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the word of God in Revelation, there is yet what St. Paul spoke of, the opposition of science, falsely so called, which it is the great object of this Institute to combat. It is not so much with the great leaders of scientific thought with whom we have to deal, but rather with their followers, who pervert their utterances, who misuse the doctrines of science and religion, and bring about a seeming clash where there is in reality none. (Hear, hear.) In the spread of knowledge at the present day the great point to be attained is to keep clearly before the minds of those to whom the facts of science often come for the first time that they are not antagonistic to the faith of their youth. (Hear, hear.) These things, rightly understood, are not antagonistic to the faith of their forefathers, but are only two forms of the same truth. I would say, therefore, to the theologian, Remember that in quietness and confidence is strength—do not be frightened by some seeming contradiction; while to the would-be scientist I would say, Do not be in a hurry—no half-knowledge of science, even in its best-known branches, should teach you that, by some seeming contradiction, you have upset the faith of ages. And I would ask, Is it a new thing that there should be this seeming antagonism? We need only turn to the early Christian apologists to find that almost the same battles were being fought in the first three centuries as we are fighting now, and we may safely have confidence that, although the loss may be to us if we are on the wrong side, the truth will not suffer. The truth shall prevail; but there is one danger to be guarded against, and it is this: that there are many scientific men who feel profoundly sure that there is no antagonism, yet, as they never bring their minds to see what the alleged antagonism seems to be, they cannot get into sympathy with those who fancy there is an antagonism, and thus are led to stand entirely aloof from the controversy, having a true sense of its hollowness, but at the same time a false idea that it does not matter. Hollow as it is, it does matter if a false view of religion and science is spread abroad, as it has been spread abroad, among the half-educated classes. (Hear, hear.) Our object is, as far as we can, to help the establishment of those principles which have been so well laid before us this evening, both among those who clearly understand the subjects dealt with; and those who only half understand them, well knowing that the truth will prevail, and that we need not fear the result, if we are but faithful to that truth. (Applause.)

The following address, by Professor R. L. DABNEY, D.D., LL.D., of Texas University, was then, in the author's absence, read by Mr. D. Howard, V.P.I.C.,—a member of the Council.

THE INDUCTIVE LOGIC.

By Professor R. L. DABNEY, D.D., LL.D., Texas University.

MUCH is said in glorification of the Inductive Logic, or Method of Induction; little is understood of its true nature. No stronger testimony against the unauthorised character of much that is called "Physical Science," under the cover of sophistical inductions, can be cited than that of John Stuart Mill (*Logic*, vol. i., pp. 480, 481, 7th London edition):—"So real and practical is the need of a test for induction, similar to the syllogistic test for ratiocination, that inferences which bid defiance to the most elementary notions of inductive logic are put forth without misgiving by persons eminent in physical science as soon as they are off the ground on which they are familiar with the facts, and not reduced to judge only by the arguments. And as for educated persons in general, it may be doubted whether they are better judges of a good or bad induction than they were before Bacon wrote. . . . While the thoughts of mankind have, on many subjects, worked themselves practically right, the thinking power remains as weak as ever; and on all subjects on which the facts which would check the results are not accessible, as in what relates to the invisible world, and even, as has been seen lately, to the visible world of the planetary regions, men of the greatest scientific acquirements argue as pitifully as the merest ignoramus."

In these days, when the followers of physical research imagine so often that the theologians are in a state of active hostility against them and their sciences, it is well that we can cite this accusation from one who is as remote as possible from an alliance with theologians. This able witness proves, at least, so much, that every beam of light which can be thrown on the true nature of the inductive logic, though slender, is desirable. It may help, not only to clarify the sciences of matter, but to reconcile the conflict,—if any such exists,—between them and philosophy and theology.

This essay is written, however, mainly in the interest of that cause to which the Victoria Institute devotes itself,—the defence of Holy Scripture against those doubts which modern

physical science suggests. This science professes to glory in the Inductive Method. I seek to humble, and, indeed, righteously to discredit it, in so far as it is overweening and incorrect, by showing that in these places it has failed to comprehend and to obey its own professed method. If the real nature of inductive demonstration can be evinced,—if it can be proved that its method is, indeed, far different from the one so often usurped by rash physical speculations, that it is more difficult and far more rigid in its requirements,—then the wings of so-called physical science will be clipped; its flight will be restrained within more safe and wholesome limits; science will itself be a gainer in accuracy and solidity; and the apparent collisions between science and revelation will all disappear, as it is shown that they lie only in these regions of illicit flight, from which science should have been restrained by her own logical methods.

It would be instructive to trace the history of the discussions and definitions as to what induction is. We should find the professed modern followers of Lord Bacon, while conceding to Aristotle the honour of formulating the syllogism, claiming that induction is a different and a more fruitful mode of proving general truths, whose description the world owes to the great Englishman. We should find Aristotle's supporters, as Geoffrey St. Hilaire, Grote, Whately, Hamilton, asserting that he also taught the nature of induction, and that in the syllogistic form. We should find each author, whether Baconian or Peripatetic, differing from every other as to what inductive proof really is. This will be sufficiently evinced by citations from the last two logicians named; for they show us the state of the theory after all the preceding agitations of it,—after the best consideration of a Newton and a Whewell.

According to Hamilton, inductive proof proceeds thus, in form of syllogism:—

Major.—This, that, and the other magnet attract iron.

Minor.—But this, that, and the other magnet represent all magnets.

Conclusion.—∴ All magnets attract iron.

To this Whately justly objects that the second proposition is manifestly and always *unproven*. It is vain to attempt to superinduce a syllogistic form upon a mental process, at the cost of introducing, as a premise, a proposition which must regularly and necessarily be without proof. Whately proposes this, then, as the more correct form:—

Major.—What belongs to the observed magnets belongs to all magnets.

Minor.—But these observed magnets attract iron.

Conclusion.—∴ All magnets attract iron.

The hearer will observe that Whately's process only inverts the order of the first two propositions in Hamilton's; for Whately's first is only a different way of expressing Hamilton's second, and the order of the propositions given by Whately seems obviously the correct one. But the fatal difficulty remains, whether we place the assumption in the rank of a first premise or a second, how did we evince that a property found true by observation of a few magnets is true of all magnets not yet observed? The syllogism virtually reasons in a circle, assuming in a premise what it professes to prove in its conclusion. Nor does it appear how this vice can be cured, except by ascertaining the presence of the property by actual detailed observation in each individual magnet to which the conclusion ascribes it in its predication. And then the syllogism is worthless, for it tells us nothing except what was already ascertained. So Galileo. "Vincentio di Grazia objected to a proof from induction which Galileo adduced, because all the particulars were not enumerated. To which the latter justly replied, that if induction were required to pass through all the cases it would be either useless or impossible: impossible when the cases are innumerable, useless when they have each already been verified, since, then, the general proposition adds nothing to our knowledge."

But if we infer the property as to each individual thing in the class, before it has been verified in each, the illation is fatally obnoxious to that rule of logic that the conclusion from particular (or partial) predications cannot be universal. Two particular premises can only give a particular conclusion. How is this vital defect in the induction to be cured? The answer usually given by the more thoughtful logicians is:—That the inductive inference really owes its validity to another universal truth, which the reasoner implicitly carries in his mind—the belief in *the uniformity of Nature*. In the case of the magnets, for instance, the uniformity of nature authorises the physicist to infer that a property which actual observation finds in some magnets belongs to all.

But this, as Mr. Mill well remarks, does not relieve the difficulty. What authorised the mind to assume this uniformity in nature? Observation certainly does not authorise it; for the appearances of nature exhibit boundless and unexpected varieties. Does one plead—that yet, we believe these seeming varieties are all regulated by natural laws? The difficulty recurs in this question: How do we become assured that this seemingly capricious and diversified nature

is regulated by law? And a more difficult question is: How do we prove certainly which laws regulate given classes of sequences in nature? No apparent regularity in any given number of sequences is enough to prove a certain law, as Lord Bacon has shown; for this would be merely what he calls *inductio per simplicem enumerationem*, which he has proved never to be demonstrative of itself. But the logic of inductive demonstration is necessary to prove that such enumeration of agreeing cases of sequence does, or does not, express a real law. Thus, it appears that demonstrative induction must be pre-requisite, on this theory, to ground our belief in the uniformity of nature. And yet the theory makes that belief the *à priori* ground of all our inductions. This view, then, resolves itself into the absurdity of assuming, as first premise of our argument, that which we only learn in its conclusion.

How, then, can an argument from a part of the class to all the class become valid, against the fundamental rule of logic? Not a few logicians, among whom is Sir William Hamilton (*Lectures on Logic*, 32, end), have conceded that induction can never give more than probable evidence of a law. He asserts that it is impossible for it to teach, like the deductive syllogism, any necessary laws of thought, or of nature. Must we concede this? Is the problem hopeless, the gravity of which these introductory paragraphs indicate? Must we admit that all the sciences of induction, and all the practical rules of life, which are virtually inductive, are for ever uncertain; presenting us only probabilities, of which wider investigations may bring us a refutation? This we are loth to admit, even as true friends of physical science. We claim that inductive argument may have demonstrative force, when properly constructed. Such a view must be substantiated, or the proud name of *Science* should be candidly surrendered as to all the supposed laws of natural phenomena. Real demonstration cannot be grounded in uncertainties, however much these may be multiplied. Moreover, the common sense of mankind rejects the statement that the best inductions are only probable. On sundry of them we unhesitatingly stake our welfare and lives; and experience never fails to confirm their truth. The question then recurs, the great question of the inductive logic: How does the inference seemingly made from the some, or the many, to the all, become valid for the all?

