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# PART I.

## *WHAT IS EVOLUTION?*

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# CHAPTER I.

## ITS SCOPE AND DEFINITION.

**A Type of Evolution.**—Every one is familiar with the main facts connected with the development of an egg. We all know that it begins as a microscopic germ-cell, then grows into an egg, then organizes into a chick, and finally grows into a cock; and that the whole process follows some general, well-recognized law. Now, this process is evolution. It is more—it is *the* type of all evolution. It is that from which we get our idea of evolution, and without which there would be no such word. Whenever and wherever we find a process of change more or less resembling this, and following laws similar to those determining the development of an egg, we call it evolution.

**Universality of Evolution.**—Evolution as a *process* is not confined to one thing, the egg, nor as a doctrine is it confined to one department of science—biology. The process pervades the whole universe, and the doctrine concerns alike every department of science—yea, every department of human thought. It is literally one half of all science. Therefore, its truth or falseness, its ac-

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ceptance or rejection, is no trifling matter, affecting only one small corner of the thought-realm. On the contrary, it affects profoundly the foundations of philosophy, and therefore the whole domain of thought. It determines the whole attitude of the mind toward Nature and God.

I have said evolution constitutes one half of all science. This may seem to some a startling proposition. I stop to make it good.

Every system of correlated parts may be studied from two points of view, which give rise to two departments of science, one of which—and the greater and more complex—is evolution. The one concerns changes within the system by action and reaction between the parts, producing equilibrium and stability; the other concerns the progressive movement of the system, as a whole, to higher and higher conditions — the movement of the point of equilibrium itself, by constant slight disturbance and readjustment of parts on a higher plane, with more complex inter-relations. The one concerns the laws of sustentation of the system, the other the laws of evolution. The one concerns things as they are, the other the process by which they become so. Now, Nature as a whole is such a system of correlated parts. Every department and sub-department of Nature, whether it be the solar system or the earth, or the organic kingdom, or human society, or the human body, is such a system of correlated parts, and is therefore subject to evolution. We can best make this thought clear by examples:

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1. Take, then, the *human body*. This complex and beautiful system of correlated and nicely-adjusted parts may be studied in a state of maturity and equilibrium, in which all the organs and functions by action and reaction co-operate to produce perfect stability, health, and physical happiness. This study is physiology. Or else the same may be studied in a state of progressive change. Now, we perceive that the stability is never perfect—the point of equilibrium is ever moving. By the ever-changing number and relative power of the co-operating parts the equilibrium is ever being disturbed, only to be readjusted on a higher plane, with still more beautiful and complex inter-relations. This is growth, development, evolution. Its study is called embryology. 2. Take another example—*the solar system*. We may study sun, planets, and satellites in their mutual actions and reactions, co-operating to produce perfect equilibrium, stability, beautiful order, and musical harmony. This is the ideal of physical astronomy as embodied in Laplace's "Mécanique Céleste." Or we may study the same in its origin and progressive change. Now, we perceive that equilibrium and stability are never absolutely perfect, but, on the contrary, there is continual disturbance with readjustment on a higher plane—continual introduction of infinitesimal discord, only to enhance the grandeur and complexity of the harmonic relations. This is the nebular hypothesis—the theory of the development of the solar system. It is cosmogony; it is evolution. 3. Again: *society* may be studied in the mutual

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play of all its social functions so adjusted as to produce social equilibrium, happiness, prosperity, and good government. This is social statics. But equilibrium and stability are never perfect. Permanent social equilibrium would be social stagnation and decay. Therefore, we must study society also in its onward movement—the equilibrium ever disturbed, only to be readjusted on a higher plane with more and more complexly inter-related parts. This is dynamics—social progress. It is evolution. 4. Again: the *earth*, as a whole, may be studied in its present forms, and the mutual action of all its parts —lands and seas, mountains and valleys, rivers, gulfs, and bays, currents of air and ocean—and the manner in which all these, by action and reaction, co-operate to produce climates and physical conditions such as we now find them. This is physical geography. Or, we may study the earth in its gradual progress toward its present condition—the changes which have taken place in all these parts, and consequent changes in climate; in a word, the gradual process of becoming what it now is. This is physical geology—it is evolution. 5. Lastly, we may study the whole *organic kingdom* in its entirety as we now find it—the mutual relation of different classes, orders, genera, and species to each other and to external conditions, and the action and reaction of these in the struggle for life—the geographical distribution of species and their relation to climate and other physical conditions, the whole constituting a complexly adjusted and permanent equilibrium. This is a science of great

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importance, but one not yet distinctly conceived, much less named.* Or, we may study the same in its gradual progressive approach, throughout all geological times, toward the present condition of things, by continual changes in the parts, and therefore disturbance of equilibrium and readjustment on a higher plane with more complex inter-relations. This is development of the organic kingdom. In the popular mind it is, *par excellence*, evolution.

We might multiply examples without limit. There are the same two points of view on all subjects. As already said, in the one we are concerned with things as they are; in the other, with the process by which they became so. This "law of becoming" in all things —this universal law of progressive inter-connected change —may be called the law of continuity. We all recognize the universal relation of things, gravitative or other, in space. This asserts the universal causal relation of things in *time*. This is the universal law of evolution.

