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CHAPTER I

ENVIRONMENT AND EVOLUTION

The biological conception we call evolution rests on the assumption, whose truth is attested by a vast amount of evidence, that organisms vary, and that those variations which tend towards the more perfect adaptation of the organism to its environment have the best chance of being perpetuated.

The four essential factors are *variability*, *heredity*, *overcrowding*, tending to the elimination of those organisms less suited than their kin to cope with their environment, and lastly the apparent *impossibility of retrogression*. That very many other factors have played a more or less important part in the evolution of the animal and plant world as we see it to-day is true. But for our present purpose we may confine ourselves to those we have mentioned.

Before proceeding further, it is necessary that we should examine carefully what exact meaning we propose to assign to the factors we have selected.

(I) Apart from any philosophical exactitude, it is quite clear to all of us that no two living organisms, plant or animal, are quite alike. We may isolate a

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small group, all sprung from the same parents, and we shall still find differences ; not perhaps any very striking ones, though this is by no means necessarily so, but at any rate peculiarities quite marked enough for us to differentiate individual from individual. We may go still further and examine individuals all produced at one birth, and still we find differences.

Some of these differences will no doubt be due to the diverse conditions under which the individuals live : we may plant two nasturtium seeds one against a north wall, the other against a south wall, and we shall find that the first becomes "leggy," climbs higher and higher seeking the sun, and produces few flowers and little fruit until it reaches the top of the wall, while the other develops flowers and fruit all up its stem ; it is not with such differences we are concerned. The cause of them is obvious and superficial ; they are acquired characters, and we shall leave them out of consideration at present. But the others are far more deep-seated ; there seems to be no reason for them, and they have properties which differentiate them enormously in degree, if not fundamentally in kind, from acquired characters. Their cause is biologically unexplained, from the nature of the case biologically inexplicable ; "it is a datum in the world of life[1]." They are due to something in the organism itself, and the property of producing them is inherent

[1] Cf. J. Arthur Thomson, *Heredity*, p. 100.

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in all living matter. The direction of the variation of a group of individuals may possibly be determined to some extent by the surroundings of the parent organism, but there is certainly no immediate connection between the characters acquired by the parent and the variations appearing in the offspring. Of course as a rule[1] they are slight, and would appear trivial to a superficial observer, but none the less they lie at the bottom of all evolution.

(II) Now the characteristic property of these deep-seated differences, or variations properly so called, is that they are hereditarily transmissible. It is in this that they differ absolutely in kind, or at any rate so enormously in degree that for our purposes we may assume that the difference is in kind, from the acquired differences we have mentioned. It is not necessary or desirable to discuss the details of their transmission here: we are not concerned with biological controversies; the fact that on the whole these true variations tend to be transmitted to the offspring if both parents possess them, often if they are possessed only by one parent, is all that concerns us.

(III) But the total number of organisms, whether animal or plant, that comes into the world is inconceivably greater than the number that can eventually survive. A single turbot lays about nine million eggs a year. A white-ant queen lays 80,000 eggs a day.

[1] Not always, as will be explained later.

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And so there comes about a struggle for existence leading to the elimination of the less fit. On the whole those that survive will be those that are in some way better fitted to cope with their environment than their fellows.

(IV) But suppose that some unforeseen change of conditions makes the line of development entered upon by an organism unsuitable? Could not an exactly opposite process take place, and the organism pass through the stages it has already traversed, in the reverse order, changing from the more complex to the simpler, till it reaches its starting point once again and is free to evolve in a more suitable manner? This would only be a kind of inverse selection, the less unfit organisms having the better chance of survival, and at first sight the process seems natural enough. But it does not occur, to any appreciable extent at all events[1]; more, it could not occur except sporadically for two reasons, as we shall see later. This is what we mean by the impossibility of retrogression, of a reversal of the order of evolution. It must not be confused with the familiar phenomenon of the atrophic degeneration of organs not used, an elementary example of which

[1] The question of the existence of what are called "retrogressive mutations" is not taken into consideration here. Biologists will realise that it does not affect the broad aspect of evolution, and so is of no importance to the matter in hand. For details of retrogressive mutations see Lock, *Recent progress in the Study of Variation, Heredity, and Evolution*, and *The Mutation Theory*, by H. de Vries.

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is seen in the wings of the farm-yard duck, and an advanced stage of the same in the *kiwi* and *kakapo* of New Zealand and in the ostrich. Here the gradual reduction to vestiges is due simply to the combined action of lack of use leading to atrophy, and of inter-crossing with absence of selection—what Weismann called panmixia.

Thus the earliest form of the Design-Argument, which found evidence of direct mechanical contrivance in every form of adaptation to the conditions of existence, has passed away with the growth of an understanding that such adaptation must *necessarily* be found on every side in a world where the only chance of survival lay in responsiveness to environmental conditions.

It has been superseded by the doctrine that the existence of progress implies an end; that the very idea of development is purposive, teleological, or it would be indeterminate, tending to no goal[1]; that design, in the sense of purpose, is to be seen in each stage of development, in that each stage is a step towards an end; that the value of the stages is to be sought, at all events mainly, in their final interpretation. But if one may be permitted to use that very dangerous weapon,

[1] In this chapter the word *indeterminate* is used in the sense of vague, purposeless, almost chaotic. It is necessary to note this, as in a later chapter it is used, following M. Bergson, in the sense of free, not fore-ordained.

