

THE PRESENT STATUS OF EVOLUTION

(The Botanist's View)

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In the last few months I have been asked frequently to speak on this subject. My audiences, however, have not been made up of members of an Academy of Science and their friends, but of people who want evolution explained, and to know whether it is as wicked as some claim. The misunderstanding in reference to evolution is very widespread. This has arisen from ignorance of the subject, from misinterpretation of the statements of scientific men, and from what may be called a mediaeval attitude of mind. It has been a shock to educators to realize that there still remains such a mass of untrained minds that can be imposed upon by eloquent ignorance.

As one illustration of the misinterpretation of the attitude of scientific men, I may call attention to the use that has been made of the address given by Bateson at the Toronto meeting of the American Association. He has been quoted extensively as an illustration of a distinguished biologist and student of evolution who has given up his belief in the theory of organic evolution. No statement in his address can justify such a claim. The burden of his argument was that with our increasing knowledge of the complexity of the subject, our present explanations of the origin of species are inadequate. Each discovery opens up a new perspective for exploration. To quote Bateson as denying the fact of evolution is to disregard the following statement which concludes his address:

"Let us proclaim in precise and unmistakable language that our faith in evolution is unshaken. Every available line of argument converges on this inevitable conclusion. The obscurantist has nothing to suggest which is worth a moment's attention. The difficulties which weigh upon the professional biologist need not trouble the layman. Our doubts are not as to the reality or truth of evolution, but as to the origin of species, a technical problem."

To quote Bateson as having given up his belief in evolution, and in doing so to disregard this closing statement of his address, is plain dishonesty. In such ways are the people being imposed upon.

One of the curious facts in reference to the current discussion of evolution, which shows great lack of information, is the confusion of evolution with Darwinism. As you know, Darwin's explanation of the fact of evolution is simply one of a number of explanations, and it belongs to the mediaeval period in the history of evolution, when only the method of observation and inference was used. Of course, Darwin's explanation came at a psychological moment and attracted an attention that was wholly a surprise to him. It is this fact that has made his explanation so famous that many think that Darwinism and evolution are synonymous.

With this preface, dealing with the present commotion concerning evolution, a preface hardly pertinent to this occasion, but perhaps excusable under the circumstances, I shall now address myself to a scientific group, a group which I am assuming is not troubled by doubts as to the *fact* of evolution.

The problem that faces us is the *explanation* of evolution. All of the explanations proposed thus far may prove inadequate and still the fact remain to be explained. In the early history of the subject, simple explanations were offered. As facts multiplied, however, and especially such facts as genetics has been uncovering, it became evident that evolution is not a single problem, but a complex of problems, involving a multitude of factors. It is obvious now that no single explanation can be adequate for all the phenomena of evolution. It may be said that all of the classic explanations explain *some* things, but no one of them can explain *all* things. The present status of evolution will be appreciated more clearly if we evaluate the classic explanations in the light of recent knowledge.

Lamarck's explanation encountered the obstacle of the inheritance of acquired characters. Biologists presently became convinced that acquired characters are not inherited, and therefore Lamarck's explanation was thrown

out of court. Now, however, we have discovered that the inheritance of acquired characters is possible in many organisms under certain conditions, especially in the simpler organisms. This means that Lamarckism is coming into notice again, and there is a decided revival of interest in a modern modified form of this explanation.

A single simple illustration of the work on the inheritance of acquired characters in plants may be given. A great many plants have been used in experimental work of this kind. In investigating the periodicity of sexual cells in *Dictyota*, a marine alga, Williams has proved the possible inheritance of acquired characters. In a given locality the male and female organs develop simultaneously, and a general liberation of gametes and fertilization take place on a particular day. This date differs in different localities, showing a relation to tides and therefore to the amount of available light. On the other hand, there is no evidence of periodicity in seas where there are no tides. Plants transferred to the laboratory, and thus removed from tides and varying light, continue to show the characteristic periodicity of the locality from which they came. Here is an obvious adjustment of the plant to a varying set of environmental conditions which has become hereditary.

