advocates of the hypothesis of variative derivation to explain, is the existence of breaks in the chain of affinities among animals and plants. Professor Huxley asserts that "it is an easy matter to prove that, so far as structure is concerned, man differs to no greater extent from the animals which are immediately below him than these do from other members of the same order." In this, however, he is in disaccord with Wallace, Owen, Dana, Cuvier, and all the great authorities on the subject. But we demand why he restricts the comparison to points of structure, since it is man in his completeness, with all his intellectual, moral, and æsthetic faculties, that the doctrine of derivation is summoned to explain. We must insist, with Tyndal, that here yawns an immense gap which it is impossible to bridge.

But the case stands worse than this. We are not left at liberty to assume man the descendant of quadrumana nearest akin, since their lineage goes little if any further back than his. If man be a derived form, he must look for his crest among the ruling families of monkeys existing in the miocene or eocene age.

This necessity discovered, the assertion of kinship is intellectual temerity.

The chasm between vertebrates and invertebrates is one which it has taxed the ingenuity of transmutationists to bridge; but it is thought the row of cells which, in the young ascidian, presents so much the appearance of the dorsal chord of the vertebrate embryo, must be the long-sought abutment from which the arch of the bridge may be sprung. But two circumstances seem to render this hope illusory. First, the cells of the ascidian sustain relations to the *ventral* instead of the *dorsal* side of the animal; and, secondly, in the adult ascidian, in which the higher (vertebrate) characters ought to be more pronounced, there is nothing to indicate that they ever existed.

Many similar gaps exist in the actual world of life. In fact, when we remember that variative derivation implies that even the intervals between the most kindred species have at some time been filled by intermediate forms, it must appear that the actual state of the world comes far short of the requirements of the theory; and that creation, in spite of what we know of the persistence of types, must have lost incalculably more species than have come down to our times, or left their records in the rocks.

The rocky record reveals the existence of breaks of serious import in the historical succession of or-

ganic types. There are facts of a suspicious character in the very first chapter of this record. The lowest and oldest assemblage of fossils of which we have any certain knowledge is in the bottom of the Lower Silurian. According to variative derivation, these should be the simplest possible organisms—structureless, formless, and germ-like. They are, in fact, as highly organized as brachiopods and trilobites. Mr. Darwin suggests that their humbler ancestors must have been buried in strata of Pre-Silurian age; but in this country those strata have been too faithfully and too fruitlessly studied to permit such a presumption. But then, he says, their remains, though once there, have been destroyed by metamorphic agencies. We reply, it is contrary to probabilities that the immediate progenitors of animals as imperishable and as well-preserved as the stone-secreting brachiopods and cephalopods of the Silurian should have left no single trace of themselves in the well-explored strata immediately beneath the Silurian. But there is *Eozoön*, the theorist may now rejoin, as low down as the Lower Laurentian, and this is the primitive organism which we require. To this we say, the discovery makes the case even worse; for if this fragile primitive creature could have been preserved from times so early, others certainly could have been preserved during the vast succeeding stretch of Laurentian and

Huronian time, had they existed. The gap, then, between *Eozoön* and the Silurian types is an impassable gulf. Even if we admit the organic nature of *Eozoön*, it is a solitary species, representing a space of perhaps millions of years, while, in the first zone of Silurian rocks, we know more than three hundred and seventy different species. But, in truth, *Eozoön* is only doubtfully admitted within the bounds of organization. Two Irish geologists, Messrs. King and Rowney, have all along most strenuously demurred from the conclusion that it is organic; while in our own country Messrs. Burbank and Perry have brought to light some facts which are seemingly incompatible with a belief in its animal character.*

M. Joachim Barrande has treated with so much thoroughness, logic, and perspicuity the bearing of the paleontological facts of the Lower Silurian upon theories of variative development,† that we should leave the discussion very incomplete without making especial reference to his labors. Suffice it to say of his preparation for the work, that he has devoted a lifetime to the study of the Silurian system of Bohemia, and, collaterally, of all other countries; that he

* Proceedings Boston Soc. Nat. Hist., April 19, 1871, vol. xiv., p. 189.

† Barrande: *Système Silurien du centre de la Bohême.* Supplement to vol. i. See further, the Appendix to this Essay.

has published several ponderous quarto volumes of results, and that his name is as familiar to the geologists of Europe and America as is that of Ulysses S. Grant to the politicians. M. Barrande has shown that of three hundred and sixty-six species of fossils from the primordial zone of Europe and America, collected in twelve different countries, only fourteen are "migrant," *i. e.*, common to two of these countries. Now, as these species are so closely related to each other that geologists refer them to identical genera known as *Paradoxides*, *Olenus*, *Conocephalites*, *Agnostus*, etc., and as they rose into being simultaneously in various countries, and under circumstances so widely contrasted, it is difficult to conceive of any filiative relationship among them; and he feels constrained to believe that the phenomenon is the result of a common sovereign and ordaining cause.*

The "lower phase" of the Primordial Zone of the Silurian is measured by the lifetime of the genus *Paradoxides*. Contemporaneous with *Paradoxides* were a hundred and sixty-eight species of trilobites, which came suddenly into existence with the dawn of the Silurian Age—having no trilobitic forerunners in earlier time, and with no animal organism whatever of earlier date, except some very questionable

* See the 8vo "Extrait," from the "Supplement," p. 193.

forms, bearing, if we take them into account, but a remote relationship to trilobites. We seek in vain for the relics of such ancestral forms as theories of variative derivation demand.*

Again, we know of forty-six primordial genera which came into existence with *Paradoxides*. All these are very distinctly defined. We look for the intermediate generic forms which, on the derivative hypothesis, must have existed; but to this day no single one has been found.†

The larger groups are similarly isolated. We know eleven distinct family types of primordial fossils which are as sharply cut off from each other as the same families are in any subsequent age. Between a trilobite like *Paradoxides*, for instance, and an ostracod like *Primitia*, a little bivalve crustacean, the difference of conformation is so pronounced that if one could imagine the two types derived from the same common ancestor, he would feel compelled to concede the existence of a multitude of intermediate forms which must have existed before the period of *Paradoxides* and the contemporaneous ostracods. But we have said no trace of such forms has been discovered. Similar statements apply to the other family types of the primordial zone; and, in fact, to a large number

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* Op. cit., p. 206.

† Ibid., pp. 200, 201.

of zoological types distributed through the later periods of the earth's history.

The paleontological record has furnished us with other facts of even a stronger character than these. The graduated order of succession, judging from the facts in our possession, has sometimes been actually reversed. In the Mesozoic time, certain gigantic reptiles, called Deinosauria, of high organization, and in some respects presenting an approximation to mammals, existed as a dominant type. Their position was near the head of the class; and yet they had not been preceded by all the lower orders of reptiles. Serpents, for instance, did not make their appearance till the Eocene Period. In like manner Labyrinthodonts, which are hypertypical batrachians, appeared during the deposition of the Coal Measures; while typical batrachians—frogs—did not make their advent till the Eocene.* So fishes related to sharks, and gar-pikes were the earliest representatives of their class. Ordinary fishes, lower in rank than these, did not appear till the Mesozoic time.†

The primordial zone may be again appealed to for its testimony. Here, in the first assemblage of animal

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* This is a recent determination by Professor Cope: Proc. Acad. Nat. Sciences, March, 1873, p. 207.

† Facts of this class are also admitted by Huxley to present difficulties. *Critiques and Addresses*, p. 187.

forms which ever existed, we have a large predominance of animals as high in organization as trilobites. In the earlier phase, three-fourths of all the fossils are crustaceans. The remaining species are all lower in rank than crustaceans. In the later phase of the primordial, two-thirds are crustaceans. In the subsequent periods, the lower types increase still further in relative abundance, both of individuals and species. Among the trilobites themselves may be traced an inversion of the order required by theory. M. Barrande has found the embryos of this type fossilized in considerable numbers, and has studied their development-history. The successive stages are characterized by a gradually increasing number of thoracic segments. This order, according to the law universally recognized, indicates that tribolites with few segments occupy a position below those with numerous segments. Accordingly, the genera with few segments should precede, in time, the others. But the exact reverse of this is the fact. Nearly all the genera of the earlier phase of the primordial have more than eleven segments — *Paradoxides* itself having twenty. But in the second fauna of the Lower Silurian we encounter simultaneously, in all the countries of the two continents, a large number of species having few segments. We know three hundred and twenty-two species whose thorax is composed of five

to nine segments. At the same time, the second fauna does not afford a single trilobite having as numerous segments as *Arionellus*, *Sao* and *Paradoxides* of the first phase of the primordial fauna.*

It is a principle first enunciated by Professor Dana,† that the earliest representatives of a zoological group were neither the highest nor the lowest members, but generally some type a little distance above the bottom of the group. From this point the evolution proceeded chiefly upward, but also, to some extent, downward.

Were the species of animals and plants variatively derived from a few simple primordial ancestors, it is unaccountable that the simplest types have remained in existence to the present day. If changed conditions occasion new modifications, and new specific and higher types, we should expect the primitive stocks to have disappeared.

Animals are generally intolerant of changed conditions. Instead of undergoing any profound modifications, they migrate or perish. Thus, the molluscs which in Post-Tertiary time inhabited the estuary of the St. Lawrence, have removed, under changed conditions, to the shores of the North Atlantic. The

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* Barrande: Op. cit., pp. 240–242.

† Dana: *Manual of Geology*, p. 396.

descendants of species which flourished on the coast of New England in a cooler age are now to be found upon the coast of Greenland. In a similar manner, the reindeer has withdrawn, with the amelioration of the climate, from Southern Europe to Lapland.

We have thus briefly adverted to the leading classes of facts which seem difficult and, in some cases, impossible to reconcile with any of the theories of variative derivation — whether Spencerian evolution or Lamarckian transmutation, or any of the phases of Darwinism. It remains to signalize an array of facts which reveal themselves in the field of the physiological forces.

(2.) *Prominent Objections in the Field of the Physiological Forces.*—The defenders of theories of variative derivation repose great stress upon the modifying or directive influence of external conditions. A further critical examination of facts will show that an unwarranted degree of importance has been conceded to influences of this class, and that the phenomena are better explained by referring them to the action of some internal force which exerts itself both with reference to physical surroundings and with reference to the necessities of the animal, and also with reference to archetypal conceptions.

The action of the physical influence is often, if not always, against the development of the organic modification

which appears in correlation with it. Lamarck alleged that the elongated proboscis of the elephant, and the long neck and extensile tongue of the giraffe, all so beautifully correlated to the instincts of these browsing animals, have been produced by their continued efforts to secure the food suited to their organization. Now the idea is conceivable that a long-continued physical action upon an organ should result in a certain degree of modification; and that the action of muscles, in extending the lips, for instance, should eventuate in a permanent extension, as in the proboscidians; but it is *not* conceivable that physical forces should conduce to an organic modification which proceeds in a direction diametrically opposed to the direction of those forces. Now, no one can deny that the elongated fore legs of the giraffe stand in as intimate relation to its wants as its elongated neck or tongue. But the *physical* force acting upon the legs is the weight of the animal, which tends rather to shorten than lengthen them. It will not do to reply that the legs of all animals in the growing state continue to lengthen, notwithstanding the pressure in the opposite direction; since no one will pretend that this growth is the effect of the pressure, but rather of some force which, in spite of the pressure, acts toward a result correlated to the ideal concept of the adult animal. Here, consequently, is a real correla-

tion which is not produced by any known physical force. It must, therefore, be produced by some other kind of force. It will not suffice to call it a physiological force, if by this is meant some force resolvable into endosmose, capillarity, affinity, etc.—as maintained by Draper, Barker, Spencer, and others—for these are physical forces, and act, like mechanical forces, only along lines of least resistance. We see no alternative but to refer the phenomenon in question, and the whole class to which it belongs, to the directive and controlling action of some force which is superphysical.

