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ART. I. — *The Principles of Biology.* By HERBERT SPENCER, Author of "The Principles of Psychology," "Illustrations of Progress," "Essays, Moral, Political, and Æsthetic," "First Principles," "Social Statics," "Education," etc. New York: D. Appleton & Co. 1866, 1867. 12mo. 2 vols. pp. 475, 566.

MR. SPENCER'S so-called "Synthetic Philosophy" is an attempt to generalize into a universal law the nebular hypothesis, the development hypothesis, and the theory of human progress, and thus to bring all phenomena, whether of the material universe, of organic life, or of human nature, under the unity of a single idea. Whether his formula is the last and highest of scientific inductions, and, if so, whether it is capable of application to the deeper questions of philosophy, there is now no occasion to inquire, the public having probably heard, at least for the present, sufficient criticism of "First Principles." The aim of this article is a limited one, namely, to ascertain whether Mr. Spencer, having taken the development hypothesis as the basis of his Biology, has met the logical necessities of the case, and thus accomplished the highly important achievement of putting the science of life into philosophical form. Our inquiry, therefore, concerns not so much the scientific value of his facts as the philosophical value of his system, not so much the intrinsic worth of the materials as the architectural excellence and practical usefulness of the

edifice. That this inquiry is a legitimate one will not be questioned, when it is remembered that the two volumes under consideration are not intended to be a mere *résumé* of facts and laws empirically established, but rather an attempt to rationalize these as elements of a coherent philosophical whole. In his Preface to the English edition Mr. Spencer distinctly states this as his main object: "The aim of this work is to set forth the general truths of Biology, as illustrative of, and interpreted by, the laws of Evolution: the special truths being introduced only so far as is needful for elucidation of the general truths." It is confessedly as philosophy, rather than as science, that the work has its chief significance; and as such, therefore, it should be criticised.*

"The Principles of Biology," being a simple expansion of the development hypothesis, with the design of covering all the facts of organic life, the whole of Part III. (Vol. I. pp. 331–475) is devoted to a comparison of the two rival hypotheses concerning the origin of species, an elaborate argument in favor of the "evolution hypothesis," and a very ingenious explanation of what Mr. Spencer regards as the causes and methods of organic evolution. The "special-creation hypothesis" he pronounces to be "worthless by its derivation, worthless in its intrinsic incoherence, worthless as absolutely without evidence, worthless as not supplying an intellectual need, worthless as not satisfying a moral want"; and he characterizes it as a "mere verbal hypothesis," a "pseud-idea." We believe that sooner or later all disciplined minds will confirm this estimate of the "special-creation hypothesis," severe as it

* The idea may possibly be suggested by the passage above quoted, that Mr. Spencer intends nothing more than to give in these two volumes, and the seven volumes to succeed them, a simple series of "illustrations" of the laws of evolution set forth in "First Principles," without undertaking the philosophical organization of the sciences from which the illustrations are drawn. But the laws of evolution are already illustrated in "First Principles," even to redundancy; and it would be inexcusable prolixity to fill nine additional volumes with a simple enumeration of instances. Mr. Spencer's "New System of Philosophy," and the elaborate sketch of it given in his well-known "Prospectus," would thus dwindle to ridiculously insignificant proportions, and lose all claim upon the attention of speculative thinkers. If the present work have any philosophical value whatever, it must be as a philosophy of organic being, which is itself part of a still larger philosophy.

may seem. Whatever shall be the final judgment passed upon the development hypothesis, it is the only hypothesis in the field, as to the origin of species, that can be understood, the only hypothesis, consequently, that fulfils the end for which all hypotheses exist. Development and decay are the universal marks by which we distinguish the organic from the inorganic; evolution and dissolution are the double process which constitutes the entire series of vital phenomena in all individual organisms. The development hypothesis, therefore, may be broadly stated as the provisional extension *to species* of a law which is known to be true *of individuals;* and although the analogy between individual and species will not admit of being pressed too far, it still yields, when properly qualified, a clear conception in harmony with the other conceptions of science. The hypothesis of special creations, on the other hand, is utterly unintelligible, the virtual negation of all hypothesis on the subject, the delusive substitution of words for thoughts. Its advocates, having no citadel of their own to defend, can only attack the imperfectly built citadel of their opponents, which falls but to rise in greater strength. It is certainly a most significant fact, that, whenever the development hypothesis is pronounced dead and buried, it soon revives in a less vulnerable shape. The supposition of special creations, for all those who have imbibed the spirit of modern thought, is no longer tenable, and the debate turns exclusively on the acceptance or rejection of the other supposition. Although it must certainly be considered as scientifically unproved, so long as intelligent scientific men are found to call the alleged proofs of it into question, it is not too strong a statement to say that the development hypothesis, under some form or other, will probably take rank in the end with the accepted truths of science. In any event, whether the development hypothesis is to wax or wane, and whether some other hypothesis, as yet unconceived, is destined to take its place or not, it is safe to say that the hypothesis of special creations, lacking the very first element of a scientific hypothesis, intelligibility, and resting on no more solid basis than the crude religious ideas of uncivilized man, will ultimately cease to be defended. A theory which denies the unity of the universe, and the order of Nature, cannot permanently hold its ground, even

against a theory which only partially succeeds in tracing these out in detail. The absolute universality of law, and the incredibility of any real departure from it, are conceptions so strongly favored by the whole current of modern thought, that it is fast becoming a recognized scientific necessity to discard the notion of special creative epochs, and to substitute for it the principle of the unbroken continuity of life. "When we see these lowest of all known forms [the rhizopods] standing alone at the very beginning of time, and man, the highest and noblest form, appearing at the end, and an unmistakable gradation, *always upward*, through the long ages, and along all the four lines of plan, what open mind can help imbibing, if not the Darwinian doctrine, at least the spirit of the theory of development?" *

The great need of the development hypothesis at present is *to be organized*, — to be put into a more definite, symmetrical, and philosophical shape than it has yet received; and we welcome the work of Mr. Spencer as at least an attempt in the right direction. Fragmentary thinking, leaving out of sight the larger relations of facts, and embracing theories on different subjects which are seen to be mutually inconsistent when brought into juxtaposition, can be tolerated only in the infancy of science; the absolute necessity of harmony and comprehensiveness of thought, as the condition of the only possible interpretation of Nature which shall truly mirror her universal order, and reveal her secret of perfect unity in boundless variety, forces itself on the mind more and more powerfully in proportion to the increase of human knowledge. Permanent repose in the midst of antagonistic ideas and unreconciled facts is impossible; and in no way does Philosophy, as co-ordinating intelligence, more irresistibly prove her right of eminent domain over the mind of man than by compelling science itself to become philosophical in spirit and in form. Of this constraining influence the systems of Auguste Comte and Herbert Spencer, each aiming at the unification of all positive science as an organic whole, are conspicuous illustrations. It is no disparagement to either of these thinkers, entitled as they are to so much praise for the grandeur of their purpose and the patient industry of its execution, to say that neither of their

* J. P. Lesley, Origin and Destiny of Man, 1868, p. 80.

systems is more than a contribution to the great work in hand. So mighty a task, requiring not only philosophical genius, but also encyclopedical knowledge, transcends the ability of any single intellect; it is a labor imposed upon humanity itself, to be accomplished only by the united toils of many generations of great thinkers. The value of each successive systematization of knowledge must be measured by the largeness of its plan, the adequacy of its method, and the fidelity with which the method is applied in the execution of the plan. But the practical utility of a philosophy which shall reveal to science the law of its own development, and thus enable it to work intelligently rather than instinctively in the accomplishment of its ends, will be incalculable; and it is a sure mark of intellectual narrowness to treat with contempt the effort to create such a philosophy.

In taking the idea of universal evolution as its organizing principle, Mr. Spencer has sketched for his philosophy the largest plan possible in the present state of human knowledge; and here lies the cardinal merit of his attempt. But in the adoption of a false method, namely, the interpretation of universal evolution as a purely mechanical process, and in the failure to follow boldly the idea of universal evolution to its logical consequences, we find the cardinal demerits of his attempt. We cannot here enter on any general discussion of these points; but we shall discover in the work under consideration ample evidence of their truth. In the "Principles of Biology," we shall see the clashing of incompatible ideas, and the unaccountable evasion of logical corollaries from admitted principles. Mr. Spencer has thus stopped short of putting the development hypothesis into self-consistent or philosophical shape, and disappointed expectations warranted by his own "First Principles." The numerous special excellences of these two volumes, both in design and execution, must not detain us at present, though we cordially recognize them in passing; our critique does not concern itself with special details, but relates to the general scope of the work, and its success or failure as an attempt to organize the science of Biology as part of the Synthetic Philosophy. Waiving all examination into its purely scientific character, of which adepts in science are the only

competent critics, we restrict ourselves to a definite inquiry, namely, whether it has succeeded in setting forth the "general truths of Biology as illustrative of the laws of Evolution." The extent of its success in this respect is the measure of its philosophical value.

The great questions of biology, considered in its philosophical aspect, are three: What is the origin of life in the first instance? What is the origin of species or the different forms of life? What are the causes of organic evolution in general? To each of these three questions two answers are given. Life is said to originate in the first instance either by natural evolution or by supernatural interposition in the course of Nature. Species are said to originate either by gradual transitions from one form to another or by the periodical introduction of absolutely new and underived forms. These unlike answers to the first two questions spring from unlike hypotheses. If consistent with itself, the development hypothesis attributes the origin of life in the first instance, and the origin of species or the various forms of life, to a natural and gradual process, while the hypothesis of special creations attributes both to supernatural volitional acts. The former epitomizes the history of the individual and of the species alike in the one word *evolution* (with its correlate, *dissolution*); the latter admits evolution in the individual, but denies it in the species, without, however, substituting anything intelligible in its place. Each hypothesis, therefore, admitting evolution as a fact more or less universal, is confronted by a third question, namely, What are the causes of organic evolution? To this third question many answers are given, which fall, nevertheless, into two general classes. The one class finds the causes of organic evolution solely in the direct or indirect action of cosmical forces external to the organism; the other class, fully recognizing the action of these external forces, finds a concurrent cause in forces which manifest themselves in the organism alone, and are therefore irreducible to known cosmical forces. Hence among biologists two great tendencies exist, which find expression in what may be designated as the mechanist and the vitalist theories. It is the recognition of the *speciality of vital phenomena*, as not accounted for solely by mechanical or phys-

ico-chemical causes, and not by any means the fanciful speculations respecting the *unknown causes of these phenomena* in which some vitalists indulge, that constitutes the essence of the vitalist theory; and it is the negation of this speciality which distinguishes the mechanist theory from it. The vitalist theory includes the mechanist theory, with the exception of this negation, affirming its affirmations, but denying its denials.

