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ART. I.—1. *The Descent of Man, and Selection in Relation to Sex.* By CHARLES DARWIN, M.A. Two Vols. 1871.

2. *On the Origin of Species by means of Natural Selection.* By CHARLES DARWIN, M.A.

3. *Variation of Animals and Plants under Domestication.* By CHARLES DARWIN, M.A. Two Vols.

4. *Contributions to the Theory of Natural Selection.* By ALFRED RUSSEL WALLACE. 1870.

5. *The Anatomy of the Vertebrates.* Vol. III. *Mammals.* By RICHARD OWEN, F.R.S. 1868.

6. *Heat a Mode of Motion.* By JOHN TYNDALL, LL.D. Fourth Edition. 1871.

7. *Notes of a Course of Nine Lectures on Light, delivered at the Royal Institution of Great Britain.* By JOHN TYNDALL, LL.D., F.R.S. 1870.

8. *On the Scientific Use of the Imagination; a Discourse delivered before the British Association at Liverpool.* By JOHN TYNDALL, LL.D., F.R.S. 1870.

9. *Sketch of Thermodynamics.* By P. G. TAIT, M.A., Professor of Natural Philosophy in the University of Edinburgh. 1868.

10. *On the Mechanical Equivalent of Heat.* By J. P. JOULE, LL.D., F.R.S. *Philosophical Transactions.* 1850. Part I. p. 61.

11. *The Correlation of Physical Forces.* By W. R. GROVE, Q.C., M.A., F.R.S. Fifth Edition. 1867.

12. *Familiar Lectures on Scientific Subjects.* By Sir JOHN F. W. HERSCHEL, Bart., K.H. 1868.
13. *The Life and Letters of Faraday.* By Dr. BENCE JONES. Two Vols. 1870.
14. *Croonian Lectures on Matter and Force.* By HENRY BENCE JONES, A.M., M.D., F.R.S. 1868.
15. *Origin and Development of Religious Belief.* By S. BARING-GOULD, M.A. First Part.
16. *The Elements of Natural Philosophy.* By CHARLES BROOKE, M.A., F.R.S. Based on the Treatise by the late GOLDING BIRD, M.A., M.D., F.R.S. 1867.
17. *Lessons in Elementary Physics.* By BALFOUR STEWART, LL.D., F.R.S., Professor of Natural Philosophy, Owen's College, Manchester. 1870.
18. *Modern Scepticism viewed in relation to Modern Science.* By J. R. YOUNG. 1865.
19. *Energy.* By Professors WILLIAM THOMSON and P. G. TAIT. *Good Words.* 1862, p. 601.
20. *Force. Cornhill Magazine.* Vol. IV. p. 409.

SCIENCE is rendered possible to man by the consciousness of necessary judgments. Each science is founded upon certain irresistible convictions, and these convictions constitute the starting points of thought in that particular department of human inquiry. To question the reality of the primary deliverances of consciousness, or even to demand proof of their validity, is to reject, virtually, the science which professes to build upon them. To the philosopher it belongs to point out the marks by which we may determine in all the sciences, formal and real, what judgments are necessarily true. The discovery of primary truth by the application of these marks is sometimes a work of no small difficulty, even to the honest inquirer, but much more to a mind warped by prejudice. Prejudice, of necessity, impedes the action of the intellect in its attempts to think an object as it is. It leads us, unconsciously almost, to think any presented reality in harmony with previously adopted opinions, and in conformity with our wishes and desires. "The eye of human intellect," says Bacon, "is not dry, but receives a suffusion from the will and from the affections; so that it may almost be said to engender any science it pleases. For what a man wishes to be true, that he prefers believing."

"Philosophy," says Sir William Hamilton, "requires an emancipation from the yoke of foreign authority, a renunciation of all blind adhesion to the opinions of our age and country, and a purification of the intellect from all assumptive beliefs. Unless we can cast off the prejudices of the man, and become as children, docile and unperverted, we need never hope to enter the temple of philosophy. It is the neglect of this primary condition which has mainly occasioned men to wander from the unity of truth, and caused the endless variety of religious and philosophical sects. Men would not submit to approach the Word of God in order to receive from that alone their doctrine and their faith; but they came in general with preconceived opinions, and, accordingly, each found in revelation only what he was predetermined to find. So, in like manner, is it in philosophy. Consciousness is to the philosopher, what the Bible is to the theologian. Both are revelations of the truth, and both afford the truth to those who are content to receive it, as it ought to be received, with reverence and submission. But as it has, too frequently, fared with the one revelation, so has it with the other. Men turned, indeed, to consciousness, and professed to regard its authority as paramount; but they were not content humbly to accept the facts which consciousness revealed, and to establish these, without retrenchment or distortion, as the only principles of their philosophy: on the contrary, they came with opinions already formed, with systems already constructed, and while they eagerly appealed to consciousness, when its data supported their conclusions, they made no scruple to overlook, or to misinterpret, its facts, when these were not in harmony with their conclusions." *

The love of unity, though an important guiding principle in our search after truth, is often a source of error. The alchemists of former times would see in nature only a single metal, just as now many physicists profess to see in the varied phenomena of the material universe manifestations of but one force. "Some of our modern zoologists," says Hamilton, "recoil from the possibility of nature working on two different plans, and rather than renounce the unity which delights them, they insist on recognising the wings of insects in the gills of fishes, and the sternum of quadrupeds in the antennæ of butterflies,—and all this that they may prove that man is only the evolution of a molluscum." To the thirst for unity may also be ultimately traced the errors which result from a hasty resort to hypothesis. How often do we find, in recent speculations, an entire disregard of the circumstances in which hypotheses are permissible. It must be borne in mind that all suppositions are not hypotheses.

* *Lectures on Metaphysics*, Vol. I. p. 83

Assumptions are of two kinds. They relate either (1) to causes and laws, or (2) to effects or facts. The former only are properly termed hypotheses, and are allowable under certain well-defined conditions. One of the most important of these is,—that the facts to be explained, the effects to be accounted for, should be ascertained actually to exist. Cullen has truly observed that there are more false facts current in the world, than false hypotheses to explain them. Philosophy does not permit us to resort to hypotheses to account for assumed facts. The facts themselves must first be established by an appeal to consciousness, or to observation, or to the testimony of competent and credible witnesses. The disregard of this principle has been productive of much confusion and error in the physical sciences. Even Mr. Darwin, who, probably more than any other living writer, resorts to his imagination for facts, now allows that "false facts are highly injurious to the progress of science."*

We purpose, in the present article, to deal with two notable doctrines, both of which result from a false method of inquiry, namely, the theories of *Natural Selection* and of the *Conservation of Energy*. According to Professor Huxley, "the nineteenth century, as far as science is concerned, will be known in history as having given birth to these two doctrines." It is our intention to show that these doctrines are the great heresies of modern science.

The hypothesis of "Natural Selection" is illegitimate, and must be rejected for the simple reason that it is devised to account for facts which are assumed, but not proved to exist. Mr. Darwin takes for granted that naturalists have already established the existence of eight or ten unbroken chains of organised beings. He further assumes that, in each chain, one being succeeds another by almost insensible changes of structure, and that organs found in a rudimentary state in one being are found in perfection in some being further down the chain. He then adds, "Analogy would lead me one step further, namely, to the belief that all animals and plants—all the organic beings which have ever lived on this earth,—have descended from some one primordial form."

One important position, however, he now abandons. Until recently he has maintained that, though we are entirely ignorant of the causes of variability, we may take for granted that no variation can continue to exist, unless it is of some special, though unrecognised service. In his latest work,

* *The Descent of Man*, Vol. II. p. 385.

The Descent of Man, he candidly admits that in this he has been mistaken. He allows that his hypothesis of natural selection had prevented him from considering "the existence of many structures which appear to be, as far as we can judge, neither beneficial nor injurious" (Vol. I. p. 152). He might as well have gone a little further, and admitted that many variations from a given type are not merely not useful to the animal, but positively hurtful. The admissions, however, which he does make, amount to an abandonment of one of the most important assumptions of his system, "The Survival of the Fittest." This supposed fact being abandoned, it is easy to see that the theory of natural selection must, as a necessary consequence, be given up. Mr. Darwin is evidently not quite prepared to take this step. For the present, he contents himself with allowing that he has "attributed too much to the action of natural selection." But after giving up the fact of "the survival of the fittest," he cannot consistently retain the hypothesis of natural selection; for the theory was avowedly framed to account for this assumed fact alone. He still retains the supposed facts of transmutation and variation. This, however, will avail nothing, since he has never professed to account for variability by natural selection. Even in his *Descent of Man*, he says, "with respect to the causes of variability, we are in all cases very ignorant" (Vol. I. p. 111). He clings tenaciously to the assumption that existing species are the modified descendants of other species, and maintains that man is derived from some less highly organised form. Here is his outline of the complete genealogy of man:—

"By considering the embryological structure of man—the homologies which he presents with the lower animals—the rudiments which he retains—and the reversions to which he is liable, we can partly recall in imagination the former condition of our early progenitors; and can approximately place them in their proper position in the zoological series. We thus learn that man is descended from a hairy quadruped, furnished with a tail and pointed ears, probably arboreal in its habits, and an inhabitant of the Old World. This creature, if its whole structure had been examined by a naturalist, would have been classed amongst the Quadrumana, as surely as would the common and still more ancient progenitor of the Old and New World monkeys. The Quadrumana and all the higher mammals are probably derived from an ancient marsupial animal, and this through a long line of diversified forms, either from some reptile-like or some amphibian-like creature, and this again from some fish-like animal. In the dim obscurity of the past we can see that the early

progenitor of all the Vertebrata must have been an aquatic animal, provided with branchiæ, with the two sexes united in the same individual, and with the most important organs of the body (such as the brain and heart) imperfectly developed. This animal seems to have been more like the larvæ of our existing marine Ascidians than any other known form."—*The Descent of Man*, Vol. II. pp. 389, 390.

For the benefit of those of our readers who do not enjoy a personal acquaintance with all their congeners, we remark that an Ascidian is "an invertebrate, hermaphrodite, marine creature, permanently attached to a support. They scarcely appear like animals, and consist of a simple, tough, leathery sack, with two small projecting orifices."

But it is surely time for us to ask what proof have we that the facts are as they are thus asserted? It is admitted that the actual history of organised beings during the historic period supplies no evidence whatever of the existence of the supposed gradations. We appeal to the geological record, but with no better result. Geology has not yet furnished a fact which indicates the transition of one species to another, nor of one form of a complex organ to another less imperfect. "He who rejects these views," says Mr. Darwin, "on the nature of the geological record, *will rightly reject my whole theory;* for he may ask in vain where are the numberless transitional links which must formerly have connected the closely allied or representative species found in the several stages of the same great formations." It is true that Huxley contradicts Mr. Darwin on this point. In his lecture on the "Pedigree of the Horse," delivered at the Royal Institution in April 1870, he says:—"The rocks reveal to us transitional forms between animals now existing and those long gone, and yield to the philosopher fossils transitional between groups of animals now far apart." But he does not produce a single fact in support of this bold assertion. All the facts mentioned by him are isolated, and fail to supply the required connecting links. We still have nothing but discontinuity. In this same lecture he also informs us "that the doctrine of evolution, as set forth by Darwin, rests upon three pillars of observation and experiment. The first of these is the production of living matter from matter not living; the next is the production of new species by natural selection; the third pillar is historical evidence of living animals succeeding each other in a way which meets the requirements of the doctrine."