As Mr. Mill has pointed out (very inconsistently for his own philosophy), demonstrated truths can only be proved from premises containing necessary principles. To construct a

method of inductive logic, we must recur to the correct principles of rational psychology. In the *Examination of the Sensualistic Philosophy of the Nineteenth Century* (pp. 265, 272) it was shown that the deductive syllogism could be successfully defended against the famous criticism of Locke and his followers, only by recognising the necessary *à priori* and intuitive judgments of the reason as first premises. Locke had objected, that since the syllogism is confessed to be faulty which concludes more in its third proposition than is contained in its premises, no syllogism can establish any truth not known before. It must, then, be either sophistical or useless. In dissolving this objection, it was granted that it would have real force if the mind is entitled to hold no general propositions except the empirical ones derived from mere observation. But admit that the mind is entitled to other judgments than the empirical,—to the intuitive, namely,—and that they are universal, and the way appears in which the synthesis of propositions becomes a valid and fruitful source of new knowledge.

A similar foundation must be found for the inductive reasoning. The sensualistic psychology cannot furnish it. Hence the inconsistencies of Mr. Mill's treatise on the Inductive Logic, at once the most incorrect and the most correct which has appeared, combining the truest insight into the inductive problem with the clearest contradictions of himself. The theory that all valid judgments are empirical must be surrendered; the intuitive and primitive judgments of the reason must be recognised, as immediately giving us truths which are not only valid, but necessary and universal. Among these are the all-important axioms,—that every effect must proceed out of some efficient *cause*: that the concrete efficient contains *power* to produce the effect: that the same efficient cause, other conditions remaining, must produce the same effect. The theory of inductive demonstration to be asserted, then, is the following [which will commend itself sufficiently, in the absence of those details of discussion, which are forbidden by the limits of an essay]:—

Permanent properties, or attributes of the things in nature, are potential powers, or energies, which become actual when the suitable relations are established between them and other properties or potential energies.

A regular law of nature is nothing else than the expression of the presence of an efficient cause. Its regularity is the immediate consequence of the self-evident judgment, "Like causes, like effects." The problem is to discover, not the "physical cause," or the "conditional cause or causes," or

the "occasional causes" of effects; but to discover the efficient cause.

Hence, in every demonstrative induction of any general law, our task is simply to distinguish the seeming antecedents in observed sequences, from the efficient causal antecedent. As soon as this latter is found, the law of nature is found; for, we repeat, a natural law is no more than the expression of an efficient cause.

Hence, the reasoning process in every valid induction is a syllogism,—as Whately asserted,—but not an invalid one, reasoning from the some to the all:—a syllogism, in which the major premise is always the necessary and universal judgment of cause, and the minor is some truth of observation. And the argument yields general truths, because the premises always contain a universal truth; demonstrated conclusions, because the premises contain necessary truth.

And thus the inductive logic is reconciled with the demonstration that *all* our valid processes of argument must be reducible to syllogism. The problem, then, is to distinguish between those observed sequences which certainly will hold in the future, and those which will not. And *between the antecedent and consequent of the former sort, there must be known to be a necessary tie; for it is self-evident that only a necessary tie can ensure the certain recurrence of the second after the first.* But it is equally evident, both to the human reason and experience, that nature has no necessary tie between her events, except that of *efficient cause*. Hence it appears that the sole remaining *problem of Induction is to distinguish the causal sequences we observe, from the accidental.* Whenever we see what we term an effect, a change, a newly beginning action or state, this necessary law of the reason assures us that it had its cause. Had not that cause been efficient of that effect, it would not have been true cause. It must, then, have communicated power. That power will always be efficient of the same effect, when it acts under the same conditions. Hence, when we have truly discriminated the cause from the mere antecedent, the *propter hoc* from the *post hoc*, we have found therein a certain and invariable law of nature. We have read nature's secret. We are now enabled to predict her future actions; and so far as we can procure the presence of the discovered cause and conditions, we can command nature, and produce the effects we desire. This, and this alone, is *inductive demonstration*.

The reader is now brought to the proper point of view to understand why the induction from a mere enumeration of agreeing instances can never rise above probability; and why

it does, as we admit, raise a probable expectation of recurrence in the future. *So far as the observed presence of a given antecedent, seemingly next before the consequent, raises the probability that we see in that antecedent the true, efficient cause; just so far have we probable evidence that the consequent will follow it in future.*

But ordinarily the observed sequences can only raise a probability that we have found in the antecedent the true cause; for this reason: *that we know there are often such things as unobserved, or latent, or invisible causes.* For instance, the old empirical chemists knew that something turned the metal, when sufficiently heated, into the calx. They talked of an imponderable agent which they named *phlogiston*. They had not suspected that oxygen gas was the cause; for this gas is transparent, invisible, and its presence in the atmosphere had not been clearly ascertained. Had the frequently observed sequence, then, led them to the conclusion that *heat* was the efficient and sufficient cause of calcination, they would have concluded wrong. Further experiment has taught us this error: some metals, as potassium, calcine rapidly in the midst of intense cold, if atmosphere and water be present. None of the metals calcine under heat, if atmosphere and water are both excluded, as well as all other oxygen-yielding compounds. Here, then, is the weakness of the induction by the mere enumeration of agreeing instances: *We have not yet found out but that an unobserved cause comes between the seeming antecedent and the effect, the law of whose rise we wish to ascertain.*

And here is the practical object of all the canons of inductive logic, and of all the observations and experiments by which we make application of them; to settle that question, *whether between this seeming antecedent and that effect, another hitherto undetected antecedent does not intervene?* Just so soon as we are sure there is no other, whether it be by many observations or few, we know that the observed antecedent is the true efficient cause; and that we have a law of nature which will hold true always, unless new conditions arise, overpowering the causation. Not only is it possible that we may be assured of the absence of any undetected cause between the parts of the observed sequence by a few observations; we may sometimes reach the certainty, and thus the permanent natural law, by a single one. To do so, what we need is, to be in circumstances which authorise us to know certainly that no other antecedent than the observed one can have intruded unobserved. Such authority may sometimes be given by the testimony of consciousness. For instance, a party of explorers

are travelling through a Brazilian forest, where every tree and fruit are new and strange to them. One of the travellers sees a fruit of brilliant colour, fragrant odour, and pleasing flavour, which he plucks and eats. Soon after, his lips and mouth are inflamed and swollen in a most painful manner. The effect and the anguish are peculiar. His companions, who have eaten the same food, except this fruit, and breathed the same air, do not suffer. This traveller is certain, after one trial, that the fruit is poisonous, and unhesitatingly warns his companions with the prophecy: "If you eat this fruit, you will be poisoned." What constitutes his demonstration? His consciousness tells him that he has taken into his lips absolutely nothing since the previous evening that could cause the poisoning, except this unknown fruit. He remembers perfectly. He has tasted nothing except the coffee, the biscuits, and the dried beef which had been their daily and wholesome fare. But, *no effect—no cause*. This fruit, the sole antecedent of the painful effect, *must therefore be the true cause*; and must affect other human lips, other things being the same, in the same way. His utter ignorance of the fruit does not in the least shake his conclusion. The traveller has really made a valid application of the "method of residues." He has argued validly from a *post hoc* up to a *propter hoc*.

THE METHODS OF INDUCTION.

We are now prepared to advance to the correct definition of the inductive demonstration. It may be, in form, an enthymeme, but always, in reality, is a syllogism, whose major premise is the universal necessary judgment of cause, or some proposition implied therein. This view of the inductive proceeding corresponds with that conclusion to which the reflection of twenty centuries has constantly brought back the philosophic mind: that all illative processes of thought are really syllogistic, and may be most completely stated in that form; and that, in fact, there is no other process of thought that is demonstrative. The history of philosophy has shown frequent instances of recalcitration against this result, as those of Locke, of Dr. Thomas Brown, and of their followers; but their attempts to discard syllogism, and to give some other description of the argumentative process of the understanding, have always proved futile. The old analysis of Aristotle still asserts its substantial sway; and successive logicians are constrained, perhaps reluctantly, the more maturely they examine, to return to his conclusion—that the syllogism gives the norm of all reasonings. If our

definition of the inductive demonstration, then, can be substantiated, it will give to logic the inestimable advantage of reconciling and simplifying its departments. The review of opinions given by us at the outset revealed this state of facts : that logicians felt, on the one hand, that no reasoning process could be conclusive, unless it could be shown to conform, somehow, to syllogism ; and on the other, that the custom and fashion of distinguishing induction from deduction as different, or even opposite, kinds of argument, had become prevalent, if not irresistible. Consequently, the most of them, following the obscure hints of their leader, Aristotle, endeavoured to account for induction as a different species of syllogism, in which we conclude from the some to the all, instead of concluding from the universal to the particular or the individual. And then immediately they were compelled, by the earliest and simplest maxims of their logic, to admit that such syllogisms are inconclusive ! And they have to confess this in the face of this fact : that this induction is the *organon* of nearly all the sciences of physics and natural history ; sciences whose results are so splendid, and so important to human progress ! Such a result is not a little mortifying and discreditable to philosophy. But we hope to show that it is a needless result. It will appear that induction is not only syllogistic, and therefore within the pale of demonstrative argumentation, but regularly and lawfully syllogistic. Mill has had a sufficiently clear conviction of the necessity of accomplishing this, to teach (vol. i., pp. 362-365) that the conclusions of this species of reasoning can only become solid when grounded in a universal truth. This, he thinks, is our belief in the invariability of the law of causation. But he then (p. 345) very inconsistently adds, that this universal truth itself is but a wider induction, which approaches universal certainty sufficiently near, by reason of its breadth. This universal and necessary truth, we hope to show, is the intuition of cause for every effect, along with the truths involved therein.