As perhaps many of you know, very recently much more important and convincing testimony as to the inheritance of acquired characters has been secured by Guyer in his experimental work on eye defects in white rabbits. In short, there seems to be no doubt but that acquired characters *may be* inherited.

Darwin's explanation encountered the obstacle of variations of a sort that were claimed to be inadequate to account for the results of evolution. It ought to be kept in mind that this objection does not involve the idea of natural selection. That such selection occurs is obvious, for some forms survive and others perish, but does this result in building up new species with these small variations we call continuous? The question whether Darwin's variations are adequate for his conclusion is being examined critically by geneticists.

DeVries' explanation simply changes the type of variation subjected to selection. Instead of a new species being built up gradually, it is born full fledged, and natural selection merely decides which of the fledglings shall survive. This explanation encountered the objection that the so-called mutating forms are simply hybrids splitting. In fact, the original classic example of mutation, *Oenothera Lamarckiana*, has turned out to be probably a hybrid, and not a genuine case of mutation. The situation was concealed for a time by the fact that the ratio of a splitting hybrid and the ratio shown by these so-called mutants were very far from consistent. This, however, has now been explained by work in genetics, so convincingly, in fact, that DeVries himself has accepted the explanation. His attitude toward his proposed explanation of evolution should be understood. He told me on several occasions that he was not at all sure of this explanation, but that he prided himself not on his theory, but on the fact that he had started a new method of studying evolution, that is the experimental method.

I might also state for your benefit an experience I had showing the same spirit in Darwin with reference to his explanation. As you know, Asa Gray was the champion of Darwinism in this country, writing many notable papers on the subject, which were afterwards collected in a volume entitled *Darwiniana*. On one occasion Dr. Gray showed to me a letter he had received from Darwin after the latter had read one of these papers. In the letter Darwin said: "You have stated the case so clearly and convincingly that I am almost persuaded to believe it myself." In other words, these pioneers in evolutionary theory realized better than their followers that their explanations were only tentative, to be tested by subsequent investigation. They were *suggestions* rather than *conclusions*, to be thought about rather than believed.

Weismann's explanation, revived by Lotsy, that hybridization is responsible for evolution, encountered the obstacle that although hybridizing multiplies variations, it can never account for original differences. It results in mixtures of various kinds, but introduces

nothing new. It is the appearance of new things that leads from one great group to another.

Another subsidiary explanation is called "isolation," which certainly accounts for the survival of variations that might otherwise have been swamped out by crossing and competition. After all it is a method of natural selection; that is, selection is usually made by competition, but sometimes by isolation.

Now, however, we are in the modern period in the history of evolution. Darwin carried the method of observation and inference to its limit in space and time, but inference is not demonstration. At present we are developing the technique of demonstration, by opening up the great field of heredity, which is not only vast in extent, but also extremely complex. When a species ordinarily begets its own kind, according to well defined laws of inheritance, what are the very occasional conditions that make it beget or at least start another species? At the present time, therefore, attention is being focused upon the experimental study of inheritance, the field of genetics, which may be rightly called also the experimental study of evolution. This newly developed field of genetics, with its increasing complexities, has taught us that evolution is a very intricate process, and that some of the earlier explanations, like that of Darwin for example, deal only with the more superficial phenomena. They are true as far as they go, but they do not get at the fundamentals. To say that evolution is discredited because Darwin's explanation does not explain the whole situation would be like discrediting the rotation of the earth because some one explanation is not satisfactory. It was in recognition of this modern genetical attack upon the problems of evolution, with its multiplying complications, that Bateson spoke of evolution as he did, as a problem not yet solved. Of course, any explanation of evolution must take into account the machinery of heredity, and we are finding that machinery not only complicated, but now and then producing unexpected results, which the geneticist must explain.