Now as Mr. Darwin himself teaches that life was breathed by the great Creator into that primordial form from which all other organic creatures have descended, it is scarcely just to

represent that his doctrine of evolution rests to any extent upon the assumption that living matter may be produced from matter not living. Professor Huxley's own views on this subject are, if we mistake not, confused and even contradictory. In his paper on the "Physical Basis of Life," his great purpose seems to be to show that the phenomena of life, and even of mind, may result from the action of purely physical powers. "I take it," he says, "to be demonstrable that it is utterly impossible to prove that anything whatever may not be the effect of a material and necessary cause." But if we turn to his address delivered at the last meeting of the British Association, we find him labouring to prove that there is absolutely no evidence to justify the assumption that living matter may be produced from matter not living! Surely he must have forgotten that Mr. Darwin had asserted, long before, that "science does not countenance the belief that living creatures are ever produced from inorganic matter."

Since neither the actual history of animate beings nor the geological record supplies proof that the facts are what the believers in the theory of natural selection assert them to be, we are led to inquire whether there is any other source of evidence open to us. If we propose to examine the statements of Scripture, we are instantly met with the cry that the Bible was not given to teach science! We freely admit that there is a sense in which the Bible was not designed to teach physical science. But it would be easy to show that in precisely the same sense the Bible was not intended to teach the science of morals or even the science of theology. But are we to infer from this that the Bible contains no reliable statement of the facts which moral philosophers and theologians employ in building up their respective sciences. Even if we are not allowed in the region of science to take for granted the Divine authority of the Bible, we may, at least, be permitted to plead that its account of the origin of species is as deserving of our attention as the assertions of Darwin, and Wallace, and Huxley. Can science show that a necessity was imposed upon the Creator to start with the production of but one organism? Can science advance any reason for not supposing that the Creator had ten, or ten thousand, or ten million points of departure? The arguments employed by Mr. Darwin merely prove that it was possible for the Deity to create a single living being which should have within itself all the elements to be employed by Him in the production of myriad forms of existence for countless ages. We are not

disposed to deny that this was within the range of the Divine agency. So long as Mr. Darwin does not insist, with Mr. Mill, that Omnipotence implies power to make two and two four in one world and five in another, we agree that it is an essential attribute of the Deity. But science strictly has nothing to do with *possibilities*. It takes account only of the *actually existent*. By actually existent we do not mean what is merely existent now, since the "actually existent" can be contemplated in relation to time past and future, as well as present. It is with the actual as opposed to the possible that science has to deal. As a naturalist, Mr. Darwin has observed and carefully recorded a multitude of most interesting facts, but these facts have no connection with his theory of evolution, and lend it no support. His "primordial form" exists nowhere but in "the scientific imagination." Naturalists, therefore, are bound to accept the Scripture statement in evidence. What then does Moses say? He tells us that life was breathed into many forms; that each plant was made after its kind, and each animal after its kind; and that all were created very good, having all their organs perfectly adapted to the purposes we now see them fulfil, not needing subsequent improvements to fit them for use. It is thus evident that in every particular the statements of Moses are directly opposed to those of Mr. Darwin. It does not belong to the philosopher, as such, to determine which account is correct. All that the philosopher insists upon is that if the naturalist can produce evidence to prove that there was but a single point of departure, it will still have to be maintained that the beginning of each sentient being now is the result of a special act of creative power not less than was the beginning of the first "Ascidian" into which was breathed the breath of life.

Mr. Darwin, in his most recent work, boldly applies his theory of evolution to man—to the faculties of his soul as well as to the powers of his body. But in dealing with mental phenomena he is evidently out of his element. In order to make the facts of mind fit his theory he resorts to the wildest assumptions. His account of the moral sense is almost as wide of the realities of which sane intellects are conscious as is the notable theory of Professor Bain. According to Bain our moral judgments are determined by our hopes and fears. Hence if parents reward their children for interested or selfish acts only, and punish them for all manifestations of disinterested good-will, they will necessarily judge that selfishness is morally right and praiseworthy, and that benevolence is wrong and deserving of punishment! We are unable to

see any advantage that the Darwinian doctrine has over that of Professor Bain. Both writers persistently ignore the fact that there are necessary truths in ethics not less than in mathematics. Regarding Mr. Darwin's views of the moral faculty, an able writer says :—

"We wish we could think that these speculations were as innocuous as they are unpractical and unscientific, but it is too probable that if unchecked they might exert a very mischievous influence. We abstain from noticing their bearings on religious thought, although it is hard to see how, on Mr. Darwin's hypothesis, it is possible to ascribe to man any other immortality, or any other spiritual existence, than that possessed by the brutes. But, apart from these considerations, if such views as he advances on the nature of the Moral Sense were generally accepted, it seems evident that morality would lose all elements of stable authority, and the ever-fixed marks, around which the tempests of human passion now break themselves, would cease to exert their guiding and controlling influence. Mr. Darwin is careful to observe that he does not wish 'to maintain that every strictly social animal, if its intellectual and social faculties were to become as active and as highly developed as man, would acquire exactly the same moral sense as ours.' If this be the case, why should our existing moral sense be deemed a permanent standard? 'If, for instance,' says Mr. Darwin, 'to take an extreme case, men were reared under precisely the same conditions as hive-bees, there can scarcely be a doubt that our unmarried females would, like the worker bees, think it a sacred duty to kill their brothers, and mothers would strive to kill their fertile daughters, *and no one would think of interfering.*' What is this but to place every barrier of moral obligation at the mercy of the 'conditions of life?' Men, unfortunately, have the power of acting not according to what is their ultimate social interest, but according to their ideas of it; and if the doctrine could be impressed on them that right and wrong have no other meaning than the pursuit or the neglect of that ultimate interest, conscience would cease to be a check upon the wildest, or, as Mr. Darwin's own illustration allows us to add, the most murderous revolutions. At a moment when every artificial principle of authority seems undermined, we have no other guarantee for the order and peace of life except in the eternal authority of those elementary principles of duty which are independent of all times and all circumstances. There is much reason to fear that loose philosophy, stimulated by an irrational religion, has done not a little to weaken the force of these principles in France, and that this is, at all events, one potent element in the disorganisation of French society. A man incurs a grave responsibility who, with the authority of a well-earned reputation, advances at such a time the disintegrating speculations of this book. He ought to be capable of supporting them by the most conclusive evidence of facts. To put them forward

on such incomplete evidence, such cursory investigation, such hypothetical arguments as we have exposed, is more than unscientific—it is reckless."—*The Times*, April 8, 1871.

The way is now prepared for an examination of Mr. Darwin's hypothesis of "Natural Selection." This hypothesis must not be confounded, as is frequently done, with the doctrine of evolution. Speaking with philosophical strictness the latter is not an hypothesis at all. It is an assumption of fact, but as yet its validity has not been established. We may very safely assert that there is not a fact recorded in the works of Mr. Darwin which implies even the possibility of the transformations and gradations for which he contends. But granting that the facts are precisely what he affirms them to be, the question arises, does the hypothesis of natural selection explain these facts—does it account for their existence? He never asserts that natural selection is the cause of the assumed variations. On the contrary, he teaches that natural selection can act only upon variations already existent. He represents it as securing "the survival of the fittest" by destroying all variations that are either injurious or useless. He speaks of it as a power intently watching each variation, of course for the purpose of ascertaining whether the variation will give to the creature possessing it any advantage in the great struggle for existence. In his last work he candidly confesses that natural selection is sometimes caught napping. It is thus he accounts for the continuance of useless variations.

We have found it no easy matter to determine the precise reality which Mr. Darwin intends to symbolise by the term "Natural Selection." He admits that the term is in some respects a bad one, as it seems to imply conscious choice. To show that there may be selection without consciousness and without intention or choice, he quotes the remark of Huxley that "when the wind heaps up sand-dunes it sifts, and *unconsciously selects* from the gravel on the beach grains of sand of equal size." So, says Mr. Darwin, "for brevity's sake I sometimes speak of natural selection as an intelligent power; in the same way as astronomers speak of the attraction of gravity ruling the movements of the planets."* Having conceded that we must suppose an Intelligent Agent to account for the existence of that primordial organism from which all animate creatures have proceeded, he evidently

* *Variation of Animals and Plants under Domestication*, Vol. I. pp. 6, 194.

deems it unnecessary to admit the continued exercise of the agency of the Creator, to explain the ever-changing phenomena presented to observation. But if Mr. Darwin intends, as we suppose he does, to eliminate as far as possible all evidence of design from such phenomena, then his reference to the attraction of gravity is for him most unfortunate. In gravity we have a force acting in harmony with a well-ascertained law. This force is a constituted power dependent upon the agency of the Creator, not only for its existence, but for the conditions of its continued exercise. Hence the actions determined by the force of gravity are not explained until we trace out the Personal Agent who is the real originator of those movements. The actions are not, if we speak with philosophical strictness, produced by the force, but by the agent employing that force simply as an instrument to accomplish perceived and designed ends. The hypothesis that all phenomena which cannot be referred to the power of created agents are the *immediate* sequents of the Divine volition is not allowable. We must admit the fact of secondary causation. This, however, does not imply that the so-called "secondary causes" are anything more than "instruments." They never produce or originate effects, and always involve, as their necessary correlative, the existence of an Intelligent Agent.

Nor must we confound law with secondary cause. Thus, the law of gravitation can have existence only as a rule of action in the mind of the great Ruler, who is the real originator or cause of the movements which we immediately refer to the force of gravity. Hence we regard it as a primary and necessary truth that all regulated action implies an agent who exerts his power in accordance with a perceived rule. Some, perhaps, may deny that we are under the necessity of so thinking. But it is not difficult to show that the judgment in question possesses all the marks of a self-evident and necessary truth. "He who rejects it will assuredly be able to present nothing better deserving of credence."

But Mr. Darwin's assumption that natural selection does not involve the exercise of choice or purpose by some mind or person, cannot be admitted. The action which he attributes to natural selection is clearly regulated action. Why should natural selection favour the preservation of useful varieties only? Such action cannot be referred to blind force; it can belong to mind alone. Mr. Darwin sometimes confesses that his hypothesis carries absurdity on the very face of it. Thus he says:—

"To suppose that the eye, with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree. When it was first said that the sun stood still and the world turned round, the common sense of mankind declared the doctrine false; but the old saying of *Vox populi vox Dei*, as every philosopher knows, can never be trusted in science. Reason tells me, that if numerous gradations from a perfect and complex eye to one very imperfect and simple, each grade being useful to its possessor, can be shown to exist; if, further, the eye does vary ever so slightly, and the variations be inherited, which is certainly the case, and if any variation or modification in the organ be ever useful to an animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, can hardly be considered real."

"This reminds us," says Professor Young, "of Kepler's fortuitous salad. The story goes that the astronomer having delayed coming down to his supper, his wife, who was something of a shrew, took him to task for keeping her waiting. He excused himself by telling her he had got so absorbed in thinking of the theory of 'the fortuitous concourse of atoms' that he had forgotten the salad she had prepared. Katherine naturally asked for an explanation of this odd theory. He replied, 'Suppose that from all eternity there had been flying about atoms of vinegar, and atoms of oil, and atoms of lettuce, you perceive that in time we might have had a salad.' 'Aye, aye,' said his wife, 'all that might be, but you wouldn't get one so nicely dressed as this!' So in reference to the fortuitous eye, formed as supposed, we think it would have been a far inferior eye to that which Mr. Darwin employed in penning the foregoing scheme."—*Modern Scepticism*, p. 161.