If we now inquire what relation the mechanist and vitalist theories bear to the development and special-creation theories, we find a curious reversal of natural affinities. The vitalist and special-creation theories are sometimes found associated in the supposed interest of dogmatic theology; while the mechanist and development theories are sometimes found associated in the opposite interest. But, philosophically, the vitalist theory is most closely allied to the development theory, and the mechanist theory to the theory of special creations. Regarding the evolution of the universe as a gradual change from homogeneity to heterogeneity, produced by natural forces which are at bottom diverse manifestations of a single inscrutable force, the spirit of the development theory, at least as generalized by Mr. Spencer, would seem to require the recognition of mechanical, physical, chemical, biological, psychological, sociological, and moral phenomena, as an ascending series of dynamical facts, which are reducible to unity, not by denying the essential diversity of the facts themselves, and thus ignoring the law of the series, but rather by tracing those connections of the facts which constitute them a series. If the cosmos is evolved as a universal whole by an immanent force, and not by a force operating *ab extra*, then, unless the law of evolution changes, those organized beings which exist in the cosmos as partial wholes must also be evolved by immanent forces. To place the primary cause of organic evolution outside the organism is a conception precisely analogous to the conception of a creator outside the universe, — a conception which Mr. Spencer, at least, repudiates. The spirit of the development theory manifestly allies it with the vitalist rather than with the mechanist theory. In like manner, the spirit of the special-creation theory, which regards the universe as originated by a First Cause external to the universe, not immanent in it, and

which imagines each newly created species to have been in some way fashioned out of plastic materials and then vivified from without by foreign influences, would seem to be identical with the spirit of the mechanist theory, which regards the organism as only a living machine, created by the direct and indirect action of external forces alone. The special-creationist, it is true, attributes to the creative power both intelligence and will, and maintains the origination of life to be due to miraculous intervention in the course of Nature, — an assumption which the biological mechanist declines to make. But, regarding the organism as either supernaturally created or naturally evolved *by external power*, both look at it as practically a manufactured machine, and the resemblance is greater than the difference. Hence, we repeat, the mechanist theory is less closely allied to the development theory than to the theory of special creations, while the vitalist theory, maintaining the natural evolution of life by the reciprocal play of external and internal forces whose manifestations cannot be classified together, alone appears to harmonize with the spirit of the development theory.

In determining the value of a biological system based on the idea of evolution, it becomes necessary to consider the answers it gives to the three great questions of philosophical biology, namely: What is the origin of life in the first instance? What is the origin of the various forms of life? What are the general causes of organic evolution? From the answers which Mr. Spencer has given to these three questions we derive our estimate of the philosophical character of his "Biology."

The great work of Mr. Darwin, on the "Origin of Species," which has done so much towards perfecting the development hypothesis, is chiefly confined to the discussion of the second of these three questions, the first being intentionally ignored, and the last being considered only with reference to the causes of variability in species. It exhibits, therefore, certain theoretical *lacunæ*, which must be filled before the development hypothesis can become a general philosophy of organic evolution. For carrying out the avowed purpose of the work, the principles so powerfully advocated and so beautifully illustrated by Mr. Darwin are perhaps sufficient; it being taken for

granted that life already exists at the start, the logical requirements of the development hypothesis are perhaps met, if it can be proved that beneficial variations occur in individuals, descend to offspring, are increased by fresh variations in the same direction through natural selection in the struggle for life, and thus become established as permanent characteristics of new specific forms. But, manifestly enough, more than this is required to meet the demands of a complete theory of the origination and development of life in general, or to make the science of biology illustrate a universal law of evolution. Mr. Darwin, however, aims at no such object. His object, being a definite one, has confessedly nothing to do with the origin of life itself; and it cannot justly be alleged as a defect in his admirable work, that he has not done what he never meant to do. At the same time, by way of parenthesis, he has turned aside from his avowed purpose to make statements which biology, if ever established on the principle of universal evolution, must revise.

"I need hardly say," he writes, in opposition to Lamarck's theory of the continual production of new and simple forms by spontaneous generation, "that Science in her progress has forbidden us to believe that living creatures are now ever produced from inorganic matter." * The distinct denial of spontaneous generation from inorganic matter under present cosmical conditions, though not necessarily implying denial of it under past conditions, seems to lend a peculiar significance to the phrases which we italicize in the following passages. "The whole history of the world, as at present known, though of a length quite incomprehensible by us, will hereafter be recognized as a mere fragment of time, compared with the ages which have elapsed since *the first creature*, the progenitor of innumerable extinct and living descendants, *was created*." † "Therefore I should infer that probably all the organic beings which have ever lived on this earth have descended from some one primordial form, *into which life was first breathed by the Creator*." ‡ "As the first origin of life on this earth, as well as the continued life of each individual, is at present beyond the scope

* Origin of Species, p. 119.

† Ibid. p. 424.

‡ Ibid. p. 431.

of science, I do not wish to lay much stress on the greater simplicity of the view of a few forms, or of only one form, *having been originally created*, instead of *innumerable miraculous creations having been necessary at innumerable periods;* though this more simple view accords well with Maupertuis's philosophical axiom of 'least action.'" *

Comparing, on the one hand, this unequivocal denial of spontaneous generation from inorganic matter, at least under existing cosmical conditions, and, on the other hand, this repeated reference to an initial act of creation, it seems probable, notwithstanding the extreme guardedness of his language, that Mr. Darwin is inclined to accept the hypothesis that life in the first instance originated in an unrepeated (and therefore miraculous) creative act. He apparently regards as the only alternatives an initial miraculous creation and periodical miraculous creations; for *an initial natural creation would be simply spontaneous generation out of inorganic matter*. But, as Mr. J. P. Lesley remarks in his brilliantly written volume, "Science can take no note of the supernatural, unless it becomes natural, and takes the oath of allegiance to Nature. Nature itself is too supernatural to require any additions from the realms of human ignorance." † The development theory must stand or fall with the theory of spontaneous generation. Logic permits no other conclusion. It may be, as Mr. Darwin regards it, quite "immaterial" whether we believe that life first appeared in a single form or in several forms, since under varying conditions various forms might be naturally evolved; but it is very far from "immaterial" to the integrity of the development theory whether we believe that life first appeared *with* or *without* special miraculous creation. If the arguments against special creation on which the development theory relies have any validity or logical force whatever, they are valid against the special creation of the primordial form or forms. The development theory is philosophically worthless, if it cannot altogether dispense with the help of that kind of agency, the assumption of which is its chief objection to the antagonist theory. It is bound to fill up the chasm between the organic and the inorganic, — it is bound

* Variation of Animals and Plants under Domestication, Vol. I. p. 24.

† The Origin and Destiny of Man, 1868, p. 164.

to adhere unflinchingly to Mr. Darwin's favorite maxim, *Natura non facit saltum*, — or else confess itself logically even more untenable than the theory it opposes. This is no exaggeration. If special creation is held to recur periodically, then miracle becomes in some sort legitimated by this very periodicity, and so far challenges the respect of science by wearing the mask of law. But if it is held to have occurred once, and once only, then the mask falls off and reveals the hideousness of absolute anomaly.* Paradoxical as it may sound, therefore, it is a severer tax on "faith" to accept Mr. Darwin's solitary creation than to accept the innumerable creations of his opponents. Theology must believe more, philosophy must believe less. Law without miracle is the faith of science. The conception of the strict universality of law, which is rapidly undermining the special-creation theory in all its forms, must yet cause the development theory to assume some form which shall not involve the very same irrationality in its most aggravated shape. Logic imperatively demands that it shall furnish, without having recourse to any assumed deviation from the established regularities of Nature, some intelligible hypothesis of the manner in which *unorganized matter becomes organic tissue.* Until it shall be in a condition to do this, it cannot be regarded as even philosophically self-coherent, much less as scientifically proved.

In the hands of Mr. Darwin, therefore, the idea of natural evolution, although admirably employed to elucidate the origin of species, throws no light on the origin of life itself. Yet so long as this great question is either altogether ignored or answered by assuming a solitary miracle, it is manifest that the development theory, however competent to account for the gradual differentiation of organisms into varieties, species, genera, etc., is incompetent to yield an adequate philosophical basis for a general science of life. In forming our estimate, therefore, of the philosophical value of Mr. Spencer's "Principles of Biology," it is necessary first of all to ascertain his attitude towards the theory of spontaneous generation.

* "If all subordination of miracle to law is abjured, then it is *ipso facto* disproved." William Adam, An Inquiry into the Theories of History. London: 1864. p. 111.

Apparently recognizing the logical necessity, inherent in the development theory, of bridging the chasm between the organic and the inorganic, and of discovering intermediate or transitional conditions of matter, Mr. Spencer, in his opening chapters, devotes considerable space to the subject of colloids and crystalloids, and their mutual relations. He refers to Professor Graham's important researches, and quotes from him the following remarks. "The colloid is, in fact, a dynamical state of matter, the crystalloidal being the statical condition. The colloid possesses *energia*. It may be looked upon as the primary source of the force appearing in the phenomena of vitality. To the gradual manner in which colloidal changes take place (for they always demand time as an element) may the characteristic protraction of chemico-organic changes also be referred." Mr. Spencer himself then adds: "The class of colloids includes not only all those most complex nitrogenous compounds characteristic of organic tissue, and sundry of the oxy-hydro-carbons found along with them, but, *significantly enough*, it includes several of those substances, classed as inorganic, which enter into organized structures." * It is difficult to perceive any particular significance in the fact stated, unless it points to the colloidal condition of matter as a connecting link between its organic and inorganic conditions, — which, again, is significant only as suggesting the natural evolution of the one from the other. Mr. Spencer also praises De Maillet as in advance of his age, on the ground that "his wild notions as to the way in which natural agencies acted in the production of plants and animals must not make us forget the merit of his intuition that animals and plants *were* produced by natural causes." † Furthermore, as we have already seen, Mr. Spencer condemns the special-creation hypothesis as "worthless," and advocates in its stead the development hypothesis; and we are therefore confirmed in the expectation, already so amply warranted, that, as a philosophical thinker, he will clearly perceive and frankly avow the logical consequences of the hypothesis he adopts. The spirit and tenor of his whole philosophy are as hostile to the postulate of an initial special creation as they are to that

* Principles of Biology, Vol. I. pp. 16, 17.

