GENE ECOLOGY

DR. RITU GOSWAMI

ASST. PROF. IN BOTANY

R R BAWA DAV COLLEGE FOR GIRLS,

BATALA

Species differ in their environmental requirements. They also differ in respect of their tolerance to environmental fluctuations.

The species occur in several morphological forms in different habitat conditions. Gote Turesson (1922), a Swedish worker conducted a series of experiments on variations within a Swedish plant species *Plantago maritina*.

He collected a group of 20 or more individuals of the same species from different areas and planted them under identical environmental conditions in his experimental garden at Akark.

He noted that:

(i) Several intergrading forms existed within the species which differed from one another in morphological or physiological features and

(ii) Some of differences might be unstable and induced only by the environmental factors while some others might be permanent (i.e., genetically fixed).

These observations led him to formulate the concept of gene ecology which brought about many revolutionary changes in plant taxonomy.

The population sampling and subsequent procedures that Turesson followed led him to conclude that

- species differ from one another morphologically, physiologically and in habitat requirements

and

- on the basis of such studies he proposed the following classes of morphological forms within a species:

1. Ecads or Ecophenes or Habitat forms,
2. Ecotypes,
3. Ecoclines
4. Ecospecies, and
5. Coenospecies.

1. Ecads or Ecophenes:

These are also called **epharmones** or habitat forms which are environmentally induced variations. They belong to the same genetic stock or species and the variations in their morphology (in shape, size, number and reproductive capacity) are induced by the environmental influences.

The variations are not fixed but are temporary, somatic and reversible.

If one type of ecad is transplanted into environment of another type of ecad, the differences would disappear.

These morphological variations are not permanent because the genetic composition of ecads is not affected and so they are identical in their genetic behaviour and inter-fertile.

The variants or ecophenes may differ to such an extent that they can be treated as separate species.

Eg. *Euphorbia hirta* plants growing in the grassland are prostrate and profusely branched while the plants of the same species growing on the footpaths are compact, small leaved and cushioned. When these forms are grown under identical habitat conditions, their differences disappear.

2. Ecotypes:

These are also called ecological or physiological races.

The term ecotype was proposed by Turesson (1922) to the groupings of populations or ecological races or sub-species of a species in relation to different environmental or habitat conditions.

These are inter-fertile forms or biotypes of a species which possess different genetic compositions or genotypes and arise due to mutations, hybridization and isolation.

Though the different ecotypes of a species are morphologically and genetically distinct, yet because of their inter-fertility, they are put into one taxonomic species.

- Ecotypes are morphologically, physiologically and developmentally adapted to live under varying environmental conditions.
- Ecotype is the product of genetic response of a population to a habitat.
- In ecotypes adaptations are irreversible, i.e., they retain their features even when planted in a neutral habitat.

The differences in the ecotypes are so marked that some of them are treated as separate species by old taxonomists.

Mishra and Shiva Rao (1948) found *Lindenbergia polyantha* and *L. urticaefolia* to be the ecotypes of the same species.

The two ecotypes differ from each other in respect of their tolerance to high doses of lime. *L. polyantha* can tolerate high doses of lime.

In another study,
Ramakrishnan (1959, 60) has shown that red and green populations of *Euphorbia thymifolia* are two ecotypes.

- The red ecotype grows in calcium rich (calcicol) as well as calcium deficient soils
- The green ecotype is a calcifuge i.e., it cannot grow in calcium rich soil.

The red ecotype possesses a pair of dominant alleles whereas the green type possesses a pair of recessive alleles.

Ecotypes have been reported in several species of plants,
such as

- *Euphorbia hirta*
- *Cassia tora*
- *Ageratum conyzoides*
- *Cenchrus ciliaris*

During last two decades, many investigators have studied either only a few populations or several widely separated populations and have shown that each population was an ecotype and the term is now being widely used below the level of species. Our increasing knowledge of genecology and population differentiation has shown that an **ecotype may be the ecological unit but not an evolutionary unit.**

There is strong trend among evolutionary biologists to emphasize the importance of the local environment in shaping the population. Since the unit of study is the local population, it seems most appropriate if we present our information in terms of local population, rather than to imply that local population is an ecotype.

Characteristics of Ecotypes:

1. Ecotypes of a species, though genotypically distinct, are always inter-fertile.

2. They retain their original features when cultivated in a natural habitat.

3. Ecotypes are genetically fixed.

4. A species with wide ecological amplitude can be distinguished on the basis of morphological and physiological characters into different habitat forms or ecotypes.

5. They occur in distinct habitats.

6. Ecotypes are discrete entities with clear differences which separate one ecotype from another.

7. The differences are not due to plastic response to change in environment but are actually due to natural selection of locally adapted populations.

Formation or Origin of New Ecotypes:

Now ecotypes can be produced by the following methods:

1. Hybridization:

It is produced by the natural cross between two species. For example, when Spartia stricta is naturally crossed with S. altemiflora, the new hybrid S. townsendii results which eliminates both the parents from their natural habitats owing to its greater adaptability.