Newton asks, *Was the eye contrived without skill in optics?* Mr. Darwin allows that if the eye required an intelligent being, skilled in the laws of optics, his theory must fall to the ground. In the second volume of the *Journal of the Transactions of the Victoria Institute* there is a remarkable paper on the Darwinian theory by the Rev. Walter Mitchell, M.A., one of the Vice-presidents of the Society. We regret that this paper is not more widely known. We shall, therefore, quote from it somewhat extensively:—

"Let us test," says Mr. Mitchell, "the credibility of Darwinism on issues raised by Darwin himself—such, for instance, as the formation of the human eye on his hypothesis. 'If it could be demonstrated,' he says, 'that any complex organ existed which could not have been formed by numerous successive slight modifications, my

theory would absolutely break down.' The whole spirit and tenor of all that Mr. Darwin writes on this subject may be thus paraphrased:—'The argument from design is the greatest crux I have to get over; I must evade it or deny it altogether—design can have no place in my system: admit it, and my hypothesis falls to the ground.' He admits that if such a complex organ as the human eye could not be formed, as he says it has been, by the law of natural selection, his theory must break down. How then upon this system is so complex an organ as the eye formed? The primordial being of Mr. Darwin is not formed with any eye from which our own may trace its ancestry. It is to be traced back to an organ not optical at all, or made with any reference to the laws of light, but to the mere chance exposure of a nerve of sensation to the influence of light. . . . I take the eye, as I believe I have a right to do, on sound scientific principles, as a perfect optical instrument. I say nothing of the secretion of that black pigment which absorbs the superfluous rays of light. I say nothing of that marvellous mechanism which changes the curvature of the lenses of the eye in a manner no human instrument can ever do. I say nothing of the iris—that varying diaphragm so sensitive to light, not for vision but for contractibility—which admits into the camera obscura of the eye just that amount of light which is necessary for the perfection of the image on the retina. I take this marvellous instrument, and I am told by Mr. Darwin that his system must collapse, that his hypothesis must crumble to dust, unless I can believe, as a thing within the range of credibility, that this perfect instrument has originated without a designer. For this is the force of Mr. Darwin's argument, that these lenses, so perfectly adapted to the laws of light in geometrical form and refractive powers on the rays of light, with all the marvellous mechanism for adapting them for near and distant vision, manifest no unanswerable evidence of design; that it is credible that all this marvellous combination and perfect adaptation to the laws of light are due to no forethought, no design, no wisdom. That all this has been formed simply by the law of natural selection. That some being possessed of sensitive nerves, some æons of ages ago, had one of these nerves accidentally exposed to light. I am told, without proof, that any nerve of sensation—by which, I presume, is meant a nerve sensitive to the touch—if exposed to light, would be sensitive to light; that this nerve becoming so sensitive to light became protected by a transparent film. That I must admit these assumptions, contrary to all we know about nerves of sensation, as credible. That, starting from such an imperfect eye as this, I am to arrive at the human eye according to this law: that an animal possessed of such an imperfect eye as a nerve covered with a transparent film would have such an advantage in the fierce struggle for existence as to destroy all its eyeless congeners; that it would necessarily propagate animals with like imperfect eyes; that in the course of time, if any accidental improvement took place in the film better adapted for the purposes of an eye, the animal with the improved eye would succeed better in the struggle for life, and propagate suc-

cessors with the improvement. And so the chance improvements, occurring through no law of design, but seized upon by the stern law of the fierce battle for existence, during a succession of unaccountable ages, is sufficient to render the formation of such an instrument as the human eye credible. I ask for proofs of so monstrous an hypothesis —something to render it credible. I am told that animals exist having eyes far more imperfect than those of man; but the series which is to set forth the slow steps of successive improvements of the eye are not to be traced in the present great variety of eyes now found among the animal creation. There are breaks in the law of progression. In one direction I may start with one eye, then eight eyes, then countless myriads of eyes or lenses, in the same living being. How is it, in the formation of the eye according to this principle of chance improvements, when I trace the eyes of so great a proportion of what are called the higher animals, I find this law of divergence strictly confined to the number two, while among the lower orders of the animate world it ranges through such a wide variety? Why such uniformity in one direction? Why so great a variety in the other? Again, setting aside this difficulty, and supposing that the missing links of a series of imperceptible gradations are buried in the undiscovered strata of past geological ages, I ask, why do the animals with the eyes taken as examples of imperfect ones still survive in that battle for existence in which they ought long ago to have been worsted? But here I would pause, and ask whether the eyes taken by Mr. Darwin as imperfect eyes are so? I deny their imperfection. I believe they are as perfectly adapted to the wants of their owners as my eyes are to mine. I believe the eight lenses of the spider, or the millions of lenses of the bee or the butterfly, are as perfectly adapted to the necessities of those animals as man's, or those of any other being. I know that if I search for the microscopic lens invented by Coddington from his knowledge of the laws of optics, in the works of animate nature, I find it in any one of the lenses of the common house-fly. But if it be credible that such a complex organ as the eye is formed in this way, I must assume all other complex organs to be created in a similar manner. . . . I say fearlessly that any hypothesis which requires us to admit that the formation of such complex organs as the eye, the ear, the heart, the brain, with all their marvellous structures and mechanical adaptations to the wants of the creatures possessing them, so perfectly in harmony, too, with the laws of inorganic matter, affords no evidence of design; that such structures could be built up by gradual chance improvements, perpetuated by the law of transmission, and perfected by the destruction of creatures less favourably endowed, is so incredible, that I marvel to find any thinking man capable of adopting it for a single moment. Mr. Darwin not only deprives us of any evidence of design in the physical structures of animate life, he would also eliminate that evidence from the psychological phenomena of living beings. He feels bound to bring the cell-making instinct of the hive-bee within the working of his hypothesis. He does not deny, as some of his admirers

have endeavoured to do, the mathematical perfection of the cells constituting the honeycomb. He does not seek to evade the problem by the fiction of equal pressures exerted by equal hemispheres pressing against each other. He does not ignore the fact that the angles of the terminal planes of the hexagonal cells were determined and measured long before there was any hypothesis as to their formation, and even before the mathematical problem was solved which showed that the bee's cell was the only form which gave the greatest amount of store-room with the least possible expenditure of material. The hive-bee makes each comb of two sets of cells placed back to back. Each cell is terminated by three flat lozenge-shaped planes, each plane being shaped like the diamond on playing cards. The three planes terminating a cell on one side of the comb, are the bottoms of three different cells on the other side; so that the hexagonal cells are not placed back to back. Indeed, the partition wall of the two sets of cells forms a series of lozenge-shaped cups on either side, and gives marvellous strength to the structure of the comb, on the same principle which causes the Gothic architect to support the weight of his roof by flying buttresses. A thousand—nay, a myriad of angles might be chosen for the rhomb-lozenge, any one of which would imitate the structure of the bee's cell as to its general appearance. Rigid mathematical evidence shows, however, that the bee chooses just that one angle of 109° 28″ which gives the greatest economy of material with the greatest power of storage. . . . How does Mr. Darwin account for the hive-bee acquiring this marvellous instinct for making so perfect a mathematical structure? Why a chance improvement in cell-making, manifesting itself among a certain set of bees, gave them an advantage in the struggle of life above other bees! This improvement was transmitted to the next generation; then another improvement was made in the same manner; and so on, till, in process of time, as an accidentally exposed nerve became a perfect eye, a race of bees gradually improved an almost shapeless cell into the mathematical perfection of that of the hive-bee!"

As Mr. Darwin refuses to allow that the action of natural selection necessarily implies the existence of consciousness and purpose, he ought not to be surprised at the use made of his doctrine by writers of the atheistical school. Büchner, Vogt, Haeckel, &c. accept his theory, because they think it dispenses with the necessity of supposing an intelligent Creator and Ruler, in order to account for the phenomena of the universe. Dr. Büchner emphatically denies the existence of design. He says, "the stag was not endowed with long legs to enable him to run fast, but he runs fast because his legs are long." And is not this precisely Mr. Darwin's position respecting the eye? The eye was not made for seeing; we see because we happen to have eyes! He frequently finds it very difficult to reconcile his theory, not merely with the

doctrines of the Bible, but with the instinctive judgments of his own mind. Hence he often uses language altogether out of harmony with his special opinions. Although he affirms that the action of natural selection does not imply conscious choice, yet he says, "Natural selection will pick out with unerring skill each improvement." He represents it as a "power always intently watching each slightly accidental variation." He speaks of the woodpecker, with its feet, tail, beak, and tongue, as being "so *admirably adapted* to catch insects under the bark of trees." Professor Owen accepts Mr. Darwin's doctrine of the transmutation of species, and even agrees with Huxley in regarding all forces as material; but rejects the hypothesis of natural selection. To this he opposes the theory of "Derivation," and holds that in all animate creatures there is "an innate tendency to change, irrespective of altered surrounding circumstances." He thus assigns a secondary cause for variations, and recognises creative power in the variety and beauty of the results. But the hypothesis of "Derivation" must be rejected, for the very reason that we reject the theory of "Natural Selection." The facts it professes to explain, have not been proved to exist.

The closing paragraphs of Mr. Darwin's work on the "Variation of Animals and Plants under Domestication" curiously reveal the perplexity of which he is conscious. He says:—

> "If we assume that each particular variation was from the beginning of all time pre-ordained, the plasticity of organisation, which leads to many injurious deviations of structure, as well as that redundant power of reproduction which inevitably leads to a struggle for existence, and, as a consequence, to the natural selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything, and forms everything. Thus we are brought face to face with a difficulty as insoluble as is that of free-will and predestination."

But the difficulty here referred to, is of Mr. Darwin's own creation. It exists nowhere but in his fertile imagination. Had he started with a correct philosophy of causation, the difficulty could not have arisen. He refers to free-will and predestination, but there is no insoluble difficulty here. There is mystery, we grant, but not more than exists in connection with every ultimate fact, whether revealed in the Bible or in human consciousness. The affirmed difficulty respecting predestination is merely the result of a false definition of the

doctrine. We once heard a celebrated theologian in Scotland discoursing on this subject. He started with the assumption that, if God is a sovereign, He must be the cause or author of every event, and that, consequently, man cannot be free in the sense of having power to originate and decide his own volitional activity. He then dwelt upon the "insoluble difficulty" presented by the statements of Scripture regarding predestination and moral accountability. He represented the Bible as teaching that we are responsible for actions not really originated by us, at the same time admitting that every sane mind must affirm that we cannot be justly held accountable for acts of the will of which we are not the real authors. It is easy to see that the asserted difficulty resulted exclusively from an incorrect definition of sovereignty. In like manner, Mr. Darwin's "insoluble difficulty" has arisen solely out of his false theory of natural selection. No philosopher can accept this theory, since it so manifestly violates every condition of a legitimate hypothesis.

Let us now turn for a moment to a much older doctrine than this. As, in the present paper, we proposed to deal with the heresies of science in their purely philosophical aspect, we consented to leave out of view the Divine authority of the Mosaic account of the beginnings of organic existence. Since the theory of natural selection is directly opposed to the fundamental principles of philosophy, its advocates must do battle with the metaphysician before they venture to assail the theologian. How, then, does Moses account for the facts described in the first chapter of the Book of Genesis? Not by the action of the blind forces of matter; not by what Huxley terms "natural causes;" but by referring them to the agency of an intelligent and all-wise God. Now, we are asked to reject this ancient doctrine for that propounded by Darwin. If we are to accept the testimony of Professor Huxley, the whole scientific world has decided in favour of the Darwinian hypothesis. In his paper "On the Methods and Results of Ethnology" he treats with scorn the doctrine that God created Adam and Eve. He thinks the idea of creation unphilosophical! He calls the theory of Adam's creation Adamitic monogenism. He says: "Five-sixths of the public are taught this Adamitic monogenism, as if it were an established truth, and believe it. I do not; and I am not acquainted with any man of science, or duly instructed person, who does."* Now, in the language of Mr. Grove, we ask:

* *Fortnightly Review*, Vol. I. pp. 273, 275.

