

IS NATURAL SELECTION AN OUTWORN TERM?

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In the *Origin of Species* Darwin remarked that it was necessary to use such terms as natural selection and the struggle for existence in "a large and metaphorical sense including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny." (Darwin 19-? p. 78). Some believed that these usages implied too much, but Darwin hoped that with a little familiarity such superficial objections will be forgotten, since "Everyone knows what is meant and is implied by such metaphorical expressions" (p. 99 *ibid.*).

Notwithstanding his sanguine hopes, antagonism to the phrase, natural selection, still finds expression in scientific journals (McAtee, 1949). Consequently, there may be some excuse for describing briefly a few recent experiences which validate the use of natural selection or survival of the fittest in the Darwinian sense. I do not propose a complete discussion of the subject, indeed completeness is not possible in view of the writer's limited opportunities. Rather I shall describe briefly some observations which validate the concept of natural selection as Darwin employed the phrase. I have already taken some pains to establish the breadth of Darwin's concepts. Another quotation from the *Origin of Species* clearly indicates the core of the definition as employed by Darwin.

"On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favorable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest. Variations neither useful nor injurious would not be affected by natural selection."

It is a fundamental law of life to vary. Zoologists who have used chemicals experimentally to destroy insects and other forms of life quickly discover that a similar or identical dose yields variable results against different individuals of the same species. Prior to the use of DDT as an insecticide, the innate variations in resistance which houseflies, *Musca domestica*, might exhibit toward the compound doubtlessly existed but were neither useful nor injurious. When that chemical was first used, variations which are well known were encountered. Therefore, houseflies offered abundant material to test natural selection as soon as DDT became a part of their usual environment. Entomologists of Orlando, Florida, were able to breed highly resistant flies by experimental breeding in the laboratory, and artificial selection of the more resistant individuals. These selected houseflies could withstand successfully much larger dosages of DDT than required to kill their ancestors (Lindquist and Wilson, 1948). Experimentally the efficacy of selection was demonstrated.

Notwithstanding the innate variability of houseflies toward the toxicity of DDT, that chemical was widely used to control the pests. Suddenly the variations became of tremendous significance for the survival of the species. For two or three years many American homes enjoyed practically fly-free summers. But natural selection was approximately as successful among wild flies as experimental selection proved to be in the Orlando laboratory. Particularly in southern California, where a large number of generations per year are possible, DDT resistant flies appeared. At Bellflower, California, a strain of flies was found which required 300 times as much DDT to kill them as normal flies (March and Metcalf, 1949), and the resistance was inherited as proved by breeding tests. The same phenomena was observed in widely separated parts of this country. As yet DDT resistance

among houseflies is not known in Canada, possibly because of the short Canadian summer which does not permit as many generations per year. Consequently, fewer Canadian flies have been exposed to DDT, and natural selection has only a reduced opportunity to exhibit its power.

The case of the housefly and DDT-resistance is only one of many instances in which insects exposed in their natural state to a deleterious chemical have succumbed at first, but after several generations experience, they have developed resistance toward the chemical and have successfully returned near to their former abundance. The individuals with variations tending toward chemical susceptibility were destroyed and the resistant forms were preserved. Perhaps Darwin made an unfortunate choice when he inserted the word "rigid" in the first sentence of the last quotation, but this is largely a question of semantics rather than biology. Certainly under a state of nature, selection has proved far more efficacious than many of us believed possible, and it seems fully as powerful as Darwin expected. The results which are established by laboratory test and by numerous field observations conform closely to the Darwinian theory.

A review of all instances where insects have acquired resistance to insecticides is unnecessary for purposes of this note. However, the fever ticks of cattle, *Boophilus* spp. illustrate some points not apparent in the instance of the housefly and DDT. The U. S. Bureau of Animal Industry recommended the extermination of this tick in 1905 and later conducted a campaign intended to achieve the objective (Report of the Chief of the Bureau of Animal Industry 1905 and subsequently). As McAtee (1949) indicates, the elimination of the last tick proved difficult, but the Bureau persisted. After more than forty years of effort the tick was eliminated from Continental United States, and the campaign was carried to outlying possessions.

