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SPECIES CONCEPT

Defining "species" has been one of the major problems of the taxonomists. The main purpose of defining a species is to make it a historical, temporal and a spatial entity. Various definitions have been put forward by various workers, yet, the uncertainty still persists.

Mayer (1957) reviewed the works of others on the species problem and came to conclusion that all definitions given so far by the early workers, can be broadly grouped into three main concepts ---------

a. Typological or Essentialist Species Concept,
b. Nominalistic Species Concept,
c. Biological Species Concept

N.B. A fourth species concept named, Evolutionary Species Concept, has been added to the list by Grant (1971) and a fifth one called Phylogenetic Species Concept has been postulated by Cracraft in 1983.

a. TYPOLOGICAL SPECIES CONCEPT :

It was prevalent from the time of Plato, Aristotle and has been accepted by Linnaeus and his followrs (Cail, 1958). This school of philosophy is usually referred to as *essentialism* following Carl Popper and is also known as *essentialistic species concept*. According to it ----------

- The observed diversity of the universe reflects the existence of a limited number of underlying universals or types.
- Individuals do not stand in any special relationship to each other, being merely expressions of the same type.
- Variations are trivial and considered as imperfect manifestation of a type.
- Species can be recognized by the essential characters and these are expressed in their morphology. It is therefore called morphological species concept and the species is termed as *morphological species*.

Criticism : This species concept is rejected for two reasons ----

- ***Conspecific individuals* :** Conspecific individuals are frequently found in nature in spite of their sharp morphological differences due to ----------
    1. Sexual dimorphism,
    2. Age difference,
    3. Other individual variations.
- ***Sibling species* :** These are species having close morphological resemblance, yet reproductively isolated from each other. This primarily happen due to difference in behaviour and niche occupancy. Eg. *Drosophila pseudoobscura* and *Drosophila persimillis* are sibling species.

b. NOMINALISTIC SPECIES CONCEPT:

This concept was advocated by Occam, Robinet, Lamarck, Decan and their followers. This concept was popular in France in 18th century and curiously has some supporters in these days also. According to this concept ----------→

- Only individuals exist, species are man's own creation.
- Nature produces individuals and nothing more; species has no actual existence.
- Species have been invented in order that we may refer to great nmumber of individuals collectively (Bessay, 1903).

Criticism:

Species of organisms are not human construction nor are they type in the sense of Plato, Aristotle etc. They are something that have no equivalents in the realm of the inanimate.

c. BIOLOGICAL SPECIES CONCEPT :

This concept emerged around 1750. it was argued by statement made by Buffon, Merrem, Roigt and many other naturalists and taxonomists of 19th century and carried on by Jordon (1905), Lotsy (1918), Dobzhansky (1937), Mayr (1960), Wilmath (1967) etc. According to this concept, *species are groups of actually or potentially interbreeding natural populations which are reproductively isolated from similar such groups.* ----- **Mayr (1969)**

Mayr has further postulated that -------→

- ♣ ***Species is a reproductive community:*** Every species has a natural instinct to recognize a potential mate for sexual reproduction.Various biological forces and factors aids in the process of mate selection thereby promotes interbreeding within the individuals of a species.
- ♣ ***Species is an ecological unit:*** Each species member interacts with individuals of other species so as to develop an environment of cooperation or competition thus promoting niche aggregation, niche segregation or niche displacement.
- ♣ ***Species is a genetic unit:*** Each species has uniqueness by virtue of the conserved gene pool it possess. Isolating factors prevents intermingling of these conserved gene pools and restricts flow of gene from one species to another.

Significances :

1. The biological species concept solves the paradox caused by the conflict between the fixity of the species of the naturalists and fluidity of the species of the evolutionists.
2. It combines the discreteness of the local; species at a given time with a evolutionary potential for continuous changes.

3. Biological species concept combine the elements of the typological and nominalistic concept by stating that species has independent realities and typed by the statistics of population of individuals but differ by stressing on the populational aspect and the genetic coheism of the species.
4. It helps in abandoning the bewildering variety of standards introduced by the taxonomists of th past regarding --- morphology, isolation, etc.
5. It helps in solving the riddle of taxonomy for such abnormal cases in which distinct species exhibit great morphological similarities (Sibling species).
6. Species, subspecies, infraspecies etc. have now new meaning.

Limitations:

- **Uniparental organisms:** The basic concept of sexual interbreeding for generation of species is violated in following individuals --------→
  - Organisms reproducing by self-fertilization (eg. *Taenia solium*)
  - Organisms reproducing by parthenogenesis (eg. some aphids)
  - Organisms reproducing by budding, fragmentation, fission etc (eg. Yeast, *Spirogyra sp.*, *Trypanosoma sp.*)
- **Reproductive isolation without major morphological difference:** Two species might exist with very difficult to judge morphological differences but with pronounced reproductive isolation. Such species are called *sibling species*. Example: *Drosophila pseudoobscura* and *Drosophila persimillis* are two sibling species close morphological resemblances. Reproductive isolation has set in between the two due to their differential preference for foraging time and niche selection. *Drosophila pseudoobscura* are active in the evening hours and prefer warm climate to live in while *Drosophila persimillis* remain active in the morning and prefer cool high altitudinal climate.
- **Morphological difference without reproductive isolation:** Sometimes, two morphologically different populations interbreed at random whenever they meet and it becomes difficult to understand whether these populations are two different races under same species or two species under same genus. Example: Morphologically different snails under the genus *Cerion* has different isolated populations which mate whenever they meet.
- **Hybrids:** Some time two different species mate to produce a hybrid form . Example: Horse and donkey rarely mate to produce a viable but sterile hybrid animal, the mule.
- **Semispecies:** Geographical isolation of a species may sometime give rise to a group of organism that have a position between a subspecies and a full species. In such cases it becomes difficult for a taxonomist to determine the position of these organisms ------→ a separate species or a subspecies under the same genus.

