TYPES OF NATURAL SELECTION

Natural selection is that force which produces systematic heritable changes in a population from generation to generation, creating evolution. Thus it may become a directional phenomenon, producing changes in a definite direction, giving rise to new species. Natural selection may be very fast or very slow depending upon the environmental demands and rate of genetic changes. American naturalists K. Mather & J.M. Theoday (1953) divided natural selection into 3 categories, viz., stabilizing or normalising selection, directional or balancing selection and disruptive selection.

The standard distribution of a trait across a population

1. Stabilising or Normalising selection or Centripetal selection: This type of natural selection operates in stable environmental conditions and in a short span of time, when species living in a particular environmental conditions are perfectly adapted to live in it. Thus individuals with extreme characters will be at a disadvantage as compared to the individuals having average characters and the latter would be favoured by natural selection. In is therefore a negative selection that weeds out continuously the less fit as well as more specialised genotypes from the population.

The effect of stabilizing selection on trait distribution

Examples: H.C. Bumpus (1899) observed 133 sparrows killed in a storm and found that those birds that were killed possessed abnormally long or short wings, away from the average. Oppossum, an American marsupial, has changed very little over the past 60 million years. Similarly, in the case of *Sphenodon,* not much change has taken place during the past 150 million years due to almost stable environment in New Zealand. M.N.Karn & L.S. Penrose (1951) studied the survival rate of human babies in London hospitals and found that most of the babies that survived after birth had an average weight of 7.5 pounds.

2. Directional or Balancing selection or Orthogenesis: This selection is always associated with environmental change, owing to which average characters become non-adaptive. Therefore, it favours individuals with non-average or extreme characters, which may prove useful in the changed environment. This is directional and progressive selection, which gives rise to new types from the original population, which have the ability to survive the change in the environment. By keeping the gene from disappearing in heterozygous condition, natural selection provides a species with reserves upon which it may draw when condition changes. Species that have lots of heterozygotes and plenty of variations are the fittest ones in changing environments.

The effect of directional selection on trait distribution

Examples: Evolution of horse is a good example of directional selection in which a small forest dwelling animal, *Hyracotherium,* had to undergo successive changes in its body when the environment changed from forest to grassland, giving rise to a tall, fast-running, grazing horse (see chapter 'Evolution of Horse'. Evolution of black form of industrial melanic moth *(Biston betularia)* from grey ones in England in 19th century is also directional selection. Gradual replacement of susceptible mosquitoes by the DDT resistant strains due to excessive use of insecticide is an example of directional artificial selection.

3. Disruptive or Diversifying selection: This type of selection pushes some of the phenotypes away from the population average but at the same time maintains them in the population. Thus polymorphism appears and is maintained in the population. Uniformity of characters in young individuals and bimodal or trimodal diversity of characters in the adults is also considered to be due to disruptive selection. It enhances adaptability of a population. Megamutations may produce new types but they are not eliminated even when they are not advantageous.

The effect of disruptive selection on trait distribution

Examples: White tigers and white leopards are common in the populations. The former must have given rise to Siberian tiger and the latter to snow leopard by migration. Similarly, origin of bird's wing from a reptilian foreleg must have occurred due to megamutation, but it may not have been an advantageous character in the formative stage but was still maintained in the population and became advantageous later. Polymorphism is very common in insects, such as butterflies, aphids and hoppers (winged and wingless forms), web-spinners and social insects. Polymorphism permits the species to exploit different types of ecological conditions by different forms. Widely distributed species, living in mosaic of environmental conditions, usually possess polymorphism.

K-selection and r-selection: These two categories are made based on the density of population and reproductive rate at which the natural selection operates.

K-selection operates in stable environmental conditions in which species live in saturated population densities. These populations show sigmoid growth curves and live near the carrying capacity. Selection favours those individuals that have enhanced competitive ability at high population densities near the carrying capacity. Such populations have slow growth rate and prevail in non-seasonal tropics.

r-selection operates on populations having rapid growth rate but low adaptiveness. They can rapidly exploit new environment, such as a burnt out forest or brief summer in mountains or in areas of uncertain environmental stress, e.g. storm,

drought, fire etc. Such populations are good pioneers and can rapidly exploit a new environment with their high biotic potential and no selection pressure. They show J-shaped growth curves, as in the case of seasonal insects.

Natural selection in microorganisms

Microorganisms reproduce in three ways and natural selection may be different accordingly.

1. In self-reproducing individuals: If the process of self-reproduction is perfect, there is no room for natural selection. But the process is never complete and mutants appear from time to time. If these mutants reproduce less efficiently, they are eliminated but if they reproduce more efficiently, they can maintain themselves side by side, causing diversification in the population. Fore example, protozoa reproducing by binary fission, Hydra by budding and coelenterates by strobilation.

2. In self-fertilizing individuals: Hermaphrodite or parthenogenic individuals usually pass the same genotype to their offspring, which are called "pure races". Unless there are mutations, the genotype of each individual will remain unchanged. When several such races are exposed to natural selection, some of them are favoured while others are eliminated, which will alter the ratio accordingly. For example, flatworms, lower insects and other invertebrates reproduce by self-fertilization.

3. In cross-fertilizing individuals: In cross-fertilising microorganisms no two individuals are alike genetically and every population possesses genes in different frequencies. Natural selection may increase the frequencies of some genes and decrease the frequency of others. Since new genotypes are constantly produced by cross-fertilisation, selection has an opportunity to exercise its effect. The character becomes heterozygous and dormant and survives for some generations, without being expressed and exposed to natural selection. During this period environment may change and the character may become advantageous. This also produces heterozygosity in the population.