"Does the newly proposed view remove more difficulties, require fewer assumptions, and present more consistency with observed facts, than that which it seeks to supersede?" Believing that our readers are "duly instructed persons," we leave them to decide the question for themselves. Should anyone demand how we know that the marvellous combinations and adjustments of powers existent in every organic being are the result of intelligent design, we reply that we shall not stop to "bray such a man with a pestle in a mortar among wheat," for sure we are that by this, or any other means, "his folly will not depart from him." "He who explores the structure of the human eye, its expressive forms, its exquisite movements, its union of tenderness and strength, its magic chamber furnished with lenses and curtains, and its delicate canvas which receives the vivid pictures of external objects and presents them to the brain, while it takes back the creations of the mind and gives them an external form and locality,—he who studies this masterpiece of Divine mechanism, and who does not join in the fervid ejaculation, 'He that formed the eye, shall He not see!' deserves to be degraded from the rank of intelligence, and placed in that small appendix to human nature which the moralist only recognises,—'the blind leaders of the blind.'"*

We shall now proceed to a brief examination of the theory of the "Conservation of Energy." We need hardly say that the fundamental assumptions of Thermodynamics are here involved. This theory, like that of natural selection, affords a remarkable instance of the error which necessarily results from an incorrect method of procedure. In former papers we have given illustrations of the kind of service that philosophy affords to the theologian. To the physicist it is capable of rendering a service not less valuable. And yet the supporters of the hypothesis of the conservation of energy resolutely refuse aid from the philosopher, and, indeed, generally speak of metaphysical discussions with contempt. Thus Professor Tait, in his paper "On the Dynamical Theory of Heat," says:—"We have no wish to stupefy our readers with the metaphysical arguments on this question, which, in countless heaps, encumber the shelves of mediæval libraries; nor do we think that, if we had ourselves attempted their perusal, we should now be able, with a clear head and unpuzzled mind, to sit down to our work. . . . Let metaphysicians keep to their proper speculations about mind and thought, where they

* *Edinburgh Review*, Vol. LVIII. p. 437.

are at all events safe from being proved to be in the wrong, however extravagant their conclusions may appear to the less presumptuous, and therefore (if on no other account) less fallible, student of the laws of matter."* Now, we think that the recollection of that voice which for nearly twenty years was heard within the walls of the room which adjoins his own, should have restrained Professor Tait from speaking thus of metaphysicians. We have always found that those physicists who affect to despise metaphysics, nevertheless cling tenaciously to certain metaphysical doctrines of their own. These doctrines, too, are often of the crudest kind, and belong to the philosophical systems of the past. The Professor is himself an illustration of this. He tells us that in the physical world we are cognisant of but four primordial ideas besides *time* and *space*, namely, *matter*, *force*, *position*, and *motion*. To which of these, he asks, does heat belong? He says that, "till we know what the ultimate nature of matter is, it will be premature to speculate as to the ultimate nature of force, though we have reason to believe that it depends upon the diffusion of highly attenuated matter throughout space." He then informs us that "sensible heat" is neither matter nor force, but *motion;* while the so-called "latent heat" of Black is not to be regarded as heat at all, but *position!* Our readers will allow that these statements are, to say the least, unsatisfactory. A strictly philosophical analysis of our necessary judgments regarding the qualities and powers of matter would have prevented this confusion. Will Professor Tait inform us whether *experiment* has shown that sensible heat is motion, and latent heat nothing more than position? Until this is done we shall venture to maintain that these assertions are nothing but assumptions made to meet the necessities of the hypothesis of conservation. He finds himself compelled to employ the word *force*. He tells us that "force is recognised as acting in two ways—(1) So as to compel rest, or to prevent change of motion; and (2) So as to produce, or to change motion." But it belongs to the metaphysician exclusively to determine the precise significance of our necessary judgments respecting the reality of which the term force is the verbal symbol. The refusal to be guided by the teachings of a sound philosophy regarding the nature and origin of our notion of power has given rise to many false theories in ethics as well as in physics. The following is but one out of many

* *North British Review*, Vol. XL.

instances we had noted of the very loose employment of the term force :—

"Force is that which produces or resists motion.' It is indestructible. When it has ceased to exhibit itself in one form it has not ceased *to be*, but it has assumed expression in some other form. A force cannot originate otherwise than by devolution from some pre-existing force or forces. . . . In physics light, colour, heat, electricity, chemical affinity, attraction and repulsion, are modes of force. Matter is the vehicle through which force acts, is propagated, and alters its direction. Motion is the mode of alteration of force, and the transfer of it in greater or less intensity from one point to another. . . . Light, heat, electricity, &c., are correlatives, and the degree, intensity, or quantity of the one taking the place of, or superinduced by another, always bears an exactly definite proportion to the degree, intensity, or quantity of that other whose place it takes, or by which it is superinduced. . . . The train [locomotive] is brought to rest by reconversion of the propelling force into heat. . . . Vital and mental and nervous action are also modifications of force. . . . Mental exertion has produced ideas which remain in the mind, and the maintenance of these ideas consumes a large portion of the force received, which thus becomes latent. It is not only through the food that force passes to the brain; each sense is a force-conductor as each muscle is a force-liberator. Sights, sounds, scents, are modes of motion; nay, even qualities are so much more, or so much less force. . . . Dimension is a modification of force. Solidity, liquefaction, vaporisation, are modes of force. . . . Light is a modification of force. According to the theory now universally received it consists of a vibratory motion of the particles of a luminous body propagated in waves which flow in at the pupil of the eye, and, breaking upon the retina at the back, transmit their motion along the optic nerve to the brain, where they announce themselves as consciousness of light by resolution into an idea. Sound is the undulation of the air. The force applied by the finger to a harp-string flings the air into agitation, and the ripples sweep in at the ear, vibrate on the tympanum, and are thrilled to the auditory ganglion, where they transform themselves into a musical idea. . . . The force from the stroke of the waves of light is broken up by the brain, and then becomes an idea. In the formation of the idea the force becomes passive." He speaks of remembrances as "fossil percepts," and explains how we may use them up. "Say it is an ideal of beauty, the sculptor elaborates it in marble, and runs the pent-up force out of the brain. . . . Force modified by the brain appears as volition, cognition, and feeling."—*Origin and Development of Religious Belief*, Part First, Chapter I.

After so luminous an exposition of the fundamental principles of modern dynamical science, Mr. Baring Gould evidently felt it would not be a right thing to allow the already much abused metaphysicians to escape without giving his

testimony to the cloudiness of their speculations. He says: "In following the thoughts of modern German philosophers, the difficulty of arresting them, and reducing them to a clear and easily intelligible system, is extreme; the moment one fancies that a thought is assuming precision and outline, it throws out a cloud of ink like the sepia, and leaves the pursuer bewildered and in the dark." * But he must excuse our saying that our philosophical brethren in Germany have seldom succeeded in putting together so many words without thought corresponding, as he himself has done, in the sentences we have quoted.

We shall now consider the principal assumptions of the more distinguished supporters of the theory of the conservation of energy:—

First. They take for granted that *force is motion, and nothing but motion.* "Inert matter in motion," says Professor Bain, "is force under every manifestation." † Mr. Brooke, referring to the change of views since the publication of the fifth edition of Dr. Golding Bird's *Natural Philosophy* in 1860, says: "The numberless facts that have in the interval been observed and recorded, have tended only to confirm the opinion that *the various physical agents* are not forms of matter, but *modes of motion.*" ‡ It is true that he makes a distinction between force and energy. "The term *energy*," he says, "means simply the power of doing work; *force* means the power of producing energy. These terms have been frequently confounded together; thus we are accustomed to speak indifferently of the force of the powder and the 'force' of the shot. But this is one of those confusions of terms that is very likely to lead to a confusion of ideas: strictly speaking, the powder has force, the shot only energy. Again, the force of the powder is only *potential*, or capable of being called into activity, while it remains yet unignited; but, on the moment of ignition, its force becomes *actual.*" His doctrine regarding the nature of force has thus no connection with that of a sound philosophy. By force, Mr. Brooke evidently means what other advocates of conservation mean by "potential energy." Thus Mr. Rankine speaks of "heat-potential" as distinguished from what is usually termed "sensible heat"—a form of kinetic or actual energy. Both forms of heat, we are told, are modes of motion; only in the case of potential-heat the motion is, in some mysterious way, stored up,—

* *Origin and Development of Religious Belief.* Part First, p. 290.
† *Logic—Induction*, p. 21.
‡ *The Elements of Natural Philosophy.* Sixth Edition. Preface.

motion at rest, in fact! Well may Mr. Brooke admit that this "latent" or "potential" heat "has ever been held up as the great stumbling-block of the dynamic theory, because it is impossible to conceive motion to be reduced to a state of quiescence, but remaining still ready to start again into action."* In this we quite agree, and hence we think it unnecessary to give Mr. Brooke's reasons for believing a doctrine which he allows to be inconceivable. Mr. Grove teaches that, if we attempt to analyse our conception of force, viewed as the cause of any perceived motion, we can get nothing beyond some antecedent motion.† Hence the terms force and energy are not the symbols of distinct realities, but denote the same thing in different relations. A given motion, viewed as a cause, is force, while the very same motion, thought as an effect, is energy. And by cause the supporters of this theory really mean nothing but an immediately antecedent event. This is the doctrine of Professor Tyndall. He regards it as a primary and self-evident truth that "the cause of motion must itself be motion." He asserts that "we can make no movement which is not accounted for by the contemporaneous extinction of some other movement." Taking this for granted, he finds little difficulty in reaching the conclusion that, since light, heat, electricity, magnetism—cautiously omitting all reference to gravity—produce motion, they are themselves nothing but modes of motion.

But Dr. Tyndall is not content with this application of his assumed principle: he invades the province of the metaphysician, and decides that even "sound is motion." We find him frequently referring to this *fact* for the purpose of illustrating and confirming his dynamical theories. Unfortunately for his dictum, it can be demonstrated that sound is not motion. He falls into the very common error of confounding the condition of an effect with the effect itself. Sound is not motion, but sound. A logical definition of sound is impossible. He forgets that each thing is itself, and not something else. We allow that the vibration of the sounding body is a constituted condition of the existence of sound. We also admit that the undulations of the atmosphere, or of some other medium, are necessary to our perception of sound, since a given sound exists independent of our perception of it. Professor Tyndall also teaches that all our sensations are resolvable into so many kinds of molecular movement!

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* *Elements of Natural Philosophy*, p. 786.
† *Correlation of Physical Forces*, p. 26.

Mr. Grove, too, defines sound as motion, and yet he allows that motion itself is incapable of definition. He says, "that to attempt to define it, would be to render it more obscure."* But philosophy teaches that the term sound designates an unresolvable fact, quite as much as the term motion does. If motion is motion, as Grove teaches, then sound must be sound. Tyndall's definition of heat violates the same logical laws. He tells us that "heat is a mode of motion." Now, we are willing to grant that motion of some kind, mechanical or molecular, may be a constituted condition of the action of the powers of heat. But how can this prove that heat is itself motion? Strange that our physicists do not see that these pretended explanations do but "darken counsel by words without knowledge." In every path of human inquiry, we speedily come to a barrier on which we behold, inscribed as in letters of light, "Thus far shalt thou go, but no further." To go beyond is impossible, so long as it shall please our Maker to continue those limitations upon our cognitive faculties of which we are conscious. Hence, how much more philosophical, to say the least, to admit that there are unresolvable mysteries, to confess our ignorance, than to impose upon ourselves and others by the pretence of knowledge.

