III.

OF LAWS IN GENERAL, AND THE ORDER OF THEIR DISCOVERY.
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[The following chapter was contained in the first edition of First Principles. I omitted it from the re-organized second edition, because it did not form an essential part of the new structure. As it is referred to in the foregoing pages, and as its general argument is germane to the contents of those pages, I have thought well to append it here. Moreover, though I hope eventually to incorporate it in that division of the Principles of Sociology which treats of Intellectual Progress, yet as it must be long before it can thus re-appear in its permanent place, and as, should I not get so far in the execution of my undertaking, it may never thus re-appear at all, it seems proper to make it more accessible than it is at present. The first and last sections, which served to link it into the argument of the work to which it originally belonged, are omitted. The rest has been carefully revised, and in some parts considerably altered.]

The recognition of Law being the recognition of uniformity of relations among phenomena, it follows that the order in which different groups of phenomena are reduced to law, must depend on the frequency with which the uniform relations they severally display are distinctly experienced. At any given stage of progress, these uniformities will be best known with which men's minds have been oftenest and most strongly impressed. In proportion partly to the number of times a relation has been presented to consciousness (not merely to the senses), and in proportion
partly to the vividness with which the terms of the relation have been cognized, will be the degree in which the constancy of connexion is perceived.

The succession in which relations are generalized being thus determined, there result certain derivative principles to which this succession must more immediately and obviously conform. First is the directness with which personal welfare is affected. While, among surrounding things, many do not appreciably influence us in any way, some produce pleasures and some pains, in various degrees; and manifestly, those things whose actions on the organism for good or evil are most decided, will, ceteris paribus, be those whose laws of action are earliest observed. Second comes the conspicuousness of one or both phenomena between which a relation is to be perceived. On every side are phenomena so concealed as to be detected only by close observation; others not obtrusive enough to attract notice; others which moderately solicit the attention; others so imposing or vivid as to force themselves on consciousness; and, supposing conditions to be the same, these last will of course be among the first to have their relations generalized.

In the third place, we have the absolute frequency with which the relations occur. There are coexistences and sequences of all degrees of commonness, from those which are ever present to those which are extremely rare; and manifestly, the rare coexistences and sequences, as well as the sequences which are very long in taking place, will not be reduced to law so soon as those which are familiar and rapid.

Fourthly has to be added the relative frequency of occurrence. Many events and appearances are limited to certain times or certain places, or both; and, as a relation which does not exist within the environment of an observer cannot be perceived by him, however common it may be elsewhere or in another age, we have to take account of the surrounding physical circum-
stances, as well as of the state of society, of the arts, and of the sciences—all of which affect the frequency with which certain groups of facts are observable. The fifth corollary to be noticed is, that the succession in which different classes of relations are reduced to law, depends in part on their simplicity. Phenomena presenting great composition of causes or conditions, have their essential relations so masked, that it requires accumulated experiences to impress upon consciousness the true connexions of antecedents and consequents they involve. Hence, other things equal, the progress of generalization will be from the simple to the complex; and this it is which M. Comte has wrongly asserted to be the sole regulative principle of the progress.

Sixth comes the degree of abstractness. Concrete relations are the earliest acquisitions. Such analyses of them as separate the essential connexions from their disguising accompaniments, necessarily come later. The analyses of the connexions, always more or less compound, into their elements then becomes possible. And so on continually, until the highest and most abstract truths have been reached.

These, then, are the several derivative principles. The frequency and vividness with which uniform relations are repeated in conscious experience, determining the recognition of their uniformity, and this frequency and vividness depending on the above conditions, it follows that the order in which different classes of facts are generalized, must depend on the extent to which the above conditions are fulfilled in each class. Let us mark how the facts harmonize with this conclusion, taking first a few that elucidate the general truth, and afterwards some that exemplify the special truths which we here see follow from it.

The relations earliest known as uniformities, are those subsisting between the common properties of matter—tangi-
bility, visibility, cohesion, weight, etc. We have no trace of a time when the resistance offered by an object was regarded as caused by the will of the object; or when the pressure of a body on the hand holding it, was ascribed to the agency of a living being. And accordingly, these are the relations of which we are oftenest conscious; being objectively frequent, conspicuous, simple, concrete, and of immediate personal concern.