To effect this, the methods of induction must be explained. When we speak of observed sequences, we mean a set of observed, resembling cases where one state or change seems immediately to precede another change, or "effect," which we are studying. These cases may be observed by ourselves, or witnessed to us by others. The *fact* of the sequence is the only material thing. But, first, one's own observation must be honest and clear, and his record of the case exact. He must not see his hypothesis in the facts, but only what occurs there. And, second, a case taken on testimony should be

fully ascertained by a judicial examination of the evidence. Having now this set of agreeing instances, more or less numerous, which gives us, as it stands, only an induction *per enumerationem simplicem*, our task is, so to reason from it as to discriminate the *propter hoc* from the *post hoc*. The result of this task, when successfully performed, is to give us a "law of nature," which is such because it is a law of true, efficient causation. It is to effect this we need the methods of logical induction. In stating them, the chief guide will be Mr. Mill, whose discussion in this point seems the most complete and just.

As his excellent treatment has made the methods of induction familiar to scientific men, little more will be needed for present purposes than the mention of them.

1. The "method of agreement" is applied when in several observed cases a result, X, is preceded by different clusters of apparently immediate antecedents. In one instance, A, B, and C are observed to precede X; in another, A, D, and E precede X; in a third, A, F, and G precede X. On comparing all the cases, we conclude that A was, all the time, the true, efficient cause of X, because it alone was present each time X arose. The canon of the "method of agreement," then, is, Whichever of observed antecedents remains *alone unchanged* next before the effect is the true cause thereof. But this canon may yet fail to give us a demonstrated result (a), because a latent antecedent may lurk unobserved among A, B, C, D, E, F, G, not detected in either instance; (b) because one efficient may produce X at one time and another at a different time; and (c) two or more causes may have combined to produce X.

2. "The method of difference" is applied to a set of instances when, if one of a given group of antecedents is present or is absent, a given sequent is correspondingly present or absent. A and B and C are followed by X and Y and Z. But when the antecedents are B and C (A being absent) only Y and Z follow, X being absent. A appears the *cause* of X, so far, that is, as we can *know* that the second group of antecedents, after which the one effect, X, failed, differed from the previous group *only* in the *one circumstance*, the absence of A, we know that A efficiently causes X.

Yet the demonstration may not be exclusive, because A may be only one possible cause of X; for often similar effects are the results of different causes, as heat results from chemical reaction, or from electricity, or from percussion, or from compression, or from friction, or from vital energy.

3. The method of "agreements and differences" combines

the evidence of the last two. The antecedents A, B, and C are followed by the sequents X, Y, and Z, and A, D, and E by X, V, and W; but wherever A is absent from among the antecedents,—as B, C, or B, F, G,—X is also absent from among the sequents. A is the cause of X.

4. We have the “method of residues.” We have as a group of antecedents A, B, and C, followed by the sequents X, Y, Z. A has been proved by some other canon to cause only X; B, similarly, causes only Y. Then, though C and Z remained unknown by experiment, inference would teach us that C is the efficient of Z.

5. The method of “corresponding variations” remains (so clearly asserted by Sir Isaac Newton in his “*Regulæ Philosophandi*”). Let it be supposed that X seems the regular sequent on A. If, in every experiment, X increases or diminishes as A does, A is efficient cause of X. For, affecting the antecedent could not of itself regularly affect the consequent except through a causal tie. Were not heat the cause of expansion in the mercury, this liquid in the thermometer would not regularly expand as heat is increased, and contract as it is diminished.

INDUCTION IS SYLLOGISM.

It is now time that we returned and redeemed our promise to show that induction is but the old syllogistic logic, inasmuch as each demonstrative process is but an enthymeme, whose real major premise is the intuitive judgment of cause, or some corollary thereof. We are glad to have the powerful and very emphatic testimony of Mr. Mill to this doctrine. In Book III., chap. 21, he says:—“As we recognised in the commencement, and have been enabled to see more clearly in the progress of the investigation, the basis of all these logical operations is the law of causation. The validity of all the inductive methods depends on the assumption that every event, or the beginning of every phenomenon, must have some cause; some antecedent, on the existence of which it is invariably and unconditionally consequent.”

Let us submit this assertion to a more critical examination; and first, as to the method of agreement. In the first case, or cluster of cases, we saw $A+B+C$ followed (possibly among other effects) by X. In the second, $A+D+E$, and in the third, $A+F+G$, are also followed by X. The reasoning, rigidly stated, now proceeds thus (and that it may proceed strictly, it is necessary to make the supposition that no other causal antecedents are present except A, B, C, in the first case, &c., which, in practice, it will usually be very difficult to

know) : in the first case, the cause of X must have been either A or B or C, or some combination of them. Why? Because it is a universal *à priori* truth that there is no effect without a cause. This step thrown into a formal syllogism will be :—

1. No effect can arise without a cause.

2. But X arose preceded only by A + B + C ;

Therefore A or B or C, or some combination of them, must be cause of X.

So, we prove that, in the second case, A + D + E, and in the third, A + F + G, must have caused X. But next we construct another syllogism :—

1. A cause must be *present at the rise* of the effect (immediate corollary from the intuition of power and efficiency in cause).

2. B and C were absent in the second and third cases ; D and E were absent in the first and third cases ; F and G were absent in the second and third cases, while yet X was always present ;

Therefore, none of these, but only A was cause of X each time.

Thus, by the successive examination of all the methods of induction, it is shown that they are all virtually syllogistical. The simple and satisfactory conclusion is thus reached, which unifies our theory of logic, and which also secures for careful and sufficient inductions that apodeictic character which is so essential to make them scientific propositions, and which we yet saw denied to them by so many great logicians. Induction and deduction are not two forms of reasoning, but one and the same. The demonstrative induction is but that species of syllogism which, getting its minor premise from observed sequences of facts, gets its major premise from the intuition of cause.

It is to be lamented that Mr. Mill, after teaching so much valuable truth, and displaying so just an insight up to this point, should then assert a view of our universal judgment of cause, which, if true, would destroy his own science. He believes, after the perverse metaphysic of his father, Mr. James Mill, and of the school of Hume, that the mind has no such universal *à priori* judgments. He believes that our general judgment of cause is itself empirical, and is gotten simply by combining a multitude of inductions *enumerationis simplicis*. But these, he admits, are not demonstrative ; and the whole and sole use of all the canons of induction is to lead from these invalid colligations to certain truths. And he has confessed that this is only done by assuming the universal law of cause ; so that his conception of the whole inductive logic is of a process which assumes its own conclusion as its

own premise! That he is not misrepresented will appear from the following citations from his *Logic*, Book III., chap. 21 :—“ As was observed in a former place, the belief we entertain in the universality throughout nature of the law of cause and effect, is itself an instance of induction, and by no means one of the earliest which any of us, or which mankind in general can have made. We arrive at this universal law by generalisation from many laws of inferior generality,” p. 100. “ Is there not, then, an inconsistency in contrasting the looseness of one method with the rigidity of another, when that other is indebted to the looser method for its own foundation? ” p. 101. “ Can we prove a proposition by an argument which it takes for granted? ” p. 96. This question, Mr. Mill then says, he has “ purposely stated in the strongest terms it will admit of,” in order to reject the doctrine of a belief in causation as a necessary, intuitive law, and to assert his (as we think, erroneous) doctrine, which attempts to make the inductive process prove its own fundamental premise. His apology for this violation of the very first principle of logic and common sense is, that the belief in causation, while only an empirical induction, is “ an empirical law coextensive with all human experience; at which point the distinction between empirical laws and laws of nature vanishes, and the proposition takes its place among the most firmly established as well as the largest truths accessible to science,” p. 103.

One question dissipates this attempted solution. Is a process of inductive demonstration only valid, then, to one whose empirical knowledge “ is coextensive with all human experience ”? No. Mr. Mill, for instance, when explaining the proof of a natural law by the “ method of difference,” made these two correct statements: that this method is rigidly conclusive when its conditions are observed; and that it is by this method the common people really infer the commonly known laws. It appears, then, by his own statement, that a beginner in inductive reasoning, long before he has widened his knowledge until it is “ coextensive with all human experience,” may make, and does make, inductions to general laws that are valid. Whence does he procure his universal major premise? Again: the empirical knowledge of the most learned observer in the world bears but a minute, almost an infinitesimal, ratio to the multitude of consecutions of events which take place outside of his knowledge. The idea that mere empirical observation can ever establish a law as universal is therefore delusive. It proceeds upon the supposition that, as the number of agreeing observed instances is widened, the probability grows towards a certainty that their

agreement expresses the universal law, because the cases actually tested bear a so much larger ratio to the cases not tested. But it must be remembered, if the intuitive and original character of our judgment of cause be denied, we have no means, except the empirical, to know whether the cases of sequence still untested, and therefore unknown, will conform to our supposed law or not. And the belief arising out of this supposed *calculus* of probabilities is utterly deceptive. For the number of cases tested, however large, is still, in the mind of the most learned physicist, infinitesimally small, compared with the number of the unknown cases occurring in nature, not to speak of the more multitudinous cases in past ages. When the physicist has observed for years, the number of instances empirically tested does bear a larger ratio to the number with which he began. True, and this is precisely the delusion which cheated Mr. Mill's mind. But it is the increased ratio of the empirically known to the unknown which is necessary, for the purpose of even grounding a probability. But this still remains infinitesimally small.