Naturally, this intensive study of evolution through experimental work in inheritance has somewhat

restricted the presentation of evolution. When the only method was inference from observed facts, there was no limit to inference, and it could be made to include the whole plant and animal kingdoms. Now, however, the experimental method limits us to a few generations, and the wide-ranging inferences are left to the unscientific who are not particular about the facts.

In considering the relative merits of these explanations, it is not necessary to subscribe to a belief in any one of them, to the exclusion of the others. All of them may be factors in evolution, and it is altogether probable that no one of them is adequate to explain all evolutionary changes. We need them all, and more besides.

A good method of evaluating these explanations and any others that may be offered is to realize the questions any explanation of evolution must answer. There are at least four conspicuous questions: (1) What is the cause of variation? (2) What is the nature of the variations that are important in evolution? (3) How may variations be perpetuated and multiplied? (4) How are the variations manipulated to effect progressive evolution?

Lamarck's explanation goes farther than any other in answering the first question, the cause of variation, and also in suggesting a basis for progressive evolution. Darwin and DeVries accept the variations without attempting to explain the cause, differ as to the kind of variations used, and agree as to the method of manipulating them. The hybridization explanation answers the third question, how variations are perpetuated and multiplied. It will be noted that no one of them answers all these questions.

Such an estimate of the proposed explanations emphasizes the fact that there must be more exact experimental evidence before much further progress can be made in solving the problems of evolution. It was in realization of this that at the beginning of the present century the study of evolution culminated in, and became diverted into, genetics, the experimental study of inheritance, which has already suggested many things, and promises to be still more suggestive in the future.

As an illustration of this, reference may be made to the results of this work as bearing on the mutation explanation. Until genetics began to uncover the machinery of inheritance, which of course is fundamental in producing variations, the general belief in evolution included the following ideas: Inheritance of acquired characters is exploded; Darwinian variations are dubious as a basis for explaining evolution; but mutation, with natural selection among the mutants, doubtless accounts for the facts. Now what does genetics tell us? The majority of mutants may be called degenerates, the new characteristics shown serving to adapt the mutant more poorly to the environment than the parent was adapted. In fact, the general statement is that the majority of mutants are much worse than their parents, and none of them are better. If only a few were better equipped, they would furnish sufficient material for evolution; but with none better equipped, evolution is blocked.

Such considerations have made many biologists feel less certain in explaining evolution than they were a few years ago. This loss of faith in mutation, added to recent discoveries on inheritance of acquired characters, has caused many to seek an explanation of progressive evolution in Lamarekian terms.

The great problem we are facing is progressive evolution, commonly called "orthogenesis", which history has made so evident. Continuous variations, discontinuous variations (so-called "mutations"), and hybrid variations may all be explained as due to a complex of factors. Such variations, however, are like the waves on the surface of a choppy sea, running in every direction, and getting nowhere. Progressive evolution, however, may be likened to a deep-seated oceanic current which moves steadily in one direction without any reference to the choppy surface. How can we explain this oceanic current? In my own field, I have been impressed by the progressive evolution of the gymnosperms, of which we have continuous records from the Paleozoic to the present time. Throughout that tremendous stretch of time, in spite of all imaginable changes in external

conditions, certain structures have changed steadily in one direction, and these changes have resulted in the origin and development of the various great groups. What kind of variation furnishes the material for such evolution, and what are the conditions that produce such variations? These questions have not been answered, except in such a vitalistic way that the appeal is to faith rather than to knowledge.

In reviewing the status of the subject of evolution today, it seems fair to conclude that competent opinion is in a condition of flux, inclining now in this direction and now in that as the results of experimental work are reported. It is time for the open mind, for no one can foretell what a day may bring forth. With Lamarck's view once abandoned and now revived, Darwin's view once accepted and now doubted, DeVries' view once hopeful and now questionable, and all the other views fluctuating in apparent importance, no person is in a position to pass judgment. My feeling is that we have been simply playing with the surface, discovering minor factors, drawing general inferences from special cases. This was a necessary introduction to the subject. We begin by wading in shallow water, and as we advance the water gets deeper, until now we must realize that it is over all our heads.