Similarly with the ordinary phenomena of motion. The fall of a mass on the withdrawal of its support, is a sequence which directly affects bodily welfare, is conspicuous, simple, concrete, and very often repeated. Hence it is one of the uniformities recognized before the dawn of tradition. We know of no era when movements due to terrestrial gravitation were attributed to volition. Only when the relation is obscured—only, as in the case of an aërolite, where the antecedent of the descent is unperceived, do we find the conception of personal agency. On the other hand, motions of intrinsically the same order as that of a falling stone—those of the heavenly bodies—long remain ungeneralized; and until their uniformity is seen, are construed as results of will. This difference is clearly not dependent on comparative complexity or abstractness; since the motion of a planet in an ellipse is as simple and concrete a phenomenon as the motion of a projected arrow in a parabola. But the antecedents are not conspicuous; the sequences are of long duration; and they are not often repeated. And that these are the causes of their slow reduction to law, we see in the fact that they are severally generalized in the order of their frequency and conspicuousness—the moon's monthly cycle, the sun's annual change, the periods of the inferior planets, the periods of the superior planets.

While astronomical sequences were still ascribed to volition, certain terrestrial sequences of a different kind, but some of them equally without complication, were interpreted in like manner. The solidification of water at a low tempe-
rature, is a phenomenon that is simple, concrete, and of much personal concern. But it is neither so frequent as those which we see are earliest generalized, nor is the presence of the antecedent so manifest. Though in all but tropical climates, mid-winter displays the relation between cold and freezing with tolerable constancy; yet, during the spring and autumn, the occasional appearance of ice in the mornings has no very obvious connexion with coldness of the weather. Sensation being so inaccurate a measure, it is not possible for the savage to experience the definite relation between a temperature of 32° and the congealing of water; and hence the long continued belief in personal agency. Similarly, but still more clearly, with the winds. The absence of regularity and the inconspicuousness of the antecedents, allowed the mythological explanation to survive for a great period.

During the era in which the uniformity of many quite simple inorganic relations was still unrecognizable, certain organic relations, intrinsically very complex and special, were generalized. The constant coexistence of feathers and a beak, of four legs with an internal bony framework, are facts which were, and are, familiar to every savage. Did a savage find a bird with teeth, or a mammal clothed with feathers, he would be as much surprised as an instructed naturalist. No: these uniformities of organic structure thus early perceived, are of exactly the same kind as those more numerous ones later established by biology. The constant coexistence of mammary glands with two occipital condyles to the skull, of vertebrae with teeth lodged in sockets, of frontal horns with the habit of ruminating, are generalizations as purely empirical as those known to the aboriginal hunter. The botanist cannot in the least understand the complex relation between papilionaceous flowers and seeds borne in flattened pods: he knows these and like connexions simply in the same way that the barbarian knows the con-
nexions between particular leaves and particular kinds of wood. But the fact that sundry of the uniform relations which chiefly make up the organic sciences, were very early recognized, is due to the high degree of vividness and frequency with which they were presented to consciousness. Though the connexion between the sounds characteristic of a bird, and the possession of edible flesh, is extremely involved; yet the two terms of the relation are conspicuous, often recur in experience, and a knowledge of their connexion has a direct bearing on personal welfare. Meanwhile innumerable relations of the same order, which are displayed with even greater frequency by surrounding plants and animals, remain for thousands of years unrecognised, if they are unobtrusive or of no apparent moment.

When, passing from this primitive stage to a more advanced stage, we trace the discovery of those less familiar uniformities which mainly constitute what is distinguished as Science, we find the succession in which knowledge of them is reached, to be still determined in the same manner. This will become obvious on contemplating separately the influence of each derivative condition.