† Ibid. p. 408.

of successive special creations; and this supposition as to the origin of life being set aside, no supposition remains but that of natural evolution, or, in plain English, spontaneous generation. If the essence of the spontaneous-generation hypothesis is the principle that living organisms either are or have been evolved out of inorganic matter without any intervention of miraculous agencies, (and the alleged spontaneous generation of *Vibrios*, *Bacteriums*, etc., in infusions of organic matter, has its chief theoretic importance as foreshadowing the establishment of this large principle,) then it cannot be denied that this hypothesis should be regarded as necessarily an integral part of the development hypothesis, — bone of its bone, and flesh of its flesh. Biology *as science* may avoid all discussion of a question which is at present beyond settlement by observation and experiment; but biology *as philosophy* is not at liberty thus to disregard the self-evident necessities of logic. We are certainly warranted in concluding that Mr. Spencer is bound by the spirit of his own system to employ his unquestioned ability and large scientific acquirements in the open defence of a doctrine which is so plainly a corollary from his "First Principles." We come to this conclusion with the less reluctance, because we are quite willing to share whatever *odium theologicum* may be involved in the acceptance of what we consider to be the most rational hypothesis as to the appearance of life on the globe.

When, however, we come to inquire what reply Mr. Spencer has really given to the first great question which a philosophical biology must answer, namely, What is the origin of life in the first instance? we find no definite reply of any sort in the volumes before us. There being but two conceivable replies to this question, special creation and spontaneous generation, we are bewildered to find that Mr. Spencer unequivocally repudiates the former, and somewhat evasively repudiates the latter, thus rejecting not only the popular view, but also the view necessitated by his own philosophy. Instead of trying to solve the problem of the first origin of life, he, like Mr. Darwin, ignores it altogether, — a procedure perfectly legitimate in the "scientist," but wholly illegitimate in the philosopher. His rejection of the special-creation hypothesis is very explicit; his

acceptance of the evolution hypothesis is equally explicit. Yet all that he has to say concerning the hypothesis of spontaneous generation, which is an integral part of the evolution hypothesis, is contained in a foot-note of less than four lines, and that an almost contemptuous allusion! In reference to an innovation of his own in the use of the word *heterogenesis*, he remarks: "Unfortunately, the word *heterogenesis* has been already used as a synonyme for 'spontaneous generation.' Save by those few who believe in 'spontaneous generation,' however, little objection will be felt to using the word in a sense much more appropriate."* From this passage it is impossible to avoid the inference that Mr. Spencer wishes to imply his disagreement with "those few who believe in spontaneous generation." Any other interpretation would be inconsistent with the respect due to manifest moral sincerity and intellectual courage. For the same reason the supposition is wholly untenable, that, believing spontaneous generation to have occurred in the past, he would disavow belief in it, on the ground that it is not known to occur under existing cosmical conditions. The impression is unavoidably given by the spirit of the passage quoted, that Mr. Spencer regards the hypothesis of spontaneous generation, whether in the past or the present, as unworthy of credence. This impression is strengthened by the following passage, which plainly means evasion of the question of the first origin of life: "Moreover, we have to take into account not only the characters of immediately preceding ancestors, but also those of their ancestors and ancestors of all degrees of remoteness. *Setting out with rudimentary types*, we have to consider," etc., etc.† To "set out with rudimentary types" is to evade the question how those types originated. There being but two conceivable answers to the first great question of philosophical biology, Mr. Spencer apparently rejects both, and offers no other in their stead. It is sufficiently clear, therefore, that he has in this respect signally failed to make biology "illustrate the laws of evolution."

We do not, however, consider Mr. Spencer's disowning of the spontaneous-generation hypothesis as necessarily fatal to it.

* Principles of Biology, Vol. I. p. 210, foot-note.

† Ibid. Vol. II. p. 9.

The development hypothesis, as a whole, is gaining ground every day with reflecting persons of all classes, simply because it is the *only* hypothesis anywhere presented that does not clash with the deep faith of the age in universal law. There are not a few persons who can penetrate deeper than Mr. Spencer has done into the idea of universal evolution, and see that this idea necessitates the assumption of spontaneous generation. In fact, since the spontaneous-generation hypothesis simply supposes the gradual evolution of the lowest forms of life out of inorganic matter, while the special-creation hypothesis supposes the instantaneous creation of the highest forms out of the same inorganic matter, it is clear as noonday that *special creation is neither more nor less than spontaneous generation in its most monstrous form.* The one hypothesis harmonizes with the idea of universal law, the other glaringly contradicts it. Nor is it on philosophical grounds alone that the hypothesis of spontaneous generation rests. Regarded in a purely scientific light, it is strictly an open question. Although incapable of verification in some of its aspects, actual experiments, conducted by men of the highest scientific reputation, justify the statement, that, in other aspects, spontaneous generation may be a normal fact, even at the present time. A few words on this subject will not, we trust, be deemed out of place.

In its widest sense, *generatio æquivoca*, or "spontaneous generation," called also *spontéparité* by Dugès, and *heterogenesis* by Burdach, means *the coming into existence of an organized being otherwise than by parentage.* The phrase is by no means intended, as vulgarly supposed, to signify *fortuitous* generation, that is, to imply the absence of causation; it does imply that organisms of the lowest order may originate in appropriate media in other ways than by ordinary reproduction, but it also implies the action of natural causes and the invariability of natural laws in the most rigorous sense of those words. The processes of heterogenesis, if facts, are conceived to be as truly regulated by the laws of Nature as the commonest facts of observation; there can be no more "chance" in the one case than in the other. The hypothesis of heterogenesis assumes no deviation from universal laws; whereas the hypoth-

esis of special creations, postulating the sudden apparition, without parentage, of the most highly developed animals and plants, and that, too, confessedly by supernatural volitions, takes for granted a kind of spontaneous generation which is utterly irreconcilable with universal order. Every objection, therefore, brought against the former hypothesis tells with tenfold force against the latter. Either hypothesis is consistent with theism; the former alone is consistent with faith in the harmonious economy of the universe. Much of the popular repugnance to the doctrine of heterogenesis arises from its supposed atheistic tendencies; whereas such tendencies no more exist in this than in any other doctrine which implies the strict universality of natural law. Apart, however, from all theological prejudices, it encounters a formidable obstacle in the justifiable demand of science itself, that all genesis of new organisms shall be explained by parentage until genesis without parentage is proved, — that the law of homogenesis shall be assumed to be strictly universal, until a complementary law of heterogenesis is experimentally established. Harvey's famous maxim, *Omne vivum ex ovo*, as amended by Charles Robin into *Omne vivum ex vivo*, and by Milne Edwards into *Tout corps vivant provient d'un corps qui vit*, unquestionably justifies the opponents of heterogenesis from the standpoint of positive science, and throws the burden of proof upon its advocates. But, looking at the question from a higher point of view, the scientific advantage seemingly gained by rejecting heterogenesis is more than offset by the greater philosophical disadvantage of not being able to explain the first origin of life without having recourse to miracle. If life ever originated without miracle, it is fairly presumable, that, under similar conditions, it so originates now. Whether the conditions are now similar or not experiment and observation must decide. But the nebular hypothesis would necessitate the admission that there was a time when no organisms existed, — that there was a time, consequently, when a first organism appeared. This first organism must be supposed to have been naturally evolved out of inorganic matter by heterogenesis, or else to have been miraculously created by supernatural intervention, — a supposition as contrary to the spirit of positive science as it is to the spirit

of philosophy. The question of the first origin of life cannot always be ignored by scientific thinkers; and when it is once fairly raised, the burden of proof is transferred to the advocates of universal homogenesis, who must explain the apparition of the first organism, which *ex hypothesi* had no parents, as best they can.

The chasm, however, between homogenesis and heterogenesis is not so wide as is commonly supposed. In the last analysis *all generation is spontaneous*. Throughout the entire animal kingdom, generation commences by ovules, which exist as organisms prior to fecundation.* Heterogenesis is not supposed to create suddenly an adult organism, but to proceed in the same way as normal ovulation, which must be itself spontaneous in the commencement.† As in the tissue of the stroma an ovule spontaneously originates under appropriate conditions, so it is supposed to originate by heterogenesis in other proligerous substances. That ovules, thus spontaneously originated, may develop into living individuals without the previous process of fecundation, is shown by the singular phenomena of so-called *parthenogenesis*, as illustrated in the case of certain *Lepidoptera*, in some species of which the males have never been found.‡ Nothing more than this is supposed to take place in heterogenesis, except that the nutritive medium in which the germ originates is different. "It is surprising," says M. Pouchet, "that we should have to wait till the nineteenth century for the discovery that the initial process in both forms of generation is precisely the same." § In either case, that "tendency to individuation," by which Schelling defined life, mani-

* Théorie Positive de l'Ovulation Spontanée et de la Fécondation des Mammifères et de l'Espèce Humaine. Par F. A. Pouchet. 1847. pp. 27–73.

† "Nous devons insister sur ce point, c'est que la génération primaire ne produit jamais un animal de toutes pièces, mais que seulement elle engendre des *ovules spontanés* dans le milieu proligère, absolument sous l'empire des mêmes forces qui façonnent des ovules dans le tissu de l'ovaire." Pouchet, Hétérogénie, 1859, p. 326; so p. 665.

‡ Principles of Biology, Vol. I. p. 215. So also Mr. Darwin: "Ovules occasionally, and even in some cases frequently, become developed into perfect beings without the concourse of the male element. J. Müller and others admit that ovules and buds have the same essential nature." Animals and Plants under Domestication, Vol. II. p. 431.

§ Hétérogénie, p. 15.

fests itself under appropriate circumstances in the formation of a new individual. "There is, however, one fact implying that function must be regarded as taking precedence of structure. Of the lowest rhizopods, which present no distinction of parts, and nevertheless feed and grow and move about, Professor Huxley has remarked that they exhibit life without organization." * Whether in homogenesis or heterogenesis, life must first manifest itself in the production of a germ in an appropriate medium of environment, — manifest itself without antecedent organization, — manifest itself in peculiar motions and arrangements of matter not explicable by any known causes in the environment; and the question at issue between the two hypotheses is simply this: Are previously existent organisms the only natural media productive of such germs? The modes of reproduction known as fission and gemmation (*scissiparité* and *gemmiparité*), which are still farther removed from ordinary gamogenesis than even the phenomena of parthenogenesis, seem to stand as connecting links between the two extremes of ovarian and "equivocal" generation. Here, too, the philosopher must accept the maxim, *Natura non facit saltum.* If Mr. Darwin, in the acknowledged paucity of intermediate forms, may reasonably appeal to the "imperfection of the geological record" in behalf of the natural evolution of species, so may the heterogenist, with equal reasonableness, appeal to the imperfection of the biological record in behalf of the natural evolution of life itself. Whether the appeal is reasonable or unreasonable, it is, at least, a logical necessity of the development hypothesis in both cases.

