THE ROLE OF MUTATION IN EVOLUTION

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This paper is dedicated to retiring University of California Professors Curt Stern and Everett R. Dempster.

1. Introduction

Eleven decades of thought and work by Darwinian and neo-Darwinian scientists have produced a sophisticated and detailed structure of evolutionary theory and observations. In recent years, new techniques in molecular biology have led to new observations that appear to challenge some of the basic theorems of classical evolutionary theory, precipitating the current crisis in evolutionary thought. Building on morphological and paleontological observations, genetic experimentation, logical arguments, and upon mathematical models requiring simplifying assumptions, neo-Darwinian theorists have been able to make some remarkable predictions, some of which, unfortunately, have proven to be inaccurate. Well-known examples are the prediction that most genes in natural populations must be monomorphic [34], and the calculation that a species could evolve at a maximum rate of the order of one allele substitution per 300 generations [13]. It is now known that a large proportion of gene loci are polymorphic in most species [28], and that evolutionary genetic substitutions occur in the human line, for instance, at a rate of about 50 nucleotide changes per generation [20], [24], [25], [26]. The puzzling observation [21], [40], [46], that homologous proteins in different species evolve at nearly constant rates is very difficult to account for with classical evolutionary theory, and at the very least gives a solid indication that there are qualitative differences between the ways molecules evolve and the ways morphological structures evolve. Finally, there is the amazing complexity of each gene and every protein, and the superastronomical numbers of combinatorial possibilities in theoretically possible genes and proteins, which together appear to make the evolution of specific macromolecules utterly impossible with undirected mutation and natural selection [33], [45].

At present there appear to be two approaches to a resolution of these differences. One is to conclude that nearly all molecular polymorphism and molecular evolution is due to origin by mutation, and fixation by random drift, of molecular variants (alleles) that are completely neutral with regard to the processes of natural selection [20], [21], [24], [6]. Then one is left with an unspecified