It is, however, time to inquire whether a sound philosophy admits the validity of the assumption that force is nothing but motion. Assuredly it does not. There can be no motion except as the result of the exercise of force, but in no instance can the force itself be resolved into motion. Even a body in motion does not possess any force by virtue of that motion. Hence if it strike a body at rest, and thereby set it moving, there is here no real origination of motion. We have nothing but a distribution of the motion rendered possible by that action of force to which we refer the motion of the first body. To increase the quantity of motion, it is in vain that we resort to mechanical contrivances: we must supply the requisite conditions of new exertions of force. Hence, in direct opposition to Tyndall, we assert that we never account for the existence of any given motion by merely referring it to some previous motion. The origin of the motion is explained only when we trace out the reality, whether person or thing, possessing and exercising force. If the force is traced to a thing as distinguished from a person, the mind demands, in order to the complete explanation of an existent effect, that

* *Correlation of Physical Forces*, p. 24.

we admit that some person or intelligent agent has supplied the conditions of the action of that force. This Sir John Herschel insisted upon long ago, and we are not aware that anyone who claims to be regarded as a philosopher would think of denying what is most certainly a primary and necessary truth. Of course, Professor Huxley denies it, but it is well known that when he gets beyond his own special province, in which he is justly distinguished, it is his habit to "dogmatise in negation." He asserts:—

"The whole analogy of natural operations furnishes so complete and crushing an argument *against the intervention of any but what are termed secondary causes in the production of all the phenomena of the universe,* that in view of the intimate relations between man and the rest of the living world, and between the forces exerted by the latter and all other forces, I can see no excuse for doubting that they are co-ordinated terms of nature's great progression from the formless to the formed; from the inorganic to the organic; from blind force to conscious intellect and will."—*Evidence as to Man's Place in Nature,* p. 108.

In his paper on the "Physical Basis of Life," he affirms, what no sane mind ever questioned, the impossibility of an effect which has no cause. But he as confidently asserts that which no true metaphysician can allow, that every effect is the result of the action of a material and necessary cause. Philosophy teaches that only a person or intelligent agent can be a primary cause, and that the so-called "secondary causes" are merely the means or instruments by which intelligent beings accomplish contemplated and designed ends. The bold assertions of Huxley afford a remarkable confirmation of the truth of Darwin's recent statement,—that the absence of knowledge begets confidence more frequently than its presence.

We have seen that Mr. Grove, in common with other believers in the theory of conservation, assumes that all the physical forces are but modes of motion. But in the closing chapter of his valuable book, he makes an admission which is inconsistent with this doctrine. He says:—

"Another confusion of terms has arisen, and has, indeed, much embarrassed me in enunciating the propositions put forth in these pages, on account of the imperfection of scientific language; an imperfection in great measure unavoidable, it is true, but not the less embarrassing. Thus, the words light, heat, electricity, and magnetism, are constantly used in two senses, viz., that of the force producing, or the subjective idea of force or power, and of the

effect produced, or the objective phenomenon. *The word motion, indeed, is only applied to the effect, and not to the force,* and the term chemical affinity is generally applied to the force, and not to the effect; but the other four terms are, for want of a distinct terminology, applied indiscriminately to both."

Mr. Grove thus abandons the fundamental assumption that force is nothing but motion. Does he not here teach that force, while the cause of motion, is not itself motion?

But let us inquire a little more particularly respecting the teachings of a sound philosophy. Force and motion are necessary correlatives. But forces are only one class of the powers belonging even to the various forms of material existence. It is an old heresy that all the phenomena of the material universe are resolvable into motion, and that all material effects are nothing but transformations of motion. This opinion harmonises with the theory of causation held by Hume, Brown, and Mill. These writers maintain that, apart from the time-relations of phenomena, there is no reality corresponding to our notion of force or power. Professor Tyndall, in his lecture on "The Scientific Use of the Imagination," makes a similar mistake. He seems to teach that the term force is not the sign of any reality presented either to observation or to consciousness; it has only an ideal existence,—it is but a fiction of the imagination. He tells us that, without the faculty of imagination, "our knowledge of nature would be a mere tabulation of coexistences and sequences. We should still believe in the succession of day and night, of summer and winter; but the soul of force would be dislodged from our universe; causal relations would disappear, and with them that science which is now binding the parts of nature to an organic whole" (p. 6). But this view of the province of imagination is wholly false. The imagination never creates its own object. It can only combine variously the realities which have already been presented to observation or to conciousness. Thus a man born blind, and who has never seen colours, cannot represent them in imagination, either singly or in combination. So, too, a man born deaf cannot imagine sounds. Hence it is not possible to imagine force, unless force itself has been presented to our cognitive faculty. We cannot account for the existence in our language of such words as power, energy, force, &c., unless the reality symbolised by these terms has been perceived either as an absolute, or as a relative, object of cognition. Each material reality possesses both qualities

and powers. Formerly, physicists dwelt almost exclusively upon the qualities, losing sight in a great measure of the powers. The tendency now is to explain all the phenomena of matter by referring them to the action of its powers. Thus extension and colour are material qualities, not powers. Mr. Baring Gould, as we have seen, asserts the opposite of this. In reading the *Life of Faraday*, we cannot but be struck with that philosopher's tendency to resolve all our judgments respecting matter into judgments of force. Hence his sympathy with the opinions of Boscovich. According to the theory of Boscovich, matter fills space by virtue of its forces, but does not occupy it. In harmony with this, Faraday remarks:—"We know nothing about matter but its forces—nothing in the creation but the effect of these forces; further our sensations and perceptions are not fitted to carry us; all the rest, which we may conceive we know, is only imagination." Hence he taught that the ultimate atoms are *centres of force*, and not so many little bodies either possessing forces, or surrounded by them. With him, forces constitute matter.

The objections to this theory of the nature of matter are admirably stated in a letter to Faraday by Dr. Thomas Mayo:—

"Your atmosphere of force, grouped round a mathematical point, is not, as other hypothetical expressions have been in the course of your researches, an expression linking together admitted phenomena, but rather superseding the material phenomena which it pretends to explain. It resolves, in fact, as it would appear to me, all matter into a metaphysical abstraction; for it must all consist of the mathematical point, and the atmosphere of force grouped around it. . . . The question which the philosopher has to answer in deciding whether he should accept this or any other hypothesis on the subject, is whether it best interprets phenomena, or is least at variance with them; the objection which you take to atoms on the ground of their uncertain magnitude is one which presumes that we pretend to more knowledge of them than those who entertain that theory *need* affect to possess. Indeed, your mathematical point is either a simple negation, as having neither magnitude nor parts; or is itself, after all, a material atom. The objection that *silver must vanish if its forces are abstracted*, may prove the necessity of forces to our conception of silver, but does not disprove the necessity of silver to our conception of its forces."—*Life of Faraday*, Vol. II. p. 180.

Mr. Wallace, in his *Contributions to the History of Natural Selection*, teaches that matter *is* force, and not a reality pos-

sessing and exercising force. He also endeavours to resolve all force into volition, as the following extract will show :—

"It has been long seen, by the best thinkers on the subject, that atoms, considered as minute solid bodies,—from which emanate the attractive and repulsive forces which give what we term matter its properties,—could serve no purpose whatever, since it is universally admitted that the atoms never touch each other; and it cannot be conceived that these homogeneous, indivisible solid units are themselves the ultimate *cause* of the forces that emanate from their centres. As, therefore, none of the properties of matter can be due to the atoms themselves, but only to the forces which emanate from the points in space indicated by the atomic centres, it is logical continually to diminish their size till they vanish, leaving only localised centres of force to represent them. . . . Matter is essentially force, and nothing but force; matter, as popularly understood, does not exist, and is, in fact, philosophically inconceivable. When we touch matter, we only really experience sensations of resistance, implying repulsive force; and no other sense can give us such apparently solid proofs of the reality of matter as touch does. This conclusion, if kept constantly present in the mind, will be found to have a most important bearing on almost every high scientific and philosophical problem, and especially on such as relate to our own conscious existence." [After asserting that all force is probably *will-force*, he asks, "What is force?" and says:] "We are acquainted with two radically distinct, or apparently distinct, kinds of force: the first consists of the primary forces of nature, such as gravitation, cohesion, repulsion, heat, electricity, &c.; the second is our own will-force." [He argues that our own *will* is the only primary cause of force of which we have any knowledge; and then adds:] "It does not seem an improbable conclusion that all force may be will-force; and thus that the whole universe is not merely dependent on, but actually *is*, the WILL of higher intelligences, or of one Supreme Intelligence. . . . Matter as an entity distinct from force, does not exist; FORCE is a product of MIND. Philosophy has long demonstrated our incapacity to prove the existence of matter as usually conceived, while it admits the demonstration to each of us of our own self-conscious, ideal existence. Science has now worked its way up to the same result, and this agreement between them should give us some confidence in their combined teaching."—Pp. 363, 369.

Both Faraday and Wallace overlook the important fact that we are conscious of necessary judgments regarding the qualities as well as the powers of material realities. Mr. Wallace is evidently an idealist, and an idealist greatly in advance of the school of Berkeley. If matter is nothing but force, and if all force is in its very nature spiritual, then we see no possibility of establishing the existence of anything beyond the facts of our own consciousness.

But how shall we account for the origin of our notion of power? As a matter of fact, we are conscious of an idea of agency quite distinct from our judgments respecting the mere succession of events. *This notion of power originates in the consciousness of ourselves producing or causing our volitions.* This, of course, is not admitted by Mr. Mill, because he denies the consciousness of self-personality. But we are here dealing with a question of fact, which every one can settle for himself by appealing to his own consciousness. If we are conscious only of successive mental states and acts, then all our judgments of continued existence and of personal identity are destitute of validity. Power, therefore, is predicated primarily of a conscious personal agent only. Hence it is that our first judgments of causation relate to ourselves originating our volitions. We are causes, our volitions are effects. All other effects produced by us are produced not immediately, as are our volitions, but mediately or instrumentally. Hence it is that our first judgment of secondary causation must refer to the relation between volition and some of its constituted sequents. Having gained the notion of power in the consciousness of our self-personality, we then, in perfect accordance with a well-known law of thought, transfer this notion, first to our volitions, and ultimately to material realities. For example, before us is lying a quantity of gunpowder. Is not the conviction forced upon our minds that this substance possesses, by virtue of its constitution, power to produce certain effects? We allow that this judgment is conditioned upon the facts of observation; but that does not in any way affect the real significance of the judgment itself. And we further allow that, apart from the effects viewed either as actual or possible, we can form no conception of the power belonging to the gunpowder. It is so with all relative objects of cognition.