The difficulty in this case is paralleled by that of every case in which we attempt to conceive of physical agencies as developing organs from their incipiency; as, for instance, the electric organs of certain fishes, the illuminating organs of fire-flies and other insects, and the mammary organs of a whole class of vertebrates. Mr. Darwin himself has admitted the difficulty.

Nor does the situation seem to be materially altered when we attempt to apply the theory to organs in any stage of development. The physical influences, strictly speaking, are generally opposed to the result. The result takes place, and manifests a correlation to the physical conditions; and a natural suggestion is, that the physical conditions were the

cause. The *conditioning* cause they may be, but not the *efficient* cause.

Another general principle indicating that the efficient cause of organic modifications is hyperphysical, is the fact that *very specific physical influences are not always, nor even generally, accompanied by such modifications as are, in parallel cases, attributed to them.* The quadrumanous tribes of different countries are accustomed to ascend trees for the purpose of procuring nuts to serve as their natural food. Their long arms, their four prehensile extremities, and, in some cases, their prehensile tails, seem especially adapted to the function of climbing; and, on derivative hypotheses, these organs have been moulded to these capabilities by the pressure of their wants and long practice in efforts to climb. But the nuts, for the procurement of which these organs are so serviceable, are equally, in some cases, the principal food of the native people of the same countries; and they are in the habit of training these quadrumana to collect the nuts for them. One of the baboons of Sumatra is said to exercise great judgment in selecting only the ripe ones, and in pulling no more than he is ordered.* The capuchin and cacajao monkeys, according to Humboldt,† are similarly expert. Now, it seems

* Raffles, Sir Stamford: *Linnean Trans.*, vol. xii., p. 244.

† Humboldt: *Personal Narrative.*

that these quadrumana and the people associated with them are equally in need of the cocoa-nut, and are surrounded and influenced by the same climate, the same longings, and the same food; and it is unaccountable that Nature has not developed for the men a set of organs as well adapted to the situation as those she has given to the brutes. If, furthermore, we assert that men are developed quadrumana, we behold in these cases a development directly opposed to the tendency of the strongest physical influences.

To take another example from a different field, Professor Hooker* informs us that he traced distinctly a stream of identical vegetable forms all the way from Scandinavia to Tasmania. "Scandinavian genera," says he, "and even species, re-appear everywhere from Lapland and Iceland to the tops of the Tasmanian Alps. * * * They abound on the Alps and Pyrenees, pass on to the Caucasus and Himalaya, thence they extend along the Khasia Mountains and those of the peninsulas of India to * * * Java and Borneo, * * * and re-appear on the Alps of New South Wales, Victoria, and Tasmania, and beyond these again on those of New Zealand and the Antarctic islands—*many of the species remaining unchanged throughout.*" These are very remarkable facts, even

* Hooker: *Flora of Tasmania.* Introductory Essay. Reprinted, Amer. Jour. Science and Arts [2], xxix., 323.

taken by themselves; but the more extraordinary the width of this distribution of identical species, the more completely are we at a loss to account, on derivative principles, for such uniformities of character under circumstances so diverse. The widely separated stations of these Scandinavian species can hardly possess any other common resemblance than their Alpine climate. If, however, it were supposable that similar conditions have developed identical species at points so remote, a degree of coincidence is implied which is rendered extremely improbable by the doctrine of chances; and if we suppose that Scandinavian species have migrated to the antipodes, the wonder is that they had not been transmuted before traversing half the circumference of the earth. The explanation of these and similar phenomena seems to be, that specific types possess a degree of constancy which withstands all external modifying influences, except within certain limits of elasticity which do not sacrifice their identity.

We should remark further, *that the same physical influence is often accompanied by profoundly differing organizations.* It is natural to suppose that an apterous insect and an apterous vertebrate would be excited by similar longings for the power to rise above the earth. It should be supposed that in the same region, and under the same set of circumstances, the

necessity of flight would result in the development of wings constructed at least upon the same fundamental plan. But the plan of the insect's wing is conformed to the articulate archetype, and the plan of the bird's wing to the vertebrate archetype. Nor is the result the same when the wings are developed under the same archetype. The bird's wing is a fan of quills fixed in a consolidated mass of obsolescent phalangeal, metacarpal, carpal, and ulnar bones and cartilages, and leaving the hinder extremities entirely free. The bat's wing is a leathery membrane stretched over the elongated and fully articulated fingers, and thence joining the body and the whole length of the posterior limb, and continuing to the tail. It is fair to bring into the same comparison the winged reptiles which, though no longer existent, manifested a correlation of an identical kind by means of a still different structure. The wing of the *Pterodactyl* was a leathery membrane stretched only from the fifth digit to the hinder limbs. This digit was accordingly enormously elongated, while the others were of normal length. On the doctrine of correlation to ideal archetypes, these various plans of alar structure are intelligible and beautiful; but on the hypothesis of development through the influence of forces essentially physical, the spectacle is inexplicable.

Similar difficulties arise in the structural differ-

ences between the pectoral fin of a fish and the paddle of an Enaliosaurian reptile, or a whale; between the elongated neck of the giraffe and the elongated proboscis of the elephant; between the provision of flattened-cylindrical, dentinally-imbedded, enamel-plates in the molar of the extinct American elephant, and the simple enamel crust of the molar of his contemporary and germane proboscidean, the American mastodon; between the provision of a rattle in certain species of serpents, and the absence of it in their neighbors. In short, wherever the same functions are executed by locally associated animals by means of organs having divergent structures and conformations, it seems most natural to suppose that these results have been produced by something more than material influences. And when, at the same time, we see them admirably conformed to intelligible ideal concepts, we feel impelled toward a conviction that an inner-working force is operating with a view to ends, and in disregard of the opposition or co-working of physical forces.

We feel led to carry this point to the extent of suggesting that the absence of any organ in any animal which has been found subservient to the needs of another animal in the same province, is a circumstance for which no unequal influence of physical conditions can be summoned to account. It is not easy to per-

ceive, for instance, in what respect the squirrel has less need of organs for aërial locomotion than the partridge, or the sparrow, or the diver. Yet these all live together with the squirrel, under identical physical conditions, but with strongly contrasted locomotive apparatus. One would think the porpoise would be as much benefited and convenienced by the faculty of breathing water as his neighbor the sturgeon is. If the moccasin needs a poison-fang for self-defense, so does the garter-snake. It may momentarily relieve certain cases to assert that the organizations and instincts and needs of animals differ; but why do they differ? That is the problem we are seeking to resolve.

The true explanation of these phenomena, as of many others, is the fact that *organic modifications have regard to ideal concepts as well as external conditions.* Organic structures, as we have already intimated, are correlated to correlates of two different categories: *First*, Physical surroundings; *Second*, Ideal concepts. The physical surroundings are, 1. Conditions connected with climate, food, topography, etc.; 2. The condition of the organs of the body in reference to each other. The ideal concepts are, 1. Archetypes or ideal plans according to which organic structures are conformed, like the concept of a sub-kingdom, a class, or an order; 2. Antecedent, regu-

lative principles, methods, or laws of activity, under which organic evolutions are carried on; as those various principles or criteria which signalize differences of rank among animals, and the concept of an animal adapted to a particular element, food, or station.

Now, the modifications which exist with reference to ideal concepts are as real and as great as those which exist with reference to physical surroundings. Indeed, they are much greater, for they affect and determine the *fundamental* structures, while physical surroundings, by all admissions, impress only the details. But modifications having reference to an ideal concept are not wrought out by physical influences. The bird and the butterfly, exposed to the same physical influences, and urged by the same needs, develop locomotive organs *functionally* similar for these reasons; but they are *structurally* diverse, for no other reason assignable than that the whole plan of the butterfly is fundamentally different from that of the bird, and the wings of each must harmonize with the plan of the animal. Thus, also, the porpoise does not acquire the ability to respire water, not because the necessity is less than in the sturgeon, but because an ideal concept or principle dominates and constrains the organization of the porpoise, the whale, the dolphin, and the manatee *against* the analogies and influences, and, one would almost think, the necessities, of

an aquatic habitat. This ideal concept is the law of diversity applied to the mammalian class, which ordains that nature shall afford *aquatic* mammals as well as terrestrial; and *some force* overrules the predisposing influence of the watery element.

The young batrachian, during a certain period of its existence, possesses perfectly developed gills, and breathes water like its neighbor, the fish. After a time, without the least change in its physical circumstances, air-breathing organs begin to undergo a development, and the gills begin to be absorbed. This complete transformation of the tadpole's structural adaptations takes place without the slightest diminution of the present necessity for breathing water, with all the physical conditions opposed to it, and only in *anticipation* of changed conditions which are destined to be assumed in obedience to an internal law of the creature's being, shaping all its organization with reference to the ideal concept of an amphibious batrachian.

The pampas of the La Plata appear to be admirably adapted to the nature and wants of the wild horse. But, according to all information, these favoring conditions, existing through a geologic period, failed to develop any herds of horses, since these modern herds are derived from individuals escaped from a state of domestication. This failure of nature

to produce the quadrupeds suited to the conditions is the more surprising since we know that the equine type of quadrupeds existed in America from the period of the Eocene. We are, in fact, acquainted with the remains of twenty-one species of horse-like animals; and the genus of true horses has been traced down to the times immediately preceding the present. Here we see that, though the favoring conditions of equine life did not change, they failed to perpetuate a type of animals already in existence.

Similar difficulties arise in reference to most of those types of animals and plants which human agency has transferred from one continent to another, and which, in their new conditions, have continued to be perpetuated, in the wild state, with undiminished or even with increased luxuriance. These are evidences that the physical conditions of the countries receiving the new importations had not been adequate to develop certain forms of organization most admirably suited to them, and that consequently the organisms existing in a country and correlated to it have not grown out of it, but have been introduced into it by some power from without.

The controlling influence of a fundamental concept in shaping the organization of animals is further seen in *identity* of conformation under diversified conditions. The porpoise dwelling in the sea breathes air

like the ox dwelling on the land. That the porpoise or the whale should be endowed with lungs requiring it to rise to the surface to breathe, is quite as unexpected and incongruous as if the buffalo had been gifted with gills demanding a periodical plunge into the watery element to perpetuate its existence. Here is a unity of fundamental type—the mammalian type, which predestines the marine and the terrestrial mammal equally to certain structural modifications, however apparently incompatible with the conditions to which they may be assigned by another ideal concept —diversity of adaptations under unity of plan.

The whole range of varying adaptations within the limits of any fundamental type of structure supplies an exhaustless fund of illustrations of a similar character. The vertebrate type of animal structure is, in its essentials, identical in animals which walk on the earth, like the deer; or burrow beneath the earth, like the mole; or live in trees, like the squirrel; or fly in the air, like the bat; or swim in the water, like the whale. It is still the vertebrate type, under another class-modification, which in its ordinal gradations presents us with the soaring eagle spying out his prey, the sparrow seeking the ripened seed, the hummer balanced over the nectar of a flower, the duck filtering the lake-side ooze, the diver plunging for the perch, the woodpecker drilling for his grub, the hen

scratching for her worm. Do we realize that this wide diversity of structures and adaptations among mammals and birds exists under a single fundamental concept—that of the vertebrate archetype; and that an equal range of modifications under the same concept may be traced through the classes of reptiles and fishes? And do we realize that this conformity to an archetype is preserved sometimes *against* the tendency of the environment, and even to the inconvenience of the animal? Now, it has been suggested that this general subordination to a fundamental type implies common descent from some remote ancestor; but, to say nothing here of missing links, does it not look more like the influence of an urgent, all-controlling power, acting under the guidance of an intelligible plan which thus holds sway entirely apart from physical conditions, and with the sole purpose of asserting the dominion of thought in the organic world?