But it has so happened that in the popular mind the term evolution is mostly confined to the development of the organic kingdom, or the law of continuity as applied to this department of Nature. The reason of this is that this department was the last to acknowledge the supremacy of this law; this is the domain in which the advocates of supernaturalism in the realm of Nature had

* The term *Chorology*, used by Haeckel, nearly covers the ground.

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made their last stand. But it is wholly unphilosophical thus to limit the term. If there be any evolution, *par excellence*, it is evolution of the individual or embryonic development. This is the clearest, the most familiar, and most easily understood, and therefore the type of evolution. We first take our idea of evolution from this form, and then extend it to other forms of continuous change following a similar law. But, since the popular mind limits the term to development of the organic kingdom, and since, moreover, this is now the battle-ground between the advocates of continuity and discontinuity—of naturalism and supernaturalism in the *realm of Nature*—what we shall say will have reference chiefly to this department, though we shall illustrate freely by reference to other forms of evolution.

### Definition of Evolution.

Evolution is (1) continuous *progressive change*, (2) *according to certain laws*, (3) and by means of *resident forces*. It may doubtless be defined in other and perhaps better terms, but this suits our purposes best. Embryonic development is the type of evolution. It will be admitted that this definition is completely realized in this process. The change here is certainly continuously progressive; it is according to certain well-ascertained laws; it is by forces (vital forces) resident in the egg itself. Is, then, the process of change in the organic kingdom throughout geologic times like this? Does it correspond to the definition given

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above? Does IT also deserve the name of evolution? We shall see.

**I. Progressive Change.**—Every individual animal body —say man's—has become what it now is by a gradual process. Commencing as a microscopic spherule of living but apparently unorganized protoplasm, it gradually added cell to cell, tissue to tissue, organ to organ, and function to function; thus becoming more and more complex in the mutual action of its correlated parts, as it passed successively through the stages of germ, egg, embryo, and infant, to maturity. This ascending series of genetically connected stages is called the embryonic or *Ontogenic* series.*

There is another series the terms of which are coexistent, and which, therefore, is not in any sense a genetic or development series, but which it is important to mention, because to some degree similar to and illustrative of the last. Commencing with the lowest unicelled microscopic organisms, and passing up to the animal scale, *as it now exists*, we find a series of forms similar, though not identical, with the last. Here, again, we find cell added to cell, tissue to tissue, organ to organ, and function to function, the animal body becoming more and more complex in structure, in the mutual action of its correlated parts, and the mutual action with the environment, until we reach the highest complexity of structure and of internal and external relations only in the highest

* *Ontos-gennao* (individual-making, or genesis of the individual).

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animals. This ascending series may be called the natural history series; or, the classification or *Taxonomic series.** The terms of this series are, of course, not genetically connected; at least, not directly so connected. In what way they are connected, and how the series comes to be similar to the last, we shall see by-and-by.

Finally, there is still a third series, the grandest and most fundamental of all, but only recently recognized, and therefore still imperfectly known. Commencing with the earliest organisms, the very dawn of life, in the very lowest rocks, and passing onward and upward through Eozoic, Palæozoic, Mesozoic, Cenozoic, to the Psychozoic or present time, we again find first the lowest forms, and then successively forms more and more complex in structure, in the interaction of correlated parts and in interaction with the environment, until we reach the most complex internal and external relations, and therefore the highest structure only in the present time.† This series we will call the geological or *phylogenic* series.‡ According to the evolution theory, the terms of *this* series also are genetically connected. It is, therefore, an evolution series. Furthermore, it is the most fundamental of the three series, because it is the *cause* of the other two. The Ontogenic series is like it because it is a brief recapitulation, through heredity, as it were from memory, of its main points. The Taxonomic series

* *Taxis*, *nomos* (relating to science of arrangement).
† This statement is general; it will be modified hereafter.
‡ *Phule-gennao* (kind-making); genesis of the race.

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is like it because the *rate* of advance along different lines was different in every degree, and therefore every stage of the advance is still represented in a general way among existing forms. Some of these points will be explained more fully in future chapters, in connection with the evidences of the truth of evolution.

It will be admitted, then, that we find *progressive change* in organic forms throughout geological times. This is the first point in the definition of evolution.

**II. Change according to Certain Laws.**—We have shown continuously progressive change in organic forms during the whole geologic history of the earth, similar in a general way to that observed in embryonic development. We wish now to show that the *laws of change* are similar in the two cases. What, then, are the laws of succession of organic forms in geologic times? I have been accustomed to formulate them thus: *a.* The law of differentiation; *b.* The law of progress of the whole; *c.* The law of cyclical movement.* We will take up these and explain them successively, and then, afterward, show that they are also the laws of embryonic development, and therefore the laws of evolution.

*a.* **Law of Differentiation.**—It is a most significant fact, to which attention was first strongly directed by Louis Agassiz, that the earliest representatives of any group, whether class, order, or family, were not what we

* This formulation of the laws of organic succession was given by me in 1860, before I knew anything of either Darwin's or Spencer's evolution. They were my own mode of formulating Agassiz's views.



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