Short Communication

Inadequacy of Traditional Biological Population Theory in Genotypic Frequency Calculation

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It was pointed out that the genotypic frequency in a population after generations can not be obtained through the traditional method, i.e., through multiplication of gene frequency and inbreeding coefficient utilized in population genetics.

KEY WORDS : Genetic population theory, genotypic frequency, gene frequency, inbreeding coefficient.

Introduction

In population genetics, as well as in breeding theory, genotypic frequencies have been often calculated through the multiplication of gene frequencies and inbreeding coefficient (See, for example, CROW and KIMURA, 1970, ELANDT-JOHNSON, 1971, FALCONER, 1967, KARLIN, 1969, KEMPTHORNE, 1957, and LI, 1955). Invalidity of uses of some basic concepts in the traditional population genetics was already implied by SHIKATA (1979). The invalidity is more precisely stated in the present paper.

Basis

SHIKATA (1979) found that the frequencies of genotypes A_1A_1 , A_1A_2 and A_2A_1 , and A_2A_2 not to be expressed by the traditional expression $p_1^2(1-f) + 2p_1p_2(1-f)$, and $p_2^2(1-f) + p_2f$, but to be expressed by $(1/2)[F(1) + (f_1 - f_2)]$, $f(0)$, and $(1/2)[F(1) + (f_2 - f_1)]$, where p_1 and p_2 are the frequencies of genes A_1 and A_2 (in the traditional approach), f is the traditional inbreeding coefficient, f_1 and f_2 are the frequencies of A_1 and A_2 , and $F(1)$ and $F(0)$ are the frequencies of homozygotes and heterozygotes. Here, p_1 and p_2 stand for the frequencies of A_1 and A_2 , respectively, in the traditional theory. Likewise, f_1 and f_2 stand for the frequencies of A_1 and A_2 , respectively, in the present theory. Actually, the gene frequency of A_i , $i=1,2$, is a same quantity in the two theories, and so p_i must be equal to f_i in principle, namely, $p_i = f_i$, $i=1,2$. Use of the two mutually different symbols p and f in the two theories is for the purpose of clear distinction between the traditional approach and the present one.

Result

As is shown above, it was found that the traditional theory of population genetics and of breeding fails in obtaining genotypic frequency through multiplication of gene frequencies and inbreeding coefficient. Therefore, the traditional theory needs reconsideration in its basis.

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Discussion

The natures of the quantities such as gene frequency, inbreeding coefficient, frequencies of homozygotes and heterozygotes, etc. were discussed in SHIKATA (1979). Both gene frequency and inbreeding coefficient are found to be obtained from a single component of a vector representing a population. In the population, the gene frequencies are not the constants which are known, therefore they can not be used as the constants throughout generations in calculation of genotypic frequencies.

The manners of combination of genes in populations are also not fixed but changed in general from generation to generation.

By the traditional approach, the obtainment of the genotypic frequencies was aimed from the two kinds of quantities, i.e. gene frequencies and inbreeding coefficient, in which the generation equations were thought to be solved with relative ease, compared with the solution of the generation equation before simplification through its symmetries. However, SHIKATA (1979) showed that the use of inbreeding coefficient (shown as $f_1(1)$ and $f_2(1)$, there) is of no value for that purpose.

This is a fundamental problem to be considered further in the traditional theory of genetic populations.

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遺伝子型頻度計における従来の生物集団理論の無効性

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世代を重ねた後の生物集団中の遺伝子型頻度は従来の集団遺伝学，育種学等において遺伝子頻度と近交係数との積の形で求められるとされて来た。このような形では遺伝子型頻度が求められないことを指摘した。