M. Milne Edwards conveniently divides the question of spontaneous generation.† Designating production by parentage as homogenesis, and production without parentage as heterogenesis, he divides the latter into the three following classes: —

1. Agenesis, or the formation of a living being by the spontaneous organization of non-living matter.

2. Necrogenesis, or the formation of living beings in conse-

* Principles of Biology, Vol. I. p. 153.

† Leçons de la Physiologie et de l'Anatomie Comparée de l'Homme et des Animaux, 1863, Vol. VIII. p. 251. The entire Seventy-first Lecture (pp. 237 – 298) is devoted to a discussion of the theory of spontaneous generation, which is strongly opposed.

quence of the dissociation of the parts of a dead organism, which, as parts, should still preserve the faculty of living, and of developing into new organic forms.*

3. Xenogenesis, or the formation of living beings by the physiological action of a living organism which should transmit to them the principle of life without impressing on them its own organic characters; the new being would not be of the same nature as its parent, and would represent a different species.

We have no space to devote to the history of the hypothesis of heterogenesis, which, however, has the authority of many of the most eminent names in science, both ancient and modern; but we cannot dismiss the subject without saying that the most recent and most trustworthy experiments tend as much to confirm as to invalidate the hypothesis, on the whole. The investigations of M. Pouchet, an ardent advocate, and of M. Pasteur, an equally ardent opponent of this hypothesis, have given fresh interest to the question within the last few years. Very recently M. Donné has performed experiments which render it probable that heterogenesis is a fact; † and this probability is increased by the results obtained in England by Dr. Child, and in this country by Professor Jeffries Wyman, whose reputation for accuracy and impartiality has no superior.‡ After comparing

* This would be in virtue of what M. Milne Edwards himself recognizes as a physiological fact under the name of "l'indépendance biologique des particules constitutives de l'économie animale" (p. 249), and explains more fully a little later, illustrating it by the hematic globules, etc. (p. 273). M. Claude Bernard, Virchow, and other eminent physiologists, recognize the same fact.

† "Je prends des œufs de poule, je pratique une ouverture à leur sommet, je perce le jaune à l'aide d'un stylet préalablement rougi au feu, et je laisse écouler un tiers environ de sa matière intérieure; je remplis le vide avec de l'eau *distillée* bouillante, je ferme l'ouverture hermétiquement avec de la cire ramollie qui se fond au contact de l'œuf chaud et adhère exactement autour du trou. J'abandonne ces œufs à la température de mon cabinet, variant de 17 à 24 degrés. Cinq jours d'après, j'enlève le bouchon de cire, et j'examine la matière de l'œuf au microscope. Elle fourmille de vibrions d'une grande activité. Je ne crois pas pouvoir mieux répondre aux objections de M. Pasteur. D'où proviendraient, en effet, les germes de ces vibrions? On ne peut raisonnablement admettre qu'ils pré-existent dans la matière de l'œuf; j'ai démontré qu'il n'en existe jamais dans les œufs abandonnés à leur décomposition naturelle. On ne dira pas non plus, je pense, qu'ils sont contenus dans l'eau distillée." Cosmos, Revue Encyclopédique Hebdomadaire des Progrès des Sciences, 16 Janvier, 1867, p. 84.

‡ American Journal of Science and Arts, September, 1867, pp. 152–169.

the various degrees of temperature shown by trustworthy evidence to be compatible with organic life in various thermal springs in Nature, and concluding that 208° Fahrenheit is its extreme limit of endurance, as thus far determined by observation, Professor Wyman minutely describes a long series of delicate and ingeniously devised experiments conducted by himself for the purpose of ascertaining "how far the life of certain low kinds of organisms is either sustained or destroyed in water which has been raised to a high temperature." The most remarkable of these experiments showed that seven flasks, hermetically sealed, and containing a boiled solution of "extract of beef" (Borden's concentrated juice of beef, evaporated to a nearly solid substance, free from tissues and entirely soluble), became the seat of infusorial life *after being continuously boiled for four hours*, — three of the flasks on the second day, and four of them on the fourth day. If the boiling was prolonged to five hours, as was done with other flasks, no infusoria appeared. If the infusoria thus developed in hermetically sealed flasks, after prolonged boiling for four hours, came from germs or spores previously existent in the organic solution,* then these germs or spores must be capable of resisting the destructive action of boiling water during that period of time; but if these germs or spores are incapable of resisting the destructive action of boiling water during so long a period, then the developed infusoria must have been generated spontaneously, that is, independently of pre-existent organisms. To determine this point, if possible, Professor Wyman instituted additional experiments. The usual signs of life manifested by infusoria being locomotion, growth, and reproduction, and initiation of the processes of fermentation or putrefaction, he inferred that "inactivity in the presence of organic material suitable for nourishment, and of air at the ordinary temperature, added to the absence of the other signs of life, must be considered as the best indication of death." Experiment showed that all motion of the vibrios

* "Soit une infusion organique qui a subi l'ébullition. Exposée à l'air, elle s'altère, elle montre en très-peu de jours des cryptogames ou des infusoires. Eh bien, il est prouvé par mes expériences que son altération est uniquement due à la chute des particules solides que l'air charrie toujours. Rien, rien d'autre n'est la cause de la vie dans les infusions *qui ont été portées à l'ébullition.*" L. Pasteur, Leçons de Chimie et de Physique, 1862, pp. 243, 244.

ceased at about 135° Fahrenheit, and all motion of the ciliated infusoria ceased at less than 130°; and that "the solutions to which *boiled* infusoria were added did not become invaded by animalcules sooner than those to which none had been added, while those to which *unboiled* infusoria were added were in all cases invaded at least one day, and in some two or three days, earlier." These results confirm the opinion of Spallanzani himself, perhaps the most determined opponent of heterogenesis, that the action of boiling water a little prolonged destroys the vitality, not only of developed animals and plants, but also of their eggs and seeds, and render the hypothesis of heterogenesis by far the most plausible explanation of the appearance of infusoria in organic solutions, after continuous boiling for four hours in hermetically sealed flasks. To dismiss the whole subject of spontaneous generation, therefore, as Mr. Spencer has done, with a polite shrug of the shoulder, instead of at least honoring with his opposition a theory associated with the names of such men as Buffon, Oken, Lavoisier, Bremser, Treviranus, Tiedemann, Burdach, J. Müller, Dugès, Dujardin, Eudes Deslongchamps, A. Richard, Pouchet, Joly, Donné, Professor Wyman, and Professor Owen (whom Milne Edwards calls *l'anatomiste le plus éminent que l'Angleterre possède aujourd'hui*), does little credit to Mr. Spencer either as student of science or philosopher, especially when this theory is self-evidently a corollary from his own fundamental principles.

To the second great question of philosophical biology, namely, the origin of species, we have already seen that Mr. Spencer returns substantially the same answer as Mr. Darwin. The first seven chapters of Part III. of his "Principles of Biology" give an admirable summary of arguments tending to prove that species have been naturally evolved, rather than supernaturally created. For the phrase *natural selection* employed by Mr. Darwin, Mr. Spencer occasionally substitutes the phrase *survival of the fittest*, which is in some respects a clearer and more scientific name for the great principle indicated. So far as the origin of species is concerned, a more methodical form of statement is the chief gain which the development theory has received in Mr. Spencer's hands; and recognizing the full value of this gain, we pass on to give a

careful consideration to his answer to the third great question, What are the causes of organic evolution?

The "Synthetic Philosophy" teaches that "all phenomena are incidents in the redistributions of matter and motion," * that all phenomena conform to one and the same "law of evolution," † and that in all phenomena the change which constitutes evolution "is *a change in the arrangement of parts*, — of course using the word *parts* in its most extended sense, as signifying both ultimate units and masses of such units." ‡ From the nature of these principles, therefore, it is under the necessity of seeking to formulate all phenomena in mechanical terms, not by way of metaphor or mere analogy, but in conformity with the fundamental assumption (everywhere made, though nowhere distinctly stated) that *philosophy is universalized mechanics*. The "Principles of Biology," as might be inferred from these premises, is an elaborate defence of the mechanist theory of organic evolution, the essence of which theory is the principle that all vital processes and actions are explicable as, in the last analysis, mechanical or physico-chemical phenomena, and that every organism is a living mechanism, originated and developed solely by the forces recognized by mechanics and chemical physics. In other words, the organism is directly or indirectly the product of the environment alone, exhibiting no phenomena that require the recognition of any force or forces to be called *vital* in any special sense. This theory Mr. Spencer advocates in its extreme form, since his philosophy necessitates the interpretation of even chemical phenomena as, at bottom, merely complex manifestations of the universal laws of mechanics; and he avows this theory with honorable frankness. "For those progressive modifications upon modifications which organic evolution implies we find *a sufficient cause* in the modifications upon modifications which every environment over the earth's surface has been undergoing, throughout all geologic and pre-geologic time." § Mr. Spencer accordingly maintains that no forces other than general cosmical forces are concerned in the evolution of organized beings; that all so-called vital phenomena being expli-

* First Principles, p. 499.
† Ibid. p. 148.
‡ Ibid. p. 221.
§ Principles of Biology, Vol. I. p. 465.

cable as direct or indirect effects, cumulative through the ages, of external forces in the environment, it is quite unnecessary to assume any force or forces which need be regarded as vital in any peculiar sense. We now proceed to show that the general answer thus given to the third great question of philosophical biology is developed in detail into perhaps the most perfect form which the mechanist theory has yet assumed.

The last seven chapters of Part III.* discuss the causes of organic evolution as illustrated in the gradual origination of species. In Chapter VIII. Mr. Spencer criticises, as crude, the successive phases of the development theory advocated by De Maillet, Dr. Erasmus Darwin, Lamarck, the author of "Vestiges of Creation," and Professor Owen, because they attribute evolution to some "intrinsic proclivity," "inherent tendency," or "innate aptitude," existing in organisms and gradually moulding them into higher and higher forms. "In whatever way it is formulated," says Mr. Spencer, "or by whatever language it is obscured, this ascription of organic evolution to some aptitude naturally possessed by organisms or miraculously imposed on them is unphilosophical. It is one of those explanations which explain nothing, — a shaping of ignorance into the semblance of knowledge. The cause assigned is not a true cause, not a cause assimilable to known causes, not a cause that can anywhere be shown to produce analogous effects. It is a cause unrepresentable in thought, — one of those illegitimate symbolic conceptions which cannot by any mental process be elaborated into a real conception. In brief, this assumption of a persistent formative power inherent in organisms, and making them unfold into higher forms, is an assumption no more tenable than the assumption of special creations: of which, indeed, it is but a modification, differing only by the fusion of separate unknown processes into a continuous unknown process." † Instead of assuming any such fictitious causes, Mr. Spencer attributes evolution solely to "the changing incidence of conditions." ‡ This changing incidence of conditions he proceeds to analyze, in

* Principles of Biology, Vol. I. pp. 402 - 475.