Again, the postulate of the uniformity of nature would not be, on Mr. Mill's theory, even one that might be provisionally assumed, because it is obnoxious at its first suggestion, and throughout our provisional course of inquiry, to apparent contradictions. To the merely empirical eye nature appears variable and capricious almost as often as she does constant. So that, had our inductions only an empirical basis, instances of apparent testimony against this general premise might multiply as fast as instances of seeming concurrence in its favour. The real reason that the results of induction are not thus embarrassed is that true induction is not merely empirical, as Mr. Mill supposes. Once more, if the general premise underlying each case of induction is only an assumption, then it is *a priori* possible it may involve an error. If it does, why may not that element of error be multiplied and spread itself through the body of connected processes in a geometrical degree? Then the body of supposed science is always liable to turn out, after all, like the Ptolemaic hypothesis of the heavens, an inverted pyramid, an ingenious complication of propositions forced into a seeming harmony by their common trait of involving the radical error. Science has often shown that a hypothetic structure may be widely built out, and may stand long in apparent strength, and yet be overthrown.

We close this refutation with this testimony from Esser, adopted by Hamilton (*Logic*, Lec. 32, end): "It is possible only in one way to raise induction and analogy from mere probability to complete certainty, viz., to demonstrate that the

principles which lie at the root of these processes, and which we have already stated, are either necessary laws of thought, or necessary laws of nature."

Hamilton and his German teacher, Esser, here do two things, one of which is right and the other is wrong. They utterly refute Mill's attempt to ground an apodeictic induction on his false metaphysic as to man's primitive judgment. This is the right thing. They also deny to the inductive logic all apodeictic character. This is their wrong teaching. Surely this conclusion is as much against common sense and the universal practical convictions of mankind, as it is against their experience. Men assuredly believe that they have a multitude of certain demonstrated inductions. They are right in believing so. On these practical inductions, simple and brief in their processes it may be, yet real inductions, men are proceeding with absolute confidence, in their business, every day of their lives. It is by an induction that we all know we shall die. Does any man think his own death only a high probability? All know death is certain.* Here are all the modern triumphs of physical science, which civilised mankind regard as much their assured possession as the pure propositions of geometry. No one regards their laws as of only probable truth. The world entrusts its wealth, health, life, to them with absolute faith. But most of the laws of physics are truths of induction. Hamilton's conclusion, then, while right in denying a foundation for their certainty where Mill and his predecessors propose to place it, in the uniformities of nature, is wrong in allowing to the inductive logic only probable force. He, like the rest, overlooked too much the concern which our primary judgment of causation has in these processes. They did not correctly apprehend the relation of this great intuition to them. It is humbly claimed that, in explaining that relation by means of a rigid and exhaustive analysis of the inductive methods, this branch of logic has been reconciled with itself, and with the practical convictions of mankind. Its complete exploits of proof are discriminated from its incomplete ones. The former are lifted out of their uncertainty, to the prerogative of the syllogism, by showing that they do not conclude from some to all; but from a universal and necessary judgment to particulars and individuals. Why should it be thought a strange thing that this primary judgment should be found to hold so fundamental a place at the very corner-stone of the sciences? The farther philosophy is rightly pursued, the more is the unique importance of this

* That is, humanly speaking.—ED.

great norm of the reason, *Ex nihilo nihil*, in all the departments of human thoughts disclosed. It is the regulative notion of the reason.

In defending the intuitive quality of this judgment, then, we are defending the very being of the natural sciences, and also of theology. This is the principle of the reason, on which both the cosmological and teleological arguments for the being of a God are founded. Hume, the great finisher of the Sensationalist metaphysic, saw, that in denying to the mind an intuition of cause, he was undermining those arguments. Teach with him, that this judgment is only an empirical one, learned from experience; and his cavil against those arguments, —that the world, if an effect, is one too singular and unique to be argued about as we argue of common, experienced effects, —at once becomes formidable. To undermine theology was his purpose. But we have shown that his metaphysic also undermines the sciences. The inductive method, on this philosophy of Hume, becomes as baseless and uncertain as he wished theology to be; and its doctrines are degraded from certainties to guesses. The history of the inductive sciences illustrates this influence. When they were prosecuted by the Boyles, Newtons, and the illustrious company of Christian physicists, whose metaphysic was that of Cudworth, Clarke, and Butler; they gave the world those splendid and solid results which constitute the wonders of modern civilisation. But when the votaries of the inductive sciences, like Dr. Huxley, have embraced the empiricism of Hume, Comte, and Mill, they stagger and grope, and give the world, in place of true science, the vain hypotheses of evolutionism and materialism. In asserting the true nature of induction we have been pleading the cause of science, no less than of theology.

FINAL CAUSE AND INDUCTION.

If we may judge from the gentleman last named, the hostility of the empirical school is particularly directed against the theistic doctrine of Final Causes. They see how intimately it is connected with the teleological argument for the being and attributes of God. But the doctrine that each thing has *some* final cause; that a wise Creator did not make it aimlessly; this is the main guide of induction. It is by its light we are guided to the discovery of the laws of cause and effect. The illustration given by Dr. Harvey's discovery of the circulation of the blood is equally splendid and familiar. He himself informed Boyle that he was led to it by the fact that he found in the veins, membranous valves opening towards the heart, and in the arteries similar valves opening the other

way. He reflected that Nature never does anything in vain (which is the same thing as saying that every structure has some final cause); and he was thus taught that the blood flows inward to the heart from the parts of the body by the veins, and outwards by the arteries. In like manner, the doctrine that every structure has certainly *some* function is the very lever of the construction of comparative anatomy. But what is this function but the final cause of the structure? To discover the function is the main task this science proposes to itself. This is the end pursued through all the comparative dissections. And when the function, or final cause, is discovered, the physiologist knows that he has discovered a general law, not only of that variety or species, but of all species possessing that organ. Cuvier argued: No animal devoid of canine teeth will ever be found with its feet armed with prehensile claws. Why? Because the function of the canine teeth is to masticate living prey; but nature, after depriving the mouth of such teeth, and equipping it only with graminivorous teeth, will never perpetrate the anomaly of arming the feet with claws whose function is to catch living prey. Such is the character of the arguments of this great science. Deny the doctrine of final cause, and it has no basis.

Indeed, if final causes are discarded, there is no longer any basis for any inductive demonstration. The object of this process, in every branch of science, is to discover a *general and permanent law*. How do we accomplish this? Let the admitted answer be repeated: It is accomplished by distinguishing from among the seeming antecedents of a given effect, that one which is the "invariable unconditional antecedent" (Mill). For the very nature of inductive logic is to assure us that when we have truly found this invariable unconditional antecedent in some cases, it will infallibly introduce that effect in all similar cases. This is what is assumed as the "natural law." But how are we authorised to infer this? By our general premise concerning "the uniformity of nature." But the system which discards final cause also denies that there is any intuition of a necessary law of cause.

Now, if there were no other ground for invariable unconditional sequence, would an intuitive expectation of the universality of any law of cause be better grounded than this empirical one? Let this be pondered (our main effort has been to show that this expectation is intuitive, and not merely empirical, and that for this reason the inductive inference holds good). Could the intuitive or *à priori* reason consistently hold this expectation if it saw in a true cause no efficient

power? Obviously not. This would be to expect the first link certainly to draw in the second, when there was no certain connexion between them. But, again, if efficient power in a second cause is not the expression of any final cause whatsoever, in any intelligent agent, would the reason ever regard it as a *certain* connexion between the parts of the sequence? Obviously not. For, the first lesson the reason has learned about the material bodies, which are the seats of the *phenomena*, is, that they are blind, inert, unintelligent. All the education the reason has received about these bodies is, that they are *subject to variation*. Our whole discussion is about "effects." But what is effect save change? The very problem of all science is, *Nature's changes*. How did the reason learn from nature's perpetual variations, then, to trust in the invariability of nature? And especially when this nature is material, and too blind to have consciousness either of her own changes or stability, of her observance or violation of her supposed laws? To explain this intuitive expectation of the invariability of causal changes, as a healthy act of the reason, there must be somewhere a sufficient cause of the law in nature. And the only sufficient cause is the final cause which is the expression of the intelligence which made and governs nature. We believe in the stability of a natural law, when we discover it, only because we believe in *the function* which a stable intelligence has designed in endowing that thing with that law. Why are we so certain that "like causes always produce like effects"? Because the same reason tells us that the power deposited in that natural cause was put there by a supreme intelligence, and, therefore, for a final cause; and that the wisdom which planned will certainly regulate, on the same consistent plan, the machinery of causation there established. The postulates of theism are necessary to ground the inferences of induction. The doctrine of divine purpose, and that of the stability of the law of true causes, are the answering parts of one system of thought. When this is asserted, it is not designed to retract the proposition so often asserted as fundamental, that our belief in the regularity of the law of cause is intuitive, or to represent that judgment now, as a *deduction* from the propositions of theism. What is meant is this: that the Creator, while He did fashion the human reason so as to be intuitively necessitated to believe in cause, also gave it, that He might be consistent in so fashioning it, the evidence of His own causation and intelligent design in all his works. The two judgments are complementary to each other; the suppression of the latter would leave the other inconsistent. *God's constancy to his own ends* is the only

explanation of that stability, which he has necessitated us to expect in the laws of the second causes by which he designs to effectuate those ends. Or else, the alternative explanation must be, that the causal ties in physical sequences are eternal and necessary, essentially immanent in the very being of the material bodies acting and acted on, *and this is fatalism*. Let the Huxleys and Comtes, then, choose between this absolute fatalism and the doctrine of final causes. They have no other alternative.

