

The Extent of the Effectiveness of Natural Selection

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In his "History of Biology," Eric Nordenskiöld draws this conclusion concerning natural selection: "that it does not operate in the form imagined by Darwin must certainly be taken as proved, but does it exist at all?"(8)

No one denies that Charles Darwin's doctrine of evolution by "natural selection" or Spencer's paraphrase "survival of the fittest" has had tremendous influence. The promulgation of this idea must be given credit for the acceptance of evolution. Before the time of Darwin there were several men, such as Buffon, Goethe, and Lamarck, who believed that organic species were developed by natural forces rather than having been designed by a Creator, but most scientists doubted their doctrine. When a method was advanced, however, by means of which evolution might come about, a majority of scientists accepted evolution, agreeing with Darwin that present plants and animals developed from simple protoplasm by a series of small changes, rather than originating as well organized types.

The operation of evolution by natural selection is based upon the following assertions:

1. Organisms produce more seeds, eggs, or young ones than can grow to maturity under average conditions.
2. This prodigality of reproduction, along with the vicissitudes of nature, result in a struggle for existence in which a majority of plants and animals die.
3. Organisms vary slightly from their parents in every conceivable direction.
4. In the struggle for existence, those individuals which chance to have favorable variations live and produce offspring, while the balance perish.
5. These variations are heritable, and are not only passed on but also accentuated in future generations, until the individuals differ enough from their remote ancestors to be considered a new species.

Extent of Agreement

The first of these assertions is a matter of common observation and no one denies that nature has great potential powers of reproduction. The other four, however, have been foci of much dispute.

At present, biologists agree that the vicissitudes of nature along with competition tend to eliminate those plants or animals which are markedly below the average. For instance, in nature we find few or no notably weak individuals such as are found in the breeding plot or laboratory, in which places we endeavor to save the life of every plant

¹ I am indebted to Dr. Edwin Y. Monsma of Calvin College for reading this manuscript.

or animal. There is no reason to think that weak forms do not appear in nature but they soon lose their lives. On the other hand, in areas where man has interfered with nature, Pennsylvania for instance, where predators have been killed and deer protected, natural selection is impeded, with the result that albino and crippled deer are found rather frequently.

It seems that biologists agree that natural selection tends to set a lower limit, thus maintaining a standard of health and vigor. But beyond this principle there has been much disparity of thought, which we shall proceed to discuss.

Indefinite Terms

It has been pointed out that the natural selection doctrine bears the stamp of a scientist's reasoning rather than of experimentation and quantitative reports, such as are characteristic of most twentieth century investigations. Weissman (5) himself a proponent of selection, admits, "We can usually not prove that any given adaptation is due to natural selection." Oscar Hertwig (5), finding very little in selection with which to agree, complains, "The formulae of explanation, 'struggle for existence,' 'survival of the fittest,' 'selection' are very vague expressions, which only gain scientific value by the mode in which they are applied in the concrete case."

One is inclined to agree with Hertwig when he observes the great diversity of plants and animals living together, in an environment which can not be so very diverse. Why has that big shell resisted the surf? It must be very hard and resistant. Why has that fragile little shell also survived? It must have been able to fall into the cracks between the stones. While these examples do not come directly from Hertwig, they are in line with what he says about the indefinite meaning of the expressions used. Employing them, one can not predict that a certain habitat will develop a certain type of species to the exclusion of others.

Some Influences Not Mentioned

It is natural that people base their doctrines upon certain ideas which they assume to be correct, without having proved them to be so. It is well that these assumptions be stated, however, as a geometrician states his axioms, and Thomas Jefferson writes, "We hold these truths to be self evident."

Natural selection seems to be founded upon the assumptions that animals are selfish and ruthless almost without limit. Once in a while an example favors this idea, as when a weasel kills a whole flock of chickens, many more than he can devour or even suck the blood. But Long (7) writes that in his experience, bears, wolves, and other carnivores kill only when they are hungry, they kill quickly, and only as many as are needed.

Douglas Dewar (2), an ornithologist of India, has this to say: "The general rule in nature is, 'Never fight when a fight can be avoided.' The most familiar example of the rule in operation is the well-known habit of birds surrendering their perches to new-comers. When individual A flies to a perch occupied by individual B the latter almost invariably

gives way without demur. The particular perch is of no value to the occupier, but a whole body may be a matter of life or death."

Now it is true that Darwin did not write so much of actual combat as of competition and more subtle struggle. But Hertwig (5) counters that organisms die in large numbers, not from struggle, but from cold, starvation, and the like. It is easily seen that if no individual had been the recipient of a variation which would enable it to live with less food or less heat, in such a case natural selection would cause no change in the next generation because the survivors would be no different from the ones which perished.

As I have discussed elsewhere (11), the "Origin of Species" was written at a time and place where ruthless and unrestrained competition was going on in industry and commerce, and Darwin broadened this human situation to include the whole organic realm. During the half century which followed, the idea of struggle became so popular that writers sought for it almost everywhere. Weissman (12), in his very influential book, "The Germ-Plasm," speaks of struggle for expression among the *ids* (genes). But modern geneticists have not found this fight for supremacy; on the other hand, the recessive gene regularly yields to the dominant gene and so becomes latent.