† Ibid. p. 404.

‡ Ibid. p. 409 : compare p. 467.

Chapters IX. and X., into "external factors" and "internal factors": the former comprising astronomic, geologic, meteorologic, and external organic changes (that is, changes in surrounding organisms); and the latter comprising loss of homogeneity, multiplication of effects, and increasing definiteness of consequent differentiations. But these internal factors must not be supposed to be in any sense independent factors or con-causes; they are themselves merely the *results* of the external factors, — merely the *mechanical reaction* of organisms against the action of external forces, — which by gradual accumulation in the course of innumerable generations work a gradual change in the structural and functional characteristics of species. "We find progression to result, not from a special inherent tendency of living bodies, but from a general-average effect of their relations to surrounding agencies." * In Chapters XI. and XII. are explained the principles of "direct and indirect equilibration," by which "perturbations produced in the moving equilibrium of any organism" result in the establishment of a "new moving equilibrium, adjusted to the new arrangement of external forces," and which thus, by inward changes induced from without, adapt the organism to a changed environment. "What is ordinarily called adaptation is, when translated into mechanical terms, direct equilibration; and that process which, under the name of natural selection, Mr. Darwin has shown to be an ever-active means of fitting the organisms to their circumstances, we find, on analysis, to be expressible in mechanical terms as indirect equilibration." † In Chapter XIII. is explained the co-operation of the internal and external factors in producing the general result of organic evolution; and in Chapter XIV. is pointed out the convergence of the evidences which lead to the final establishment of the evolution hypothesis. Thus the organism is shown to be the exclusively mechanical product of the environment, without any concurrent cause whatever manifesting itself in the organism in any peculiar way; these external and internal factors, constantly co-operating, *include all the causes of organic evolution*, and any reaction of the organism on the environment, however seemingly spontaneous, is merely part

* Principles of Biology, Vol. I. p. 430. † Ibid. p. 466.

of the multiplication of effects produced in the first instance by the incident forces and mechanically reflected upon them.

Mr. Spencer has thus given, if not an adequate, at least a consistent and ingenious, explanation of the evolution of species, without having recourse to any but mechanical conceptions and mechanical terms. That the same laws which govern the evolution of species must also govern the evolution of individuals, and that the mechanist theory, if applied to the explanation of the one, must be as rigorously applied to the explanation of the other, no one more clearly perceives than Mr. Spencer, as appears from the following passage: "Those universal laws of the redistribution of matter and motion, to which things in general conform, are conformed to by all living things, whether considered in their individual histories, in their histories as species, or in their aggregate history."* To assume, therefore, in the explanation of evolution as illustrated in individual organisms, any "tendency" or "aptitude" not explicable by mechanical conceptions and expressible by mechanical terms (an assumption which we have already seen to be most severely reprehended by Mr. Spencer) would be manifestly to violate the cardinal principle of the mechanist theory, and undermine, not only the "Biology," but also the whole "Synthetic Philosophy." After Mr. Spencer's emphatic condemnation of all such assumptions, when made by the earlier advocates of the development hypothesis, we are certainly justified in the expectation that Mr. Spencer himself, in converting this hypothesis into a philosophy of organic evolution, will be especially on his guard against making any similar assumptions. Clearly, by Mr. Spencer's own confession, it would make no difference whether the assumed "tendency," or "aptitude," or "power," should be held to inhere in all the individuals of a species, gradually developing it into higher and divergent forms, or in all the tissues of an individual, gradually developing it into the common form of its species. In any case, the assumption of an inherent tendency, power, or aptitude, whether "naturally possessed" or "miraculously imposed," would, according to Mr. Spencer himself, be "unphilosophical"; it would be a non-mechanical conception,

* Principles of Biology, Vol. I. p. 464.

utterly at variance with the principle that all biological phenomena must be explained as simple "redistributions of matter and motion"; it would, in Mr. Spencer's own phrase, be "no more tenable than the assumption of special creations"; it would, in short, be an unconditional surrender of the mechanist theory to the vitalist theory, — a voluntary confession of its own incompetence to become the basis of a self-consistent philosophy.

What shall be said, then, of the speculative value of Mr. Spencer's system of biology, if we find it making that very assumption which it so pointedly condemns in others, and that, too, not in mere carelessness of expression, but deliberately and repeatedly? Incredible as it may seem, such is actually the fact. Being unable to explain the normal repair of wasted tissues in accordance with the mechanist theory, Mr. Spencer is driven, much against his will, to offer what he himself has designated as "one of those explanations which explain nothing," namely, the assumption of "inherent tendency or power." "But . . . . the facts cannot be thus wholly accounted for, since organs are in part made up of units that do not exist as such in the circulating fluids. The process becomes comprehensible, however," — (how so, if the offered explanation is merely a "shaping of ignorance into the semblance of knowledge"?) — "if it be shown that . . . . groups of compound units have *a certain power of moulding adjacent fit materials into units of their own form.*" * He then cites certain remarks of Mr. Paget on the permanent effects wrought in the blood by the poison of scarlatina and small-pox, as justifying the belief that such a "power" exists, and attributes the repair of a wasted tissue to "forces analogous to those by which a crystal reproduces its lost apex." (Neither of which phenomena, however, is explicable by mechanical causes.) In the same manner he renders "comprehensible" the ability of an organ to recomplete itself, when one of its parts has been cut off, by assuming in it a "force which constrains the newly integrated atoms to take a certain definite form"; illustrating this "force" by the reproduction of the amputated leg or tail of a lizard, by the development of the fragment of a begonia leaf into a young

* Principles of Biology, Vol. I. pp. 177 – 183.

begonia, and by the growth of the segment of a polyp into a young polyp; and concluding as follows: "We have, therefore, *no alternative* but to say that the living particles composing one of these fragments have *an innate tendency* to arrange themselves into the shape of the organism to which they belong. We must infer that a plant or animal of any species is made up of special units, in all of which there dwells *the intrinsic aptitude to aggregate into the form of that species.* . . . . We are thus *compelled* to recognize *the tendency to assume the specific form as inherent in all parts of the organism.*" To this special power, tendency, or aptitude (singularly enough, the very words here used are the ones so severely criticised, when similarly used by others) Mr. Spencer assigns the special name of *organic polarity*, which he believes to inhere in certain *physiological units* intermediate between the chemical and the morphological units of the tissues. But he nowhere ventures to reduce it to the category of mechanical forces, although half conscious, as his language shows, that the assumption of such a force is an uncomfortable and dangerous excrescence in a philosophy which aims at the mechanical interpretation of all phenomena.

Furthermore, notwithstanding the logical necessities of the "law of evolution," which Mr. Spencer explicitly declares to be invariable throughout the entire history of organisms, *whether as species or as individuals*, we find him abandoning the mechanist theory, to which he had faithfully adhered in explaining the evolution of species, and practically adopting the vitalist theory, when he explains the general causes of the evolution of individuals. Forgetting his own unqualified condemnation of all ascription of organic evolution to "aptitudes" or "tendencies," he makes the very same ascription himself, in order to account for the morphological development of each organism according to its own specific type. Two sets of factors, he says, must be taken into account, — "internal organizing forces, tending to reproduce the ancestral form, and external modifying forces, tending to cause deviations from that form." These factors of the first class, or the internal organizing forces, are "the *formative tendencies* of organisms themselves, — the *proclivities* inherited by them from antecedent organisms, and

which past processes of evolution have bequeathed"; and they are to be referred, in the last analysis, to that "organic polarity" already described.* Here, then, we have occult properties or "tendencies," naturally possessed by organisms, assigned by Mr. Spencer as true causes of morphological evolution, in manifest oblivion of his previous emphatic rejection of all such tendencies, "whether *naturally possessed* or miraculously imposed."

It will be noticed, however, that Mr. Spencer attributes the possession of these "tendencies," or "proclivities," to natural inheritance from ancestral organisms; and it may be argued that he thus saves the mechanist theory and his own consistency at the same time, inasmuch as he derives even the "tendencies" themselves ultimately from the environment. To this we reply, that Mr. Spencer, who advocates the nebular hypothesis, cannot evade the admission of an absolute commencement of organic life on the globe, and that the "formative tendencies," without which he cannot explain the evolution of a single individual, could not have been inherited by the first organism. Besides, by his virtual denial of spontaneous generation, he denies that the first organism was evolved out of the inorganic world, and thus shuts himself off from the argument (otherwise plausible) that its "tendencies" were ultimately derived from the environment. Lastly, even if we pass over these difficulties, it would be preposterous to claim that *an inherited tendency to reproduce a previously existent type of organic structure* can be accounted for by any principles known to mechanics. This reproduction of ancestral forms is a strictly biological phenomenon, upon which mechanics throws not the faintest glimmering of light; and Mr. Spencer's "formative tendencies," even if suffered to stand as a convenient name for an unknown cause, must stand wholly outside of the mechanist theory.

