Quadrant II- Transcript and Related Materials

Programme : **Bachelor of Science (Third Year)**

Subject : **Zoology**

Semester : **V**

Course Code : **ZOC 107**

Course Title : **Molecular Biology and Evolution**

Unit : **8 – Genetic basis of evolution and study of fossils**

Module Name : **Hardy Weinberg's Law of equilibrium**

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Notes:

In 1908, British mathematician, Godfrey Hardy and the German physician, Wilhelm Weinberg independently derived a mathematical equation.

"Representing the distribution of alleles and genotypes pertaining to a specific gene locus in a panmictic Mendelian population".

Further, it was worked under certain conditions and realize the genetic structure of a population may not change over a time.

Thus established the concept of "Hardy Weinberg principle of Equilibrium".

Hardy-Weinberg equilibrium provides the theoretical framework for Population Genetics.

" Hardy Weinberg Principle states that relative frequencies of various kinds of genes in the gene pool of a large and randomly mating sexual, panmictic population tend to remain constant from generation to generation in the absence of evolutionary forces, such as Mutation, Natural selection, and gene flow".

This principle makes an important assumption of Random mating.

Hardy and Weinberg discovered that under the assumption of random mating, the frequencies of the alleles in the population can be used to predict the frequencies of the genotypes in that population.

- Let's suppose, in a population a gene is segregating

  two alleles 'A' and 'a', frequency of 'A' is 'p', frequency of 'a' is 'q'

  If we assume, the members of the population mate randomly,

  Probability of diploid genotypes of the next generation will be

  for 'A' is p and 'a' is q

  Probability of AA zygote is p x p=p^2 & aa zygote is q x q = q^2

  Probability of Aa heterozygotes will be p x q = pq or 2pq for 2Aa

The predicted genotype frequencies, p^2, 2pq, and q^2, are simply the terms in the expansion of binomial expression

$$(p + q)^2 = p^2 + 2pq + q^2$$

This simple relationship between genotype frequencies and allele frequencies will persist as long as the population mates randomly.

To illustrate Hardy-Weinberg Principle, let's consider a hypothetical population composed of 1000 individuals, out of which 490 'AA', 420 'Aa', and 90 'aa'

First, calculate the frequencies of the two alleles, A and a

This is done by counting the two types of alleles and dividing each count by the total number of alleles in the population.

Frequency of A = (2 X 490 + 420)/ 2000 = 0.70 = p

Frequency of a = (2 X 90 + 420)/ 2000 = 0.30 = q

Also, note, p +q = 0.70 + 0.30 = 1

Now, using this allele frequency, let us predict the genotype frequencies.

Allele frequencies are A = 0.70 & a = 0.30

In the next generation, under random mating assumption, genotype frequencies will be

AA : p^2 = 0.49; Aa : 2pq = 0.42; aa : q^2 = 0.09

Thus, in a population of 1000 progeny, we predict 490 AA, 420 Aa and 90 aa.

These are the same numbers we began with, illustrating that once the Hardy-Weinberg genotype frequencies have been obtained, they will persist in the population, indefinitely under the absence of evolutionary forces.

Conditions for Hardy-Weinberg Equilibrium:

1. Extremely large population size
2. Random Mating: Population should be Panmictic
3. Biparental Mode of Reproduction
4. Homogeneous Age structure
5. Absence of Evolutionary Forces

Significance of Hardy-Weinberg Principle:

1. Provides a theoretical baseline for measuring evolutionary change.
2. Tends to conserve gains which have been made in the past and also to avoid too rapid changes.
3. Maintains heterozygosity in the population.
4. Prevents evolutionary progress.
5. Populations in nature rarely meet the stringent conditions necessary to maintain them at Hardy-Weinberg equilibrium.
6. It means Hardy-Weinberg Principle is essential to determine whether the population is evolving or not?
7. In order to ascertain that evolutionary agents are operating or not, the allele and genotype frequencies of the population are determined generation after generation and then compared.
8. The pattern of deviation from Hardy-Weinberg ratio will tell the agent/ agents responsible for evolutionary change.