Perhaps the least mentioned assumption of this doctrine is that an organism of high organization has an advantage in the struggle for existence, since it is claimed that this struggle accounts for the origin of high organization. But this reasoning raises the question as to how the simple animals continue to survive, and even thrive in some cases. Darwin (1) saw the question more clearly than the answer, as shown by the following remark: "for what would it profit an Infusorial animalcule, for instance, or an intestinal worm to become highly organized?" What indeed! But according to the theory they should either become better organized or else decrease in numbers.

If animals developed specialized structures as a result of the advantage conferred, what shall we say about the opossum, *Didelphys virginiana*, which has generalized teeth and legs and a very little brain, yet increases in numbers. Vernon Bailey (4) measured brain size by filling craniums with beans, securing the following results: opossum 21; skunk 35; Arctic hare 46; porcupine 70; red fox 198; coyote 325; gray wolf 438. Hartman (4) says, "Stupidity runs in the family. This branch of the animal kingdom stood still in the process of evolution, outstripped by its competitors, the higher animals."

But this abundant marsupial has increased its range from the Middle Atlantic States into New England, and introduced into California it has become abundant on the Pacific coast. For some reason, nature has favored an artless, unspecialized animal, perhaps through its omnivorous appetite.

Yet the opossum is not an exception but an example of organisms of low organization and success in survival. Hydra has but two cell layers, no skeleton, brain, nor stomach, yet it devours the complex crustacean *Daphnia*, and shows no indication of a decrease in numbers. Among plants the tall ones shade out the shorter ones, even though the tall ones may be less highly organized. It seems doubtful if

natural selection should be credited with the origin of highly organized species.

Nature of Variations

Much of the opposition to the selection theory in the nineteenth century was from the environmental school. Lamarck and his disciples taught that the response of the organism to environment, use, and disuse was passed on to succeeding generations. All modern geneticists (10), with the exception of a group in Russia under political domination, are agreed that such effects can not be found in experiments. It is true that geneticists do not deny the effects of environment upon plants and animals themselves, but contend that such an effect does not recur in a succeeding generation apart from the environment which called it forth.

Direct effects of radiation upon germplasm do create an hereditary effect, but this is not a response of the organism; rather, a direct, deleterious effect upon the germinal material, resulting in mutation or chromosomal breakage.

The authors of natural selection did not classify variations, but most of them are environmental or acquired characters, which simply drop out of the picture at the end of a generation. The other variations are either the reorganization of a gene called a mutation or a change in the configuration of chromosomes. Some geneticists apply the name mutation to both. Since hereditary factors do not change gradually but only at mutation, species are immutable, that is, unchanging, between mutations. To be sure, if a pair of chromosomes contains unlike members of a pair of genes—the heterozygous condition—there will be diversity in the offspring; not new characters, however, but recombination of characters which have appeared before. Characters which are new, not latent in the germplasm nor called forth by the environment, arise only at mutation.

The present proponents of evolution by natural selection are the Neo-Darwinists, who hold that nature selects among mutations rather than among variations in general. This new front makes the process of evolution much longer and harder to visualize, for many species mutate only once in a million generations on the average. Adding to the difficulty is the recent statement by Dobzhansky (3), which often has been made before, that "Most mutations are more or less injurious to the organism." Indeed this statement is so true that one can name the observed beneficial ones on his fingers, and even the most of them are doubtful.

If this paucity of observed changes seems strange, one needs only to go to cytology to see the care that is taken to prevent change. In mitosis, in maturation of gametes, see how exactly the chromatin, indeed each separate chromosome, is divided and the halves pulled to the forming daughter cells.

In the light of the above facts, it is to be expected that in the absence of mutation, which usually is true, the effectiveness of selection will diminish and finally cease. In a given population, man selects repeatedly a limited type as seed stock, discarding all the rest, until

much homogeneity is attained. If a point is reached at which all individuals in the population are alike in their germplasm, it does not matter which one is chosen as seed stock, the progeny will be the same.

Such results indeed are observed in breeding, for instance in increasing the sugar content of beets. The sweetest strains of the ordinary table beet were selected for the commercial production of sugar, with the result that improvement was rapid at first. From 1800 to 1878 the percentage of sugar was increased from 6 per cent to 17 per cent (6). Encouraged by such success, selection was continued for forty years, but there was no further increase in sugar content.

According to present data, there is no reason to think that natural selection produces greater results than man's selection. More time is involved but the limiting factor is not time but contained genes. And while it is true that mutations may cause marked changes, they are so rarely beneficial that natural selection seems inadequate as a basis of organic evolution. It does, however, seem to set a lower limit in vigor and thus helps to maintain a standard.

Is There Another Basis?

In view of the above difficulties, we wonder if any other basis for evolution is better. Do we have observed data for orthogenesis or for creative evolution? Could we not agree with Heribert-Nilsson (9) of Sweden that the only kind of evolution which has occurred is a series of reductions of the original germplasm? Since the natural selection theory brought about the original acceptance of evolution, what do we do, now that selection is largely discredited?

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