Nothing can be plainer than that the "organic polarity of the physiological units," by which Mr. Spencer would render "comprehensible" the processes of organic repair and organic evolution of individuals, is a conception of the same order with the "tendency to higher forms" of the early

* Principles of Biology, Vol. II. pp. 8, 9.

pioneers of the development theory, — with the "physiological soul" of Stahl, the "archæus" of Van Helmont, the "nisus formativus" of Barthès, the "force vitale" of Bichat, the "vegetative force" of Needham, the "force génésique" of Pouchet, the "idée créatrice" of Claude Bernard, the "propriétés élémentaires des tissues" recognized even by the Comtists, etc., etc. If the use of such phrases is really an attempt to explain the *ignotum per ignotius*, — if the naming of the force which manifests itself in biological phenomena is meant for anything more than a frank avowal of ignorance, a simple recognition of facts not to be classed with purely mechanical or physico-chemical facts, — then we see no reason why Dr. Darwin's or Lamarck's "tendency to higher forms" is not quite as respectable, in a philosophical point of view, as Mr. Spencer's "formative tendencies" or "organic polarity." Having to work out its problems with fewer equations than it has unknown quantities, biology can find no solution which does not involve terms of x and y; and this seems the only valid defence for the use of such phrases. However this may be, it is sufficiently plain, that, on the one hand, Mr. Spencer assigns to an occult force a large share in the causation of the evolution of the individual, while, on the other hand, he assigns no place to it among the acknowledged causes of the evolution of the species, thus forgetting his own admission that the law of evolution must be in both cases the same. Shall his "organic polarity" take rank with the "external factors" or the "internal factors" by the co-operation of which he explains the evolution of species? If with the latter, shall it be reduced to "loss of homogeneity," or to "multiplication of effects," or to "increasing definiteness of consequent differentiations"? The truth is, that, while aspiring to explain all things by strictly mechanical conceptions, Mr. Spencer has very inadvertently admitted into his philosophy a conception which is in no sense a mechanical one; and its admission is tantamount to a confession that the philosophy itself is too narrow for the facts, that it cannot interpret them all as mere "redistributions of matter and motion," that it must either step outside of the mechanist theory or fail to recognize phenomena of the highest importance. It is certainly to Mr. Spencer's credit as a conscien-

tious thinker that he has fairly confronted facts which he cannot reconcile with the mechanist theory, but it is by no means to his credit as a philosophical thinker that these obdurate facts have not induced the relinquishment of the theory itself. The necessity of a non-mechanical conception, in a system whose corner-stone is the assumption that all phenomena can be mechanically interpreted, is fatal to its philosophical integrity.*

If it be said, that, in undertaking to formulate all phenomena in mechanical terms, Mr. Spencer does so in a metaphorical sense, using these terms merely for the sake of showing the essential identity of evolution in all its aspects, it must be replied, that metaphor in philosophy is a dangerous luxury, and has in this case created great confusion, — to say nothing of the singularity of writing ten volumes to prove the propriety of a metaphor. It is doubtless true that the description of biological phenomena in mechanical terms sounds exceedingly metaphorical, — which is the fault of the phenomena themselves, obstinately persisting in being biological rather than mechanical. But the supposition that Mr. Spencer means to use mechanical terms in a merely metaphorical sense is contradicted not only by his language, but also by his thought. This is sufficiently shown by his theory of the causation of organic evolution. Yet, if further proof is desired, it may be found in his theory of the production of the vertebral column by the mechanical effects of "transverse strains" (Vol. II. pp. 192 – 209), and his cognate theory of the production of massiveness in tree-trunks by similar mechanical causes (Vol. II. pp. 258 – 262). The possible defence, therefore, that, in trying to formulate biological phenomena in mechanical terms, Mr. Spencer merely uses language in a metaphorical or analogical sense, cannot stand the test of critical scrutiny; and the conclusion is unavoidable, that his real object is to account for all biological phenomena by the action of mechanical causes. His theory of "organic polarity," however, which by his own confession is indispensable in the explanation of histological changes,

* Since writing the above we have found in the Westminster Review for July, 1865, a somewhat similar exposition of the incongruity between Mr. Spencer's general principles and his theory of "organic polarity," which confirms the truth of the criticisms here made.

is the reluctant admission of a peculiarly *vital* manifestation of force, necessitating the further admissions that other than mechanical forces are co-operative with these in organic evolution, that the organism is something more than a mere machine or "moving equilibrium between internal and external forces," and that the mechanist theory, which he has adopted, utterly breaks down, when brought to the *experimentum crucis*. In other words, Mr. Spencer is constrained virtually to admit, that, after all, life is not mechanical, and philosophy is not mechanics.

The chief feature of the mechanist theory, as we have seen, is its attempt to explain the power of development and adaptation by which the organism fits itself to its surroundings as a purely mechanical reaction against the action of incident forces, — to identify all vital processes with the purely mechanical process of equilibration, direct and indirect, between the organism and the environment. But its chief feature is its radical vice. The power of adaptation to outward conditions cannot be derived *from* them, unless it exists *in* them; and if it be argued that cosmical forces are simply *transformed* into vital forces, according to a law of exact quantitative equivalence, it remains true, notwithstanding, that the *power of transformation* is unborrowed from without. The constructive and restorative energies, by which every young organism *more than balances* outward influences, subordinates these to its own capacity of growth, develops itself by means of them into its own specific type, and during its whole existence preserves this type by an unceasing process of histological renovation, nowhere manifest themselves in the inorganic environment. It is impossible, therefore, to derive them from without, or resolve organic evolution into mechanical equilibration. The external forces are more than equilibrated by the internal forces; more exists in the reaction than appears in the action; and it is the recognition of this *more* that distinguishes the vitalist theory from the mechanist theory. Mechanics may explain the evolution of the solar system out of universal nebula; but it cannot explain the evolution of living beings out of germs. The phenomena in the two cases are of different orders. In the one case there is no increase of mass, no assimilation of external sub-

stances, no adaptation to incident forces, no development of inherited form, no transmission of modified form; in the other case all these exist. The nebular hypothesis, therefore, implies only mechanical forces; but the development hypothesis, whether accounting for the evolution of species or of individuals, implies forces which may properly be distinguished as vital. It is not part of the working of any mere mechanism to originate new adaptations in order to meet new necessities; and the development hypothesis implies that such adaptations are continually making by organisms. Admitting, for the sake of argument, that the vertebral column may have been generated by the differentiating effects of transverse strains, this process of development itself presupposes the operation of an adaptative force other than mechanical. Purely mechanical effects should be exhibited in a dead as well as in a living organism, if both were subjected to the same transverse strains; but the presence or absence of what we ignorantly call life would make the difference between development and non-development of the vertebral column. Similarly, the subjection of a dead tree-trunk to transverse strains could never produce that increase of massiveness which Mr. Spencer has so ingeniously shown to follow in the case of a living tree: gradual weakening and ultimate rupture would be the purely mechanical effects. It is life in the organism, not incident forces outside of it, which must be regarded as the primary and unknown cause of biological development and adaptation; and the mechanist theory, refusing to recognize the speciality of vital phenomena, or recognizing it as in the last analysis only a peculiarly complex manifestation of mechanical forces, is a practical evasion of the problem to be solved. Professing to answer a question which the vitalist theory regards as at present unanswerable, it is an assumption of knowledge to cover the fact of ignorance, a substitution of pseudo-solutions for uncomfortable enigmas. Over the profound mysteries of organic evolution it spreads a thin crust of superficial explanations, and then fancies it has filled up the great quicksand which has engulfed so many theories. But the quicksand is there still.

It is an instructive fact, that, by whomsoever advocated, the mechanist theory is always necessitated to incorporate into

itself non-mechanical elements, when it comes to explain in detail the causes of organic evolution. In his latest work Mr. Darwin inclines to adopt the mechanist theory, so far as the causes of variation are concerned. "We will now consider," he says, "the general arguments, which appear to me to have great weight, in favor of the view that variations of all kinds and degrees are directly or indirectly caused by the conditions of life to which each being, and more especially its ancestors, have been exposed. . . . . These several considerations alone render it probable that variability of every kind is directly or indirectly caused by changed conditions of life. Or, to put the case under another point of view, if it were possible to expose all the individuals of a species during many generations to absolutely uniform conditions of life, there would be no variability." * When variations of all kinds and degrees, that is, all the gradual differentiations by which the vast multitude of existing species has been evolved out of the primordial form or forms, are thus attributed solely to the cumulative action of the conditions of life, without any recognition of a concurrent cause in that constant self-adaptation by organisms for which the conditions of life cannot account, it would seem fairly inferrible that the mechanist theory is supposed to explain the evolution of species, if not of individual organisms. This inference appears to be in some degree confirmed by Mr. Darwin's evident dislike of all terms that imply any real speciality in vital forces,† — a dislike certainly justifiable, so far as it springs from a desire to substitute the known for the unknown, but not justifiable, if it leads to the adoption of insufficient explanations. On the other hand, in speaking of the "co-ordinating and reparative power which is common, in a higher or lower degree, to all organic beings," he makes use, although apparently under protest, of the phrase *nisus formativus;* ‡ and so far lends his sanction to the vitalist

* Variation of Animals and Plants under Domestication, Vol. II. pp. 306, 308.

† "We thus get rid of such vague terms as spermatic force, the vivification of the ovule, sexual potentiality, and the diffusion of mysterious essences or properties from either parent, or from both, to the child." Ibid. — Author's Preface to the American edition.

‡ Ibid. Vol. II. pp. 353 - 356.

theory, when he refers to the evolution of individual organisms. But whether Mr. Darwin inclines to embrace the mechanist theory in whole or in part only, he finds himself unable to construct his new hypothesis of "pangenesis," by which he seeks to rationalize the facts of reproduction and evolution of individuals, without the use of conceptions quite as "vague" as those he condemns.* He supposes in all the cells of the organism a capacity of "throwing off" certain free, reproductive granules or atoms of inconceivable minuteness, which he calls "gemmules," and which, circulating freely through all parts of the system, are aggregated into buds or into the sexual elements in virtue of a peculiar "mutual affinity." These gemmules depend for their development upon union with other nascent cells or units, and are capable of transmission in a dormant state to successive generations. "Thus an animal does not, as a whole, generate its kind through the sole agency of the reproductive system, but each cell generates its kind. . . . . Each living creature must be looked at as a microcosm, a little universe, formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars in heaven." The hypothesis of "pangenesis" thus rests on the assumption of various special powers not manifested outside of the organism, — a power in all cells of throwing off reproductive gemmules (apparently by some other process than fission, gemmation, or any known mode of self-multiplication), a power in the gemmules of uniting with each other and of aggregating in certain parts of the organism, and a power in the gemmules thus aggregated and brought into relation of "becoming developed into cells like those from which they were derived," which is quite as "mysterious" as the power usually assumed in the fertilized germ of becoming developed into a form like that of its parent organisms. The problem of the causation of inheritance of structure is thus transferred from the entire organism to its constituent cells; it is pushed one step farther back, but remains essentially the same problem still. We cannot see that Mr. Darwin has done much more than to multiply unknown quantities, introduce as many "vague" conceptions as he "gets rid of," and raise quite as

* Variation of Animals and Plants under Domestication, Vol. II. pp. 428 - 483.

many new questions as he answers old ones. The point to be here noted, however, is that his hypothesis is quite outside of the circle of mechanical conceptions, and does not even profess to be framed with any reference to the mechanist theory. It has the advantage, in this latter respect, over Mr. Spencer's hypothesis of "organic polarity," since it is not offered as part of a philosophical system with whose general principles it should harmonize; but it reminds us none the less forcibly of the necessary incongruity of the mechanist theory with the facts of organic evolution, and suggests the pertinent inquiry whether a larger theory is not necessitated by the very idea of evolution as the basis of a universal philosophy.

