CHAPTER XIII

LAWS OF NATURE

Various meanings of "Law".

There is a certain ambiguity in the word "Law." It is important, therefore, to bring out its various meanings in order to understand exactly the meaning of a Law of Nature.

Firstly, "Law" may mean a *rule or order issued by a government or superior authority and imposed upon the subjects*. Such a law is called a *Political Law*. It commands obedience by means of the *force of penalties and rewards* attached to its violation and observance.

Secondly, "Law" may mean a *Moral Law*. A moral law carries no legal terrors and sanctions with it ; nor is it an order coming from the will of a sovereign political authority and enforced over the subordinates. Such are, for example, the rules of conduct, courtesy, etiquette and the like which are set up and observed by a society.

Thirdly, "Law" may mean a *uniformity existing among the phenomena of Nature*. "Law" in this sense means *what uniformly or always happens in Nature* and is called a *Natural Law* or a *Law of Nature*. It is not concerned with human actions as Political and Moral Laws are, but with the events of Nature. Examples : material bodies are subject to gravitation ; friction produces heat ; heat expands bodies and cold contracts them ; water rises to a height of 34 feet in a pump, etc.

All these laws express the *uniform occurrence of events in Nature.*

A little reflection will serve to show that Political and Moral Laws are *violable* and differ with different countries and times, but Natural Laws are *inviolable*, *constant* and *all-pervading*. The distinction between them is most appropriately summed up by saying that Political Laws express what *must be*, Moral Laws, what *ought to be*, and Natural Laws, what *is*. Thus, there are *Must-judgments* of Political Laws, *Ought-judgments* of Moral Laws, and *Is-judgments* of Natural Laws.

Classification of the Laws of Nature.

All laws are generalizations. But not all generalizations are of the same degree of universality and certainty. Hence laws can be classified as higher and lower according to the degree of their *generality* and *certainty*. Taking *degree of generalization* as basis, we can classify laws into *three classes*, *i.e.*, *Axioms*, *Primary or Ultimate Laws*, and *Secondary Laws*.

I. Axioms.

Axioms are the most general laws which are self-evident. They are the foundations of all other laws. They do not depend upon any law or principle going before them. Resting, as they do, on their own evidence, they cannot be proved by any other law. Nor need they be proved because they are self-evident truths. Although they themselves cannot be proved, yet they are the foundations of

all proof. They are, so to speak, like the eye which sees other things but cannot see itself. As examples of Axioms we may mention the Laws of Identity, Non-contradiction, Excluded Middle, Causation and the Axioms of Mathematics. All these laws are unproved first principles which have to be *assumed* as true without proof.

II. Primary or Ultimate Laws.

Next in order of generality to Axioms come Primary or Ultimate Laws. As they are less general than Axioms, they are proved by the latter and are, therefore, not self-evident. Thus, while Axioms are *self-evident and Assumed Truths*, Primary Laws are *Proved Truths*. They are, however, the most general laws *established* by sciences. In astronomy, *the Law of Gravitation*; in Chemistry, *the Atomic Theory* (*i.e.*, matter is composed of atoms which are indiscrete and rigid particles); in Physics, *The Wave Theory of Light* (*i.e.*, light travels in the form of waves or undulations); in Biology, *the Law of Self-preservation* (*i.e.*, every species tries to preserve itself) are examples of Primary Laws. Such Laws are also called *Scientific Laws*, and, as they are based on causal connections among facts, they possess *perfect scientific certainty*.

III. Secondary Laws.

Less general than, and subordinate to, Primary Laws are Secondary Laws. They refer to a limited group of facts; hence their sphere is not so wide as that of Primary Laws. They are subdivided into *Derivative Laws*, *Empirical Laws*, and *Probable Laws*.

(*a*) **Derivative Laws.**—Derivative Laws are special applications of Primary Laws. They are also called *Derived Laws* because they are derived or deduced as corollaries from Primary Laws. Examples :—

(*i*) *The Law of the Pendulum* (*i.e.*, the time of oscillation of a pendulum is proportional to its length), and *the Law of the Water Pump*, *i.e.*, the maximum height to which water can rise in a pump is 34 feet) are derived from the Law of Gravitation.