In other countries a policy of voluntary control was inaugurated. Infested cattle were dipped in the same arsenical solutions employed for eradication in the United States, but when the numbers of ticks were forced below levels of economic significance dipping ceased. Whereas these arsenical dips used intensively over small area after small area exterminated the tick bit by bit, the same dips used extensively over large areas like Australia and South Africa gradually lost their efficacy (Whitnall and Brackford, 1947; 19th Ann. Rept., 1945 Australia). Today in those countries where control rather than eradication was practiced, arsenic-resistant fever ticks are spreading rapidly, and cattlemen are turning to other agents to stop the successful recrudescence of the fever tick. Where small numbers could be successfully exterminated by arsenical dips, large numbers and several generations through natural selection successfully resisted the same agent.

Possibly the purist may insist that exposure of insects in a state of nature to insecticides is an artificial situation, and therefore, the phrase, natural selection, cannot be applied. Nevertheless, the situation closely parallels some of the hypothetical examples described by Darwin. Consequently, the results observed have some importance as a verification of Darwinism. Using a broad but scarcely metaphorical definition we have seen natural selection operate.

Only small organisms having several generations per year are able to expose a sufficient number of generations and of individuals to a deleterious factor to make possible a successful response. Even with small animals as we have seen, a successful response may not be achieved if the agent is applied to small segments intensively and successively. Furthermore, only economically important species like houseflies and cattle ticks are observed sufficiently closely over long periods of time, and over wide expanses of territory to ascertain if a successful response is being made. Nevertheless, the first stages of this cycle are apparent all about us among other organisms.

A few decades ago, a blight of chestnuts was accidentally introduced into the United States. I was able to observe the effects of this parasite upon a magnificent and virgin stand of chestnuts in the Great Smoky Mountains during the summer of

1947. For hours I walked through a tangle of dog hobble and blackberries. All around were large, dead chestnut trees, some prostrate, others still standing. The trunk of one prostrate giant which lay across the trail was more than breast high; and after climbing onto it, I estimated by pacing that it was more than 60 feet to the lowest limb. Along the trail I saw a very few infected but living individuals. Most were mere suckers from surviving roots, but one was a tree with a trunk more than a foot in diameter. Dead limbs and other lesions proved the tree was infected, yet burrs from the fall before littered the ground. As McAtee states, it is difficult to exterminate the last survivor of a race. Perhaps, after a passage of sufficient time a blight resistant chestnut will repopulate the steep slopes of the Great Smokies, but for a slow breeding organism, like the chestnut, sufficient time means centuries, not a few years as with houseflies.

Meanwhile we can only hope that the status of the chestnut will some day change from that of an unsuccessful, declining population to a successful, increasing species. Nevertheless, we fear the worst. We remember the great hordes of passenger pigeons, which formerly darkened American skies. Whether the last survivors were destroyed by a natural predator, namely man, or whether, as a parasitologist suspects, an introduced pathogen, *Trichomonas gallinae*, finished the work begun by man is unimportant. Extermination is possible. It occurred in the geological past, before man evolved, and it occurs today. Perhaps the passenger pigeon foretells the fate of the chestnut, or perhaps that tree will some day make a successful response to the blight.

Natural selection may be, as McAtee (1949) insists, a purely negative principle. Nevertheless, the results of this force, when coupled with the struggle for existence, as Darwin closely united the two, may lead to positive results and the survival of a threatened and badly mauled species such as the chestnut or the fever tick.

The instances where natural barriers have broken down, and organisms have invaded new areas to the detriment of forms formerly successful in that area are too numerous to enumerate. We may observe today the effects of the invasion of the upper Great Lakes by the sea lamprey. The geological record shows the effects upon the native fauna of the invasion of South America by northern mammals at a late period. Indeed the geology of that continent influenced markedly the character of the *Origin of Species*. The generalizations Darwin formed from observations in that land and elsewhere might have enabled a keen analyst to predict the results of our modern uses of insecticides. It is very difficult to formulate terms or phrases which will describe these broad principles without in some degree giving offense to someone's semantic preconception. However, Darwin's terms such as, "struggle for existence," and "natural selection," suggest the relationships as they actually exist. Possible "survival of the fittest" should be discarded for reasons of an emotional nature, but the others may be used in a large and almost metaphorical sense as Darwin intended, at least until better terms are formulated.

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