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B.Sc. Zoology Part III

HARDY-WEINBERG LAW OF GENETIC EQULIBRIUM

INTRODUCTION

- **G. H. Hardy** was an English Mathematician, W. Weinberg was a German physician.
- Both these scientist discovered independently mathematical formulation in 1908, to find out the gene and genotype frequencies in a population for a particular gene pair.
- This formula of gene regarding frequencies of gene and genotype is known as Hardy-Weinberg law of genetic equilibrium.

HARDY-WEINBERG LAW

- Hardy-Weinberg law state that, relative frequencies of various kind of gene alleles remain constant from generation to generation, if population is large, mating at random and any kind of evolutionary forces such as mutation, natural selection or migration is absent.
- This law is expressed by the algebraical equation:-

$$P^2 + 2pq + q^2 = 1$$

Where, p = frequencies of dominant alleles

q = frequency of recessive alleles

pq = frequency of heterozygote

- It is also called as Hardy-Weinberg equilibrium, because the gene frequencies in a population are maintained in a certain equilibrium.
- Due to this genetic changes are stopped.
- If the population follows the Hardy-Weinberg equilibrium, then the role of evolution is zero.

- This law can be explained by citing example of a hypothetical large population which contain equal number of individuals with black (HH) and grey (hh) hairs which interbreed at random.
- The types of mating among them is of following three types:-

  (i) HH X HH

  (ii) hh X hh

  (iii) HH X hh

- If they are 50% males and 50% females, then F_1 individual produced in the ratio of 1:2:1

Parents- HH♂ X hh♀ HH♀ X hh♂

- Frequency of each H or h gene = 50% = 0.5 on representing their mating in checker board we find following results:-

Male gamete \ Female gamete	0.5H	0.5h
0.5H	0.25HH	0.25Hh
0.5h	0.25hH	0.25hh

- If 'H' is represented by 'p' and 'h' is represented by 'q'

  Then, HH = p X p = p^2 = 0.25

  hh = q X q = q^2 = 0.25

  Hh = p X q = pq = 0.25

  Hh + Hh = 2Hh = 2pq = 0.25

  Hence, **$p^2 + 2pq + q^2 = 0.25 + 0.50 + 0.25 = 1$**

- This is the Hardy-Weinberg equation.

IMPORTANCE OF HARDY-WEINBERG LAW

(i) It emphasizes that in the absence of an evolutionary forces of all the genotype in a population reproduce equally successfully.

(ii) In the absence of all evolutionary forces, the mating is a completely at random phenomenon in a population.

(iii) It relates simply to statics of a large mendelian population.

(iv) It provides basis for calculation, if the recessive homozygous is harmful.

(v) It provides basis to examine the trends of gene frequencies in large populations.

(vi) It acts as a guide to indicate whether evolution is occurring or not.

(vii) It concludes the rate of changes of gene frequencies is a function of the speed of evolution.

(viii) The equilibrium maintains heterozygotes in population.

(ix) It tends to conserve gains of characters that have been made in the past.

FACTORS AFFECTING HARDY-WEINBERG LAW

1. MUTATION

- The raw material for evolution is produced by mutation.
- It is caused by any mistakes in duplication of gene during cell division.
- Most of the mutation occurring in nature of recessive, they may be dominant and are expressed immediately.
- Continuously occurring mutation in a population constitutes mutation pressure.
- It tends to alter the gene frequencies in a gene pool.
- A change in gene frequencies upsets the genetic equilibrium.

2. NATURAL SELECTION

- Natural selection operates upon the raw materials produced by mutation.
- Nature selects those individuals which have beneficial mutation and eliminates containing harmful mutations.
- This also provides them to spread more rapidly than other.
- This lead to the different reproductive genes.
- The differential reproduction of genes upsets Hardy-Weinberg equilibrium.

3. NON-RANDOM MATING

- Mating is a selective process, mates are selected on the basis of a number of characters e.g., Health, mentality etc.
- The non-random mating causes uneven and random recombination of genes.
- As a result some genes spread more rapidly than others.
- This causes change in genes frequencies.
- Thus the genetic equilibrium is disturbed causing progress of evolution.

4. SMALL POPULATION AND GENETIC DRIFT

- Large mendelian population is the primary need for the maintenance of Hardy-Weinberg genetic equilibrium.
- Because the gene frequencies change purely by chance in a small population.
- It is called Sewall Wright effect.
- A change in gene frequency purely by chance in small population is called genetic drift.
- It upsets genetic equilibrium in a small population and act as an evolutionary force in small populations.

5. MIGRAION AND GENE FLOW

- When immigrated individuals mate with the in mates of the population, the transfer of genes of one population into another population occurs. This is called gene flow.
- This result in production of new type of genetic recombination due to an addition or loss of genes in the gene pools.
- As a result the gene frequency is changed it caused upsetting of Hardy-Weinberg equilibrium.

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