(*ii*) *The Law of Definite Proportions* (*i.e.*, the same chemical compound always contains the same elements combined together in the same definite proportions, *e.g.*, water always contains two units of hydrogen and one unit of oxygen) is derived from the Atomic Theory.

(*iii*) *The Law of Reflection* (*i.e.*, when a ray of light falls on a polished surface, it is reflected according to certain laws) and *the Law of Refraction* (*i.e.*, when a ray of light passes from one medium to another, it suffers a change in direction) are derived from the Wave Theory of Light.

(*iv*) *The Law of Reproduction* (*i.e.*, every species, in order to preserve itself, reproduces its kind) is derived from the Law of Self-preservation.

Because Derivative Laws are derived from Primary Laws, they share the certainty of the latter. They differ from Primary Laws not in certainty but in generality or range of application. They are, however, necessary steps for rising to the higher laws, and, therefore, Bacon calls them

"Media Axiomata" or "Middle Axioms" or "Intermediate Generalities."

(*b*) **Empirical Laws.**—Empirical Laws are nothing but empirical generalizations. They are uniformities based merely on uncontradicted experience or observation. Because they are neither traced from Primary Laws nor do they rest on any causal connections, they are much less certain than Derivative Laws. "When a law is ascertained, and we do not know how to connect it with other laws, it is called an "*Empirical Law.*" Mill says, "Scientific inquirers give the name of 'empirical laws' to uniformities which observation or experiment has shown to exist, but on which they hesitate to rely for want of seeing any reason *why* such a law should exist." When we speak of the "reason" why a fact or law exists, what we mean by its "reason" is simply its connection with other facts or laws. Thus, *empirical laws are those laws which are not shown to be connected with or deduced from other established laws*. Strictly speaking, it is even somewhat misleading to call them "Laws." Laws are established truths, but empirical generalizations are not established truths. They possess only empirical certainty and not scientific certainty. They are, however, resolvable into more general laws; but as long as they are not so resolved, they remain empirical. *Thus, empirical laws may be considered as secondary laws, underived for the time being from any higher laws, yet derivable from them in the long run.* The nature of empirical laws is best summed up by Gibson. He writes, "There are *three essential marks* which must be included in the definition of an empirical law. In the *first*

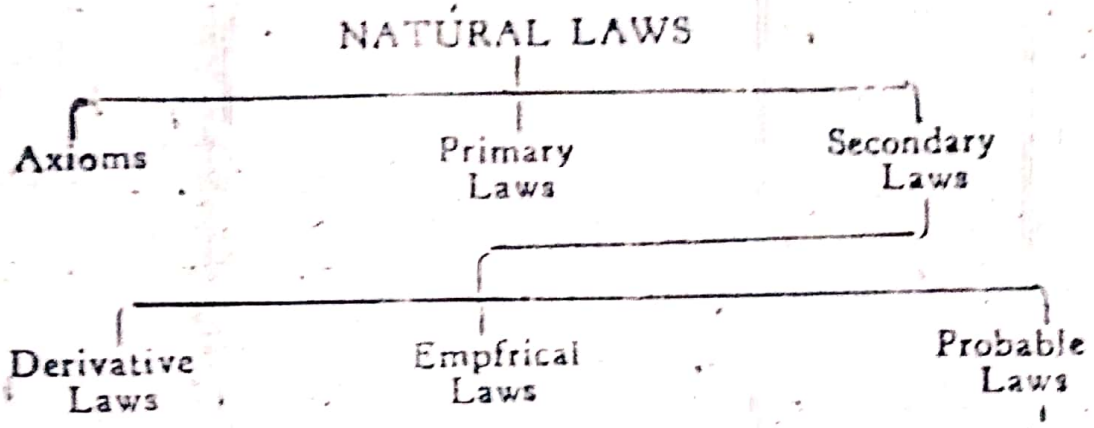
place, it *must have been gained through direct observation of facts*. In the *second* place, it *must not already have been explained as a particular case* or *specification of some law more fundamental than itself*; it is a law, in fact, which has not itself been systematized. Thus, Kepler's Laws of Planetary Motion were empirical in this sense *until* Newton showed that they were necessary deductions from his own principle of Universal Gravitation. They then became specifications or expressions of the Law of Gravitation. In the *third* place, *an empirical law is not an explanatory law*. It is a law *descriptive of the behaviour of facts*, without at the same time being explanatory, or descriptive of the mode or *behaviour of a cause*."