It must here be noted that, when power is predicated of anything but a person, as for instance, when we affirm that a volition has power to move the hand, or that heat has power to move a body, we never think that the power *originates* the effect or change in the sense in which an intelligent agent originates his volition. We are, however, compelled to think that the volitions of agents supply the necessary conditions of the action of all secondary powers. It was an acute remark of Dr. Reid that the relation existing between primary and secondary causes is exactly expressed by the terms *Agent* and *Instrument*. Our readers will perceive the bearing of all this on certain prevalent theories. How often have we been told that

science demonstrates that our Maker cannot hear our prayers, and that miracles are impossible. But philosophy shows the falsity and absurdity of all such assertions. It proves beyond all possibility of question that the unceasing exercise of the agency of the Creator is the condition of the continued action of the constituted powers of the universe. In a former paper we denied the right of Positivists to be considered philosophers, because, in direct opposition to some of the best established truths of philosophy, they seek to shut God out of His own world. We see, too, how philosophy strikes at the very root of the evolution theory. It shows that there can be no event, and, therefore, no beginning of conscious existence without the exercise of power by an intelligent agent. Hence it is that the Creator's agency is as necessary to the beginning of each separate sentient being as it was to the origin of the first living organism. Philosophy rejects the monstrous assumption that, "because we were *born*, therefore we were *not created*." Nor can the conclusions of a sound philosophy be evaded by any attempt to clothe the so-called "laws of nature" with attributes which can belong only to an intelligent agent. Philosophy knows nothing of law except as a rule of action existing in some mind. We cannot predicate agency of law. There is no "creation by law." It may be *according to* law, but the power to originate can belong only to the agent. Even when it is said that secondary powers act according to law, it is not meant that the powers themselves choose to obey a perceived rule. It is the agent, whose volitions constitute the conditions of the action of these powers, who really conforms to the rule or law. Wherever we have regulated action—action in harmony with law—there we have evidence of the working of a mind.

Now, whenever the believers in evolution can show us a watchmaker who can construct a watch with Baden Powell's "self-evolving powers," so that it shall be able to evolve out of the depths of its own consciousness, and without any interposition of the agency of its maker, another watch like itself, or rather, as the theory demands, a watch slightly better than itself, then, and not till then, shall we allow that they have even conferred intelligibility upon their doctrine. When they have done this we shall be prepared to consider the question of its validity.

As we can form only a relative cognition of the powers of the material universe, it follows that we can classify these powers only through the effects which their existence renders possible. Hence the supposition that all the phenomena

presented to observation are manifestations of but one force is inadmissible. If all effects were the same in kind, then we might refer them to separate actions of a single force. The unity really revealed by the phenomena of the universe is of another kind. The marvellous adjustments of the various forms of material existence, the correlations of physical forces, and the harmonious action of all known powers, reveal the working of *One Mind.* This fact fully recognised, the soul's craving for unity is met. Even Mr. Darwin confesses that "one hand has surely worked through the universe." The advocates of the theory of the conservation of energy further assume that *a motion once originated cannot cease.* This is what they mean when they assert that energy is never lost. An able supporter of this doctrine says: "When any kind of action ceases some other and equal action arises. There is never an absolute ceasing; never an absolute beginning. If any action come to an end, some other continues or follows elsewhere; if any action begin, some other, in that beginning, comes to an end."* Mr. Grove asserts that "all motion is, in one sense, perpetual. In masses whose motion is stopped by mutual concussion, heat or motion of the particles is generated; and thus the motion continues, so that, if we could venture to extend such thoughts to the universe, we should assume the same amount of motion affecting the same amount of matter for ever."† Brooke, and many other believers in conservation, might be quoted to the same effect. The assumption now under consideration rests avowedly upon Newton's "First Law of Motion," viz., that "every body continues in its state of rest, or of uniform motion, in a straight line, except in so far as it may be compelled by impressed forces to change that state." "These propositions," says Mr. Grove, "may seem somewhat arbitrary, and it has been doubted whether they are necessary truths; they have for a long time been received as axioms, and there can at all events be no harm in accepting them as postulates."‡ *No harm!* A curious reason this to assign for accepting a doctrine. Besides our most distinguished men of science are continually seeking to impress upon theologians that *they* never appeal to authority,—*their* doctrines always rest upon the surer basis of observation and experiment! Newton was generally right in his deductions, but we are not prepared to admit his infallibility. When he asserts that only a Being skilled in optics

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* *Cornhill Magazine*, 1861, p. 415 † *Correlation of Physical Forces*, p. 259.
‡ *Ibid.* p. 27.

could construct the eye, all, of course, excepting Mr. Darwin and those who bow to *his* authority, will admit that Newton affirms a necessary truth, about which there can be no rational doubt. But when he states that a body once in motion would continue so for ever, in the same direction and with the same velocity, unless impeded by the action of some other force than that which originally impelled it, we refuse our assent. It will not be contended that the truth of this statement can be established by experiment since it would require an eternity to make the experiment! The fact is, Newton's assumption is based upon a metaphysical error, viz., that "the continuance of a body in motion, in the same direction and with the same velocity" is, like "the continuance of a body at rest," *not an effect.* We commend this fact to the attention of Professor Tait. It will no doubt furnish him with an additional reason why he should be even yet more careful in his avoidance of the metaphysical treatment of physical questions.

No truth in philosophy is better established than this, that each change of the position of a body in space is an effect, demanding, in order to account for its existence, the action of a force belonging to some reality,—person or thing. The degree of the force exerted can be measured only through the effect produced. Now, according to Newton's "First Law of Motion," an exertion of force, which will move a body one-millionth part of an inch, is quite sufficient to move it ten millions of miles. Hence Mr. Grove's statement, that some have doubted whether this is a necessary truth, did not greatly surprise us.

The supporters of the doctrine of the indestructibility of energy have adopted a method the reverse of scientific. They start with the assumption of perpetual motion by means of transformation. In order to make facts fit their hypothesis, they take for granted that heat, light, electricity, and magnetism, are modes of motion, but not requiring a material basis to account for their phenomena. Some, however, seem to be aware that motion of necessity implies *something moving*, and that this something must be matter in some of its forms, and that, consequently, it is a great mistake to suppose that the dynamical theory is inconsistent with the materiality of heat. Finding that they have been a little too hasty in getting rid of the old imponderables, they are now quietly bringing them back under a new name, hoping, doubtless, that their few remaining friends may not be able to recognise them. Instead of the "imponderables," we now have "the *luminiferous ether* which fills stellar space, and even permeates all the

grosser forms of material existence." The phenomena of heat, light, electricity, and magnetism, are now explained by supposing the ether susceptible of the four corresponding modes of motion. "I have," says Professor Tyndall, "endeavoured to make as clear to you as possible, that bold theory, according to which space is filled with an elastic substance capable of transmitting the motions of light and heat. And consider how impossible it is to escape from this or some similar theory,—to avoid ascribing to light, in space a *material basis*. . . . Is it in the human mind to imagine motion without, at the same time, imagining something moved? Certainly not. The very conception of motion necessarily includes that of a moving body."* Respecting the nature of the "ether," Dr. Tyndall says that it is a *material substance*, possessing determinate mechanical properties, and that it is highly elastic. So far, chemical analysis has not determined anything beyond the fact that the ether belongs to the class "jellies." We need not wonder that a real philosopher like Faraday should make very light of such wild notions as these, and that he should persistently refuse to recognise them as belonging to science. It is but recently that Tyndall denied the materiality of heat, on the ground that it is motion. Grove, not having a like facility in changing his opinions, still clings to the doctrine that motion does not imply matter moving. He insists that "*it requires no great stretch of imagination to conceive light and electricity as motions, and not as things moving!*"† Thus the two most distinguished advocates of the dynamical theory are at issue on a point of vital importance.

Further, the theory of the conservation of energy demands not merely that we allow that one mode of motion may be converted into another, but that in any given series of transformations each motion is exactly equivalent to the one which preceded it and determined its existence. Tyndall, we have seen, holds that only motion can be the cause of motion. Consequently, according to this assumption, we have nothing in the effect which did not previously exist in the cause, and hence there is no production or origination of motion—nothing but a transformation. Dr. Tyndall illustrates the supposed transformation thus:—

"Here is a cold lead bullet, which I place upon this cold anvil, and strike it with a cold sledge-hammer. The sledge descends with a

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* *Notes on Light*, p. 71.

† *Correlation of Physical Forces* p. 25.

certain mechanical force, and its motion is suddenly destroyed by the bullet and anvil; apparently the force of the sledge is lost. But let us examine the lead: you see it is heated, and we shall by and by learn that if we could gather up all the heat generated by the shock of the sledge, and apply it without loss mechanically, we should be able by means of it to lift the hammer to the height from which it fell. . . . When our sledge-hammer descended upon our lead bullet, the descending motion of the sledge was arrested; but it was not destroyed. The motion was transferred to the atoms of the lead, and announced itself to the proper nerves as heat."—*Heat a Mode of Motion*, pp. 7, 27.

Now the assertion that "if we could gather up all the heat generated by the shock of the sledge, and apply it mechanically, *we should be able, by means of it, to lift the hammer to the height from which it fell,*" is not true. How does Dr. Tyndall in this experiment measure the amount of mechanical motion? Not by the *vis viva*, not even by the *momentum*, but simply by the weight of the sledge multiplied into the distance through which it falls. Let us suppose that, instead of striking the anvil with the hammer, it is pulled through the same distance *by the force of gravity alone*, what will be the result? The heat generated will not be nearly so great as when the fall is the effect of the combined action of gravity and muscular force. Dr. Tyndall quietly drops out of view in this experiment the all-important element of *velocity*, simply that he may make his facts fit his hypothesis. It is confidently asserted that the experiments by which Dr. J. P. Joule determined the mechanical equivalent of heat support the conclusion in question. We as confidently affirm that they do not. Through the kindness of Dr. Joule we have been permitted to form our own judgment respecting the precise significance of these experiments, and also to determine to what extent they warrant the various doctrines which have been based upon them. We cannot, however, enter upon this question now. We merely remark that Dr. Joule, like Faraday, is a most painstaking experimentalist. Like him, too, he values facts above all price, but holds theories with a very loose hand.*

* Much confusion has arisen in recent dynamical speculations in consequence of not perceiving that the physicist and the philosopher must of necessity contemplate Dr. Joule's experiments from very different points of view, and with reference to totally distinct inquiries. We have space for but a single illustration,—one of the experiments for determining "the mechanical equivalent of heat." By means of machinery a weight of 772 lbs. is made to turn a small paddle-wheel placed in one pound of water. Dr. Joule found that the descent of the weight with a given velocity through one foot raised the temperature of the water exactly one degree Fahrenheit. The same result was obtained when

Even with the assumptions already noted the advocates of the theory of conservation find that they are not able to explain all the facts. For example, we apply a single spark of fire to an ounce of gunpowder, and thereby explode it. We then explode 10,000 tons of powder by the application of another spark. No supporter of the theory will venture to tell us that in these cases the energy of the explosion is exactly equivalent to the energy or motion of the spark; so, rather than give up their pet hypothesis, they make another appeal to our credulity, and ask us once more to tax our imagination. They tell us that energy or motion is of two kinds, *actual* and *potential*. We have heard much about the *potential* energy of coal, and have endeavoured to think it as it is represented to be—"stored up motion," "bottled sunlight," &c., but in vain. We are not yet sufficiently skilled in —shade of Bacon, pardon the expression!—the "scientific use of the imagination." But let us hear Professor Tyndall's exposition of the nature of the two forms of energy:—

"I have here a lead weight attached to a string which passes over a pulley at the top of the room. We know that the earth and the weight are mutually attractive; the weight now rests upon the earth, and exerts a certain pressure upon its surface. The earth and the weight here *touch each other;* their mutual attractions are, as far as possible, satisfied, and *motion*, by their mutual approach, is no longer possible. As far as the attraction of gravity is concerned, the possibility of producing motion ceases as soon as the two attracting bodies are actually in contact. I draw up this weight. It is now suspended at a height of sixteen feet above the floor, where it remains just as motionless as when it rested on the floor; but by introducing a space

