THE RATE OF PRODUCTION OF RECOMBINANTS BETWEEN LINKED GENES IN FINITE POPULATIONS

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1. Introduction

Problems concerning the rate of production of recombinants between linked loci in finite populations are important in applications to natural and artificial populations (for a review see [1]). We shall be mainly concerned with applications to the theory of breeding experiments with laboratory populations. Closely related (but not identical) problems arise in the study of the speed of evolution in wild populations.

We consider two linked loci in a diploid population with alleles A, a and B, b at the first and second locus, respectively. The normal or "wild type" gamete is ab but the mutant chromosomes Ab and aB are also assumed to be present in the population. The gametic output of a double heterozygote aB/Ab contains the four types, Ab, aB, AB, ab in the proportions $(1 - r)/2$, $(1 - r)/2$, $r/2$, $r/2$, where r is the recombination fraction, $0 \leqq r \leqq 1/2$.

Recombination is one of the main constituent processes of evolution. To analyze the relative importance of recombination one asks questions of the following kind. Suppose the normal gamete ab occurs with a high frequency in a population while the mutant gametes Ab, aB are maintained at low frequencies by mutation selection balance. Then, in the long time scale of evolution, the eventual formation of an AB recombinant is certain. How long is the time between successive appearances of an AB recombinant? If the population is large, a satisfactory answer for this problem can be found from simple deterministic models. Our main interest lies with the similar problems which arise in finite captive populations.

The concrete problem we investigate takes the following form. Consider a two locus diallelic population consisting initially of N diploid individuals including only the genotypes Ab/Ab, Ab/aB, aB/aB. Each generation is produced by random sampling from the gametic output of the preceding generation, maintaining a fixed population size of N. An individual with a recombinant gamete may eventually appear, but this outcome is not certain. If no recombination ever occurs (for example, when $r = 0$), then there is effectively only a single locus

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