THE APODEICTIC INDUCTION.

In concluding this exposition, then, it is necessary to remark on the looseness and confusion which have prevailed in the use of the term "induction," as of the word "analogy."

1. Sometimes the mere colligation of resembling cases has been called induction.
2. Sometimes the name has been given to the mere tentative inference from the some of the observed cases to the all, including the unobserved.
3. Sometimes it has been used to describe what is in reality no *process* of argument at all, but the mere formulating in a single proposition of a class of observed facts, as when, having seen by inspection a given predication true of each and every individual separately, we predicate it of the class. Thus Hamilton, more than once.
4. But the *inductive demonstration* is wholly another and a higher matter. It is the valid inference of a law of nature, from observed instances of sequence, by applying to them a universal necessary judgment, as premise, the intuition of cause for every effect. It has been often said, as by Grote's Aristotle, for instance, that induction is a different process from syllogism, and is, in fact, preliminary thereto; that induction prepares the propositions from which syllogism reasons. This is true of that induction, abusively so-called, which we have just numbered first and third. It is not true of inductive demonstration. It has usually been assumed that while induction is a species of reasoning, it is a different, and even an opposite species from deduction. The first and third actions of the mind, abusively called inductions, do, indeed, differ from deduction; but they are not argumentative processes at all; they do not lead to new truth, either inwards or downwards. They merely formulate in general terms, or in general propositions, individual precepts or individual judgments already attained. True induction, or inductive demonstration, is simply one department of syllogistic reasoning, and is as truly deductive as the rest of syllogism; giving us, namely, those deductions which flow from the combination

of the universal and necessary intuition of cause, with observed facts of sequence.

This explanation of the nature of the Inductive Logic powerfully confirms the cautions of its wisest practitioners, as to the necessity of painstaking care in its pursuit. It is a method of ascertaining truth closely conformed to the divine apophthegm, "With the lowly is wisdom." It is evidently a modest science. Only the greatest patience, candour, and caution in observing, and the most honest self-denial in guarding against the seduction of one's own hypotheses, can lead to safe results. After this review, the charge which Mr. Mill brought against much of the pretended inductive science of our day, quoted by us at the outset, appears every way just. What else than unsafe results can be expected from persons who have never truly apprehended what the inductive argument is; when they venture to employ it, with the most confused notions of its real nature, and under the *stimulus* of competition, haste, prejudice, and love of hypothesis? Time and the future have a huge work of winnowing to perform upon the fruits of the busy mental activity of this generation, before the true wheat is gathered into the garners of science.

As Moses and our Saviour epitomised the Ten Commandments into the one great law of Love, so the canons of valid induction may be popularly summarised in one law. It is this: *So long as all the known facts can be reconciled with any other hypothesis whatsoever than the one propounded as the inference of the induction, even though that other hypothesis be no better than an invention or surmise, the inductive argument is invalid to give a demonstration; it yields only a probability.* This rule receives an excellent illustration from the legal rule of "circumstantial evidence" in criminal trials. And the illustration is so good for two reasons: that there is so close a resemblance, in many points, between inductive reasoning and circumstantial evidence; and that the great men who, as jurists, have settled the principles of the legal science of evidence, have brought to their problem the ripest human sagacity, sobered and steadied by the consideration that these principles were to have application, in dreadful earnest, to the lives and liberty of all citizens, including themselves.

But the learned judge instructs the jury that the prosecution are bound to show, not only that the hypothesis of A. B.'s guilt *may satisfy* all the observed facts, but to demonstrate absolutely that *it alone can satisfy* them; so that the logical result shall be, not only that we may, but that we must, adopt this, as the only true explanation of the circumstances proven.

And the judge will authorise the defence to test that point thus : If another hypothesis than A. B.'s guilt, which, as a proposition, is naturally feasible, can be even invented, though unsupported by any array of proved facts, which may also satisfy the facts established before the court, the prosecution have failed to establish the guilt of the accused. The ingenuity of the lawyers on that side is no less than was supposed, and the probability of A. B.'s guilt may remain ; but it is not *proved*, and the man must be discharged.

We also learn that unless the induction be positively demonstrative, it must give way in the presence of any adequate, intelligent, parole-evidence, affirming a different cause for the phenomenon. Another more popular reason supports this conclusion. Does one say, "The living witness may be dishonest or deceived ; but my facts and inductive argument are wholly dispassionate, impartial, and valid" ? He forgets that his facts also have no better foundation than the professed eye-witnessing of some human witness. Does he say, "They are facts ; for I saw them" ? He is but a human witness. Or if he derives his facts from the observations of others, they are mere human witnesses. But the facts are a premise of his inductive logic. The inference cannot be more valid than its premise. It thus appears that it is wholly unreasonable to claim superiority for an induction over testimony, for this is as though one should claim that "testimony is stronger than testimony." The only consistent meaning would be the arrogant assumption that "my testimony is honest and the other's dishonest." This conclusion, that competent testimony is superior to any except an absolute, exclusive induction, is practically accepted by all sound physicists. Let all the facts previously known tend to refer the effect to a supposed cause, so that the scientific world is almost prepared to accept it as a law ; if one competent observer arises, testifying to another actual cause for the effect, seen by him to produce it in a single case, the other hypothesis is withdrawn. For science admits that here is a case which cannot be reduced under it. An illustrious instance will be remembered in the first telescopic examinations of Galileo. He saw that the planet Venus was *gibbous* at a time and in a way she would not have been according to the Ptolemaic hypothesis. That one observation, with men of true science, made an end of the Ptolemaic theory. The only alternatives were to surrender it, or to say that Galileo did not see Venus gibbous at that part of her orbit.

A very important application of these logical principles is to the inductions of geologists concerning the mode of forma-

tion of *strata* and mineral deposits. The rule has been recalled, that the law, "Like causes, like effects," does not authorise its converse, "Like effects reveal the same cause." For, as is so obviously clear, two independent causes may produce effects exactly similar. Now, much of the supposed inductive reasoning of treatises on geology is, in reality, but an application of this vicious converse. Observation shows us a given stratum of rock or indurated sand and slime, resulting from sedimentary deposition from water. The inference is, therefore, all stratified rocks are sedimentary. And some treatises on geology assume this unsafe and invalid surmise so absolutely as to use the words "sedimentary" and "stratified" as synonyms. A very plain and useful instance of this sophism is given by the case of the Italian savant, who inferred an immense age for the strata in a volcanic spot of South Italy, by examining a well. The sides of this little excavation showed certain strata of volcanic earth superposed on lava. The savant's assumption was, that all this earth was formed gradually by disintegration of hard lava; and as the process is notoriously slow, the thickness of the beds of loose earth denoted a vast lapse of time. Now, had he been certain that disintegration was the *only* cause of volcanic earth, his inference might have been worth something. But the heedlessness of his logic was put to shame by a very simple statement of fact, made by the peasants. Disintegration of hard lava was not the only cause of volcanic earth. Another cause was dust and ashes, showers from the neighbouring volcano. These peasants had been actual eye-witnesses of several such emissions, which, guided by a favouring breeze, had covered their fields with an inch or two of new soil in a single night. And by the simple light of this other cause, which the great savant had not thought of, it was clearly shown that the accumulation, for which he required many scores of centuries, had been the actual work of about two hundred years.

To the candid mind these hints are enough. The most careful observer is most fully aware of these facts: that our knowledge of the terrestrial energies which have exerted themselves in our globe is imperfect; that the grade of speed at which known forces are now observed to act, may have been exceedingly different at other times and under other conditions of temperature and climate; that the causations which would need to be accurately determined, in order to settle many of these physical questions, were probably complicated beyond all reach of our observation and ascertainment at this late day.