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other fluids were employed, allowance of course being made for the difference in their capacity for heat. It is sometimes said, but erroneously, that Dr. Joule has also determined, by actual experiment, that the expenditure of one degree of the heat existent in a pound of water will raise 772 lbs. through the space of one foot. But the question how much mechanical work can be done by a given quantity of heat is far from settled. Now to the physicist the downward motion of the weight is so much "mechanical energy," the heat produced so much "work done." To the philosopher, on the other hand, the motion of the weight is not energy or force at all, but simply an effect determined by the earth's force of gravity, while the action of the heat is another effect. The whole series of effects, beginning with the descent of the weight and terminating with the heat generated, the philosopher refers to a specific action of the force of gravity. This force he views as distributed, each effect expending a portion of the force. The physicist regards the heat produced as transformed mechanical energy or motion, while the philosopher sees in this not the conversion, but the correlation of two physical forces, the action of gravity supplying the condition of the action of the heat previously existent, though latent, in the water. To the physicist the descent of the weight viewed in relation to the heat is *a cause*. To the philosopher this motion, viewed in the same relation, is not a cause, but *a condition*.

between the floor and it, I entirely change the condition of the weight. By raising it I have conferred upon it a motion-producing power. There is now an action possible to the weight which was not possible when it rested upon the earth—*it can fall,* and in its descent can turn a machine, or perform other work. Let us employ, generally, the useful and appropriate term *energy* to denote the power of performing work; we might then fairly use the term *possible energy* to express the power of motion which our drawn-up weight possesses, but which has not yet been exercised by falling; or we might call it 'potential energy,' as some eminent men have already done. This potential energy is derived, in the case before us, from the pull of gravity, which pull, however, has not yet resulted in motion. But I now let the string go: the weight falls and reaches the earth's surface with a velocity of thirty-two feet a second. At every moment of its descent it was pulled down by gravity, and its final moving force is the summation of the pulls. While in the act of falling, the energy of the weight is active. It may be called *actual* energy, in antithesis to *possible;* or it may be called *dynamic* energy, in antithesis to *potential;* or we might call the energy with which the weight descends *moving force.* The great thing, now, is to be able to distinguish energy *in store* from energy *in action;* potential energy from actual energy. . . . Our weight started from a height of sixteen feet; let us fix our attention upon it after it has accomplished the first foot of its fall. The total pull, if I may use the term, to be expended on it has been then diminished by the amount expended in its passing through the first foot. At the height of fifteen feet it has one foot less of potential energy than it possessed at the height of sixteen feet, but at the height of fifteen feet it has an equivalent amount of dynamic or actual energy, which, if reversed in direction, would raise it again to its primitive height. Hence, as potential energy disappears, actual energy comes into play. *Throughout the universe, the sum of these two energies is constant.* To create or annihilate energy is as impossible as to create or annihilate matter; and all the phenomena of the material universe consist in transformations of energy alone. The principle here enunciated is called the law of the *conservation of energy.* . . . To Nature nothing can be added; from Nature nothing can be taken away; the sum of her energies is constant, and the utmost men can do in the pursuit of physical truth, or in the applications of physical knowledge, is to shift the constituents of the never varying total. The law of conservation rigidly excludes both creation and annihilation."—*Ibid.* par. 153, 154, 155, 626.

The statement that the sum of the actual and potential energies of the universe is a constant quantity, Sir John Herschel has clearly shown to be nothing but a truism. It is so simply in consequence of what he terms "the unfortunate phrase potential energy."* According to Professor

* *Familiar Lectures on Scientific Subjects,* p. 469.

Tyndall, in the case supposed, the weight, when resting on the surface of the earth, is destitute of all energy, potential and actual. Yet he tells us that "*it exerts* a certain pressure." This is an error. The pressure is an effect produced by the earth's force of gravity, and therefore not exerted by the weight. We leave out of view the infinitesimal amount of pressure determined by the weight's attraction of the earth. If the energy of the universe is an unvarying quantity, it follows that the weight can acquire power, not by a creation of energy, but only by its transference from some other reality. This Dr. Tyndall allows. But the question arises, *what is energy?* Several distinct and totally different answers have been given. We shall in this connection refer only to one. Professor Balfour Stewart has a series of papers in *Nature* on this question.* He asserts that energy is not a *quality* but a *thing*. We have no conception of what he means;—but this may be due to the fact that we did not learn our metaphysics in the lecture-room of Professor Tait. Stewart says that "the chemist has always taught us to regard quantity, or mass of matter, as unchangeable, so that amid the many bewildering transformations of form and quality which take place in the chemical world, we can always consult our balance with a certainty that *it* will not play us false. But now the physical philosopher steps in and tells us that energy is quite as unchangeable as mass, and that the conservation of both is equally complete. There is, however, this difference between the two things: the same particle of matter will always retain the same mass, but it will not always retain the same energy. As a whole, energy is invariable, but it is always shifting about from particle to particle, and it is hence more difficult to grasp the conception of an invariability of energy than of an invariability of mass." Dr. Bence Jones, Secretary to the Royal Institution, asserts the exact opposite of this. He makes no distinction whatever between force and energy, and consequently confounds two totally distinct theories, viz., "the conservation of force" and "the conservation of energy." He says that force cannot be separated from matter at all, thus denying Stewart's doctrine respecting the transference of energy. He tells us, for example, that "the union between matter and gravity is as inseparable as the union between matter and chemical force. Matter without weight is not matter at all; the weight belongs to the matter, and cannot be taken from it." † But to return to Tyndall's

* *Nos.* 26, 31, 36, 40.

† *Croonian Lectures*, p. 18.

illustration. He tells us that when the weight is suspended at a height of sixteen feet its condition is changed; that it possesses a power which it did not possess when it rested upon the earth;—"*it can fall.*" So also affirms Professor Stewart. He supposes a stone thrown upwards, and "caught at the summit of its flight and lodged on the top of a house." He asks "what has become of the energy of the stone? Has this disappeared? Far from it; the energy with which the stone began its flight has no more disappeared from the universe of energy than the coal, when we have burned it in our fire, disappears from the universe of matter. But this has taken place: the energy has changed its form and become spent, or has disappeared as energy of actual motion, in gaining for the stone a position of advantage with regard to the force of gravity." According to Stewart the potential energy of the stone at its maximum height is simply its position, and by virtue of the position thus gained the stone possesses a power to fall. All this we deny. The stone has not, in consequence of its upward motion, acquired a power to fall. Why cannot the so-called potential energy of the stone determine a further upward motion? The power which is supposed to be existent in the stone at the moment its upward motion ceases, has no reality; it is simply a creation of energy by "the scientific imagination." When the stone or the weight falls to the ground, it is not through the action of any power belonging to the objects themselves, but is simply the result of the exercise of the earth's force of gravity.

We accept the doctrine of the conservation of force as opposed to that of the indestructibility of energy. No one has stated this doctrine with greater clearness than Faraday. He says: "A particle of oxygen is ever a particle of oxygen; nothing can in the least wear it. If it enter into combination and disappear as oxygen—if it pass through a thousand combinations, animal, vegetable, and mineral—if it lie hid for a thousand years, and then be evolved, it is oxygen with its first qualities: neither more nor less. It has all its original force and only that." * Hence it is evident that the theory of the conservation of force is really nothing but one aspect of the doctrine that matter is indestructible except by Him who gave it existence. Each material reality, as we have seen, possesses both *qualities* and *powers*, and hence the two aspects of conservation.

It is necessary to call attention here to a distinction too

* *Researches in Chemistry*, p. 454.

generally overlooked by the physicist. It is admitted, in reference to the force of gravity, that we have a power in constant action. If it does not produce motion, it determines the existence of pressure or weight. But the action of many forces is intermittent, and we are often able to supply the constituted conditions of this action. Now we must carefully distinguish between a given force and some particular action of this force. The force may be exerted a thousand times and in a thousand different combinations, still there is no change in the force itself. The same results are always possible provided the conditions of its action are the same. But while the force itself cannot be diminished in amount, every action of the force is expended or exhausted in the production of a limited number of effects. Each action is of definite degree, and this degree can be measured only through the effects determined. Hence it is that we are unable, by any mechanical arrangements, to make the least addition to any given action of force. To augment the results we are compelled to resort to fresh exertions of force. We employ mechanism simply and only for the purpose of distributing force. Thus the fall of a body weighing 772 pounds through one foot is work, but it is not useful work. The fall is an effect determined by the action of gravity in a given time. But when this weight is attached to machinery, we distribute the action of gravity. Instead of a single useless effect as before, we now have a plurality of useful results, sustaining to each other the relation of means to end. *Each result consumes a definite portion of the action of the force.* In the case of the steam-engine, though we employ not the force of gravity, but the power existent in heat, the same reasoning is applicable.

Further, we maintain that the forces of the universe are often *correlated*, but are *never convertible*. We find much in the writings of both Faraday and Grove to support this doctrine. But we are obliged to allow that their statements are not always consistent. Faraday taught that electricity, heat, magnetism, and other powers of matter "are all connected," but he affirms that "we cannot say that any one is the cause of the others." The term "Correlation," first employed in science by Grove, we regard as a very happy one. He teaches that forces "are correlative, but not identical."

"Reviewing," says Mr. Grove, "the series of relations between the various forces which we have been considering, it would appear that in many cases where one of these is excited or exists, all the others are also set in action: thus, when a substance, such as sulphuret of antimony, is electrified, at the instant of electrisation it becomes *magnetic*

in directions at right angles to the lines of electric force; at the same time it becomes *heated* to an extent, greater or less, according to the intensity of the electric force. If this intensity be exalted to a certain point, the sulphuret becomes luminous, or *light* is produced; it expands, consequently *motion* is produced, and it is decomposed, therefore *chemical action* is produced."—*Correlation of Physical Forces*, p. 242.

Sir Henry Holland tells us that "the same single electrical current from a voltaic battery is capable in its circuit of evolving heat and light,—of creating magnets,—of producing mechanical force,—of violently affecting the nervous and muscular organisation,—and of inducing, by decomposition or combination, the most powerful chemical changes, simply according to the nature of the different material objects which the experimentalist interposes in the circuit." * It is thus evident that forces are correlated in the sense that the action of one supplies the necessary condition of the action of another. Thus in the illustration of the spark exploding the powder, the action of the power of the spark is not the *cause* of the explosion. The action of the force existent in the powder itself is the true cause, while the action of the spark merely supplies the necessary condition of the action of the power belonging to the gunpowder.

The supporters of the theory of the conservation of energy overlook the fundamental distinction between correlation and convertibility. Heat can never be converted into light, nor light into heat; heat cannot be converted into electricity, nor electricity into magnetism. But realities possessing the powers of heat, light, electricity, and magnetism, may come into such relations that the action of any one of these powers shall supply the conditions of the action of all the rest. Failure to perceive the distinction in question has been productive of the wildest theories. We can notice only two. The first is that all the energy we derive from plants and animals is drawn from the sun. In a recent paper on "Vitality" we are told that—

"Besides the mechanical actions which he produces in the surrounding planetary system, the sun acts as a *radiant* body, from which issues, in the form of minute waves, a power whose functions have but recently been fully apprehended. These waves, impinging upon the optic nerve, produce light, and impinging upon other nerves, produce heat, the impressions of heat and light depending on our organisation, different parts of which are affected differently by the self-same thing. But the function of the sun is not only to illuminate and warm us; for,

* *Essays*, p. 12.

without his vibrations, vegetable life—and consequently animal life, which depends ultimately upon that of vegetables—could have no existence. A few years ago, when the sun was affirmed to be the source of life, nine out of ten of those who are alarmed by the form which this assertion has latterly assumed, would have assented, in a general way, to its correctness. Their assent, however, was more poetical than scientific, and they were by no means prepared to see a rigid mechanical signification attached to their words. This, however, is the peculiarity of modern conclusions; that there is no *creative* energy whatever in the vegetable or animal organism, but that all the power which we develop by the combustion of wood or coal, as well as that which we obtain from the muscles of men and animals, has been produced at the sun's expense."