2. Mutation:
Due to natural mutation and recombination small gene pools accumulate in a segregating population which make it better adapted to the particular habitat or environment. Some new ecotypes also arise by cultivation or protected growth as it eliminates competitive selection.

3. Chromosomal changes:
Structural changes in the chromosomes such as translocation, inversions, and loss or addition of chromosome segments produce changes in genotypes and phenotypes resulting in the formation of new ecotypes. Polyploidy also leads to the formation of new ecotypes because polyploids hardly exhibit ecological tolerance as their parents do.

Kinds of Ecotypes:
Ecotypes have been observed in a large number of species and the cause of ecotype differentiation may be the latitude, altitude, light, soil, biotic interference, physiological changes, etc.

According to varying environmental conditions, ecotypes may be of following types:

1. Climatic ecotypes:
Ecotypes which are produced due to varying climatic factors as light, temperature, water and wind are called climatic ecotypes. Turesson (1930) has recorded the climatic ecotypes in *Leontodon autumnalis*.

2. Edaphic ecotypes:
Ecotypes which are produced due to differences in edaphic or soil factors, such as soil moisture, excess or deficiency of nutrients, change of soil pH, etc. are said to be edaphic ecotypes. Misra and Rao (1948) have studied *Lindenbergia polyantha* and Ramkrishnan (1961) has studied *Euphorbia thymifolia* and recorded several edaphic ecotypes in them.

3. Climatic-Edaphic ecotypes:
The ecotypes produced due to the influences of both climatic and edaphic factors are called climatic-edaphic ecotypes. Panday and Jayant (1970) have reported climatic-edaphic ecotypes in *Cenchrus ciliaris*.

4. Altitudinal and latitudinal ecotypes:
These ecotypes are produced due to change in altitude and latitude. Such ecotypes are found in *Cassia tora, Anagallis arvensis, Pinus* and many other gymnosperms.

5. Physiological ecotypes:
These ecotypes are produced due to physiological changes as in photoperiod, water absorption, nutrient uptake, etc., for example in *Boutelona curtipendula*, there are two photoperiodic ecotypes-short day and long day which are morphologically alike.

Delimitation of Ecotypes:
Ecotypes are not always based on morphological characters. Sometimes, single ecotype has several ecophenes which depend upon the habitats.

Now a days following techniques have been applied to differentiate ecotypes:

(i) Morphological features:
In this case morphological or physiological features of several individuals are studied at random in different populations of a species and one or few characters are considered and the results obtained are shown in the graph. Unimodal curve shows homogenous population, bimodal, trimodal and multimodal curves show two, three and many ecotypes in the population respectively.

(ii) Anderson's Scatter Diagrams:

This was devised by Anderson (1940) to delimit ecotypes. For this some measurable characters are taken into consideration.
One character (for example, leaf length) is plotted on one axis of the graph and other character (for example leaf breadth)
is plotted on another axis. In this way large number of characters are taken from different localities.

(iii) Cytological behaviour.
In this case karyotypes and their behaviour are observed in different forms. The differences in cytological behaviour show the existence of distinct ecotypes.

(iv) Transplantation experiment:
In this experiment plants from all the different localities are grown under uniform environmental conditions and their morpho-physiological characters are compared with plants growing in natural habitat. If the characteristic features are not changed in the neutral area, the existence of particular ecotypes is confirmed.

(v) Breeding experiments:

In this case, crossing is done between different forms of variable nature followed by self-fertilization to determine the characteristic features of variable forms. If the characteristic features show segregation in the offspring's, the presence of distinct ecotypes can be proved.

Significance of Ecotypes:

1. Cultivation of economically important plants has been made possible in different habitats.
2. New ecotypes of a species enable it to be adapted to climatically and edaphically different places.
3. Ecotypes help the species to extend its ecological range and spread to new areas.
4. Morphological variations can be marked in the species growing on varying habitats which lead to evolution.

3. Eco clines:

Eco clines are the intermediate forms which are found in the transitional regions between two adjacent regions occupied by separate ecotypes of a species. They are produced by hybridization between two related ecotypes and they survive under intermediate environmental conditions Thus a continuous change in the characteristics of plants from one region to another is apparent.

4. Ecospecies:

Ecospecies and coenospecies are two parallel terms. Gregor (1939) defined ecospecies and coenospecies purely on the basis of fertility-sterility criteria, eliminating any specific demand for morphological, physiological or cytological differences. According to him, ecospecies is a unit of gene ecological classification. An ecospecies has one or more ecotypes but ecotypes of one ecospecies do not produce viable offspring when crossed with the ecotypes of other ecospecies.

5. Coenospecies:

Different ecospecies which can undergo occasional crossing but do not produce viable offspring are collectively brought under coenospecies. In other words, populations incapable of exchanging genes with other populations of the same species are referred to as coenospecies.