4. The evolution theory presents a most interesting and instructive case for the application of this logic. Its main points are: that what we supposed to be distinct *genera* of animated beings did not originate in the creation of first progenitors, from whom all the subsequent individuals descended by a generation which transmitted, by propagation, precisely the properties essential to the *genus*; but that higher *genera* were slowly evolved from lower; that the causes of the differentiations wherein the more developed individuals differ from their less developed progenitors, are to be found in three unintelligent physical influences,—heredity, the influence of the environment on the being's powers, and the survival of the fittest. The observed facts from which this hypothesis claims to derive its induction may be grouped under these general statements: that in fact the known *genera* of animated beings form a continuous ascending scale, from the most rudimental up to man, the most highly organised; thus suggesting the ascent of organisation along this ladder, from a lower stage to a higher; that a multitude of organs and limbs are actually seen to grow from their infantile to their adult states, under the interaction of their environment and the instinctive animal exertions of them; that the conditions of animal existence are, in the general, such that the individuals possessing most of the natural vigour, qualifying them to reproduce a strong or a developed progeny, are most likely to survive, while the less qualified perish; and that observed facts in the breeding of animals present cases in which the rule does not hold that "Like produces only its like," but often it produces the slightly unlike, differing from itself by a slight shade of improvement or deterioration. These facts, the theory claims, when a very long time is allowed for the slow and irregular, but in the main progressive, action of the forces they disclose, prove that all animated *genera* can be accounted for as the ultimate progeny of the most rudimental protozoon.

The task in hand here is not to give a full refutation of this theory, but to criticise it in the light of the logical principles established, simply in order to see whether it is an induction. It appears at once that it has no claim to come under the head of either method of induction, not even of the loosest, the method of agreement. Indeed, it cannot be said to have a single *instance* (much less an agreeing multitude) in the proper sense of inductive instances. To resort for simplification to our notation, let A stand for the aggregate of supposed evolutionary agencies, which are the combined cause; let X stand for the effect, a *new genus*. There has not been pre-

mented one instance, as yet, in which A has been followed by X, even seemingly, A being accompanied or unaccompanied by other antecedents, B, C, D, etc. The utmost which can be claimed is, that a few "varieties" have been evolved, but no permanent *species* or *genus*, which can meet the tests of generic character. Even these "varieties" cannot be proved to be the effects of the supposed evolving physical causes, since it does not appear that they have evolved themselves, except when these unintelligent influences were guided by a rational purpose, as that of the stock-breeder or bird-fancier. Again, the theory fails as to man, the rational, and the highest result, of the supposed evolution,—in that its energies are unintelligent and blind; but man has a reason. There must be enough in the cause to account for the effect. And it fails as to man and all the lower animals, in that their organs all display, even down to the lowest, the work of thoughtful design and the intelligent selection of final cause; whereas the evolving energies are all blind and unintelligent. Nor has the first instance been found where the influences of "environment" have evolved a single new organ or physical faculty, in the sense necessary to the theory. The facts observed are these: that when nature has implanted the generic organ or function by regular propagation, but in the infantile state, the "environment" has presented the occasion, not the cause, for its growth, by its own exercise up to its adult strength. The fish's fin grows by beating the water, in this sense; the bird's wing by beating the air; the child's arm by the wielding of his toys. But where is the first instance that the environment has evolved a new organ over and above the generic model? Where has environment placed a new fin on a fish's back, or an additional finger on a youth's hand? The instances ought to be of this nature, to give any show of an induction. And the organ evolved ought to become not merely an individual peculiarity, but a permanent trait transmitted uniformly by propagation.

The canon of the inductive logic requires, again, that all other possible causes, other than the one claimed in the hypothesis, shall be excluded by at least some of the known instances. But the theistic account, which is made entirely probable, to say the least, by arguments in morals and natural theology, presents another sufficient cause in the creative power and wisdom. Since the origin of species antedates, confessedly, all human observation and history, this cause for it is probable, until atheism is demonstrated. Even were the evolution theory an induction from real instances, in which these evolving influences were truly adequate to the effect,

there would be no valid induction until the theistic cause was positively excluded by a demonstration of atheism. And to offer the conclusion which would flow from such an induction, when completed, as sufficient for that atheistic demonstration of the non-existence of a Creator, which alone would complete the induction; this would plainly be "reasoning in a circle." The conclusion would have to be assumed, in order to make out the process leading to it. But supposing there may be a Creator of perfect wisdom and power and full sovereignty, it is always supposable that he may have seen reasons for clothing his creatures with those very qualities on which evolution argues against a Creator. Is it said that the regular gradations of organised life suggest the belief that the higher forms were evolved from the lower, along the stages of this ladder? But the theistic hypothesis suggests, with more probability, the belief that the Creator had reasons for filling all the stages of this ascending scale with *genera* and *species* which are yet distinct. To lift the former surmise to the faintest approach to an induction, the latter hypothesis must be precluded.

Once more, the scheme is fatally defective in that it has *no verification*. Not a single new *genus*, or even individual, has been presented, or can be evolved by experiment, to confirm the hypothesis. Indeed, it is impossible, from the nature of the case, that there can be a verification, since the advocates of the scheme admit that the latest evolution, that of man, was completed long before the earliest human history. The most that can be said for this theory is, that it is an ingenious collection of guesses, which bear a fanciful but deceptive likeness to real analogies.

So far the pretended argument goes in its simpler form. Its manifest invalidity constrains some evolutionists, as Le Comte, to surrender it. But these assert that deeper researches into the parallelisms of organic relations give a truly inductive ground for their theory. It is claimed that the likeness between the stages which Agassiz (chiefly) disclosed in embryology, paleontology, and our existing gradations in natural history, now called the ontogenic, the phylogenic, and the taxonomic gradations, establishes evolution by a solid induction. The animals now upon the earth form a gradation, through the four grand divisions of radiates, molluscs, articulates, and vertebrates, from the lowest and simplest up to the most complicated and highest. So, evolutionists assert, the living creatures made known by the fossils as once having lived in paleontologic ages, show the same gradation. And third, the transformations through which the foetal organisms,

even of the highest species, pass from the *ovum* to the adult, exhibit the same gradation. The proposed argument is, that these analogies give an inductive proof that *species are evolved from species* by an equally natural law of evolution.

Let it be again observed that all we need attempt, in criticising this supposed argument by the principles of induction, is to show that the process is invalid. And we would preface the farther criticism by the *caveat*, that we do not admit the parallelism of the three sets of instances, in the sense claimed by evolutionists. The paleontologic series, for instance, in order to support this pretended evolutionist induction, should be a series of higher and more complete animal forms succeeding the more rudimental in time. But such it is not. At each paleontologic period, some of the four groups of living creatures are found coexisting, in at least some types of each, and not merely successive. The palæozoic strata are found to contain vertebrate fishes, along with the radiates and molluscs of that first period. And, if we may trust Agassiz's assertion, there is no evidence that the embryonic changes of any individual animal of a higher group exemplifies all the gradations from the lowest group up to its own. These mutations of its foetal life only illustrate fully the gradations of the species in its own group.

But, waiving for the time these questions of fact, we show, in this pretended induction, this vital defect: it mistakes an analogy (an imperfect one) in the method of action of certain vital energies for a causal identity. The essential link of a demonstrative induction is lacking. If we take, for instance, the embryonic order of development, all that is proved by the multitude of cases colligated is, that the individual *ova* are all endued with a vital energy which causes, and thus insures, the growth of each individual into the matured type of its own species. For such, and such alone, is the result, as observed. In no single case has an individual *ovum*, be its analogy of mode of development to that of other species what it may, resulted in an evolution into a different species from its own. Hence, there is not a particle of inductive evidence that this causal energy which we see at work is competent to such evolution. Each individual gives an instance of a development through an embryonic series? True. But in every instance the development terminates within the strict limits of its own species; and the induction from the latter set of facts is precisely as broad and as inexorable as from the former.

Again, the analogies noted all receive their sufficient solution from another hypothesis, namely this, that they are the expressions of a common plan of thought, by which the

creative Mind voluntarily regulates its creative and providential actions. Now, as we saw, the conclusion from an induction is not demonstrated, unless the instances collected preclude all other probable, and even possible, hypotheses. Here is the other hypothesis, not only probable and intrinsically reasonable, but, in the light of other arguments, certain—the theistic one: that the reason why the vital energies wrought in paleontologic creatures in a way analogous to the way they work now is, that the same God created and governed then, and that he sees good reasons for following, in the different ages, similar types of working. It might be conceded that the analogies under discussion, if viewed alone, would be insufficient to prove the existence and action of a God. Yet they do suffice to show that solution a probable one. This alone is enough to prove the evolutionist conclusion invalid.

The argument, then, is not a demonstrative induction. Here our logical criticism might stop. But it will be instructive to show how it is confirmed by the positive refutation which other laws and facts of natural history inflict upon the evolution theory. This is excluded, as a tenable explanation of the organised universe, by the following instances, which do have, what the previous analogies have not, an application in strict accordance with the principles of induction.

1. No existing species has displayed a particle of tendency towards the change in a single truly specific attribute, within the longest period of human history. The mummies, as well as the effigies, of the living creatures associated with the oldest Egyptian remains, were found by Cuvier and by Kunth specifically identical with the same creatures now existing in Egypt. Researches into antiquity have everywhere led to the same result. Now, if evolution of one species from another is to be inductively proved, some instances at least tending to the result must be adduced. The fact that all human knowledge through three or four thousand years presents no approach to a single instance, is fatal.

2. In paleontology, each species, so far as known from its fossils, has remained absolutely fixed during the continuance of its period. It is very true, that a species may be found in a subsequent cosmical period, showing resemblances to, and improvements on, a given extinct species of the previous cosmical period. But this fact makes nothing for evolution, because science shows that there has been, between the two periods and their two sets of living creatures as two wholes, a clear breach, interrupting the natural and regular forces of reproduction. The evolutionist must show some instance where, within the limits of some one cosmical period, a

different species has been naturally evolved from one simpler than itself.