This writer allows that it is a somewhat disquieting circumstance that the most "advanced philosophers" of the present day have arrived at the conclusion that *life*—all vital energy—"is derived, not from the fiat of a supernatural agent, but from a reservoir of *inorganic* force." "Whence," ask Professors Thomson and Tait, "do we immediately derive all those stores of potential energy which we employ as fuel or as food? What produces the potential energy of a loaf or a beaf-steak? What supplies the coal or the water-power without which our factories must stop? The answer, going one stage back, is quite satisfactory. To the sun we are indebted for water-power, coal, and animal and vegetable food."* Tyndall might be quoted to the same effect. Huxley refers not only the powers of life, but even those of thought and feeling, to the reservoir of inorganic force, and asserts, as we have already seen, that "it is demonstrable that it is utterly impossible that anything whatever may not be the effect of a material and necessary cause."† But as Professor Huxley, whenever he gets out of his own special province, makes assertions the most inconsistent and contradictory,—when he can teach that we may accept the materialistic doctrines without being materialists,—when, after so confidently asserting that there are no causes in the universe but material causes, he can, in the very same paper, confess that he knows nothing about the matter,—he puts himself out of court: his statements are not even admissible in evidence.

The doctrine that all the powers now existent in our world have been derived from the sun, we reject for three reasons:—*first*, because it rests upon the assumption that forces are convertible—which assumption we know to be false; *secondly*,

* *Good Words*, 1862, p. 605. † *Fortnightly Review*, Feb. 1869, p. 142.

because it is inconsistent with the hypothesis of the conservation of force—an hypothesis most satisfactorily established by the facts adduced by Faraday; and *thirdly*, because it is directly opposed to the correct philosophy of causation.

The other false theory based upon the assumption that forces are not merely correlated but mutually convertible, is that of the "Dissipation of Energy." It is asserted that, though other forces are capable of being converted into heat, yet the process is not strictly reversible. It is not possible to reconvert the whole of the heat produced into any other force. Hence the portion of heat which is incapable of transformation is said to be dissipated and lost. We are told that not even a stone can fall to the earth without changing the dynamical condition of the universe! It is argued that as each action of the earth's gravity generates heat by concussion, or friction, or by compression, and that as the whole of this heat cannot be transformed into other forces, the earth's energy is constantly diminishing, and that we are therefore gradually creeping towards the sun. Sir William Thomson and Professor Tait inform us that—

"As all energy tends ultimately to become heat, which cannot be transformed without a new creative act into any other modification, we must conclude that when all the chemical and gravitation energies of the universe have taken their final kinetic form, the result will be an arrangement of matter possessing no realisable potential energy, but uniformly hot—an undistinguishable mixture of all that is now definite and separate—chaos and darkness as 'in the beginning.' But before this consummation can be attained, in the matter of our solar system, there must be tremendous throes and convulsions, destroying every now existing form. As surely as the weights of a clock run down to their lowest position, from which they can never rise again, unless fresh energy is communicated to them from some source not yet exhausted, so surely must planet after planet creep in, age by age, towards the sun. When each comes within a few hundred thousand miles of his surface, if he is still incandescent, it must be melted and driven into vapour by radiant heat. Nor, if he has crusted over and become dark and cool externally, can the doomed planet escape its fiery end. If it does not become incandescent, like a shooting-star by friction, in its passage through his atmosphere, its first graze on his solid surface must produce a stupendous flash of light and heat. It may be at once, or it may be after two or three bounds, like a cannon-shot ricochetting on a surface of earth or water, the whole mass must be crushed, melted, and evaporated by a crash, generating in a moment some thousands of times as much heat as a coal of the same size could produce by burning. . . . Light, electric motion, and all other forms of energy, ultimately become heat. Therefore though the progress of

energy through these various stages may modify the course of events, it cannot in the least affect their inevitable termination."—*Good Words*, 1862, p. 606.

To this testimony to "the death of the universe" we add that of Professor Stewart:—

"Intimately linked as we are to the sun, it is natural to ask the question, Will the sun last for ever, or will he also die out? There is no apparent reason why the sun should form an exception to the fate of all fires, the only difference being one of size and time. It is larger and hotter, and will last longer than the lamp of an hour, but it is nevertheless a lamp. The principle of degradation would appear to hold throughout, and if we regard not mere matter, but useful energy, we are driven to contemplate the death of the universe. Who would live for ever, even if he had the elixir of life? or would purchase, if he might, the dreary privilege to preside at the end of all things—to be 'twins in death' with the sun, and to fill up in his own experience the melancholy dream of the poet—

"'The sun's eye had a sickly glare,
The stars with age were wan,
The skeletons of nations were
Around that lonely man.
Some died in war, the iron brands
Lay rusting in their bony hands,
In peace and famine some.
Earth's cities had no sound nor tread,
And ships lay drifting with their dead
To shores where all were dumb.'"

The supporters of the theory of the "Dissipation of Energy" are also believers in that of its Conservation. To ourselves, the two theories appear to be inconsistent. We are told that energy cannot be lost; that when not available in one form it is in another. We are then informed that to this there is a trifling limitation; that the whole energy of the universe is slowly but surely taking the final form of heat, and that this heat is being dissipated or lost,—lost in the sense that it is no longer available for the production of motion or of any other effect. On this ground, Sir William Thomson affirms that perpetual motion is impossible. Grove, on the contrary, teaches that the possibility of perpetual motion is an established fact of science. Thomson appears to take for granted that when heat has ceased to be available to man the Creator no longer employs that heat to determine the action of the other forces necessary for the continuance of the phenomena of the universe. Do not many of our modern physicists deserve the rebuke which the Almighty administered to the too speculative patriarch of old,—"Who

is this that darkeneth counsel by words without knowledge? . . . Where wast thou when I laid the foundations of the earth? declare, if thou hast understanding."*

We think that we have now made it evident that neither the theory of "Natural Selection" nor that of the "Conservation of Energy" has any basis whatever in fact. To a true philosopher like Faraday what can be more painful than to find such bewildering theories treated as though they were established truths, and to hear it so persistently asserted that science contradicts the Bible. Think of Professor Huxley affirming that he is not acquainted with "any man of science or duly instructed person" who believes that God created Adam and Eve! Can dogmatism be more offensive or more irrational? Let our readers imagine, if they can, how these "duly instructed persons," who pretend to regard the idea of creation as "unphilosophical," would have exclaimed had they first found the doctrines of evolution and natural selection in the Bible and not in Darwin's *Origin of Species!*

Dr. Bence Jones is a believer in the theory of conservation. He, however, differs on some important points from other prominent supporters of the doctrine. Professor Stewart, as we have seen, teaches that the "thing" called energy may be transferred from one reality to another. Thus a stone, he says, possesses an energy in one position of which it is entirely destitute in another. Consequently, taking only a limited portion of the created universe into account, we cannot affirm that its energy is a constant quantity, an unvarying amount. In opposition to this, Dr. Jones teaches that the energy belonging to any given thing cannot be separated from

* If the assumption of the "Dissipation of Energy" is really valid, we think its supporters cannot render a more valuable service to their fellows than by pointing out the most economical methods of using the various physical forces, but especially the force of gravity. To Sir William Thomson, as President elect of the next meeting of the British Association, we beg to suggest that, as a former president took for the motto of his address, "Save your coals!" he should adopt as his, "Preserve your gravity!" This would certainly be an improvement on the course taken by the president last year, who devoted the whole of his address to prove what, until that time, we really were not aware "any duly-instructed person" had ever called in question.

Our readers will now be able to understand why Professor Huxley should be so anxious that science should be taught in our schools. To him, as a member of a most important School Board, we venture to recommend that the very first lesson in science should refer to the evil of throwing stones. The lads must be taught that every stone thrown produces heat by collision; that as a portion of this heat is certainly lost, each stone thrown of necessity alters the dynamical condition of the universe, and hastens the dread moment when the earth shall fall into the sun, and their bodies and their souls be dissipated into fire-mist! Surely, the thought of such responsibility will exercise a most restraining influence upon the youngsters.

it; that a material reality, for example, if deprived of its force of gravity, would thereby cease to be material. He takes for granted that the powers of life are material forces, never supposing that any sane mind would question this. Therefore he holds that the energy of life cannot be separated from the human body. In this, science, he says contradicts the Bible, since in the Book of Genesis "we read that man was formed of the dust of the ground; and *after* he was formed the breath of life was breathed into his nostrils." According to Dr. Jones, this statement cannot be true, since it assumes that a fully formed body may exist before it lives. To this we need not reply. We merely ask, would it not be well for the advocates of the hypothesis of the conservation of energy to meet in council for the purpose of ascertaining whether they are all really agreed in reference to a single assumption on which the doctrine rests? Dr. Jones informs us that there are four or five other particulars in which science contradicts the teachings of the Book of Genesis. Some of these are even more absurd than the one we have named. But enough of Dr. Jones's puerile objections to the Bible. We can give but one more illustration of the manner in which our ablest men of science employ their present crude theories to undermine our faith in the Divine authority of the Bible. Professor Tyndall says:—

"To create or annihilate matter would be deemed on all hands a miracle; the creation or annihilation of energy would be equally a miracle to those who understand the principle of the conservation of energy. Hence arises the scepticism of scientific men when called upon to join in national prayer for changes in the economy of nature. Those who devise such prayers admit that the age of miracles is past, and in the same breath, they petition for the performance of miracles. They ask for fair weather, and for rain, but they do not ask that water may flow up-hill; while the man of science clearly sees that the granting of the one petition would be just as much an infringement of the law of conservation as the other. Holding this law to be permanent, he prays for neither. But this does not close his eyes to the fact, that while prayer is thus impotent in external nature, it may react with beneficial power on the human mind. That prayer produces its effect, benign or otherwise, upon the mind of him who prays, is not only as indubitable as the law of conservation itself, but it will be probably found to illustrate that law in its relative expansions. And if our spiritual authorities could only devise a form in which the heart might express itself without putting the intellect to shame, they might utilise a power which they now waste, and make prayer, instead of a butt to the scorner, the potent inner supplement of noble outward life."

How prayer is to be made "the potent inner supplement of noble outward life," in the absence of all faith in the power of God to grant anything that His needy creatures may ask, is, indeed, a problem. Let Dr. Tyndall himself undertake the solution of the difficulty; for sure we are that "our spiritual authorities" are not yet sufficiently practised in "the scientific use of the imagination," and are too much under the influence of Bacon, to attempt the task with any chance of success. In the meantime, as philosophers, we shall cling to our faith in the simple yet sublime declaration of God to his servant Solomon:—"And the Lord appeared to Solomon by night, and said unto him, I have heard thy prayer, and have chosen this place to myself for an house of sacrifice. If I shut up heaven that there be no rain, or if I command the locusts to devour the land, or if I send pestilence among my people; if my people, which, are called by my name, shall humble themselves, and pray, and seek my face, and turn from their wicked ways; then will I hear from heaven, and will forgive their sin, and will heal their land." —2 *Chronicles* vii. 12—14.

We beg that the leaders of thought in physical science will cease their attacks upon the doctrines of Revelation, until they are able to bring their own theories somewhat into harmony with the established truths of philosophy, since, as Mr. Grove candidly admits, the world will, in the end, follow the philosopher. By adopting this course, they will best promote the interests of science, while they will be spared the unspeakable humiliation of having to affirm that science contradicts the Word of God. The *theories* of science, no doubt, are often opposed to the teachings of Scripture, but the *facts* of science never! Absolute truth is a unity, of which the truths of the Bible, of philosophy, and of science, are but emanations. All are revelations from one and the same Omniscient Mind.