How relations that have immediate bearings on the maintenance of life, are, other things equal, fixed in the mind before those which have no immediate bearings, the history of Science abundantly illustrates. The habits of existing uncivilized races, who fix times by moons and barter so many of one article for so many of another, show us that conceptions of equality and number, which are the germs of mathematical science, were developed under the immediate pressure of personal wants; and it can scarcely be doubted that those laws of numerical relations which are embodied in the rules of arithmetic, were first brought to light through the practice of mercantile exchange. Similarly with geometry. The derivation of the word shows us that it ori-
ginally included only certain methods of partitioning ground and laying out buildings. The properties of the scales and the lever, involving the first principle in mechanics, were early generalized under the stimulus of commercial and architectural needs. To fix the times of religious festivals and agricultural operations, were the motives which led to the establishment of the simpler astronomic periods. Such small knowledge of chemical relations as was involved in ancient metallurgy, was manifestly obtained in seeking how to improve tools and weapons. In the alchemy of later times, we see how greatly an intense hope of private benefit contributed to the disclosure of a certain class of uniformities. Nor is our own age barren of illustrations. "Here," says Humboldt, when in Júíana, "as in many parts in Europe, the sciences are thought worthy to occupy the mind, only so far as they confer some immediate and practical benefit on society." "How is it possible to believe," said a missionary to him, "that you have left your country to come to be devoured by mosquitoes on this river, and to measure lands that are not your own." Our coasts furnish like instances. Every sea-side naturalist knows how great is the contempt with which fishermen regard the collection of objects for the microscope or aquarium. Their incredulity as to the possible value of such things is so great, that they can scarcely be induced even by bribes to preserve the refuse of their nets. Nay, we need not go for evidence beyond daily table-talk. The demand for "practical science"—for a knowledge that can be brought to bear on the business of life—joined to the ridicule commonly vented on scientific pursuits having no obvious uses, suffice to show that the order in which laws are discovered greatly depends on the directness with which they affect our welfare.

That, when all other conditions are the same, obtrusive relations will be generalized before unobtrusive ones, is so nearly a truism that examples appear almost superfluous.
it be admitted that by the aboriginal man, as by the child, the co-existent properties of large surrounding objects are noticed before those of minute objects, and that the external relations which bodies present are generalized before their infernal relations, it must be admitted that in subsequent stages of progress, the comparative conspicuousness of relations has greatly affected the order in which they were recognized as uniform. Hence it happened that after the establishment of those very manifest sequences constituting a lunation, and those less manifest ones marking a year, and those still less manifest ones marking the planetary periods, astronomy occupied itself with such inconspicuous sequences as those displayed in the repeating cycle of lunar eclipses, and those which suggested the theory of epicycles and eccentricities; while modern astronomy deals with still more inconspicuous sequences, some of which, as the planetary rotations, are nevertheless the simplest which the heavens present. In physics, the early use of canoes implied an empirical knowledge of certain hydrostatic relations that are intrinsically more complex than sundry static relations not empirically known; but these hydrostatic relations were thrust upon observation. Or, if we compare the solution of the problem of specific gravity by Archimedes with the discovery of atmospheric pressure by Torricelli (the two involving mechanical relations of exactly the same kind), we perceive that the much earlier occurrence of the first than the last was determined, neither by a difference in the bearings on personal welfare, nor by a difference in the frequency with which illustrations of them came under observation, nor by relative simplicity; but by the greater obtrusiveness of the connexion between antecedent and consequent in the one case than in the other. Among miscellaneous illustrations, it may be pointed out that the connexions between lightning and thunder, and between rain and clouds, were recognized long before others of the same order, simply because they
thrust themselves on the attention. Or the long-delayed discovery of the microscopic forms of life, with all the phenomena they present, may be named as very clearly showing how certain groups of relations not ordinarily perceptible, though in other respects like long-familiar relations, have to wait until changed conditions render them perceptible. But, without further details, it needs only to consider the inquiries which now occupy the electrician, the chemist, the physiologist, to see that science has advanced, and is advancing, from the more conspicuous phenomena to the less conspicuous ones.

How the degree of absolute frequency of a relation affects the recognition of its uniformity, we see in contrasting certain biological facts. The connexion between death and bodily injury, constantly displayed not only in men but in all inferior creatures, was known as an instance of natural causation while yet deaths from diseases were thought supernatural. Among diseases themselves, it is observable that unusual ones were regarded as of demoniacal origin during ages when the more frequent were ascribed to ordinary causes: a truth paralleled among our own peasantry, who by the use of charms show a lingering superstition with respect to rare disorders, which they do not show with respect to common ones, such as colds. Passing to physical illustrations, we may note that within the historic period whirlpools were accounted for by the agency of water-spirits; but we do not find that within the same period the disappearance of water on exposure either to the sun or to artificial heat was interpreted in an analogous way: though a more marvellous occurrence, and a much more complex one, its great frequency led to the early recognition of it as a natural uniformity. Rainbows and comets do not differ much in conspicuousness, and a rainbow is intrinsically the more involved phenomenon; but chiefly because of their far greater commonness, rainbows were perceived to have a direct dependence
on sun and rain while yet comets were regarded as signs of divine wrath.