(*c*) **Probable Laws.**—Probable Laws are nothing but *probable* or *approximate generalizations*. They tell us what happens *in most, and not in all*, cases. Thus, they are not universal truths but partial truths. As they are not free from exceptions, they are held with misgivings. Examples: *Most* cases of cholera are incurable,—*Most* poisons are fatal,—*Most* men are selfish,—*Most* Englishmen are reserved, etc. It is quite clear that such generalizations do not possess much of generality, still less certainty. They deserve even less than empirical generalizations to be called "laws" or "generalizations." A "law" or "generalization" means not what is approximate but what is universal; not what refers to "most cases" but to "all cases." The expression "Probable Laws" or "approximate generalizations" is, strictly speaking, a misnomer, a contradiction in terms. As, however,

this expression is sanctioned by common usage, there is no harm in adopting it provided we are clear about the meaning of the word "law" here.

Moreover, we should remember that there are varying degrees of generalization and that no law can attain the highest stage of generality and certainty unless it has passed through several lower stages. We go from approximate generalizations to empirical generalizations, from empirical generalizations to derivative laws, and finally from derivative laws to primary laws. Thus, in the beginning almost all laws are of a probable character. Our progress is from the *less general and less certain to the more general and more certain*, and from the more general and more certain to the *most general and most certain*. From probability we arrive at certainty. Our spirit of acquiring knowledge, in its scientific growth, continually looks and presses forward from probable generalizations towards primary laws which are *most complete*, *consistent* and *certain*. "The progress of science," says Karl Pearson, "lies in the continual discovery of more and more comprehensive formulae, by the aid of which we can classify the relationships and sequences of more and more extensive groups of phenomena. The earlier formulae are not necessarily wrong: they are merely replaced by others which in briefer language describe more facts."

We may show the above classification of Natural Laws in the following tabular form :—



Natural Laws are sometimes understood to mean *only* Primary Laws.

Usefulness of Laws.

1. Laws connect the various phenomena of Nature which seem to be disconnected and detached and thus reduce them to a system. Nature consists of various departments, and in each department there are laws governing the phenomena. There are, for example, Mathematical Laws. Astronomical Laws, Physical Laws, Chemical Laws, Biological Laws, Psychological Laws, Sociological Laws, etc., which are concerned with different domains of Nature. All these laws which are special to particular branches of Nature are intimately connected together. There exists, for instance, a close connection between Mathematical and Astronomical Laws, Astronomical and Physical Laws, Physical and Chemical Laws, Chemical and Biological Laws, Biological and Psychological Laws, Psychological and Sociological Laws, so on and so forth.

So far as the generality of laws is concerned, we have seen that lower or less general laws can be traced up to higher or more general laws, and these latter again to laws of yet wider generality, till all

the various laws are found to be harmoniously inter-related to form a well-ordered system. Thus it is that we come to conceive the world as a system of laws, a unity or cosmos. The Universe is, so to speak, like a building in which the various laws are cemented together like bricks, and which falls down like a house of cards even if one brick is pulled out.

2. Laws bind together several facts and thus facilitate our memory of them. We cannot remember the numerous individual facts one by one as easily as when they are connected and brought under laws. Thus, laws are a valuable aid to memory.

3. Laws underlie all explanation and knowledge. We explain facts by indicating the laws by which those facts are governed. The end of explanation and knowledge is unification, and we approach this end as we reach higher and higher laws which can unite a vast number of facts and thus systematize knowledge. This purpose of unifying knowledge is obviously served best by primary laws because of their very wide range. Secondary laws are of less *theoretical value* but of more *practical value*. Being more in touch with concrete facts, they help us in dealing with practical problems better than primary laws A rope-dancer, for instance, need not be aware of the Ultimate Law of Gravitation in order to be successful in his art, but he must know the (empirical) laws which he ardinarily employs in his practice.