There is a lesson to be learned from the existence of what have been termed rudimentary organs, which seems to clinch the teaching deduced from the foregoing group of facts. Rudimentary organs are the useless rudiments of structures which in other animals are seen developed into organs actually subservient to certain needs. Examples of these are seen in the bone called os coccygis in the higher tailless mammals, and in birds; in the rudimentary lungs of the gar-

pike and the *Necturus*, and in the air-bladders of whole tribes of fishes. We delight to regard such structures as premeditated intimations of the dominance of general plans which continue operative under all the varying conditions of life. Believers in derivative development regard them as vestiges of structures which have become obsolescent through disuse. The os-coccygis of the human subject is the shrunken caudal appendage of the lower quadrumana — the heritage bequeathed from an ignoble ancestry. Modern discovery has produced a fossil bird which seems to lend countenance to this method of explaining rudimentary organs. The *Archæopteryx*, a fossil bird of Solenhofen, had a long vertebrated tail, like a saurian, with the tail-quills fringing it on either side. Now this tail was inherited, they say, from the saurian reptiles of an earlier age; and the os-coccygis of modern birds is but its obsolescent rudiment. This certainly looks plausible; and we shall accept such explanations when no others commend themselves more strongly to our judgment, and certain stubborn facts are removed entirely out of the way.

It must be apparent that the phenomenon of the os-coccygis, viewed in isolation from other considerations, is quite as explicable on the hypothesis of dominant typical ideas as on the hypothesis of heredity. The derivative theory has no advantage, therefore,

even in cases like these, where the rudimentary condition of an organ is *subsequent* to its fully developed condition. But there is another set of cases which the hypothesis of hereditary transmission can not reach. There is, at least, an equal number of instances in which the existence of organs in a rudimentary condition is historically *antecedent* to their existence in a fully developed condition. This is the case with the rudimentary lungs of the tadpole, already cited for another purpose; and this is more notably the case with the rudimentary lungs of the gar-pikes, and of *Necturus* and other batrachians which never attain to the condition of air-breathers. Now, will the derivationist assert that the coarsely vesicular lung of the perennibranchiate salamanders is the obsolescent organ of some air-breathing ancestor? Then Nature has witnessed a degradation of her forms, instead of an advance, and the principle of natural selection must be summoned to account for a regression in the earliest representatives of this type from a remoter and more perfect state, which the testimony of paleontology assures us is purely imaginary. Admitting that the fittest to survive may have been at some period an individual *inferior* in organization to his fellows, we have not yet passed the most formidable difficulties. The gar-pike belongs to a type of fishes which existed a geological period previous to the

existence of any air-breathing vertebrate. No one doubts that the internal organization of the existing gar-pike fairly represents that of the Carboniferous and Devonian *Lepidosteidæ* in America; and no one pretends that we have any inductive evidence of the existence of air-breathing animals in America at an epoch as early as these Devonian, or even Carboniferous, ganoids. It is utterly impossible to explain their possession of rudimentary lungs on the theory of disuse of organs belonging to their ancestors. Now, on the hypothesis of an overshadowing plan of organic structure, framed by intelligence, carried into execution under the guidance of intelligence, behold how beautiful and how gratifying an explanation of all these rudimentary structures. The primitive concept of a vertebrated animal existing in the mind of creative intelligence was one which should be adapted to both elements, and should have the structures required for breathing either air or water. Thus, before the world was fitted for an air-breather, there were in existence fishes, which, with their rudimentary but useless lungs, enunciated a conformity to plan, and became the prophetic announcement of a type which should breathe air in a better condition of the world. Thus, also, the branchiate phase of even the human embryo, under circumstances where every form of respiration is superseded, is an idle modi-

fication, viewed as any thing less than an interpretation of the common formula of the vertebrated animal. In the same manner, the retention of the rudimentary tail is an expression of obedience to a general concept of the archetypal vertebrate; and, without implying any necessary genetic relationship to predecessors, it becomes a reminiscence of extinct forms, and proclaims the intellectual unity of the organic world.

We are arguing that the modifications of animals and plants have regard to ideal concepts. We have just had occasion to speak of ganoid fishes as prophetic of strictly air-breathing reptiles. We have heretofore spoken of the flying saurians of the olden time as prophetic of birds; of marine saurians, in their structures related to cetacean mammals, and prophetic of them; and certain land saurians as similarly prophetic of mammals. These several prophetic types belong to a more generalized category, known as synthetic or comprehensive types. It was the characteristic of a synthetic type to embody features which afterward became differentiated and dissociated in two or more distinct groups of species. Thus the bony-armored and frog-like labyrinthodonts became dissolved, in a later age, into two groups of reptiles—the one, bony-armored, sauroid, and higher in rank; the other, without the bony armor, but retaining the frog-

like affinities, and, consequently, lower in rank. This may serve as a single example of a method which was general in the progress of creation. The point which we desire to bring into light is this: that the very idea of a synthetic type implies retrogression on the one hand cr the other. If there were even a synthetized type in which the two or more components were of equal rank, the very supposition implies that the synthetized type, bearing the aggregated rank of two or more constituent types, was superior to either; and the resolution of the type would signalize a downfall in both directions instead of one. Now, while these phenomena must be viewed as exceptional under any law of derivative development, they are of a nature to suggest to the unsophisticated mind the existence of an intelligible method — that of advance through synthetic types — in subordination to which either the ascending or descending series of forms comes into existence.

Theories of the derivative origin of species repose great stress upon the phenomena of types and archetypes. Very recently the horse family (*Equidæ*) has been made to play a very conspicuous *rôle*. The modern horse, as anatomists understand, walks upon one toe; but there is a pair of "splint bones" on either side, whose lower extremities are marked by the place of the rough callosities of the horse's fore leg. Some

cycles back, in the Pliocene Age, existed, in the Far West, a type of horses (*Hipparion*) in which the "splint bones" are represented by real hooflets, like the two posterior toes of the ox and deer. Still farther back, in the Miocene Age, existed a horse type (*Hippotherium*, *Protohippus*) in which the hooflets were represented by fully developed hoofs, and the animal had *three* toes. In the Eocene Age, still older, existed a still more aberrant type (*Orohippus*), which walked upon *four* toes. These are admirable examples of a large class of facts which have been amply discussed by Owen, Haeckel, Chapman, and others. They are exemplifications and demonstrations of what we have been accustomed to style homological relations. We are deeply impressed and instructed by facts of this kind. We hail them as proofs of a regulative intelligence in creation; and we ascribe them to intelligence by a necessary law of our reason. We admit that the succession is an evolutionary one in a large number of cases. But it is obvious that we are not compelled to recognize a genealogical relationship in the succession; still less to ascribe it to physiological activities uncontrolled by intelligence. Let us trace a parallel. Here is the gay and fashionable "landau," one of the most finished of wheeled vehicles. We compare it with the "rockaway," and discover the two to be homologues. Looking back in time,

we perceive the farm-wagon to have been once the most perfect representative of the idea of a wheeled vehicle. But still earlier, or at least lower in the scale, stand the ox-cart and the dray; and last of all we come to the wheelbarrow. Now, these vehicles represent one archetypal idea in the various stages of its development; they sustain homological relations to each other, co-existent with obvious special "design" in the adaptations of each product. But who would think it necessary to regard the wheelbarrow the progenitor of the ox-cart and the landau? The evolutionary relation is manifest, but each term of the series is the product of an independent act of intelligence.

We content ourselves with two further statements drawn from the field of physiological activities. If the varied organs of higher beings have been acquired through conative efforts, or the influence of the environment, or as the accidental results of extraordinary births, or the cumulative products of successively accelerated or prolonged development in the embryo, then it is difficult to account for the acquisition of certain organs with the requisite degree of *suddenness*. The earliest trilobites, for instance, had eyes ready formed, but had no ancestors through whose long-drawn generations they could have been developed. They had successors, however, which,

notwithstanding the undiminished usefulness of eyes, and the undiminished amount of light, were destitute of those important organs. It is difficult to understand how on any of these hypotheses the fish, when thrown irrecoverably out of his native element, acquired the lungs of an air-breather with sufficient expedition to save him from perishing in the very first stage of his transmutation. Is it not absolutely demonstrable that lungs must have been fashioned in *anticipation* of the aërial habitat of the animal, anterior to the possibility of any influence exerted upon him by external conditions?

So, when the transition was to be made from birds or reptiles to animals that should feed their young by a milky secretion from their own bodies, the transformation must have been made complete, *toto cœlo*, in a single generation. But who can believe that any physical or physiological influence was at work which could originate, *de novo*, an organ so peculiar and so widely apart from any structure in reptiles or birds as the mammary gland, and could originate it functionally complete in the first generation?

(3) *Objections in the Field of Metaphysics.*—We conclude our statement of the difficulties of doctrines of derivative development with some considerations drawn from the field of abstract ideas.

A physical cause is a definite quantity, and can

produce but a definite and uniform result; but the series of organic forms is a progressively varying result. That force which has produced the phenomena of organization has developed an infinitude of forms and correlations to the external world and to the instincts and necessities of animals, and to ideal plans of structure and ideal methods of activity. It has behaved as no material force has ever been known to behave. It has developed results which can not possibly be referred to any common category except that of intelligent, free volition. In the water it gives one animal lungs and another gills. Among insect-eaters it drives one with the requisite equipment, like the bat, to seek its food in the air; another, like the toad, on the land; another, like the mole, in the soil. It is a force which acts with discernment, with method, with usefulness, and with a degree of independence of the co-operative action of surrounding physical influences. It has continued to act along unbroken lines of thought. It produced the pectoral fin of a fish; then, still acting on the organ, produced the leg of a salamander or alligator; then, from the same organ, the wing of a bird or bat, the fore leg of a horse, the shovel of a mole, the paddle of a whale, the arm of a man. Can any one assert that this is the mode of action of a physical cause? Physical forces, indeed, have been the instruments which, summoned

to act in varying ratio to each other, have shaped results to premeditated ends.

In the field of physical forces we find no provision for indefinite progression, but only for movement in cycles. The circle of the waters from the ocean through the clouds to the ocean again; the circle of the winds in the heavens; the sweep of cosmical bodies in their orbits; the precession of the equinoxes; the variation of a planet's obliquity to the plane of its orbit; the waxing and waning eccentricity of their orbits; nay, the very lifetime of a system or a universe—these are all but periodical phenomena in varied phases of magnitude. But the march of organic improvement has been ever resultantly in one direction. There have been deflections and partial regressions to points at which the march has acquired a quicker step; but never has the world of life returned to a former status; never has a specific or generic type, once passed, been summoned again into being. These are the phenomena of a force acting in a manner generically different from those which play upon the theatre of physical existence.

There exists an incongruity between natural selection, viewed as a force, and the results which are attributed to it. Natural selection is itself a result coordinated with a certain concurrence of physical conditions. If we recognize it as a result produced by

those conditions, then, since the result must be congeneric with the cause, we must view natural selection as belonging to the category of physical causes. It can, therefore, produce but one category of results. It can not manifest any of that deliberative, co-ordinative, thoughtful adjustment to situations and to archetypal concepts which we find to characterize the phenomena of the organic world. Assigned as a modifying condition, we acknowledge its reality. Assigned as instrumental means of accomplishing certain premeditated results, we concede it a legitimate place. Assigned as the efficient cause of results so clearly premeditated, so clearly co-ordinated in method, so expressive of the overshadowing presence of a co-ordinating intelligence, we have to repudiate its pretensions.