That races living inland must long have remained ignorant of the daily and monthly sequences of the tides, and that tropical races could not early have comprehended the phenomena of northern winters, are extreme illustrations of the influence which relative frequency has on the recognition of uniformities. Animals which, where they are indigenous, call forth no surprise by their structures or habits, because these are so familiar, when taken to countries where they have never been seen, are looked at with an astonishment approaching to awe—are even thought supernatural: a fact which will suggest numerous others that show how the localization of phenomena in part controls the order in which they are reduced to law. Not only however does their localization in space affect the progression, but also their localization in time. Facts which are rarely if ever manifested in one era, are rendered very frequent in another, simply through the changes wrought by civilization. The lever, of which the properties are illustrated in the use of sticks and weapons, is vaguely understood by every savage—on applying it in a certain way he rightly anticipates certain effects; but the wheel and axle, pulley, and screw, cannot have their powers either empirically or rationally known till the advance of the arts has more or less familiarized them. Through those various means of exploration which we have inherited and added to, we have become acquainted with a vast range of chemical relations that were relatively non-existent to the primitive man. To highly-developed industries we owe both the substances and the appliances that have disclosed to us countless uniformities which our ancestors had no opportunity of seeing. These and like instances that will occur to the reader, show that the accumulated materials, and processes, and products, which characterize the environments of complex societies, greatly increase the accessibility of various
classes of relations; and by so multiplying the experiences of them, or making them relatively frequent, facilitate their generalization. Moreover, various classes of phenomena presented by society itself, as for instance those which political economy formulates, become relatively frequent, and therefore recognizable, in advanced social states; while in less advanced ones they are either too rarely displayed to have their relations perceived, or, as in the least advanced ones, are not displayed at all.

That, where no other circumstances interfere, the order in which different uniformities are established varies as their complexity, is manifest. The geometry of straight lines was understood before the geometry of curved lines; the properties of the circle before the properties of the ellipse, parabola, and hyperbola; and the equations of curves of single curvature were ascertained before those of curves of double curvature. Plane trigonometry comes in order of time and simplicity before spherical trigonometry; and the mensuration of plane surfaces and solids before the mensuration of curved surfaces and solids. Similarly with mechanics: the laws of simple motion were generalized before those of compound motion; and those of rectilinear motion before those of curvilinear motion. The properties of equal-armed levers or scales, were understood before those of levers with unequal arms; and the law of the inclined plane was formulated earlier than that of the screw, which involves it. In chemistry, the progress has been from the simple inorganic compounds to the more involved or organic compounds. And where, as in the higher sciences, the conditions of the exploration are more complicated, we still may clearly trace relative complexity as determining the order of discovery where other things are equal.

The progression from concrete relations to abstract ones, and from the less abstract to the more abstract, is equally obvious. Numeration, which in its primary form concerned
itself only with groups of actual objects, came earlier than simple arithmetic; the rules of which deal with numbers apart from objects. Arithmetic, limited in its sphere to concrete numerical relations, is alike earlier and less abstract than Algebra, which deals with the relations of these relations. And in like manner, the Calculus of Operations comes after Algebra, both in order of evolution and in order of abstractness. In Mechanics, the more concrete relations of forces exhibited in the lever, inclined plane, etc., were understood before the more abstract relations expressed in the laws of resolution and composition of forces; and later than the three abstract laws of motion as formulated by Newton came the still more abstract law of inertia. Similarly with Physics and Chemistry, there has been an advance from truths entangled in all the specialities of particular facts and particular classes of facts, to truths disentangled from the disguising incidents under which they are manifested—to truths of a higher abstractness.

Brief and rude as is this sketch of a mental development that has been long and complicated, I venture to think it shows inductively what was deductively inferred, that the order in which separate groups of uniformities are recognized, depends not on one circumstance but on several circumstances. The various classes of relations are generalized in a certain succession, not solely because of one particular kind of difference in their natures; but also because they are variously placed in time and in space variously open to observation, and variously related to our own constitutions: our perception of them being influenced by all these conditions in endless combinations. The comparative degrees of importance, of obtrusiveness, of absolute frequency, of relative frequency, of simplicity, of concreteness, are every one of them factors; and from their unions in proportions that are never twice alike, there results a highly complex process of mental evolution. But while it is thus manifest
that the proximate causes of the succession in which relations are reduced to law, are numerous and involved; it is also manifest that there is one ultimate cause to which these proximate causes are subordinate. As the several circumstances that determine the early or late recognition of uniformities are circumstances that determine the number and strength of the impressions which these uniformities make on the mind, it follows that the progression conforms to a certain fundamental principle of psychology. We see a posteriori, what we concluded a priori, that the order in which relations are generalized, depends on the frequency and impressiveness with which they are repeated in conscious experience.

