Section B and C

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Evolution has been described as "*descent with modification*" by DARWIN. The statement needs some classification. The first question which will naturally come up is "what is it that evolves" an individual or a group of individuals Evolution cannot be an individual phenomenon, because an individual lives and dies with a fixed genotype .The recent concept about evolution has regarded it as a change in the genetic composition of the population rather than the change at individual level. Therefore, the unit of evolution as the population, rather more precisely the total number of genes of the population i.e. the gene pool. From evolutionary point of view the study of population genetics includes the study of gene pools and the changes occurring in the gene pool,

Population

Let us first consider what is a population? In a broad sense a population may be defined as an assemblage of living being that presents a closely interacting system. Thus we may speak of tree population of a forest or offish population of a lake, regardless of the species present there. But our interest is centered in a population comprising of sexually interbreeding organisms.

A population of this nature is known as genetic population or Mendelian population. It may be defined as a community of similar individuals living within a circumscribe area at a given lime aid capable of interbreeding. It is characterized by having individuals which have somewhat similar genetic constitution or gene composition and gene alignment except for some uniqueness. It means that a population possesses a given gene pool and that the interbreeding members of the population have a free access to all components of that pool i.e. there is free flow of genes. The hereditary material present in a part of a population may in time spread to the whole population. The most extensive Mendelian population is the species, the human race represents a large Mendelian population, divided into subordinate Mendelian populations or races. Moreover, the sister populations are in occasional reproductive contact, so that the gene pool of one population is connected to the gene pools of sister populations. As a result the total genetic contents of the entire species continues to be reshuffled among the member organisms.

Gene Pool: The sum total of genes of all the individuals of a Mendelian population constitutes the **gene pool.** A Mendelian population is an array of genes, temporarily embodied in individuals, but endlessly combining and recombining by the process of sexual reproduction. If the gene pool of a population is described completely, it tells us not only the kinds of genes present in the population but also the proportion of the different kinds of genes the way in which these kinds are distributed among the individuals 6F the population in' question. Suppose, if we want to know the genetic information about the smoothness and wrinkling of the pea seeds in the gene pool of a pea population, it is possible to know exactly the proportions of the smooth alleles and the wrinkled alleles and how these alleles are distributed among the individuals i e. the proportion of homozygous smooth, heterozygous smooth and the homozygous wrinkled pea plants. Suppose if these are present in equal proportions i.e. half the genes are for smoothness and half for wrinkled characteristic and these genes are represented W and w, the gene pool in the state of equilibrium will contain ¼ WW ½ Ww 1/4 ww and this will be maintained as long as random mating occurs.

A mathematical formulation to know the gene and genotype frequencies in a population for a particular gene pair was introduced by HARDY and WEINBERG in 1908. But before entering into the details of this formulation, let us understand the actual meaning of gene frequency and genotype frequency.

Gene Frequency and Genotype Frequency

The gene frequency refers to the proportion of an allele in the gene pool as compared with other alleles at the same locus, with no regards to their distribution in organisms. For example, if we consider a hypothetical population in which there are just two alleles Aa on a particular locus out of which A is dominant and a is recessive. According to the genotype three types of individuals may exist in the population : 1/4 homozygous dominant (genotype A A), 1/2 heterozygous (genotype Aa) and 1/4 homozygous recessive (genotype aa),

Suppose there are 100 individuals in a population out of which there are 40 homozygous dominant (AA), 40 heterozygous (Aa) and 20 homozygous recessive (aa), then:—

$$\text{The frequency of gene A will be } \frac{80+40}{200} = 0.6$$

$$\text{The frequency of gene a will be } \frac{40+40}{200} = 0.4$$

Therefore, the gene frequency can be calculated by dividing the number of a particular gene in question with the total number of genes present on that locus in the population.

If frequency of gene A is represented by p and that of gene a by q and at gene equilibrium condition their total frequency is represented by 1, then at equilibrium p + q =l.

or $p = 1 - q$

or $q = 1 - p$

The genotype frequency is the total number of a kind of individuals from a population all of which exhibit similar character with respect to the locus under consideration. Suppose in a population there are two alleles at one gene locus (A and a) and they are related as dominant and recessive. Naturally, three kinds of individuals homozygous dominant, heterozygous and homozygous recessive will occur in the population.

If ,

N= Total number of individuals in the population

D= Number of homozygous dominants

H= Number of heterozygous

R= Number of homozygous recessives

Then genotype frequency of AA individuals=D/N

Genotype frequency of Aa individuals =H/N

Genotype frequency of aa individuals=R/N

It means genotype frequency for a particular type of gene combination on the same locus can be determined by dividing; the number of individuals with that genotype by the total number of individuals in the population.

Genetic Equilibrium and Hardy Weinberg Law of Equilibrium

The mathematical treatment of the distribution of gene and genotype frequencies in the population was developed in 1920, principally by. R. A. FISHER and J. B. HALDANI in England and SEWALL WRIGHT in United States, but the most fundamental idea in population genetics was offered by Englishman G. H. HARDY and German W. WEINBERG simultaneously in the year 1908. It is known as Hardy-Weinberg's law. The law is the foundation of population genetics and of modern evolutionary theory. The law states:—

The relative frequencies of various kinds of genes in a large and randomly mating sexual panmictic population tend to remain constant from generation to generation in the absence of mutation, selection and gene flow.

Hardy-Weinberg's law describes a theoretical situation in which a population is undergoing no evolutionary change. It explains that if the evolutionary forces are absent, the population is large, its individuals have random mating, each parent produces roughly equal number of gametes and the gametes produced by the mates combine at random and the gene frequency remains constant, then the genetic equilibrium of the genes in question is maintained and the variability present in the population is preserved. Suppose there is a panmictic population with gene A and a on one locus, then the frequency of gametes with gene A will be the same as the frequency of gene A and similarly the frequency of gametes with a will be equal to the frequency of gene a. Let us presume that the numerical proportion of different genes in this population is as follows:—

AA	Aa	aa
36%	48%	16%

Since AA individuals make up 36 per-cent of the total population, they will contribute approximately 36% of all the gametes formed in the population. These gametes will possess gene A. Similarly aa individuals will produce 16 per-cent of all the gametes. But the gametes from Aa individuals will be of two types, i.e. with gene A and with gene a roughly in equal proportion. Since these constitute 48% of the total population, they will contribute 48% gametes, but out of them 24% will possess gene A and the other 24% will have gene a. Hence, the over all out-put of the gametes will be:

Parents		**Gametes**	**Parents**	**Gametes**
36%AA	→	36%A	16%aa	16% a
48%Aa	→	24%^A	48%Aa	24% a
Total		60% A		40% a

If the gametes unite at random, the total number of different genotypes will be:

Sperm	**Ova**	**Gene frequency**	**Offsprings**
A	A	60x60	36%AA
A	a	60x40	24%Aa
a	A	40x60	24%Aa
a	a	40x40 .	16%aa

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