A still more striking illustration of the same necessity, inherent in biology, of recognizing an order of phenomena distinct in kind from all phenomena of the inorganic world, and therefore inexplicable by purely mechanical or physico-chemical causes, occurs in a recent essay by one of the most eminent physiologists of France, M. Claude Bernard, published in the *Revue des Deux Mondes* for December 15, 1867, and entitled *Le Problème de la Physiologie Générale.* The essay is at once so interesting in itself and so germane to our subject, that we hope to be pardoned for making somewhat copious extracts from its pages in the following translation. M. Bernard, referring to the two antagonistic schools of physiologists (*les physiologistes animistes ou vitalistes* and *les physiologistes chimistes physico-mécaniciens*), declines to identify himself with either; but it will be noticed, that, in his desire to be impartial, he involves himself in contradiction by adopting each of the two opposing theories.

"The phenomena of life are as rigorously and as absolutely determined as those of the mineral kingdom. I admit, that, considered in their various forms of manifestation and in their essential nature, they possess, at the same time, a speciality of form which distinguishes them as phenomena of life, and a generality of law which assimilates them with all the other phenomena of the cosmos. In other words, I recognize in all vital phenomena special processes of manifestation; but, at the same time, I regard them also as all derived from the ordinary general laws of mechanics and chemical physics. There are,

in fact, in living organisms anatomical apparatuses or organic tools which are peculiar to them, and cannot be imitated outside of them; but nevertheless the phenomena manifested by these organs or living tissues have nothing special either in their nature or in the laws which govern them. That is a proposition which the progress of the physico-chemical sciences demonstrates more and more clearly every day, by showing that the phenomena which take place in living bodies can equally take place externally to the organism in the mineral kingdom. . . . . In the living being, I repeat, the chemical phenomena are realized by means of vital processes and of organic chemical reagents which are created by histological evolution, and which are consequently special to the organism and inimitable by the chemist. In the mechanical or physical order, vital phenomena are equally indistinguishable from mechanical or physical phenomena in general, except by the instruments which manifest them. The muscles, the nerves, the organs of sense, are only mechanical implements peculiar to living beings. In reality, therefore, general physics, chemistry, and mechanics include all the manifestations of Nature, organic as well as inorganic. All the phenomena which appear in a living body obey laws external to it, so that it might be said that all the manifestations of life consist of phenomena derived, as to their nature, from the external cosmos, but possessing a special morphology in the sense that they are exhibited under characteristic forms and by means of special physiological instruments. In the physico-chemical relation, life is only a special mode of the general phenomena of Nature; *it originates nothing, it borrows its forces from the exterior world, and does but vary their manifestations in countless ways.* Might it not even be added, that intelligence itself, whose phenomena mark the highest expression of life, is revealed externally to living beings in the harmony of the laws of the universe? But nowhere else than in living beings is it translated by instruments which manifest it to us under the form of sensibility and will. Thus would be found realized the ancient thought, that the living organism is a *microcosm* which reflects in itself the *macrocosm.*

"From what precedes," continues M. Bernard, "it evidently

follows that the physiologist, the chemist, and the physicist have only, in reality, to consider phenomena of the same nature, which must be analyzed and studied by the same method, and reduced to the same general laws. The physiologist, however, has to deal with peculiar processes which inhere in organized matter, and hence constitute the special object of his studies. . . . . The physicist and the chemist explain phenomena by the properties of the inorganic elements. The physiologist must in like manner investigate in the living being the organic elements in which functions are localized, and determine the conditions of vital activity in those elements on which he can act. The organic elements of living bodies are the anatomical or histological elements into which our organs and tissues are decomposable. Science has shown that a living body, however complex, is always constituted by the union of a greater or less number of elementary microscopic organisms, whose various vital properties manifest the different functions of the entire organism. Hence it follows that each function must have its corresponding organic element, and the object of general physiology is accurately to analyze the complex functional mechanisms in order to reduce them to their special vital elements. It is thus that the phenomena of sensibility and of motion are explained by the properties of the nervous and muscular elements, — that the phenomena of respiration and of secretion are deduced from the properties of the respiratory elements of the blood and from the properties of the glandular and epithelial elements. The organic elements of living beings, which generally present themselves under the different forms of fibres or microscopic cells, are the true concealed springs of the living machine. They are mutually associated and combined to form the tissues, the organs, and the apparatuses which constitute the wheel-work of the vital mechanisms. There is, moreover, in every living organism a true *internal environment*, in which the anatomical elements discharge their special functions and pass through all the phases of their existence. The organized or living matter which constitutes the histological elements has no more spontaneity than inorganic or mineral matter; for both require, in order to manifest their properties, the influence of external

stimuli. The spontaneity of living bodies is only apparent. . . . . It is absolutely the same agents or the same influences which excite the properties both of organic and of inorganic matter. . . . . Vital mechanisms, like non-vital mechanisms, are passive. Both simply express or manifest the idea which has conceived and created them. . . . . The animal organism is in reality only a living machine, which works according to the ordinary laws of mechanics and chemical physics, by means of particular processes which are special to the vital instruments constituted by organized matter."

Having thus determined the general relations of biology to mechanics and chemical physics, M. Bernard proceeds to explain the phenomena of organic evolution and renovation.

"The evolution and nutrition of a new being are veritable *organic creations* which take place under our eyes. . . . . Living bodies are unstable compounds which are unceasingly disorganized under the cosmical influences that surround them; they live only on this condition; and organs composed of living matter are used up and destroyed precisely like organs composed of inert matter. In order that life, therefore, should continue, it is necessary that the organized matter which forms the histological elements should be constantly renewed in proportion as it is decomposed; so that we may regard the cause of life as really residing in the organizing force (*la puissance d'organisation*) which creates the living machine and repairs its incessant losses. The ancient animist and vitalist physiologists clearly perceived this double aspect of vital phenomena. For this reason they held that an interior principle of life, which was the creative or regenerative principle, found itself in conflict with the exterior physico-chemical forces which destroy the organism. Nevertheless, if the exterior physico-chemical influences are the causes of death, or the disorganization of living matter, that does not mean, as the vitalists have believed, that there is an incompatibility between the phenomena of life and the physico-chemical phenomena: there is, on the contrary, a perfect and necessary harmony; for the causes which destroy organized matter are those which make it live, that is, manifest its properties. Neither does it prove that there is a combat or conflict between two opposite principles, —

one of life, which resists, and another of death, which attacks, and always ends by being victorious. In a word, there are not in living bodies two orders of forces separate and opposed by the nature of their phenomena, the one creating organized matter with its characteristic properties, the other destroying it through its vital manifestations; there are only histological elements which all act and develop (*fonctionnent évolutivement*) according to the same law.

"We know that there are muscular, nervous, and glandular elements, which subserve the manifestations of sensibility, motion, and secretion. There are likewise ovaric and plasmatic elements, which have the property of creating new beings, and sustaining the vital mechanisms by nutrition; but these creative and nutritive elements, like the rest, are used up and perish in discharging their functions, which themselves supply the conditions of an incessant renovation. Thus in the play of a passive machine the workmen get tired and equally expend their strength, whether they toil in constructing and repairing the wheel-work of the machine, or whether they toil in applying it to practical uses. The phenomena of organogenesis or organic creation are, then, neither more nor less mysterious for the physiologist than all the others. They reside in specialized histological elements, and have their physico-chemical conditions of existence well determined. The element of organic creation of living beings is a microscopic cellule, the ovule or germ. This element is undoubtedly the most marvellous of all, for we see that it has for its function the production of an entire organism. Phenomena ever under our eyes cease to astonish; as Montaigne says, '*L'habitude en ôte l'étrangeté.*' Nevertheless, what is there more extraordinary than this organic creation in which we assist, and how can we connect it with properties inherent in the matter which constitutes the egg? When general physiology would give an account of the muscular force, for instance, it proves that a contractile substance comes to act directly in virtue of properties inherent in its physical or chemical constitution; but when the problem concerns an organic evolution which is in the future, we are far enough from comprehending this property of matter. The egg is a *becoming;* it represents a sort of organic formula that

sums up the being from which it proceeds, and of which it has preserved, as it were, the developmental memory (*le souvenir évolutif*). The phenomena of organic creation of living beings seem to me quite of a nature to demonstrate an idea which I have already indicated, namely, that matter does not generate the phenomena which it manifests. It is only the *substratum*, and does absolutely nothing but give to phenomena their conditions of manifestation, — the sole intermediary by which the physiologist can act on the phenomena of life. Hence these phenomena must be subjected to a rigorous and absolute determinism, which constitutes the fundamental principle of all the experimental sciences. The egg or germ is a powerful centre of nutritive action, and as such supplies the conditions for the realization of a creative idea (*une idée créatrice*), which is transmitted by heredity or organic tradition (*tradition organique*). . . . . When we observe the evolution or the creation of a living being in the egg, we see clearly that its organization is the result of a preconceived law of organogenesis (*une loi organogénique qui préexiste d'après une idée préconçue*), which is transmitted by organic tradition from one being to another. We might find in the experimental study of the phenomena of histogenesis and of organization the justification of the words of Goethe, who compares Nature to a great artist. . . . . This is not all. This creative or organizing force (*cette puissance créatrice ou organisatrice*) not only exists at the dawn of life in the egg, the embryo, or the fœtus, but continues its operations in the adult by presiding over the manifestations of vital phenomena; for it is this which supports by nutrition, and renews without cessation the matter and the properties of the organic elements of the living machine. Nutrition, then, is nothing but the continuance and gradual exhaustion of this generative force (*cette puissance génératrice*). Hence, under the name of *organotrophic* phenomena must be included all the phenomena of organization and organic nutrition or secretion in the embryo, the fœtus, and the adult, since they are always governed by one and the same law. The surrounding physico-chemical conditions control the vital manifestations of the germ or ovule, like those of all the other organic elements. . . . . Life is a first cause, which escapes us like all

first causes, and experimental science has nothing to do with it; but all vital manifestations, from simple muscular contraction to the expression of intelligence, and the appearance of the organic creative idea, have in living beings well-determined physico-chemical conditions, which we can understand, and upon which we can act in order to control the phenomena over which the histological elements preside. . . . . By modifying the internal nutritive media, and taking organized matter, as it were, in the nascent state, we may hope to change the direction of its development, and thus its final organic expression. In a word, there is no reason why we should not thus produce new organic species, just as we create new mineral species, that is, cause to appear organic forms which virtually exist in the laws of organogenesis, but which Nature has not yet realized."