The incongruity between cause assigned and results produced is infinitely greater still. Supposing natural selection to be regarded a physical force, how vast a disparity in kind between the force and the moral and intellectual results attributed to it! The struggle for existence is selfish; how could it develop generosity? The struggle for existence excites and nourishes fear; how could it develop a loving trust in the Ruler of the universe? The struggle for existence deals with material wants; how can it awaken longings for immortality, or an actual faith in future

life? How can it arouse the consciousness of any spiritual want, or beget a belief in spiritual truth?

But the deepest fallacy of all is the assumption of natural selection *as a cause.** It is not a cause at all. It is only a set of conditions. Selection is an act of mind, and the selection which takes place in the survival of the fittest is a method of intelligent will. But we have no proof that this is a method by which even intelligent will ever causes a transmutation of species. We have cited many proofs opposed to this hypothesis. Neither can *direct* physical influences proceeding from the environment be viewed in the light of efficient causes of biological phenomena.

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* This truth has been recognized by Professor Huxley (*Critiques and Addresses;* Am. edit., p. 276). "On this hypothesis" [that the struggle for existence is maintained among the molecules of the organism] "hereditary transmission is the result of the victory of particular molecules contained in the impregnated germ. Adaptation to conditions is the result of the favoring of the multiplication of those molecules whose organizing tendencies are most in harmony with such conditions. In this view of the matter, *conditions are not actively productive*, but are passively permissive; they *do not cause* variation in any given direction, but they permit and favor *a tendency* in that direction *which already exists.*" Now, what is the urging force in that tendency? Mr. Huxley, in another paragraph, states: "The tendency to vary * * * may depend wholly upon *internal* conditions." Now, tacitly accepting this as Huxleyism, and *not* Darwinism, we should like to know if Mr. Huxley regards a conditioning influence as a *real cause?*

They are only a set of conditions; we may denominate them conditioning causes, but this implies an efficient cause. The efficient cause *must act in the organism.* Blood and nervous influences must be sent in such directions as to respond to the presence of the physical impression. Vital forces must perform the work, even if they do it in deference to suggestions from without. The conception of the physical environment as moulding the organs of animals is philosophic absurdity. In the actual world it is "unthinkable." Nor can we entertain the possibility that the vital forces are mere activities of chemistry and physics. We have said such activities move in circles, and that they can only produce physical results; while the results which we witness are thought, conscience, volition, emotion, correlation to ideal concepts. A *correlation* between physical and vital force is obvious, though we deny their equivalence. The efficient force producing modifications having reference to physical surroundings, is not only a force acting within; it is a force acting intelligently and beneficently; and if it be demanded how we dare attribute intelligence and beneficence to a force so hopelessly inscrutable, we demand of the objector how he dare dishonor the deepest intuitions of his own soul, and brave all the consequences of so doing?

There only remains a single thought; and this, it seems to us, presents a difficulty as formidable as can be imagined in the way of the Darwinist. That this theory may be true and sufficient, it must provide for the appearance of improved forms, not alone in single individuals or single pairs, but *simultaneously in large numbers of individuals.* Imagine an individual, or, if it be possible, a pair of individuals, endowed with a certain improvement in organization. Now, if they happen to appear in the same region, which may be probable, and, if they happen to pair together instead of with the more numerous individuals having the unimproved organization, it is true their offspring *may* inherit their peculiar organization. And then, if the offspring continue to pair together through future generations, there is a conceivable possibility of the advance being perpetuated. But how much more probable that but *one* individual should come into possession of a given new conformation; and that by crossing and recrossing with individuals not possessing it, the peculiarity should disappear. And if a *couple* of individuals should happen to be identically gifted, and they should pair together, all experience teaches that their offspring would show a tendency to revert to the old form. And if their offspring should show no such tendency, how great the probability that they would pair with individuals not

having the peculiarity; and that thus the peculiarity, by the laws of hybridity, would rapidly disappear.

The only possible way of escaping the necessity of braving this array of strong improbabilities is to resort to the assumption that a large number of individuals became simultaneously affected in a similar way; and then, in addition, to assume that such variation would be permanent; and that, sooner or later, another variation in the same direction would take place in a large number of the descendants of these individuals; and that this extraordinary concurrence of conditions would continue to be repeated through thousands of generations and thousands of years, until the variation should amount to a new specific form. It seems to us, the Darwinist is here placed in an appalling dilemma, and that the only rescue is in precipitate retreat.*

In offering this array of difficulties which the theory of derivative evolution of organic beings must encounter and vanquish, we have not taken the time to indicate in each case against what phase of the doctrine the difficulty more especially presses. We think it proper, therefore, to state, in general, that all the objections seem to be valid against those forms of the doctrine which assume a gradual variation, involving

* See *North British Review*, June, 1867, p. 286.

vast periods of time, and necessitating the intervention of all conceivable intermediate links. That is, they all rest against the theories which appeal solely to external influences, like those of De Maillet and Darwin; or to external influences supplemented by internal conative efforts, like Lamarckianism; or to progressive changes through prolonged or accelerated development of the embryo, like the teaching of the "Vestiges," and of Cope and Hyatt. That form of the doctrine held by Parsons and Mivart, and perhaps also by Huxley, admitting of progress by considerable leaps, escapes measurably from the embarrassment of supplying complete series of intermediate forms. Those theories which appeal to the possible incidents of the generative process seem to be less vulnerable than those which assign a set of external conditions as the efficient cause of organic modifications. The principle of natural selection, or survival of the fittest, it ought to be remarked, though inadequate to account for the *origin* of new forms, may be legitimately appealed to for their preservation when produced by any adequate means. Viewing specific types as absolutely constant, with a limited elasticity, it may undoubtedly be regarded the principle of survival of the fittest which maintains the species at the normal standard of healthful vigor.

V. Spontaneous Generation.

A few statements seem to be demanded in reference to the hypothesis of spontaneous generation—Heterogenesis, Abiogenesis, or Archegenesis. This hypothesis should not be regarded as necessarily involved in that of the derivative origin of specific forms. The latter is simply an attempt to explain how specific forms may have descended from one or more primitive stocks. It assumes organization existent as a postulate. The gap between vitalized organization, however simple, and dead inorganization is vastly greater than that between the summit and the base of the organic series. None of the reasonings of derivationists apply to the task of filling this gap. They may prove unimpeachably valid within the domain of organization, where we have an abutment of life on each side of the chasm to be bridged, and remain completely inapplicable where the chasm presents, on one side, no such support. The advocates of derivative theories have not generally avowed sympathy with the hypothesis of archegenesis. They have, indeed, generally repudiated it.

The opponents of these theories have illogically attributed to them a belief in archegenesis, as a necessary consequence. If we can trace a genealogical connection from man, step by step, to the monad, it is

but one step further, they say, to dead matter. We admit it; but it is like the step which Milton's Satan took in his descent from heaven to hell. Monad life and no life are as far apart as affirmation and negation. Whether the doctrine of archegenesis be sustained by facts, is an independent question to be decided. To its solution many skilled experimenters are assiduously applying themselves; and opinion seems to be held in a balance between conflicting evidences. The immediate subject of controversy is the origin of the organisms which make their appearance in infusions of organic substances from which efforts have been made to exclude the germs which float in the air. The difficulties seem to be, to know certainly what degree of heat suffices to destroy the life of all germs; to be certain that the filtering substances employed in some experiments are sufficiently fine to exclude the smallest; and to know that the non-appearance of life, in certain cases, is not due to the absence of certain conditions, rather than the successful occlusion of living germs.

The experiments have resulted in revealing several interesting facts belonging to the wonders of nature. The atmosphere and many liquid and solid substances are populated by innumerable swarms of living spores, which give rise to the phenomena of fermentation, putrefaction, and many forms of disease.

Some of these spores are so inconceivably small as to permeate the finest filters and elude the highest powers of the microscope. Many of them possess such tenacity of life as to remain unchanged at temperatures far above the boiling point of water; while some of the minutest organisms may be completely desiccated at high temperatures, kept for months in such condition, and then revived by the application of moisture.

Should spontaneous generation (so called) ever become established as a mode of origin of primitive forms, that would not invalidate the reasoning which proves existent in organization a mode of energy generically different from that which produces mere physical results. All the phenomena of life still exist, with the same demands upon him who attempts to interpret them. We should have the same evidence of the operation of what we style vital force, and no more evidence that it is congeneric with physical force, or begotten by it. We should still demand what constitutes the essential difference between two germs which the nicest microscopic study can not discriminate, but which are so antipodally diverse that one develops into a sea-weed and the other into an animal; or between two undistinguishable ovarian eggs so fundamentally unlike that one becomes a horse and the other a man?

VI. Theistic Bearings of the Doctrine of Evolution.

It constitutes an important part of our proposed discussion to advert to the bearings of development theories upon theistic belief. This is a subject which we approach with a degree of composure which, it is hoped, will not be misinterpreted. We can not deny that an opinion is prevalent that these doctrines lead directly to materialism and atheism. We can not deny that many persons of the unreasoning sort have eagerly seized hold of these theories to console themselves in the indulgence of the God-denying depravity of their hearts. Nor will we deny that here and there a mind accustomed to the methods of patient investigation has given utterance to the opinion that there is no God but force; no God but matter; no source of matter, force, or motion which lies within the compass of the knowable. Now, it is not needful to assert that the real opinions of such philosophers and scientists may have been misunderstood. We will arraign the affectation of some of them, however, who, while hinting that they hold a theistic faith, scorn the admission that this is any thing with which science or scientific men, as such, have any concern. If they can not, as devotees of physical science, distinctly avow a theistic faith, it would not im-

pair their scientific powers to avow such faith in the capacity of *men.*

Notwithstanding charges and admissions of infidelity as a sequel to faith in evolution, and notwithstanding our own denial that the derivative origin of species has been established as a fact, we have a profound conviction that the being and providence of a personal God are to no extent imperiled by the admission of the reality of any form of evolution which does not expressly posit its initial point in unintelligence. A form of evolutionary belief postulating such a source of being we deliberately pronounce an absurdity absolutely incapable of propagation, since the universal reason rises up in rebellion against it. That any form of evolutionary doctrine now current in the world is compatible with a devout recognition of the being and providence of God, we hope to be able to demonstrate.

1. *Of Evolution in the Physical World.*

Let us look first at the consequences of evolution in the physical world. Let us suppose that the proposition is firmly established that the whole material history of worlds is a mere evolution of phenomena under the activity of energies which we call the forces of nature. Two conclusions are certain at the outset: 1. The course of this evolution is *finite.* It is an evolution which we trace to an absolute be-

ginning in finite time, and it is also one which can be traced to an absolute conclusion within finite time. The organism of the universe, therefore, is not eternal, and demands a power superior to itself to originate and conserve it.* 2. It is not a self-inaugurated and self-sustaining evolution. It does not supply us with a beginning in ultimate causation. It reveals no absolute initial point on which reason can rest satisfied. Science conducts us back in the history of a world to a primitive incandescent vapor. She calls that a beginning; and may assert that every physical event of a hundred millions of ages existed potentially in that. But this is really no explanation of the ultimate and only real cause of any thing. Reason demands the cause of this beginning. What were the antecedents of the cosmical vapor? In the absence of antecedents, what was the cause of this fire-mist—of these forces active in it?

