SOME GENETIC PROBLEMS IN NATURAL POPULATIONS

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1. Introduction

This article deals with the theory of genetic changes in natural populations. It does not review the extensive and rapidly growing body of experimental and observational data, but is restricted to the mathematical theory.

Natural selection differs from that in populations under human control in two important respects. (1) The plant or animal breeder can select his stocks on the basis of any character he chooses; in nature the only criterion is the probability of surviving and leaving descendants. (2) The plant or animal breeder can select on the basis of performance of relatives as well as on individual traits; natural selection (insofar as it is intrapopulational) is typically on an individual basis.

The process of genetic change from generation to generation is stochastic, since the factors directing the change (selection, migration, mutation) are usually not constant and because of the process of random sampling of gametes in reproduction. However, it is much simpler to treat the process as deterministic, and for large populations with constant environmental factors this model is satisfactory. Under other conditions a more realistic stochastic model must be introduced. We shall deal here first with deterministic models (J. C.) and, in the second part, introduce mathematically more involved stochastic models (M. K.).

The deductive theory of population genetics and microevolution is due almost entirely to three men: J. B. S. Haldane, R. A. Fisher and Sewall Wright. Haldane has dealt mainly with deterministic processes, especially the rate of change of gene frequencies with natural selection under a wide variety of circumstances. Most of his early work is summarized in the mathematical appendix to his book, "The Causes of Evolution" [10], where references to this work are given. See also [12]. Work on stochastic processes is due mainly to Wright and Fisher. Fisher has been especially concerned with the theory of natural selection and his earlier results are summarized in his book, "The Genetical Theory of Natural Selection" [5]. He has dealt with a stochastic process in connection with the probability of persistence of a mutant gene in a population. After earlier work on the consequences of various mating systems, Wright has been especially concerned with the steady state distribution of gene frequencies under increasingly general conditions [25], [28], [30].

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