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William Occam's razor, does not this doctrine contain something "praeter necessitatem"? Would a development not externally directed necessarily be indeterminate? And if not, shall we not have to look yet deeper before we can postulate Design even in the modified form of teleology?

Evolution is adaptation to environment. Why then should it be progressive and continuous? Why should not each set of organisms reach a dead-level of comparative perfection? The question could only arise from an imperfect conception of the term environment. Let us examine what we mean by it.

In its broadest sense the word connotes *all factors which can influence the organism, however remotely, not only in its present stage, but in all future stages.*

Thus it becomes clear that each adaptation which brings, let us say, a more perfect method of locomotion must bring the organism into relation with a whole series of fresh conditions, still part of its environment, which will in their turn require thousands of generations before perfect adaptation is reached. But we must go further than this. By its own changes the organism creates fresh conditions for itself and for other organisms. One can conceive that the evolution of the Greenland whale introduced very considerable additions into the environment of the jelly-fish and pteropods it feeds upon. Thus what one may call the environment-sum is never completed while development is

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progressing. Each organism creates as it evolves, creates a new environment for itself and for others. To this also we shall have to return later.

Evolution now presents itself to us under a somewhat different aspect as the continual effort of the organism to reach equilibrium with its environment.

If it be true however that each minutest adaptation brings the organism into relation, to a greater or less degree, with a fresh series of environmental conditions, it must take ages for any organism to reach a *complete* equilibrium with a complex environment, and if the environment were itself increased, as we have seen is the case, complete equilibrium would never be reached; the organism would always be approaching perfection, but would never attain it. The curve of progress would be asymptotic. But positions of *stable* equilibrium might be reached without this complete equilibrium, i.e. without complete adaptation to the whole environment, for an equilibrium-position will be reached when further adaptation along the *particular line of development* would be disadvantageous. And these equilibrium-positions need not necessarily mean identity of organisation in the various organisms. For suppose two variations to occur at one given stage, neither being disadvantageous to the organism at that stage. Obviously each brings its possessor into fresh relations which will differ to a greater or less extent. This will necessarily lead to two divergent lines of

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development—lines diverging without any *possibility* of ultimate approach, since approach would imply a less perfect adaptation to the *then* environment of the organism for the sake of an *ultimate* adaptation to a fuller and somewhat different environment; would imply retrogression; would imply a process involving a strange teleology indeed!

This explains the existence of side-lines of development, and involves too the *possibility* at least of a direct line of progress towards an absolutely complete adaptation, even if that can never be quite achieved. We must not forget however that each stage of development imposes fresh limitations, as well as supplies a fresh horizon for the organism. Thus for a given organism at a given moment there is a definite total environment, or set of conditions which can then, or may possibly in the future be able to, affect it; but each stage of progress, while introducing fresh conditions in the present, also reduces, perhaps to a very great extent, the number of possible conditions before included in its total environment which might affect it in the future, for there is no going back. For instance, when certain fishes began to take more and more to the land, they were gradually exempted from all the conditions of the sea-life which before had been a large part of their total environment[1]. To put it simply,

[1] What can we say, then, of a land-organism which once more betakes itself to the sea? Let us take for example the whale. It can

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each stage of development circumscribes the future possibilities. It is clear from what has been said that the variation possibilities for an organism at any given stage are limited, and at each stage fresh limitations are imposed; so that although its actual environment, or acting-environment, may be increasing, yet its total environment, or the sum of all the conditions that can act on it now *or in the future* and make it evolve further, is becoming less. True, each organism *creates* as it varies and so makes for itself and for other organisms fresh conditions; but as time goes on more and more organisms being off the main line of evolution reach, or at least approach, an equilibrium position, and consequently the increase of these secondarily-created environmental conditions becomes progressively less.

Thus for a given organism at a given moment there may be a definite total environment, differing from the total environment of another organism, probably of *every* other organism, while yet one may speak of an ultimate "environment-sum" that comprehends all conditions. This "environment-sum" *must* include the "total environments" of all organisms, or their lowest

never return to true gills and fins of the same nature as, or as zoologists would say, homologous with, those of a fish. At best it can but develop similar or analogous organs, and it will be so far behind the fish in adaptation to marine conditions that its efforts may be regarded as hopeless: it has tried to turn back, failed, and is eventually added to nature's flotsam and jetsam, being incapable of further progress.

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common multiple one might almost say, *but it may include another term whose magnitude cannot be determined, and which cannot be recognised since it has not yet begun to influence any organism.* And, as we shall see, this is of very great importance. Expressed algebraically, $\Sigma_e = a_e + b_e + c_e + \ldots + x_e$. But we have neglected to take into account that environment which is constantly being created by each organism. And here we are landed in a difficulty. Up to a certain point what is created is a function of the total environment of the organism, and we could complete our formula by adding $f(a_e) + f(b_e)$, etc. But there are functions not only unknown but unknowable, and here in reality our argument breaks down. This break is of the utmost importance, in its bearing on the matters we have to consider in a later chapter, for in it lies freedom. For the present however we may disregard it, and assume that our formula is complete.

On the one hand, then, we can imagine numerous positions of equilibrium under a given series of conditions, such as that, for example, we call marine. Yet, on the other hand, we can form a definite concept of what we mean by marine life, we can form the inclusive concept, as well as appreciate the included concepts, of the various equilibrium conditions of different marine forms. So also we can conceive of an intelligence whose concept of the environment-sum

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