Now these are questions of which Reason demands an answer. She will never be satisfied till the answer is given. But physical science can trace the thread

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* This and the following views have been urged by the writer for seventeen years or more. See a lecture entitled *Theologico-Geology*, published March, 1857, and one entitled *Creation the Work of One Intelligence*, published March, 1858; also, *Mich. Jour. of Education*, May, 1858; *Ladies' Repository*, 1862–63; *Sketches of Creation*, 1870; *Geology of the Stars*, 1873; *Methodist Quar. Rev.*, 1874, etc.

no further back, and must be dumb to all ulterior inquiries. It is true, then, as physicists assert, that their sciences do not mount actually to God. But Reason ignores the name of the highway over which she ascends, and if she fails to reach primordial causation over the road which you designate science, she presses on over the highway beyond, which you may designate philosophy or intuition. She must have a first cause—a cause of matter and of force. Now, whether we be able ever to thread the history of matter back to any remoter beginning or not, Reason affirms that back of the initial point of the succession of physical phases, was adequate, ultimate, efficient causation. This is one of the clearest and strongest intuitions of the human soul. Matter and force are not self-existent, but created. Simultaneously with this verdict rises another universal and ineradicable, and, therefore, necessary instinct of humanity—the intuition of *primordial causation*—self-existent, intelligent, and eternal. Now Science, in confessing her inability to reach this conception, abandons the field for the soul's witness, Reason, with her clear adamantine utterances, to step in and answer the last inquiries. Science, we say, virtually beckons to philosophy to come to her aid; and when philosophy draws aside the veil which separates between spirit and matter, science has no "bill of exceptions" to

file. This evolutionary ferment is one, then, which began with God. *Bereshith bara Elohim.* Every incident of the history runs back to God as its originator and real cause. What a picture of the wisdom and power of God does this lowest conception of his relation to the universe present! Viewed only as a machine which runs on through chiliads of centuries how stupendous is the mechanism! What grasp of intellect in its Author!

But we have no sufficient ground for placing Deity in this distant, though causal, relation to his universe. What are these energies which we style the forces of matter, and which we discover active in matter in its incipiency and along the entire course of its evolutions? We sometimes speak of them as energies resident in matter, and inherent in it, and acting without intelligence or volition; but a close examination reveals the unphilosophical character of such conceptions. There is not a shadow of evidence that active force is or can be an attribute of matter. On the contrary, all our knowledge of force presents it as an effort of intelligent will. We have no knowledge of the origin of any force, save of that which emanates from human volition. In the human sphere, in which we are able to trace effects to their first causes, we invariably find the initial energy exerted by intelligent will. The sphere of creation presents an array of

mechanical effects not distinguished qualitatively from those which flow from human volition; and we can not, without violence to our intuitions, refer them to a different category of causation. We are driven by the necessary laws of thought to pronounce those energies styled gravitation, heat, chemical affinity, and their correlates, nothing less than the energies of intelligent will. But as it is not human will which energizes in the whirlwind and the comet, it must be the Divine Will. It is *God's present power* and volition which draws the apple to the ground and balances the planet in its orbit. Science has long tended toward the synthesis of the forces which it recognizes in matter, and all have been pronounced but forms of a single force. It only remained for her to discover the nature of the one protean, panurgic energy; and the suggestion has come from the ranks of science itself that this is simply the Divine Intelligent Will. Philosophy will not recoil from a suggestion which she has so long preserved in the royal archives of thought; and we regard this common datum, eliminated identically from the factors of physics and of metaphysics, as the long desiderated "reconciliation between Religion and Science," after which we have seen Mr. Spencer groping with a result so little comforting to our intuitions. We come back, then, after journeying over the long, circuitous, and weary high-

ways of science, to the very spot where Abraham and Moses and Joshua stood in the infancy of our race, and witness the light of the divine presence beaming all around us, permeating nature, and bringing man into near and awe-inspiring and tender relations to his Father and his God.

All this the doctrine of evolution in the physical world permits, sanctions, and almost demands.

2. *Of Evolution in the Organic World.*

But what of the doctrine of evolution in the realm of life? We are compelled to recognize the *fact* of such a succession of organic forms as constitutes, on the whole, an evolution. Now, viewing the phenomena abstracted from any theory of their cause, this developmental relation exhibits a scene of harmonies and correlations which bespeak a co-ordinating intelligence as vast as time and space. The unity of the system of facts demonstrates a unity in the directive intelligence. It demonstrates an anticipation of the end from the beginning—an inauguration and prosecution of intelligible plans through all the history of organic life, in all lands and all seas and all conditions of existence. It betrays an anticipation of man, and a system of beneficent preparations for man. It is a sublime and ever varying, but always harmonious spectacle of the manifested power, intelligence,

goodness, unity, and eternity of a Personal Existence. The more firmly we establish the fact of an evolutionary relationship in the history of organic forms, the more convincingly do we establish the exercise of these divine attributes.

But suppose the old doctrine of specific creations to become untenable, and the doctrine of a genealogical succession and connection of organic beings to be established in its place. Suppose it is convincingly proven, by-and-by, that man is descended from a monkey, or an ascidian, or a monad. What have we to say? 1. The fact of the *unity* of organic history will of course remain firmly established; and we shall have all the same facts of correlation and co-adjustment, and the same necessary evidences of the exercise of intelligence and other attributes. This deduction is wholly independent of the instrumental causes of these correlations. The facts of correlation and contrivance exist, and reason impels us to deduce intelligence; and no system of instrumental causation can be less than a dethronement of reason which attempts to negative this necessary and universal deduction. However this evolutionary relationship has been brought about, it always means the same to human intelligence. 2. When, according to our hypothesis, this doctrine becomes proven, it will be futile to contend against it. If the evidences sustain it,

mankind can not be prevented from believing it. If the evidences sustain it, and the general sentiment of the scientific world accepts and indorses it, we may safely regard it as standing for a truth in nature; or, at least, as more probably standing for truth than the dissent—perhaps unenlightened dissent—of a few individuals. As truth, it becomes the common object of all honest search; and to reject it is not only to insult the truth but to defraud ourselves. Nay, if it be truth, it is God's truth, and to reject it superstitiously or unreasoningly is an insult to the Author of truth. We incur greater danger of doing violence to truth by rejecting the general verdict of science than by devoutly accepting it.

We can not but regret the utterances of some of the opponents of the doctrine of the evolution of life and the derivation of species. It pains us to see reputable scientific writers substituting hateful names and wry faces for cool argument. In this respect we regard Dr. Dawson's late work as not above reproach. The greater sins of Huxley and Haeckel and lesser lights do not condone the errors of any scientific advocate who slips from the "straight and narrow" path of logical argumentation. Neither can we acquiesce in the position of so logical a reasoner as President Barnard, when he maintains that it is better to close one's eyes to the evidences than to be

convinced of the *truth* of certain doctrines which *he regards* as subversive of the fundamentals of Christian faith. "Much as I love truth in the abstract," he says, "I love my hope of immortality more. * * * If this, after all, is the best that science can give me, give me, then, I pray, no more science. Let me live on in my simple ignorance, as my fathers lived before me; and when I shall at length be summoned to my final repose, let me still be able to fold the drapery of my couch about me and lie down to pleasant, even though they be deceitful, dreams."* We can all surely sympathize with the impulse which prompts such language, and we need not overlook the "if" on which the alternative depends; but we think it is a higher aspiration to wish to know "the truth and the whole truth." At the same time, we have not the slightest apprehension that "the whole truth" can ever dissipate our faith in the future life. There are certain fundamental religious beliefs which no possible evidence can overthrow. They rest upon the irrefragable authority of the universal intuitions of the human reason. The firmest conclusions of science can rest on authority no higher. Nay, this is the very authority on which they all ultimately stand.

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* Barnard, F. A. P.: *The Law of Disease*, in "College Courant," vol. xiv., p. 27.

Now, as no person can believe that two necessary truths will ever appear in conflict with each other, it necessarily follows that these religious beliefs can never be successfully impugned, and that we may fold our arms and smile placidly at any movement of science which seems to be directed against them.

Suppose, then, the time should come when we should feel bound by the dictates of reason and of science to accept the doctrine of the derivative evolution of organic types, would that necessarily subvert any fundamental doctrine which we have received from our sacred Scriptures? We answer deliberately and confidently, No; and we will define, in brief, the grounds on which we stand: 1. The authority of those Scriptures has been fully vindicated by the revelations of history, languages, ethnology, archæology, and science, and we have *a priori* ground for asserting that their veracity will continue to be vindicated; 2. If, then, they are the utterances of God's truth, they must harmonize with any other utterance of God's truth.

But we do not rely solely upon these abstract, deductive propositions. We bring the specific points of comparison directly into the light of investigation, and demand, what must follow from the established fact, that the admitted developmental succession of organic types has been realized through the operation

of secondary causes. When we look the problem squarely in the face we smile in amazement that it has seemed necessary to propound it. Is it less credible that man as a species should have been developed, by secondary causes, from an ape, than that by such means man as an individual should rise from a new-born babe or a primitive ovum? It is no more derogatory to man's dignity to have been, at some former period, an ape than to have been that red lump of mere flesh which we call a human infant. And if the means by which the babe has developed into a man do not, to the common mind, seem to exclude Deity from the process, why should we feel that Deity is necessarily excluded from a similar process in leading man up from the monkey? No reason can be assigned. If you say that the babe is the man in potentiality, so may it be replied that the monkey is the man in potentiality—and so the quadruped, the reptile, or the fish. It does not exclude divine agency from the work of organic advancement to assume that it has been effected through the reproductive and other physiological processes. The Creator no less made man if he caused him to be derived by descent from an orang-outang. Man's structural organism stands in a relation of affinity to that of the monkey, which is rendered no more intimate or absolute by the admission that they belong to the same genealogical

tree; and man's intellectual and moral superiority is just as emphatic and distinguishing, and just as much a divine inbreathing, as if it were the crowning grace of an organism which could not illustrate one plan and one intelligence in the whole creation. If specific types came into being derivatively, the utmost that can be said is that this was the divine method of creating.

We can not logically hesitate to entertain similar views in reference to the hypothesis of spontaneous generation, or, more accurately, of archegenesis. Shall it be proven that organization comes forth from certain forms and conditions of dead matter, we shall simply say that this is the divine method of creating. And when we can finally look upon the living, conscious, moving being rising above the horizon of existence, we shall feel awed at the spectacle, and acknowledge ourselves brought into the nearer, visible presence of creative Divinity.

All we seek is the truth. All truth is God's truth, and the most devout act is the hearty acceptance of truth. So thought the theists of antiquity, who, like Anaxagoras,* Pliny, and Plutarch, held to the evolution of certain forms of life from dead matter. So

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* Diogenes Laërtius: *Lives.* Bohn's edit., Anax., iv. Pliny says: "Convolvulus tirocinium naturæ lilium formare discentis."

thought the priests of the Middle Ages, who held, with the philosophers, that many of the simpler forms of animals and plants were generated directly from earthy slime and fermenting substances. So thought Moses, apparently, when he wrote, in speaking of the first appearance of vegetation, that "the earth brought forth grass;" and when, in speaking of the advent of marine creatures and terrestrial animals, that "the waters brought them forth," and "the earth brought them forth." As if to render it intelligible that this method of creation does not preclude the idea of God, the historian tells us that "*God said*, let the earth bring forth the living creature * * * and it was so." *That*, then, was God's method of creating. This seems like the best evidence we have in support of the doctrine of archegenesis.