On the one hand, M. Bernard sanctions the mechanist theory by denying all speciality in vital phenomena as to their nature and the laws that govern them, by deriving them exclusively from the general laws of mechanics and chemical physics, and by admitting in them no force not "borrowed" from the external world. The speciality of form and process which they manifest is not, of course, to be denied on any theory; and this M. Bernard admits. But, on the other hand, when he comes to consider the peculiarly vital phenomena of organogenesis and organotrophy, which he himself makes coextensive with the phenomena of organization, nutrition, and secretion, whether manifested in the embryo, the fœtus, or the adult, he abandons the mechanist for the vitalist theory, by recognizing a special law (*la loi organogénique*) and a special force (*la puissance d'organisation, la puissance créatrice ou organisatrice ou génératrice, l'idée créatrice ou évolutive, l'idée créatrice organique*) which are neither mechanical nor physico-chemical. The same truth which Mr. Spencer is "compelled" and has "no alternative but" to recognize, and which therefore necessitates his theory of "organic polarity," necessitates a kindred theory in the essay of M. Bernard. But it is no essential part of the vitalist theory, as intimated by the latter, that there should be assumed a conflict or antagonism between the cosmical and the vital forces. This assumption, expressed in the well-known definition of Bichat, "Life is the sum of the func

tions by which Death is resisted," is no essential part of the vitalist theory as held by its most enlightened advocates. The vitalist theory teaches that life is the resultant of cosmical and vital forces acting in unison under fit conditions, and not a highly complex manifestation of merely cosmical forces, — that there is that in biological phenomena which constitutes them a class by themselves, and forbids the attempt to classify them with purely mechanical or physico-chemical phenomena. What these forces are in themselves we do not know; but if it is philosophical to attribute unlike effects to unlike causes, we are justified in insisting that essential differences shall not be blurred or ignored for the sake of constructing a symmetrical system. Hence we advocate the vitalist theory, not out of regard for any dogmatic or theological tenets which may be supposed to be favored by it, but solely out of regard for positive science and sound philosophy; and we find no better statement of its essential principles than is contained in the words of Mr. Lewes: "All that we are entitled to say is this: there is a *speciality* about vital phenomena, arising from the peculiarity and complexity of the conditions which determine them; and this speciality must warn us against reasoning about them as if they were *not* special, but were in all respects like inorganic phenomena; this speciality, in short, suggests the necessity of studying them in themselves, and not as if they belonged to the general phenomena of physics and chemistry, invaluable as the knowledge of these latter must always be as a means of exploration."* "In every vital process physical and chemical laws are implied, and the knowledge of these becomes indispensable; but over and above these laws, there are the specific laws of life, which cannot be deduced from physics and chemistry." †

* G. H. Lewes, Physiology of Common Life, Vol. II. p. 354.

† Ibid. Vol. I. p. 53. So also M. Littré, in the *Revue des Deux Mondes* for August 15, 1866, p. 841: "Les propriétés élémentaires des tissus une fois déterminées, il apparut que la science de la vie n'était un appendice ni de la mécanique, ni de la physique, ni de la chimie, ce qu'avaient toujours été tentés de croire les savans d'auparavant." So also Mr. Mill, in his "Positive Philosophy of Auguste Comte," Amer. ed., p. 38: "The only means, for example, by which the physiological laws of life could have been ascertained was by distinguishing, among the multifarious and complicated facts of life, the portion which physical and chemical laws cannot account for. Only by thus isolating the effects of the peculiar organic laws did it become possible to discover what these are."

In reply to what we ventured to call at the outset the three great questions of philosophical biology, namely, the origin of life in the first instance, the origin of species, and the causes of organic evolution, we find on examination that Mr. Spencer takes the following positions. To the first question he gives no definite answer at all, restricting himself to an unequivocal denial of special creation and an apparent denial of spontaneous generation, — the only conceivable alternatives. To the second question he gives the development theory as his answer, making no essential change in it and no important addition to it. To the third question he gives as his answer the mechanist theory, which, however, he is obliged reluctantly to supplement with his theory of "organic polarity," without even attempting the impossible task of reconciling the two; whereas the vitalist theory alone is in real harmony with the idea of universal evolution, on which he is attempting to rear a universal philosophy. Judged, therefore, by the avowed aim of the work, we cannot regard the "Principles of Biology" as philosophically successful. The rejection of the theory of spontaneous generation, and the adoption of the mechanist theory, are two capital defects which inhere in the ground plan of the work, destroy its symmetry as a philosophical whole, and prevent its being really "illustrative of the laws of evolution." For the former is evasion of a logical consequence of these very laws; while the latter necessitates either the denial of manifest facts or the illogical use of a foreign conception to account for them. Notwithstanding, therefore, its great and numerous excellences in other respects, the work under review fails to accomplish fully its professed object as part of the "Synthetic Philosophy."

The attempt of Mr. Spencer to put a mechanical interpretation upon all phenomena renders his assumption of universal comprehensiveness singularly inappropriate. The radical one-sidedness of his philosophy becomes more and more apparent in proportion as it is unfolded. Aiming to formulate all phenomena as merely incidents in the redistributions of matter and motion, and thus to reduce them all to the operation of a single law deducible from the persistence of force, it betrays the narrowness of its fundamental idea more and more plainly

in proportion to the increasing speciality of the phenomena it would explain. The persistence of force and the convertibility of its various forms are one thing; the actual identity of these forms is quite another thing. Philosophy requires the recognition of differences as well as of resemblances. The success or failure of Mr. Spencer's whole system turns on the answer which must be given to a very simple question, — Whether mechanics, physics, chemistry, biology, psychology, sociology, ethics, rest on classes of facts respectively so unlike as to give rise to unlike classes of conceptions, or whether the class of facts on which mechanics rests can be regarded as furnishing all the conceptions necessary to the explication of all the other sciences. By going outside of mechanics to devise a theory of "organic polarity" Mr. Spencer has himself answered this question adversely to the claims of his own system. Clearly, each science has its own peculiar conceptions, derived from observation of peculiar facts; and the only scientific course is to avoid confusion of one class with another. The different sciences relate to phenomena which are intrinsically so dissimilar as not to admit of formulation in terms of any one science; to seek thus to formulate them is sheer waste of ingenuity and labor. In its attempt, therefore, to achieve the impossible lies the fatal weakness, the fundamental and irremediable mistake, of the entire "Synthetic Philosophy." That this estimate is justified by the spirit of positive science, and justifies in turn our inability to echo the unintelligent, because undiscriminating, praise which has been lavished on this philosophy by enthusiastic admirers, will appear by the following excellent canon, stated by a well-known disciple of Auguste Comte, and ably illustrated by him in the case of Liebig's chemical theory of food: "*Never attempt to solve the problems of one science by the order of conceptions peculiar to another.*" * We should have found less to criticise in Mr. Spencer's two volumes, if he had not attempted to solve the problems of biology by the order of conceptions peculiar to mechanics.

In Mr. Spencer's judgment of the general relative value of the two hypotheses of special creation and natural development we entirely acquiesce. But we think him quite mistaken in sup-

* G. H. Lewes, Physiology of Common Life, Vol. I. p. 52.

posing that there is anything in the development theory at all irreconcilable with enlightened theism.* In some form or other, gradual evolution in unbroken continuity is more and more widely assented to, as a probably true theory of the history of life on the earth. The philosophy, however, which is to rationalize and unify the phenomena of universal organic evolution must go deeper than Mr. Spencer has gone. Even waiving all objections to his "law of evolution," it remains true that the utmost he has done is to establish a general formula. But mere generalization of facts is the function of science, not of philosophy. If philosophy is possible at all, it must explain generalization by unity of cause. The questions, therefore, which must be answered by a genuine philosophy of evolution are, whether *real causation* can be known at all, and, if so, what are the *real causes* of evolution as a continuous process. Of these questions Mr. Spencer has given no adequate discussion; nor do we propose here to discuss them. But so much as this may be said. The more completely the process of organic evolution can be traced in detail, its obscurities dispelled, and its perfect unity brought to view, the more widely its relations to the general course of inorganic phenomena can be detected in their subtile ramifications, the more plainly the universe is shown to be permeated by unvarying, harmonious, and all-inclusive law, so much the more does the entire system of Nature become admirably intelligible, and so much the greater becomes the probability of its origination in intelligence. If we grant to Mr. Spencer the demonstration of his thesis, that the "law of evolution" regulates all phenomena, he must grant in return that this is the best conceivable proof of Infinite Intelligence; for the cosmos becomes at once the embodiment of an omnipresent idea. If, as science advances, it continually discovers new adaptations and uniformities in Nature, then, although it may not be able to render

* Referring to the "elaborate appliances for securing the prosperity of organisms incapable of feeling, at the expense of misery to organisms capable of happiness," which exist in the countless species of parasites, and which he accounts for by the development hypothesis, Mr. Spencer says (Vol. I. p. 344), "With the conception of a supreme beneficence, this gratuitous infliction of misery on man, in common with all other terrestrial creatures capable of feeling, is absolutely incompatible."

a reason for everything, so many things are perpetually coming to light for which it can render a reason, that it becomes a fair induction to conclude that everywhere a reason exists. The stronger the evidence, therefore, that law is universal, and that universal law is intelligible, so much the stronger is the presumption that intelligence is Nature's root. When teleology is made to mean the direct and confident assignment of this or that motive for this or that natural adaptation, it may well be ridiculed as the bastard offspring of ignorance and conceit; but if it means only the supposition of omnipresent reason as the probable secret of omnipresent order, ignorance and conceit alone will ridicule it. The rational theist, far from imposing on Nature his own ways, is quite content to study reverently the ways of Nature; and, instead of "figuring to himself the production of the world and its inhabitants by a 'Great Artificer,'" as Mr. Spencer unintentionally caricatures theism, neither permits his imagination to deceive him with gross analogies, nor hesitates to accept with docility whatever science shall prove as to the true character of natural laws. But he is assuredly not so entangled in purely mechanical conceptions as to be incapacitated for rising to any higher idea of Infinite Intelligence than that of a Great Mechanic. Perceiving that mind is the noblest outcome of Nature, he sees in Nature itself the expression of that which is not less, but more, than mind, — the self-utterance of that which is not below him, but eternally and infinitely above; and in this supreme conviction he finds the open secret of the universe.

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