POPULATION GENETICS, MOLECULAR BIOMETRY, AND EVOLUTION

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1. Introduction

It has been said that Darwin's theory of evolution by natural selection is one of the greatest intellectual triumphs of our civilization (Crick [7]). Equally important is the recent discovery that the instruction to form an organism is encoded in DNA (or sometimes RNA) with four kinds of nucleotide bases. It is natural, therefore, that attempts be made to understand evolution in molecular terms.

Studies of evolution always contain two aspects. One is historical and is concerned with the reconstruction of past processes. The other is causal in that the underlying mechanism is pursued. Although these two are intimately connected, we are mainly concerned in this paper with the latter aspect of molecular evolution and we shall discuss several problems from the standpoint of population genetics.

As a branch of genetics, population genetics investigates the laws which govern the genetic composition of Mendelian populations (reproductive communities), and through such study, we intend to clarify the mechanism of evolution. The fundamental quantity which is used here is the gene frequency or the proportion of a given allelic gene in the population.

Because of the particulate nature of Mendelian inheritance, gene frequencies change only gradually with time under the influence of mutation, migration, selection, and random sampling of gametes in reproduction in any reasonably large population. The mathematical theory which treats such processes of change as stochastic processes was founded by the great works of R. A. Fisher [15] and Sewall Wright [66], and since then has been considerably extended under the name of diffusion models (Kimura [25]; see also Crow and Kimura [10], Chapters 8 and 9).

Although population genetics theories in general, and especially their deterministic aspects such as those initiated by J. B. S. Haldane [18], have promoted greatly the development of neo-Darwinian theory of evolution (see Haldane [21]), the real impact of the mathematical theory of population genetics has not been felt in the study of evolution. The main reason for this is that popula-

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