In the position which we have assumed respecting the theistic bearing of doctrines of evolution, we might quote an indefinite amount of concurring testimony. It was the opinion of St. Augustine that God created by conferring on the material world the power to evolve organization. St. Thomas Aquinas quotes with approval the saying of St. Augustine, that in the first institution of nature we do not look for *miracles*, but for the *laws of nature;* and that the kinds of animals and plants were only created derivatively—*potentialiter tantum*. Cornelius à Lapide contends

that at least certain animals were not absolutely but only derivatively created.* Buchanan, speaking of physical evolution, wrote, as long ago as 1859, that if it were established it would not follow from this, as a necessary consequence, "that the peculiar evidence of theism would be thereby destroyed or even diminished."† He inclines to think, though ridiculing the doctrine, that cosmical development "may serve rather to enhance" the "evidence of a presiding Intelligence and a supernatural Power." Of "physiological development" he admits that, even were it established, "it would not destroy the evidence of theism." Dr. M'Cosh declares "there is nothing irreligious in the idea of development, properly understood;"‡ and Bishop R. S. Foster§ frankly confesses: "It would not appall our faith if it should be discovered that all the forms of life below man could be traced to a spontaneous generation from the unliving monads, and that from unity they were developed into diversity, given that the spontaneous movement, from its inception to its ultimatum, emanated from and was guided by the Divine factor." Similar views

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* See further, Mivart on the *Genesis of Species.*

† Buchanan: *Modern Atheism*, pp. 56, 68.

‡ M'Cosh: *Christianity and Positivism*, p. 38.

§ Foster: *Origin of Life*, in Ingham Lectures, p. 47.

are entertained by many orthodox theologians of the present day.

Nor is it to be supposed that the advocates of these theories are generally willing to regard themselves shut out from the fold of theistic believers. It is better to be content with ignorance of a man's religious faith than to assign him a creed which he has not avowed. Whatever be the views of such writers as Vogt and Büchner and Haeckel, Mr. Darwin sincerely believes that his theory ought not to "shock the religious feelings of any one;" and he speaks of life "having been originally breathed by the Creator into a few forms or only one."* Mr. Wallace traces all natural phenomena to will, and says: "The whole universe is not merely dependent on, but actually *is*, the will of higher intelligences, or of one Supreme Intelligence."† Professor Owen‡ says: "A purposive route of development and change, of correlation and interdependence, manifesting intelligent will, is as determinable in the succession of races as in the development and organization of the individual. Generations do not vary accidentally in any and every direction, but in preordained, definite, and correlated

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* Darwin: *Origin of Species*, p. 569, Engl. edit.

† Wallace: *Natural Selection*, p. 368.

‡ Owen: *Anatomy of Vertebrates*, chap. xl.

courses." Professor Huxley* affirms that Darwinism does not affect the doctrine of "final causes," but leaves it precisely where it stood before. He, however, rejects what he calls the gross forms of teleology. Professor Asa Gray† thinks that, "as we contemplate the actual direction of investigation and speculation in the physical and natural sciences, we dimly apprehend a probable synthesis of these divergent theories, and in it the ground for a strong stand against mere naturalism." And again: "The philosophy of efficient cause, and even the whole argument from design, would stand, upon the admission of such a theory of derivation" [as Darwin's], "precisely where they stand without it." Professor Parsons‡ is a firm theist. Even admitting the course of events to be worked out after the fashion of the numbers in Babbage's calculating engine, he says: "God never leaves his machine, for if he did it would instantly perish; because it is always his present actuality which gives force and efficacy to the laws by which he works." Professor Lyman§ exclaims: "How dead the science which puts force as its first

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* Huxley: *Critiques and Addresses* (p. 272), and elsewhere.

† Gray: *Amer. Jour. Science* [2], xxix., pp. 161, 179.

‡ Parsons: *Amer. Jour. Science* [2], xxx., p. 7.

§ Lyman: *Amer. Jour. Science* [2], xxix., p. 185.

cause!" And again: "What interest does a true conception of the ever-working Creative Intellect give to science! This correspondence of the human with the divine mind!" Dr. O. W. Holmes* says: "Whatever part may be assigned to the physical forces in the production of the phenomena of life, all being is not the less one perpetual miracle, in which the infinite Creator, acting through what we call secondary causes, is himself the moving principle of the universe he first framed and never ceases to sustain." Professor Mivart† assures us that the prevalence of the theory of evolution "need alarm no one, for it is without doubt perfectly consistent with the strictest and most orthodox Christian theology." We would commend to careful reading Mr. Mivart's general treatment of the whole subject in his "Genesis of Species;" as also the sound suggestions of Mr. Murphy in his work on "Habit and Intelligence."

We summarize, finally, our conclusions from this discussion:

1. The historical succession of events in the *physical world* is a real evolution, wrought out by energies which we designate the forces of matter.

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* Holmes: *North American Review*, July, 1857.

† Mivart: *Genesis of Species*, p. 16.

2. The historical succession of events in the *organic world* is a real evolution in its main features; but in the details are many facts of a strongly discordant character. The evolution is marked by the caprices of independent will rather than the uniformity of unintelligent mechanism.

3. Admitting the evolution to be real and complete, it remains to discover the immediate or secondary *causes* of the succession of phenomena, and also the ultimate or efficient cause.

4. Of causes assigned, those which appeal to the unlimited *variability of species* rest upon an admitted hypothesis, without an authentic fact to sustain it.

5. This default of facts impairs the claims of Lamarckianism and Darwinism, though both are valid agencies in the *preservation* of useful structures and the conservation of the normal vigor of species.

6. Of all causes assigned, those which assume a *slow variative* derivation are opposed by the gaps and recessions in the geological series of types.

7. The only hypothesis which shuns, at the same time, a postulating of indefinite variability and of derivation by insensible gradations, is that first propounded by Parsons, and subsequently by Owen, Kölliker, and Mivart; but this has to encounter difficulties arising from broad gaps and frequent retrogressions in the series.

8. There exists no *a priori* ground for denying that some phase of the doctrine of filiative evolution in the organic world may yet become fully proven and established, or that even the work of creating new forms directly from inorganization may be now going on. These are simply questions of fact, to be found out by searching.

9. Should these doctrines become proven, even in their extreme phases, there will be no proof of the absence of immediate divine agency from any of the operations of life; and, having seen organization emerge from inert matter, we can believe more easily than before that "God made man of the dust of the earth." In any issue of scientific investigation in a new development of truth, Christian Theism has nothing to fear, but only new truth to gain; and should entertain a gratitude above all other interests for being placed in possession of new, solid material to incorporate into its system.

APPENDIX.

BARRANDE *VERSUS* DARWIN.

As M. Barrande's discussions have never, so far as the writer knows, been brought prominently before the general reader—scarcely even in the scientific journals—we append a condensed reproduction, intended to exhibit the spirit of his method and conclusions.

Monsieur Joachim Barrande is one of the most eminent of living geologists. Almost a lifetime has been devoted by him to the study of the Silurian rocks of Bohemia, and, collaterally, of the most ancient fossiliferous deposits of all other countries. The results of these labors are embodied in three ponderous quarto volumes, and a large number of pamphlets and volumes in octavo. The richness of the Bohemian strata in organic remains has enabled him to trace out the life of certain extinct types with an astonishing degree of minuteness and detail. The type of trilobites, for instance, extinct for hundreds of thousands of years, has been elucidated in all its stages, from the egg and the minute embryo to the adult form. The gradations in rank and succession in time of the various modifications of the trilobitic type have been profoundly discussed and permanently established, in the progress of the marvelous labors of this learned paleontologist. It results that his discussion of trilobites, though but incidental to his main work, is recognized as the most authoritative monograph of this zoological type. In the field of geological science

there is no name more familiar or more respected than that of M. Joachim Barrande.

M. Barrande is, therefore, a competent authority to testify in reference to the bearing of paleontological facts upon the doctrines of evolution. He has not omitted to turn his attention to this inquiry; and, in the supplement to the first volume of the *Système Silurien du centre de la Bohème*,* he has embodied an essay, entitled "Epreuve des théories paléontologiques par la réalité," which abounds in facts and reasonings of the utmost interest and importance. The following synopsis of this discussion is intended for the benefit of intelligent readers little versed in paleontological science.

It is necessary to premise that M. Barrande finds the oldest fossiliferous strata of Bohemia to lie at the base of the Silurian system. The assemblage of fossils in the lowest, or "Primordial Zone," of these strata constitutes his "Primordial Fauna," above which succeed his "second" and "third" faunas. In America the lowest zone of Silurian rocks is the "St. John's Group," which contains types establishing its synchronism with the "first phase" of the Primordial Zone; while the overlying "Potsdam Sandstone" is synchronized with the "second phase." Underneath the St. John's Group, in America, is a great series of crystalline schists, now commonly designated "Eozoic" or "Archean." By Sir William Logan these were divided into two systems. The "Huronian," above, was found by Murray to be about 18,000 feet in thickness, while the "Lau-

* The discussion here referred to is republished in octavo form (282 pp., 1871) for more general circulation. For a copy of this (as well as many other documents) the writer is indebted to the distinguished author. The title of this octavo brochure is "Trilobites." To this our references will be made. Further discussions by M. Barrande may be seen in an earlier publication, entitled *Distribution des Cephalopodes* (1870), and a later one, entitled *Crustacés divers et Poissons des dépôts Silurien de la Bohème* (1872).

rentian," below, with its "upper" and "lower" members, was estimated by Logan to reach a thickness of 30,000 feet. It is in the Lower Laurentian that occurs the problematical structure named *Eozoön canadense*, on the hypothesis of its animal origin.

The indispensable *criterion* of every real law of nature is its exact conformity to established facts. This is well illustrated in the accepted theories of physics and astronomy. Now, admitting the animal nature of *Eozoön*, lying near the bottom of the Laurentian system, the theoretical laws of filiation and transformation, which have been assumed to regulate the evolution of the zoological series, ought to enable us to determine approximately the nature and the relative proportions of the development of the principal types which should enter into the constitution of the first faunas, and, notably, the Primordial Fauna of the Silurian.

It is clear that if the composition of this Primordial Fauna, thus determined *a priori*, shows itself in complete discordance with the real composition, established by direct observation, we must conclude that the theoretical laws of filiation and transformation are destitute of all foundation in nature, or else that the fact which serves as the point of departure of the theories, *i. e.*, the animal nature attributed to *Eozoön*, rests in illusion. Let us look, then, at the facts.

I. Composition of the Primordial Fauna of the Silurian.

A. *Geographical Distribution.*

The Primordial Fauna of the Silurian has been studied in twelve locally distinct regions on the two continents. These may be grouped as the "Grand Central Zone of Europe" (embracing Bohemia and Spain), and the "Grand Northern Zone," stretching from Europe to America—embracing, on the former continent, Scandinavia and England, and, on the latter, Newfoundland, Canada (including Northern Vermont), New Bruns-

wick, New York, Braintree (Massachusetts), the Upper Mississippi region (in Wisconsin and Minnesota), Texas, and Georgia. This fauna contains 366 distinct species of fossils, only 14 of which occur in more than one of the twelve regions. These are designated "migrant" species. There is no species common to the two continents.

Considering the specific distinctness of these forms as they appeared simultaneously in the different regions, we are compelled to conclude that those regions were comparatively isolated from each other and without communication.

