CHAPTER XIX.

OF THE EXTENSION OF DERIVATIVE LAWS TO ADJACENT CASES.

Sec. 1. We have had frequent occasion to notice the inferior generality of derivative laws, compared with the ultimate laws from which they are derived. This inferiority, which affects not only the extent of the propositions themselves, but their degree of certainty within that extent, is most conspicuous in the uniformities of coexistence and sequence obtaining between effects which depend ultimately on different primeval causes. Such uniformities will only obtain where there exists the same collocation of those primeval causes. If the collocation varies, though the laws themselves remain the same, a totally different set of derivative uniformities may, and generally will, be the result.

Even where the derivative uniformity is between different effects of the same cause, it will by no means obtain as universally as the law of the cause itself. If *a* and *b* accompany or succeed one another as effects of the cause A, it by no means follows that A is the only cause which can produce them, or that if there be another cause, as B, capable of producing *a*, it must produce *b* likewise. The conjunction therefore of *a* and *b* perhaps does not hold universally, but only in the instances in which *a* arises from A. When it is produced by a cause other than A, *a* and *b* may be dissevered. Day (for example) is always in our experience followed by night; but day is not the cause of night; both are successive effects of a common cause, the periodical passage of the spectator into and out of the earth's shadow, consequent on the earth's rotation, and on the illuminating property of the sun. If, therefore, day is ever produced by a different cause or set of causes from this, day will not, or at least may not, be followed by night. On the sun's own surface, for instance, this may be the case.

Finally, even when the derivative uniformity is itself a law of causation (resulting from the combination of several causes), it is not altogether independent of collocations. If a cause supervenes, capable of wholly or partially counteracting the effect of any one of the conjoined causes, the effect will no longer conform to the derivative law. While, therefore, each ultimate law is only liable to frustration from one set of counteracting causes, the derivative law is liable to it from several. Now, the possibility of the occurrence of counteracting causes which do not arise from any of the conditions involved in the law itself, depends on the original collocations.

It is true that (as we formerly remarked) laws of causation, whether ultimate or derivative, are, in most cases, fulfilled even when counteracted; the cause produces its effect, though that effect is destroyed by something else. That the effect may be frustrated, is, therefore, no objection to the universality of laws of causation. But it is fatal to the universality of the sequences or coexistences of effects, which compose the greater part of the derivative laws flowing from laws of causation. When, from the law of a certain combination of causes, there results a certain order in the effects; as from the combination of a single sun with the rotation of an opaque body round its axis, there results, on the whole surface of that opaque body, an alternation of day and night; then if we suppose one of the combined causes counteracted, the rotation stopped, the sun extinguished, or a second sun superadded, the truth of that particular law of causation is in no way affected; it is still true that one sun shining on an opaque revolving body will alternately produce day and night; but since the sun no longer does shine on such a body, the derivative uniformity, the succession of day and night on the given planet, is no longer true. Those derivative uniformities, therefore, which are not laws of causation, are (except in the rare case of their depending on one cause alone, not on a combination of causes,) always more or less contingent on collocations; and are hence subject to the characteristic infirmity of empirical laws, that of being admissible only where the collocations are known by experience to be such as are requisite for the truth of the law, that is, only within the conditions of time and place confirmed by actual observation.

Sec. 2. This principle, when stated in general terms, seems clear and indisputable; yet many of the ordinary judgments of mankind, the propriety of which is not questioned, have at least the semblance of being inconsistent with it. On what grounds, it may be asked, do we expect that the sun will rise to-morrow? To-morrow is beyond the limits of time comprehended in our observations. They have extended over some

thousands of years past, but they do not include the future. Yet we infer with confidence that the sun will rise to-morrow; and nobody doubts that we are entitled to do so. Let us consider what is the warrant for this confidence.