3. If the existence of the higher forms of life were accounted for by slow evolutions from the lowest, then the paleontologic history should unquestionably present us with this state of facts: First, with a period of the simplest forms, as the radiates; then, afterwards, with a period of more developed forms, as molluscs; then with the still higher, as the articulates; and then with a period of the highest. But the state of the facts is exactly the opposite. All the paleontologic periods give us some of the four groups contemporaneously.

4. The methods of nature, in the formation of the four groups, are essentially different. While some of the species belonging to one group have a higher organisation than others, they all display a community of plan in their structure. But when we pass to another group, we meet a different plan. Hence we infer that even if we could do what has never been done, find an actual case of the evolution of a species from a lower one of the same group; the barriers separating the groups as grand divisions, would still be insuperable. Their several plans of structure are too different for the transmutation of one into another.

5. Men speak of organic life as if its different species formed one regular and continuous series "from the monad up to man." This is found to be a misconception. The animal kingdom is composed of a number of partial series. When the attempt is made to range all these in one single continuous series, fatal dislocations appear. The line of progress is not a continuous ascending line.

6. The theory of evolution assigns great force to the influence of "environment," in developing organs into those of a new species. But naturalists tell us that they find a number of the most diversified types existing and prospering together for long ages, under identical circumstances. But, were evolution true, the identity of the whole environment ought to be working an assimilation of the various types subjected to it. Again, identical species are found persisting for long ages under the most diversified environments. These facts show that there has been deposited within each species its own form of vital energy, which resists differentiation, and insists, against any influence of a changed environment, on reproducing only its own type. The rational inference is, that either each species is eternal, an impossible proposition, or else each points to an extra-natural Power, which deposited its specific vital energy in it at its beginning.

And that *Power*, in the last place, was *Mind*, because every adaptation of organs to their functions, every reappearing analogy of structures in successive cosmical periods, every relation instituted between the individual and its environment or its fellow-creatures, discloses *thought*. But evolution is claimed to be only a physical process.

Such is the use of the observed facts of the animal kingdom, as sanctioned by the true principles of the inductive logic. The result of this correct colligation is to show that evolution cannot be true.

Let us make another application of these logical principles, and that the most important of all. It concerns the limits of the *à posteriori* inference from similarity of results to identity of cause, concerning the origin of the structures composing the crust of our earth. If theism is admitted to be, not demonstrated, but even possible, then, according to the rules of induction, such inference from naturalness of structure to natural origin is inconclusive. This follows from two of its rules: first, the analogical argument from similarity of result to identity of cause, must give way before competent and credible parole evidence. The supposed but invalid argument is,—we see natural agencies producing this and that structure; therefore, all similar structures are of natural origin. But if there may be a creative God, *there* is a different sufficient cause for the origin of the earlier. And if a witness appears who may be naturally competent to testify, his testimony wholly supersedes the evidence of the supposed analogy. The only way to uphold it is to attack the credibility of that witness. If his credibility is not successfully impeached, the analogical argument must yield before it.

But such a parole-witness appears in the book known as the Christian Scriptures. It assumes to testify that there is a Creator, and that he here gives his own witness to his supernatural creation of the first structures. The value of any induction from naturalness of traits to a natural origin of those structures, must depend therefore upon the other question: whether this witness is competent and credible. Some persons attempt to evade their logical obligation here by saying that these are theological questions with which physical science, as such, has no concern; that they restrict themselves properly to the lights of this department, and, in assigning a natural origin to these structures, speak only for science. But this is a violation of the principles of natural induction, which must necessarily include some adjustment of the relations between analogy and testimony; seeing the truth of the very facts, claimed as analogical, itself rests on testimony.

Farther, the questions whether there is a Creator, and whether there have been creative causations, enter into this argument, not as theological, but as natural questions. In their relations to the inductive problem, they are as purely physical questions, as the question whether a given rock is the result of fusion or sedimentary deposition from water. A moment's reflection will show the justice of this statement. And hence it follows that an *à posteriori* analogical argument on this topic is entirely fragmentary and inconclusive, until the claims of this parole-witness are entertained and adjusted. The historical and the physical parts of the argument cannot be thus rent asunder and legitimately pursued apart.

The second rule of induction which applies to show this reasoning invalid, is that pointed out on p. 10. If there may be two antecedents, either of which is competent efficiently to produce an effect (naming one of them A, and the effect X), the closest possible induction can only prove that all A's will, *cæteris paribus*, produce X; but cannot prove that all X's are produced by A. Now, *until atheism is demonstrated*, another competent cause for natural structures may be supposed as possibly existing in the existence and action of a God. And whatever is the strength of the probable or demonstrative evidence that there is a God, from whatever valid quarter drawn, there is just so much probability of error in the attempted induction, which assigns a natural origin to all structures. To attempt to exclude the divine cause by the force of this *à posteriori* analogy is to reason in a circle; because the validity of the analogy depends wholly on the prior exclusion of the divine cause. Second, a wise Creator must have had some final cause guiding his action. We should not be so presumptuous as to surmise in advance what particular final cause prompted a given creative act, but when his own subsequent action has disclosed it we are on safe ground. It is always safe to conclude that the object for which a wise and sovereign Creator produced a given thing is the object to which we see him devoting it. When, therefore, we see him in his subsequent providence subjecting all things to the reign of natural law, we may safely conclude that, when he created them, he designed to subject them to natural law. But that which is to be ruled by natural law must needs be thoroughly natural in traits. Hence this Creator must have made the first structures, which in their origin were supernatural, in their properties entirely natural. Whence it follows that the inference from naturalness of qualities to a natural origin would be, as to those structures, wholly worthless. Let it be repeated also: that whatever probability or certainty there is

of God's existence, from any source of evidence, just so much evidence is there of this defect in the naturalistic argument. Or, in other words, to make it conclusive, its advocate must *demonstrate* (not surmise) the truth of atheism. But John Foster has shown that this is impossible.

Third. The argument is peculiarly conclusive as to living creatures. If there was a Creator, he created the first individuals of a species to be, by reproduction, the heads of the species. But in order to do this, these first parents must have been created natural. What are the qualities connoted by any name of species? The most accurate answer which the science of natural history itself can make is: they are precisely those which are transmitted regularly from parents to progeny in the propagation of the species. Then, these first individuals, in order to fulfil their final cause, to be the heads of their species, must have been, while supernatural in origin, as thoroughly natural in qualities, as any of their natural offspring.

Fourth. If this be denied, then we must assign a natural parent before the first parent of each species. Thus we should be involved in infinite series, in a multitude of instances, without cause external to themselves, a result which science herself has discarded as an impossible absurdity. Suppose, for explanation, that an observer has found some part of the very organism of one of those first heads of species, which, on the theistic scheme, was directly created by God. He would, of course, find in this fossil every property of the natural structure. Yet he cannot infer thence a natural origin for it, because on the hypothesis it is absolutely a first thing. But suppose that he may assign for it a natural origin. That origin then will be, propagation by birth from prior parents. And should a fossil organ of that parent be found, the same argument would apply again! Thus we should be driven to a ridiculous *regressus*. It is concluded, therefore, with the most perfect logical rigidity, that the argument from naturalness of structure to a natural origin is inconclusive, until the impossibility of creative agency in any age prior to authentic human testimony is demonstrated.

Fifth. This absurd *regressus* may be shown in a general way, by testing this analogical argument upon the "nebular hypothesis," that guess which the atheist Laplace suggested as only a possible hypothesis for the origin of the universe, and which some Christian physicists now seem so ready to adopt, without proof, as the real account of the matter. Let us suppose the scientific observer from some other system watching this vast incandescent mass of "star-dust," rotating

around an axis of motion, with which the nebular hypothesis begins. If he uses the analogical reasoning we are criticising, he must proceed thus: Matter is naturally inert; *momentum* must therefore be derived from some prior material force. This rotary motion, which the nebular hypothesis supposes to be the first state, cannot be the first state. Again, vapour implies evaporation. Sensible heat suggests latent heat. Hence this other first state of incandescent volatilisation cannot be the first state. Thus, by this logic, before each first state there must have been another first state.

Beneath the lowest deep another depth,
Still threatening to devour me, opens wide.

This, then, is the eternity of "Naturalismus,"—it is Atheism.

This wholesome limitation of analogical inference has been sometimes met with disdainful resistance. It has been said that it would subvert the very basis of natural science. It is exclaimed, "If we may not securely reason, 'like causes, like effects,' the very lever of scientific discovery is taken from us." The answer is very simple, that there is no intention to rob science of her prime *organon*, "Like causes, like effects." The main drift of this treatise has been to defend and explain it. Only we do not desire to see the votaries of inductive science disgracing themselves by the very shallow blunder (a blunder which the earliest class-book of Logic points out) of mistaking an all important proposition for its erroneous converse, "Like effects, the same cause." This is really the extent of our caution. The inductive logic is in no danger of being cramped or restricted by theology, within the proper domain of natural science. That domain is the known present and the known past of human history, where testimony and experience give us sufficient assurance of the absence of the supernatural. In this field, natural induction is useful and legitimate; it has been the honoured instrument of splendid and beneficent achievements. Let physicists continue to employ it there, to the full, for the further benefit of mankind and the illustration of the Creator's wisdom and glory. But in the unknown eternity of the past prior to human history, it has no place. It is like the mariner's compass carried into the stellar spaces. We know that the poles of this globe have a certain attraction for it, and, therefore, on this globe it is a precious guide. But away in the regions of Arcturus or the Pleiades, where we are not certain whether the spheres have poles, or whether they are magnetic, we are not authorised to follow it.