Having roughly analyzed the progress of the past, let us take advantage of the light thus thrown on the present, and consider what is implied respecting the future.

Note first that the likelihood of the universality of Law has been ever growing greater. Out of the countless co-existences and sequences with which mankind are environed, they have been continually transferring some from the group whose order was supposed to be arbitrary, to the group whose order is known to be uniform. And manifestly, as fast as the relations that are unreduced to law become fewer, the probability that among them there are some that do not conform to law, becomes less. To put the argument numerically—It is clear that when out of surrounding phenomena a hundred of several kinds have been found to occur in constant connexions, there arises a slight presumption that all phenomena occur in constant connexions. When uniformity has been established in a thousand cases, more varied in their kinds, the presumption gains strength. And when the known cases of uniformity amount to myriads, including many of each variety, it becomes an ordinary induction that uniformity exists everywhere.
Silently and insensibly their experiences have been pressing men on towards the conclusion thus drawn. Not out of a conscious regard for these reasons, but from a habit of thought which these reasons formulate and justify, all minds have been advancing towards a belief in the constancy of surrounding coexistences and sequences. Familiarity with concrete uniformities has generated the abstract conception of uniformity—the idea of Law; and this idea has been in successive generations slowly gaining fixity and clearness. Especially has it been thus among those whose knowledge of natural phenomena is the most extensive—men of science. The mathematician, the physicist, the astronomer, the chemist, severally acquainted with the vast accumulations of uniformities established by their predecessors, and themselves daily adding new ones as well as verifying the old, acquire a far stronger faith in law than is ordinarily possessed. With them this faith, ceasing to be merely passive, becomes an active stimulus to inquiry. Wherever there exist phenomena of which the dependence is not yet ascertained, these most cultivated intellects, impelled by the conviction that here too there is some invariable connexion, proceed to observe, compare, and experiment; and when they discover the law to which the phenomena conform, as they eventually do, their general belief in the universality of law is further strengthened. So overwhelming is the evidence, and such the effect of this discipline, that to the advanced student of nature, the proposition that there are lawless phenomena has become not only incredible but almost inconceivable.

This habitual recognition of law which already distinguishes modern thought from ancient though, must spread among men at large. The fulfilment of predictions made possible by every new step, and the further command gained of nature's forces, prove to the uninitiated the validity of scientific generalizations and the doctrine they illustrate. Widening education is daily diffusing among the mass of
men that knowledge of these generations which has been hitherto confined to the few. And as fast as this diffusion goes on, must the belief of the scientific become the belief of the world at large.

That law is universal, will become an irresistible conclusion when it is perceived that the progress in the discovery of laws itself conforms to law; and when this perception makes it clear why certain groups of phenomena have been reduced to law, while other groups are still unreduced. When it is seen that the order in which uniformities are recognized, must depend upon the frequency and vividness with which they are repeated in conscious experience; when it is seen that, as a matter of fact, the most common, important, conspicuous, concrete, and simple, uniformities were the earliest recognized, because they were experienced oftenest and most distinctly; it will by implication be seen that long after the great mass of phenomena have been generalized, there must remain phenomena which, from their rareness, or unobtrusiveness, or seeming unimportance, or complexity, or abstractness, are still ungeneralized. Thus will be furnished a solution to a difficulty sometimes raised. When it is asked why the universality of law is not already fully established, there will be the answer that the directions in which it is not yet established are those in which its establishment must necessarily be latest. That state of things which is incurable beforehand, is just the state which we find to exist. If such coexistences and sequences as those of Biology and Sociology are not yet reduced to law, the presumption is not that they are irreducible to law, but that their laws elude our present means of analysis. Having long ago proved uniformity throughout all the lower classes of relations, and having been step by step proving uniformity throughout classes of relations successively higher and higher, if we have not yet succeeded with the highest classes, it may
be fairly concluded that our powers are at fault, rather than that the uniformity does not exist. And unless we make the absurd assumption that the process of generalization, now going on with unexampled rapidity, has reached its limit, and will suddenly cease, we must infer that ultimately mankind will discover a constant order of manifestation even in the most involved and obscure phenomena.