It is, therefore, difficult to conceive how, without the influence of a sovereign and ordaining cause, animal life, developing itself in isolated situations in an independent manner, and under the influence of very different local circumstances, has, nevertheless, manifested itself simultaneously everywhere upon the two continents under forms, if not identical, at least so analogous and similar that science can not refrain from associating them under the same generic names, as *Paradoxides*, *Olenus*, *Conocephalites*, *Agnostus*, etc. (Op. cit., p. 193).

B. *Vertical Distribution and Zoological Composition of the Primordial Fauna of the Silurian.*

1. The Primordial Fauna is sharply distinguished into earlier and later "phases," according as the trilobitic genus *Paradoxides* is present or absent. In the earlier phase it is represented by 33 species; in the latter it is unknown. Each phase witnesses the presence of other but varying trilobitic genera. The total number of species of trilobites in the earlier phase is 168; in the later, 85. The total of all species in the first is 241; in the second, 127. The total number of all genera making their first appearance in the earlier phase is 46; the total for the later phase is 20. This excess of first appearances characterizes nearly all the separate orders of animals as well as the aggregate. The genera of trilobites in the two

phases are 18 and 10; ostracods, 2 and 0; annelids, 4 and 1; brachiopods, 9 and 3; bryozoa, 3 and 1; cystideans, 6 and 0.

This considerable number of primordial genera, especially in the earlier phase, ought to arrest the attention of those *savans* who imagine that generic characters are derived, like specific differences, by insensible variations long accumulated. This filiation and transformation would demand innumerable generations of intermediate forms between the primitive ideal type and the 66 types of different orders which co-existed during the primordial epoch of the Silurian. But to this day the existence of these forms is indicated by no trace whatever.

It would be impossible to conceive why all the intermediate forms between the principal types should have invariably disappeared. One would expect to encounter the descendants of at least some of them in the Primordial Fauna. But among all the forms from the lowest horizons of life upon the two continents, it would be difficult to indicate a single one which could be considered as establishing a transition between two families or two orders co-existing in the fauna under consideration. It seems, then, impossible to explain the existence of so many types so well characterized and so distinct at that epoch by the sole influence of filiation and transformation, proceeding from the supposed primitive being (pp. 194–201).

2. The analysis of the Primordial Fauna shows an extraordinary predominance of crustaceans, and especially of trilobites. The crustacean genera are 32 out of 66; the crustacean species, 264 out of 366. These crustaceans were the highest of all the classes represented in the Primordial Fauna. Their excess, as noted above, is extremely different from the proportions presented in any later periods. It would be difficult to assign a determinate cause of this predominance. In any event, it is evidently in discordance with those theories which teach that animal life has been gradually developed, starting from the lowest forms of organization; since, according to this

doctrine, the inferior forms ought to have predominated in numbers in the most ancient faunas. It is exactly the contrary which we establish.

The importance of this generalization is heightened by the fact that in the Cambrian system—whether synchronous in part with the Primordial Zone, or older—there has not been discovered to this day a single trace of trilobites or other crustaceans playing the *rôle* of *avant coureurs*. Thus the first appearance of so numerous trilobites at the origin of the Primordial Fauna offers an aspect of suddenness in disagreement with the theories (pp. 204–206).

3. Besides the predominance of crustaceans in the Primordial Fauna, a similar predominance is noticed in the numbers of molluscs compared with the still lower classes. In the first phase the species of molluscs are to those of the lower classes as 44 to 14; in the second phase, as 34 to 5. A similar though less marked predominance appears on a comparison of genera.

When we thus consider that the relative development of trilobites and molluscs underwent a gradual diminution, to give place to lower forms, we recognize the fact that it presents an order diametrically opposed to that which ought to be observed according to the theories (p. 207).

II. Absence of Foraminifera and Scarcity of Protozoa in General.

Foraminifera are those animals of extremely simple organization to which belong *Eozoön* (as supposed), *Amœba*, *Nummulites*, and similar forms. These are protozoans, a group which also embraces sponges—horny or calcareous—together with numerous other simple forms of no interest here. Foraminifera are supposed to have been represented by *Eozoön;* but, so far as we know, its existence is restricted to the lower portions of the Laurentian. It is separated, then, from the Primordial Zone by the Upper Laurentian and the Huronian. It at-

tained to immense size, quite unlike any Foraminifera known in the later ages. Now this gap is what arrests our attention. No Foraminifera are known from the Lower Laurentian until *after the close* of the Primordial Fauna. Now, the theoretical law of filiation and transformation teaches us that *Eozoön* ought to have been replaced by one or many other types of the same organization, more and more perfected, but gradually diminishing in size (p. 210). Contrary to this, other protozoans are wholly unknown until we reach the later phase of the Primordial Zone. Hence there are no animal forms revealed as the possible genealogical successors of *Eozoön*. This is something worthy to arrest attention. If there ever existed, in the whole series of geologic ages, a period favorable to the propagation of an animal type, it is, without contradiction, that where *Eozoön* reigned alone in the primitive ocean, exempt from that terrible "struggle for existence" which, according to the theory, must have successively destroyed the most powerful families of the zoological series during the later ages (p. 214).

Thus the Foraminifera, the immediate descendants of *Eozoön* by filiation and transformation, ought to have propagated themselves under all imaginable forms during the anteprimordial era.

Moreover, the innumerable forms of this family which have succeeded, especially during the Mesozoic, Tertiary, and Quaternary ages—that is to say, during the ages in which the "struggle for existence" must have been the most terrible—demonstrate to us sufficiently the powers of reproduction and vital resistance which characterize the type of Foraminifera.

From these considerations, we ought to expect to find the monuments of the work of the generations of this family preserved, as well as the relics of trilobites and brachiopods, in the rocks containing the Primordial Fauna. Thus their absence from these rocks constitutes an unexpected and inexplicable discordance between the theoretical views and the paleontological facts thus far observed.

III. Absence of Polyps in the Primordial Fauna.

Polyps, or coral-builders, are the lowest class of radiates, a sub-kingdom next in rank above protozoans, and lower in rank than molluscs or articulates. A patient inspection of the geological records of all the countries of the Primordial Fauna fails to reveal the existence of a single species of the class of polyps.

Eozoön seems singularly related to polyps in some of the elements of its structure; but the approximation seems even more marked by the vocation which it was appointed to fill in the primitive ocean. It is regarded as the chief agent in the secretion of enormous calcareous masses from the waters of the Laurentian sea. If this conclusion be correct, it must have fulfilled, during the Laurentian ages, exactly the same functions as polyps have accomplished during all the later ages, and which they are still accomplishing before our eyes.

In accordance with this double affinity in their zoological structure and in their geological vocation, one would feel led to assert that between *Eozoön* and the calcareous polyps there was but one step to take in the path of filiation and transformation. According to theoretical ideas, this step must also have been the first one taken in this path. In fact, the principle of natural selection does not permit us to imagine that the great primitive agent of calcareous secretions, *Eozoön*, at one time in possession of all the seas of the globe, could have been supplanted and eliminated except by other beings better organized for fulfilling the same functions—that is to say, by calcareous polyps.

Thus these polyps, near descendants of the first animal, according to the natural order of the zoological series, should have commenced to exist during the anteprimordial period; and the products of their calcareous secretions should be found mingled in the same rocks with those of the numerous generations of the family of *Eozoön*.

After the period of the *struggle for existence* (!), and the final elimination of the primitive type, the polyps, in their turn, should have reigned supreme over the bottom of the antepримordial seas, and should have constructed calcareous masses at least equal in magnitude to the Laurentian masses, of which one near Grenville, according to the estimate of Sir William Logan, has a thickness of about 1500 feet.

If it is true, as the same authority teaches us, that the antepримordial ages comprised an interval of time longer than that of all the geological ages succeeding, the indestructible monuments of the work of the polyps must have been repeated during the antesilurian era at least as many times as we see the reefs of corals reproduced in the vertical series of Paleozoic, Mesozoic, and Tertiary formations.

On the other hand, since the delicate structure of the tubular walls of *Eozöon* has resisted all the chemical reactions and all the crystalline forces since the most remote ages, there is no reason why the reefs of polyps should not be preserved in rocks of later origin, and especially in the same country. But in spite of this, and in spite of all considerations, no trace of polyps has yet been found in the antesilurian rocks of Canada or any other country, nor even in the Primordial zone.

This fact constitutes a strange and inexplicable phenomenon when we consider that the Primordial Fauna contains varied types both inferior and superior to polyps. Of the former, we cite sponges; of the latter, many forms belonging to echinoderms, bryozoans, brachiopods, gasteropods, and pteropods, and various types of crustaceans, principally trilobites (pp. 216, 217).

This total absence of polyps in the Primordial Fauna is in complete discordance with the theories which teach us that animal life has been gradually developed from forms lowest in respect to organization (p. 228).

IV. Absence of Acephals and Abundance of Brachiopods.

Acephals (conchifers or lamellibranchs) are a class of molluscs generally regarded as standing next above brachiopods; while still higher stand in order the groups of gasteropods, heteropods, pteropods, and cephalopods.

While brachiopods manifest themselves in considerable numbers in the Primordial Fauna, and play a *rôle* second in importance only to that of trilobites in all the countries, we are astonished to learn that nowhere in this fauna has the least trace of the class of acephals been encountered. This total absence to this day seems so much the more enigmatical, since we are acquainted with representatives, in the first Silurian Fauna, of three classes of molluscs superior to acephals, viz.: gasteropods, heteropods, and pteropods (p. 229).

The first forms of the class of acephals manifest themselves toward the origin of the "Second Fauna," that is to say, in its first or second phase, on the two continents.

Since all zoological classifications agree in placing the acephals immediately above the brachiopods* in the animal series, it is very difficult to conceive why brachiopods have so much

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* Professor E. S. Morse very ably maintains (see *Proceedings Boston Soc. Nat. Hist.*, vol. xv., pp. 315–372) that brachiopods are not molluscs, but belong to the class of worms among articulates; and hence could not be expected to sustain direct genetic relations with the acephals. He supposes ancient chætopod worms to have culminated in two parallel lines — brachiopods and modern chætopods, as *Serpula*, *Amphitrite*, etc. (loc. cit., 369). If articulates are properly ranked above molluscs, the brachiopods are thus removed to a greater distance *above* acephals than pteropods and heteropods are; and the anomaly of their early appearance is more glaring than in the case of these molluscan types. In this case, however, it will be remembered theory does not assign them to the same genealogical line, but to different lines which converge somewhere in the past.

preceded acalephs in existence. The difference between the epochs of appearance of these two closely related classes exceeds the whole duration of the Primordial Fauna, since brachiopods have existed to the number of 28 species in the first phases of this fauna, after having made their first appearance in the Cambrian age. Since, moreover, the classes of pteropods and gasteropods, superior in their organization, existed during the first Silurian periods, the absence of acalephs during the whole Primordial Fauna constitutes a grave anomaly and an interversion of the supposed order, that is to say, an inexplicable discordance between theoretic provisions and the reality (p. 233).

V. Absence of Heteropods.

Only a single species of this type of molluscs is known within the Primordial Zone, and that only in England, and near the close of the period. On the contrary, pteropods are known in considerable abundance in the lowest beds of the Primordial Zone. The first advent of pteropods antedates, therefore, the first advent of heteropods — a lower type — by the whole duration of the Primordial Fauna. Here, consequently, is another inversion of the order of gradual development supposed by the theories (p. 235).

It is well also to remark that the gasteropods, placed immediately *below* the heteropods in the zoological scale, appeared sporadically in the first phase of the Primordial Fauna in Spain and in America. These facts set forth still more conspicuously the irregularity of the absence of heteropods, while the two classes between which they are placed among molluscs are represented from the time of the first phases of the Primordial Fauna (p. 235).