In the example in question, we know the causes on which the derivative uniformity depends. They are, the sun giving out light, the earth in a state of rotation and intercepting light. The induction which shows these to be the real causes, and not merely prior effects of a common cause, being complete; the only circumstances which could defeat the derivative law are such as would destroy or counteract one or other of the combined causes. While the causes exist, and are not counteracted, the effect will continue. If they exist and are not counteracted to-morrow, the sun will rise to-morrow.

Since the causes, namely the sun and the earth, the one in the state of giving out light, the other in a state of rotation, will exist until something destroys them; all depends on the probabilities of their destruction, or of their counteraction. We know by observation (omitting the inferential proofs of an existence for thousands of ages anterior), that these phenomena have continued for (say) five thousand years. Within that time there has existed no cause sufficient to diminish them appreciably; nor which has counteracted their effect in any appreciable degree. The chance, therefore, that the sun may not rise to-morrow, amounts to the chance that some cause, which has not manifested itself in the smallest degree during five thousand years, will exist to-morrow in such intensity as to destroy the sun or the earth, the sun's light or the earth's rotation, or to produce an immense disturbance in the effect resulting from those causes.

Now, if such a cause will exist to-morrow, or at any future time, some cause, proximate or remote, of that cause must exist now, and must have existed during the whole of the five thousand years. If, therefore, the sun do not rise to-morrow, it will be because some cause has existed, the effects of which though during five thousand years they have not amounted to a perceptible quantity, will in one day become overwhelming. Since this cause has not been recognised during such an interval of time, by observers stationed on our earth, it must, if it exist, be either some agent whose effects develop themselves gradually and very slowly, or one which existed in regions beyond our observation, and is now on the point of arriving in our part of the universe. Now all causes which we have experience of, act according to laws incompatible with the supposition that their effects, after accumulating so slowly as to be imperceptible for five thousand years, should start into immensity in a single day. No mathematical law of proportion between an effect and the quantity or relations of its cause, could produce such contradictory results. The sudden development of an effect of which there was no previous trace, always arises from the coming together of several distinct causes, not previously conjoined; but if such sudden conjunction is destined to take place, the causes, or *their* causes, must have existed during the entire five thousand years; and their not having once come together during that period, shows how rare that particular combination is. We have, therefore, the warrant of a rigid induction for considering it probable, in a degree undistinguishable from certainty, that the known conditions requisite for the sun's rising will exist to-morrow.

Sec. 3. But this extension of derivative laws, not causative, beyond the limits of observation, can only be to *adjacent* cases. If instead of to-morrow we had said this day twenty thousand years, the inductions would have been anything but conclusive. That a cause which, in opposition to very powerful causes, produced no perceptible effect during five thousand years, should produce a very considerable one by the end of twenty thousand, has nothing in it which is not in conformity with our experience of causes. We know many agents, the effect of which in a short period does not amount to a perceptible quantity, but by accumulating for a much longer period becomes considerable. Besides, looking at the immense multitude of the heavenly bodies, their vast distances, and the rapidity of the motion of such of them as are known to move, it is a supposition not at all contradictory to experience that some body may be in motion towards us, or we towards it, within the limits of whose influence we have not come during five thousand years, but which in twenty thousand more may be producing effects upon us of the most extraordinary kind. Or the fact which is capable of preventing sunrise may be, not the cumulative effect of one cause, but some new combination of causes; and the chances favourable to that combination, though they have not produced it once in five thousand years,

may produce it once in twenty thousand. So that the inductions which authorize us to expect future events, grow weaker and weaker the further we look into the future, and at length become inappreciable.

We have considered the probabilities of the sun's rising to-morrow, as derived from the real laws, that is, from the laws of the causes on which that uniformity is dependent. Let us now consider how the matter would have stood if the uniformity had been known only as an empirical law; if we had not been aware that the sun's light, and the earth's rotation (or the sun's motion), were the causes on which the periodical occurrence of daylight depends. We could have extended this empirical law to cases adjacent in time, though not to so great a distance of time as we can now. Having evidence that the effects had remained unaltered and been punctually conjoined for five thousand years, we could infer that the unknown causes on which the conjunction is dependent had existed undiminished and uncounteracted during the same period. The same conclusions, therefore, would follow as in the preceding case; except that we should only know that during five thousand years nothing had occurred to defeat perceptibly this particular effect; while, when we know the causes, we have the additional assurance, that during that interval no such change has been noticeable in the causes themselves, as by any degree of multiplication or length of continuance could defeat the effect.