The source or basis of the various Laws.

Different laws are derived from different sources. Axioms are innate or intuitive. Primary

Laws result from our attempt to go from lower laws to higher and higher laws till the highest possible generalizations are reached. Derivative laws are derived from primary laws, while empirical and probable laws are totally begotten of experience.

SUMMARY

The word 'law' is used in various meanings. First law may mean a rule or order issued by a government. Secondly, law may mean a moral law; our rules of conduct are moral laws. Lastly, law may mean a natural law. A natural law means a uniformity existing among the phenomena of Nature. The law of gravitation, for example, is a natural law. A political law states what *must* be; a moral law states what *should* be; and a natural law states what *is*. Political laws and moral laws can be broken, but natural laws cannot be broken. Unlike political and moral laws, natural laws are constant; they are the same everywhere.

Natural laws are classified into *Axioms*, *Primary laws* and *Secondary laws*, according to the degree of their generality and certainty. Axioms are the most general laws which are self-evident. They are the foundations of all other laws. They neither need nor are capable of any proof. They are not proved truths but *assumed truths*. As examples of axioms we may mention the laws of Identity, Non-contradiction, Excluded Middle and Causation.

Primary laws, also called ultimate laws, come next to axioms. They are not self-evident and assumed truths but are proved truths. They are, however, the most general laws established by sciences. In Astronomy the Law of Gravitation, and in Chemistry the Atomic Theory, are primary laws. They are based on causal connections and possess perfect scientific certainty. They are also called scientific laws.

Secondary laws are less general than primary laws. They refer to a limited group of facts. They are sub-divided into *derivative laws*, *empirical laws* and *probable laws*. Derivative laws are derived or deduced from primary laws. For example, the law of the Water Pump is a derivative law; it is derived from the Law of Gravitation. Derivative laws are less general but not less certain than primary laws. Because they are derived from primary laws, they share their certainty.

Empirical laws are empirical generalizations. They are not known to be connected with primary laws; therefore they do not possess scientific certainty. Empirical laws can, however, be shown in the long run to be connected with primary laws, and then they do not remain empirical laws but become derivative laws. Kepler's laws of planetary motion were empirical in this sense until Newton showed that they

were necessary deductions of his Law of Gravitation. Thus empirical laws are those laws which are underived for the time being from primary laws but are derivable from them in the long run.

Probable laws are probable or approximate generalizations. They tell us what happens in *most*, not in all, cases. Strictly speaking, they don't deserve to be called laws. They possess very little generality, and almost no certainty.

We should, however, remember that our progress is from the least general and least certain to the most general and most certain. We go from probable laws to empirical laws, from empirical laws to derivative laws, and from derivative laws to primary laws. The laws which stand lower in generality and certainty are not necessarily invalidated but are subsumed or brought under higher and higher laws.

Usefulness of laws.—(1) First, laws connect the various phenomena of nature, which seem to be disconnected. Laws tell us that nature is a system or unity. (2) Secondly, laws are an aid to memory. Several particular facts which are difficult to remember are brought under a few general laws which are comparatively easy to remember. (3) Thirdly, laws underlie all explanation and knowledge. We explain facts by indicating the laws by which those facts are governed

QUESTIONS

1. What is the difference between the Laws of Nature and the Laws of Mind? Give examples of the Laws of Nature and explain how they are discovered. Are they forces?

2. Distinguish various kinds of Laws. What are the stages in the process of establishing a law of Nature?

3. Distinguish between and with the aid of examples display the characteristics of the following:—

Municipal Laws, Laws of Nature, Empirical Laws, Ultimate Laws.

4. What is a Law of Nature? Distinguish between Empirical Laws and Laws of Nature.

5. Is there any distinction between a Generalization and a Law of Nature? Are all Laws of Nature of the same type or of different types? If they are of different types, then what are those types?