One more application will be made, and this to a supposed social and moral induction; in order to exhibit the fitness of the logical canons for ethical as well as physical science. The case is that of the colligation of instances, so often presented by the enthusiastic fanatics in the cause of secular education, as a proof of their proposition that this species of education promotes virtue and suppresses crime. The supposed evidence is, that the statistics of prisons, penitentiaries, and criminal convictions usually show a ratio of illiterate to educated criminals considerably larger than the ratio of illiterate to lettered citizens in the commonwealth. The governor of an American commonwealth, for instance, reported that of all the convicts in his state-penitentiary for ten years, only a little more than ten per cent. could read and write. And he presented this as a conclusive demonstration that illiteracy was the cause, and a knowledge of letters would be the sufficient cure, of crime.

Now, a very simple application of the logical criticism discloses the inconclusiveness of this popular argument. The effect to be accounted for is, breaches of statute laws. The observed antecedent to this effect is, in a large majority of cases in this State, ignorance of letters. Obviously, this is but an induction *per enumerationem simplicem*, which gives no proof whether the sequence give a *post hoc* or a *propter hoc*. The argument offers neither canon of induction to complete the separation. We have in this enumeration nothing whatever to teach us whether the true efficient of the crimes does not lie, hitherto unnoted, between the supposed antecedent, illiteracy, and the effect. The pretended argument gives us no ground whatever for excluding this other obvious hypothesis, that something else may have been the true cause of the crimes, of which cause the illiteracy itself may be also another co-ordinate effect.

As soon as another equally authentic enumeration is compared with the previous one, the justice of this suspicion is fully confirmed. Farther study of the statistics of crime shows, that while American prisons contain a larger percentage of illiterate criminals than American society contains of illiterate free citizens, yet the *ratio of criminals to the whole number of citizens* in any given community is uniformly far larger where all, or nearly all, adults can read and write, and far smaller where fewer of the adults can read and write. For instance, in Boston, the boastful metropolis of free schools, with scarcely an adult who could not read and write, the census of 1850 showed that the white persons in jails, penitentiaries, and alms-houses bore to the whole white popula-

tion the ratio of one in every thirty-four. But in Richmond, the capital of a State endlessly reviled for its illiteracy, the same classes of whites bore to the whole number of white citizens the ratio of one to every one hundred and twelve! The difference in favour of the less lettered communities, as revealed by subsequent censuses, is still more astounding; and this, when extended to the whole South, as compared with the North, and as deduced by Northern students of statistics.

Now, were these enumerations of sequences employed in the same illogical way, they would seem to demonstrate exactly the opposite conclusion, *that the knowledge of letters causes crime, and illiteracy causes virtue*. This is a sufficiently biting demonstration of the worthlessness of the pretended induction. The true solution, to which the comparison of the two enumerations points, is this, that neither letters nor illiteracy causes crime in America, but another combination of moral causes, to which these states of the population are themselves related as effects. In any given prison will be found a majority of prisoners who cannot read and write. This does not prove that the possession of these arts is preventive of crime, as the other statistics show. But as American society happens to be constituted, the rearing of children without a knowledge of letters has happened to be the usual accompaniment of a domestic condition of penury and moral degradation, while families of substance and domestic morality have usually given letters to their children. Thus it is made plain that it is not the illiteracy, but the penury and domestic degradation which are the real causes of crime. The illiteracy turns out not to be the cause at all, but an incident or appendage which the domestic habits of Americans have connected with the real cause, the combination of want and domestic degradation.

But when, by the intrinsic activity of the civil government, the children of destitute and morally degraded families are universally invested with the arts of reading and writing, without that moral and economical elevation of the parents and children, to work which the State and State schools are so nearly impotent, then the result is a fearful increase in the *ratio* of criminals to the whole number of citizens. The explanation is, that it is the want and family degradation which together are the main efficient cause of crime, and which the knowledge of letters, while those continue, rather aggravates than checks.

SIR H. BARKLY, G.C.M.G., K.C.B., F.R.S.—I have been requested to move "That our best thanks be presented to Professor Dabney for the Annual Address now delivered, and to those who have read papers during the session." So far as it has been my privilege to listen to the papers read at this Institute during the session, they have seemed to me to have been generally of a character carrying out to the fullest extent the objects of the Victoria Institute; and I am sure that those who have listened to the paper of Professor Dabney will feel that the simple and eloquent language in which it is couched has gone very far, contrary perhaps to the expectation of most of those who sit here, to render the subject of inductive logic attractive to a general audience. (Applause.)

REV. T. FLAVELL, K.C.L.—I will not detain the meeting many minutes whilst I respond to the request that I should second this resolution. Sir J. H. Lefroy in moving the first resolution stated that he had not observed much unbelief during his residence in the Colonies. I do not know how long he lived there, nor in which of the Colonies he resided; but I come from New Zealand, and there are two towns in that colony—Dunedin and Christchurch—in each of which there is a free-thinking association. The men who belong to these associations are, I regret to say, very determined, not only in holding their peculiar views, but in endeavouring, by every means in their power, to spread them through the length and breadth of the land. Their way of beginning is to start with the clergy; I hope I am not making a wrong induction; but twelve numbers in succession of a paper in favour of unbelief were sent to me, I suppose for the purpose of converting me to the views it expressed. Another way of obtaining converts is to get young children into their Lyceum, and when I left Christchurch the Lyceum there had some seventy children being taught under the supervision of these people. In Dunedin, also, there is an infant class in which the teachers endeavour to inculcate these fearful doctrines into the minds of the very young. The question is, How are we to meet this tide of unbelief? There are three courses open to us. One is to let the tide alone; another is to attack these people in strong and harsh language; and the third, and I think the superior method, is to approach our antagonists in a spirit of kindness and sympathy. Two of the Christchurch clergy adopted the latter course. They issued a syllabus of lectures, in which they proposed to state their views, and invited the freethinkers to come to the church, so that they might hear their opponents freely, fully, and courteously expound their views. During six Sunday nights it was my privilege to stand in the pulpit and address large congregations, many of them being men who were members of the various freethinkers' associations. By means of the press, also, I have been able to get careful reviews and extracts from some of the very valuable papers published by this Institute put into circulation throughout the Colony of New Zealand. (Applause.) I am glad now to have the opportunity of expressing my own great indebtedness to this Institute. We in

New Zealand have a great deal to do. The distances that have to be travelled are very considerable ; our occupations are varied and arduous ; and it often happens that we have not the time to go deeply into these questions. We are unable to examine, as we should wish to do, the books written by men like Herbert Spencer and John Stuart Mill ; but at the same time we know that these books are read and devoured by many in the Colony ; and, unless we clergy can get some inkling of the views put forward by the followers of these writers, and can obtain some means of answering them, we are left completely out of the tide and lose our influence over the masses. However, by studying the papers written by such men as Bishop Cotterill, Professor Stokes, and others, and disseminating their views, we have the opportunity of doing some good. (Applause.)*

The resolution was put and carried.

REV. ROBINSON THORNTON, D.D.—Ladies and Gentlemen,—In addressing you at the present moment, I must omit the name of our noble President, for this reason, that I am about to ask you to do what I am quite sure you have already determined to do, namely, to thank him most heartily for his kindness in coming among us and taking the chair this evening. (Applause.) His kindness to this Institute, and the support he has given it, is sufficiently a matter of history ; and we are enabled to draw from it a valid induction. We have heard a good deal to-night about “ valid induction,” and I must say that the *enumeratio simplex* of what Lord Shaftesbury has done warrants our drawing an unanswerable conclusion with regard to his constant and untiring goodness and benevolence in any useful work. (Applause.) Therefore, by virtue of this induction, which I am sure even Professor Dabney would agree is an adequate one, I ask this meeting to give its cordial thanks to Lord Shaftesbury, together with its congratulations on seeing him occupying his chair as President of this Institute. (Applause.)

DR. GWYN JEFFREYS, F.R.S.—I must ask the permission of the meeting to say a few words on this occasion, because, unfortunately, I am not a member of the Victoria Institute. I cordially second the vote of thanks to its noble President, who is so celebrated for his exertions in the cause of philanthropy throughout the world, and who has certainly earned our praises for his urbanity and courtesy in the chair. (Applause.)

The resolution having been carried by acclamation,

THE EARL OF SHAFTESBURY, K.G.—You have been good enough to present to me a vote of thanks for the small services I have rendered to this Institute. It has been my duty on every similar occasion to repeat my sense

* The report of the Institute's Local Secretary in New South Wales is much to the same effect. There, the evils of a Government Educational system which does not even permit the name of God in the lesson-books are intensified by the extent to which the false idea alluded to in the Preface of Volume XVII.—“ that men of science no longer regard the Bible or the religious belief it inculcates ”—is credited by those now charged with educating the masses in the Government Schools.”—Ed.