To this must be added, that when we know the causes, we may be able to judge whether there exists any known cause capable of counteracting them; while as long as they are unknown, we cannot be sure but that if we did know them, we could predict their destruction from causes actually in existence. A bedridden savage, who had never seen the cataract of Niagara, but who lived within hearing of it, might imagine that the sound he heard would endure for ever; but if he knew it to be the effect of a rush of waters over a barrier of rock which is progressively wearing away, he would know that within a number of ages which may be calculated, it will be heard no more. In proportion, therefore, to our ignorance of the causes on which the empirical law depends, we can be less assured that it will continue to hold good; and the farther we look into futurity, the less improbable is it that some one of the causes, whose coexistence gives rise to the derivative uniformity, may be destroyed or counteracted. With every prolongation of time, the chances multiply of such an event, that is to say, its non-occurrence hitherto becomes a less guarantee of its not occurring within the given time. If, then, it is only to cases which in point of time are adjacent (or nearly adjacent) to those which we have actually observed, that *any* derivative law, not of causation, can be extended with an assurance equivalent to certainty, much more is this true of a merely empirical law. Happily, for the purposes of life it is to such cases alone that we can almost ever have occasion to extend them.

In respect of place, it might seem that a merely empirical law could not be extended even to adjacent cases; that we could have no assurance of its being true in any place where it has not been specially observed. The past duration of a cause is a guarantee for its future existence, unless something occurs to destroy it; but the existence of a cause in one or any number of places, is no guarantee for its existence in any other place, since there is no uniformity in the collocations of primeval causes. When, therefore, an empirical law is extended beyond the local limits within which it has been found true by observation, the cases to which it is thus extended must be such as are presumably within the influence of the same individual agents. If we discover a new planet within the known bounds of the solar system (or even beyond those bounds, but indicating its connexion with the system by revolving round the sun), we may conclude, with great probability, that it revolves on its axis. For all the known planets do so; and this uniformity points to some common cause, antecedent to the first records of astronomical observation: and though the nature of this cause can only be matter of conjecture, yet if it be, as is not unlikely, and as Laplace's theory supposes, not merely the same kind of cause, but the same individual cause (such as an impulse given to all the bodies at once), that cause, acting at the extreme points of the space occupied by the sun and planets, is likely, unless defeated by some counteracting cause, to have acted at every intermediate point, and probably somewhat beyond; and therefore acted, in all probability, upon the supposed newly-discovered planet.

When, therefore, effects which are always found conjoined, can be traced with any probability to an identical (and not merely a similar) origin, we may with the same probability extend the empirical law of their conjunction to all places within the extreme local boundaries within which the fact has been observed; subject

to the possibility of counteracting causes in some portion of the field. Still more confidently may we do so when the law is not merely empirical; when the phenomena which we find conjoined are effects of ascertained causes, from the laws of which the conjunction of their effects is deducible. In that case, we may both extend the derivative uniformity over a larger space, and with less abatement for the chance of counteracting causes. The first, because instead of the local boundaries of our observation of the fact itself, we may include the extreme boundaries of the ascertained influence of its causes. Thus the succession of day and night, we know, holds true of all the bodies of the solar system except the sun itself; but we know this only because we are acquainted with the causes: if we were not, we could not extend the proposition beyond the orbits of the earth and moon, at both extremities of which we have the evidence of observation for its truth. With respect to the probability of counteracting causes, it has been seen that this calls for a greater abatement of confidence, in proportion to our ignorance of the causes on which the phenomena depend. On both accounts, therefore, a derivative law which we know how to resolve, is susceptible of a greater extension to cases adjacent in place, than a merely empirical law.