VI. Absence of Cephalopods.

The absence of this (highest) class of molluscs from the Pri-

mordial Fauna has been fully established by the study of the primordial fossils of all countries (*Distrib. des Cephalopodes*, pp. 106–108). This fact, so important in the study of the evolution of life, is accompanied by another fact which is also worthy of attention. It is that toward the origin of the Second Fauna representatives of the class of cephalopods appeared simultaneously in almost all the Silurian countries under a great number of generic types and specific forms. About 165 species are known, representing 12 genera.

This simultaneous development of so many different forms upon the first horizons of the Second Fauna which present cephalopods is irreconcilable with the theoretical laws of filiation and transformation by insensible variations. In fact, according to these laws, such a development would demand an antecedent and prolonged existence of this class. Thus, the absence of cephalopods in the Primordial Fauna ought to be considered as establishing a discordance between the theories and the reality (p. 236).

VII. Discordances in the Devolopment of Trilobites.

A. *Predominance of Trilobites in the Primordial Fauna.*

This predominance is manifested in all their relations:

1. In respect to the number of genera. We know 28 genera of trilobites in the Primordial Fauna, besides 4 other crustacean genera. Of molluscan types we find 1 genus each of pteropods, heteropods, and gasteropods, and 9 genera of brachiopods. The still lower types are represented severally by only 1 or 2 genera.

2. In respect to the number of species. Of the 366 species known in the Primordial Fauna, 252 (69 per cent.) are trilobites, and 72 per cent. are crustaceans. Considering the earlier phase by itself, three-fourths of all the fossils are crustaceans.

3. In respect to the frequency of individuals. Every col-

lector knows that the fragments of trilobites are innumerable, while the traces of other fossils are rare. In Bohemia the frequency of trilobites is at least a hundred-fold that of all other fossil forms.

4. In respect to size. *Paradoxides*, characterizing the first phase of the Primordial, attains almost the largest size known among trilobites, being 28 to 30 centimetres [11 to 11¾ inches] in length. Only two larger species are known, and these attain to 35 and 40 centimetres [13¾ to 15¾ inches]. Among other fossils, the largest in the Primordial is but 9 to 10 centimetres [3½ to 4 inches] in length; and most of them are decidedly diminutive.

5. In respect to horizontal diffusion. In every country where the Primordial Fauna is known, trilobites invariably constitute the major part. They are ordinarily accompanied by a few representatives of other types, but these are different in the different countries.

Thus trilobites dominate not only over each of the other types of the Primordial, but over their aggregate. This is true, however we compare them. We must add to this that, in respect to the degree of their organization, they occupy the first rank among all the animals of this fauna. We are led to recognize here a grave discordance between the actual evolution of this tribe and that which would be assigned to it by the theories.

In fact, according to the law of filiation and gradual transformations, the evolution of the animal series having begun with the lowest type, and being compelled to produce types successively higher and higher, it follows that the most perfect type in the Primordial Fauna—that is, the type of crustaceans or of trilobites—must have been the last one to appear in the anteprimordial era; and consequently it must have presented in the Primordial Fauna but a *minimum* of development in comparison with the other types which must have

preceded it in existence and enjoyed long ages for their development. But it is precisely the contrary which we establish by appeal to facts. These facts are, then, in complete contradiction with the theories.

B. *Conformation of the Thorax in Trilobites of the Primordial.*

According to one of the theoretical conceptions, each animal should reproduce, in its embryonic evolution, or in its metamorphoses, the chronological series of forms of its ancestors, from which it has descended by filiation and transformation. Consequently the metamorphoses of the most ancient trilobites characterizing the first phase of the Primordial Fauna, such as *Sao*, *Arionellus*, *Agnostus*, etc., should represent the successive forms of their unknown ancestors.

But these trilobites, like all those with whose metamorphoses we are acquainted, present us in their embryonic development a series of forms, of which each offers one thoracic segment more than the preceding, beginning with zero. We should thence conclude that the first anteprimordial trilobites, if they existed, appeared with the thorax wanting, and that the number of their segments, beginning with unity, gradually increased in their successive transformations. *Agnostus*, whose thorax, at maturity, consists of 2 segments, and *Microdiscus*, which has 4, should represent in the Primordial Fauna 2 of the most ancient combinations, according to theory.

But it must be observed that these two trilobites are the only ones thus conformed in the Primordial Fauna. On the contrary, nearly all the other types of this fauna, and chiefly those which characterize its first phases, are distinguished by the great number of their thoracic segments. This number is almost constantly above the mean figure 11, and in *Paradoxides* it attains the figure 20, which is very near the *maximum*, 26, known in all the tribe.

Thus one would be led to think, according to the theories,

that all the primitive trilobites possessing from 5 to 9 thoracic segments must have existed in the Anteprimordial Faunas, and that they must have disappeared, according to the order of animal evolution, before the epoch of the first Silurian Fauna, never to re-appear.

Our astonishment should be greatly excited, therefore, at seeing these types appearing in great numbers in the Second Fauna, and showing themselves simultaneously in all Silurian regions on the two continents. By a singular privilege, this fauna is the *only* one in which these types predominate by the number of their species and the frequency of their individuals. It suffices to cite *Asaphus*, *Ogygia*, *Trinucleus*, etc., known to all *savans*. These genera constitute, by their presence, the principal character of the Second Fauna, as *Paradoxides*, *Olenus*, and *Conocephalites* constitute that of the Primordial Fauna.

We know in the Second Fauna 19 types whose thorax is composed of 5 to 9 segments, and they are represented by 322 species—the total number of genera of this fauna being 52, and of species, 866.

On the contrary, there exists in the Second Fauna no trilobite which presents a number of thoracic segments equal to that of *Arionellus*, *Sao*, *Paradoxides* characterizing the first phase of the Primordial Fauna.

Thus, from the theoretical point of view, we would be led to assert that the Primordial and Second faunas present a sort of interversion in the order of appearance of the trilobitic types which constitute their chief distinctive characters respectively (pp. 240–242).

VIII. Absence of Intermediate Forms.

Eleven family types are known in the Primordial Fauna. These are as trenchantly differentiated from each other as the same types in any succeeding age, or even in the actual fauna. For example, among crustaceans we have trilobites, phyllo-

pods, and ostracods. But between a trilobite, like *Paradoxides* (somewhat lobster-like) and an ostracod, like *Primitia*, a little bivalve crustacean, the difference of conformation is so marked that, were we to refer them to any common ancestry, we should necessarily conceive of a multitude of intermediate forms which must have existed before *Paradoxides* and the ostracods co-existing in the Primordial Fauna. Such intermediate forms have left no trace of themselves, either in the rocks which inclose the Primordial Fauna or in those which represent the anterior ages. Similar observations apply to the contrasts between any two of the family types of the Primordial.

It may also be observed that such observations apply equally to the family types of all the Paleozoic ages. The forms intermediate between them are universally wanting. One can not conceive why, in all rocks whatever, and in all countries upon the two continents, all relics of the intermediary types should have vanished.

This disappearance of intermediate types is so general and so constant in the series of geologic ages, and over the entire surface of the explored formations, that it seems impossible to explain it except by regarding it as the effect of a grand law of nature.

The absence of intermediate types characterizes the gaps between genera and even species, as well as between orders and families. We have, fortunately, a single striking instance of an intermediate form in the genus *Bohemilla*, which unites the characters of *Paradoxides* and *Agnostus*. *Bohemilla* ought, therefore, to occur, according to theory, among trilobites of the Primordial Fauna, unless its existence at an earlier epoch should have been established. But, by a sort of perversity which nature seems to show toward theories, *Bohemilla* does not appear in the Primordial at all, but only after the commencement of the Second Fauna, after the extinction of *Ag-*

nostus, and a whole geologic cycle after the disappearance of *Paradoxides*.

Similar anachronisms are established in the succession of cephalopods (*Distrib. des Cephalop.*, p. 465).

IX. Zoological Composition of the Cambrian Fauna.

Underneath the recognized Silurian rocks of England, Bohemia, Norway, and Sweden reposes a series of strata containing a limited number of mostly obscure remains of animals and plants. They are characterized by the relative abundance of plants and traces of marine worms. One polyp is doubtfully recognized, which is thus seen to be far separated from its nearest successor in time. Three-fourths of all the genera are known in the Silurian, and five species even range into the Silurian. Under the circumstances, it seems probable that the fossiliferous portions of these so-called Cambrian strata should be annexed to the Silurian.

But, admitting their real anteriority, we have to remark the important fact that not a single trilobite has been discovered in the Cambrian rocks, although in many cases their condition is very favorable for the preservation of the most delicate parts. We are still left profoundly impressed by the suddenness of the appearance of trilobites at the beginning of the Silurian age. This phenomenon, however, is repeated in the case of cephalopods, near the origin of the Second Fauna, and again in the case of fishes, near the close of the Third Fauna. Indeed, similar examples are repeated through all the geologic ages.

All these sudden manifestations of life under new typical forms, appearing constantly and everywhere with the plenitude of their distinctive characters, are in complete discordance with the hypothesis of a gradual development by insensible and successive variations, since such a transformation could only be wrought out through an indefinite series of intermediate forms, of which no trace has been found in any country (pp. 246–267).

X. Comparative Résumé contrasting Facts with Theory.

Such a comparison is best set forth by a diagrammatic arrangement shown on the opposite page, which we reproduce, and leave to speak for itself. The first column gives the names of the zoological groups, arranged in the order of rank. In the next two columns the actual development of the groups is represented by the relative lengths of the black lines. In the fourth column the development of the groups in the first phase of the Primordial Fauna is shown as it should be, according to theories of evolution, while the fourth column shows it as it is. In the last column are given the totals of species known in the first phases of the Primordial Fauna of the Silurian.

XI. Conclusions from the preceding Studies.

At the beginning of this discussion we alluded to the wonderful confirmation of certain astronomical previsions by the facts of observation. The theories, then, on which such previsions are based must be in harmony with the reality.

By contrast, we have now established, as the final result of our studies, that direct observation contradicts radically all previsions of paleontological theories on the subject of the composition of the first phases of the Primordial Fauna of the Silurian.

In fact, the special study of each of the zoological elements which constitute these phases has demonstrated to us that the theoretic previsions are in complete discordance with the facts observed by paleontology. These discordances are so numerous and so pronounced, that the composition of the real fauna seems to have been calculated by design for contradicting every thing which the theories teach us respecting the first appearance and primitive evolution of the forms of animal life upon the earth.

Classes, Orders, and Families.	Anteprimordial Era.		Silurian Age. First Phases of Primordial Fauna.		Species.
	Laurentian System.	Cambrian System.	According to Theory.	According to Facts.	
Trilobites					168
Other Crustaceans					1
Ostracods					10
Annelids					4
Cephalopods					...
Pteropods					14
Heteropods					...
Gasteropods					2
Acephals					...
Brachiopods					28
Bryozoans					5
Echinoids					...
Cystideans					7
Asteroids					...
Polyps					...
Sponges					2
Foraminifers	Eozoön				...

These results, moreover, are in perfect harmony with those heretofore deduced from studies on the first appearance and the distribution of cephalopods in the Silurian countries.

It remains to learn whether the discordances demonstrated ought to be imputed solely to the essential principle of the theories of filiation and transformation, or proceed in any part from their point of departure in paleontology, that is, from the supposed animal nature of *Eozoön*. This is a question whose solution we leave to those interested.

For us, we persist in thinking that science ought to maintain itself strictly within the sphere of observed facts, and rest completely independent of every theory which would tend to tempt it into the sphere of the imagination.

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