d. EVOLUTIONARY SPECIES CONCEPT:

Evolutionary species concept was postulated by Simpson (1961). According to him, *a species is a specific lineage of ancestor descendant populations, which maintains its identity from other such lineagesand has its own evolutionary tendencies and historical fate.*

Advantages:

- This concept does not harp on interbreeding as the fundamental criterion to be a species.
- It considers species to be a product of organic evolution.
- This species concept can accommodate both sexually reproducing and asexually reproducing individuals including the agamospecies.

Disadvantages:

- The evolutionary history and fate of all the organisms is not logically accountable.
- It provides no emphasis on morphologically noticeable characters of the organisms.

e. PHYLOGENITIC SPECIES CONCEPT:

This concept was postulated by Cracraft in 1983. According to this concept --------→ *a species is the smallest possible group of a sexually reproducing organisms that possesses at least one digonostic character, which is present in all members of the group but is absent all close relatives of that group.*

The diagnostic characteristic of a species may be any genetically determined feature including behavioural features. But, male and female of the same taxon can not be considered to be separate species although is genetically determined.

Advantages:

- This concept emphasizes on diagnostic characters that an organism has acquired through organic evolution.
- It is somewhat flexible with the rigidity of interbreeding laid by the biological species concept.

Disadvantages:

- It is silent about the agamospecies and asexually reproducing organisms.
- It is reluctant about the genetic variations of geographically isolated populations of same species.

ALLOPATRIC SPECIES:

Allopatric speciation occurs when the new species evolves in geographic isolation from the parent species. The species range indicated by circle in the figure below becomes subdivided by a barrier (eg. a mountain range, changing course of river etc.). Gene flow between the two subpopulations becomes impossible allowing evolution to proceed independently in each. Natural selection may favour different genotypes on either side of the barrier and random genetic drift and mutations could contribute to divergence

in the hereditary characteristics. Over time, divergence may lead to the extent that they would not be able to interbreed and speciation would be complete.

Example: speciation in the Cichlid fishes (*Haplochromis* sp.) in Lake Victoria is thought to have occurred tohrough the isolation of small founder populations caused by changes in the drainage pattern of the rivers feeding the lake. Small changes in male colouration, courtship behaviour etc. have resulted in formation of as many as 170 reproductively isolated species.

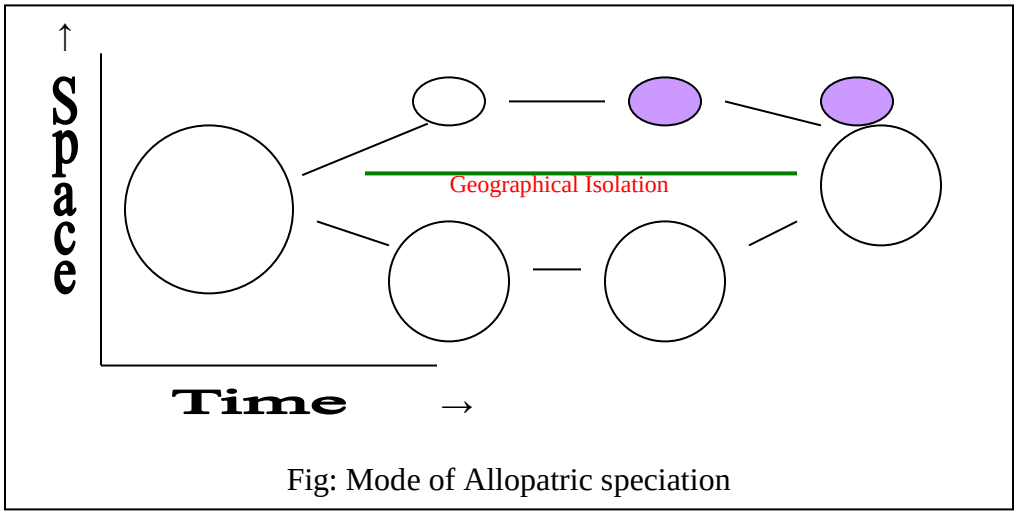

Fig: Mode of Allopatric speciation

SYMPATRIC SPECIES:

Sympatric speciation describes a situation where there is no geographical separation between the species populations. All individuals are, in theory, able to meet each other during the speciation process. This model requires a change in host preference, food preference or habitat preference. Sympatric species originate by instantaneous development of reproductive isolation between segments of species population due to selection change in their genotypes. Once reproductive isolation is established, each population follows its own evolutionary pathway and forms sympatric species.

Example: A change in the host-plant preference can happen very rapidly. The apple maggot, *Rhagoletis pomonella*, was first found on apples in 1864 having mover from its previous host , hawthorn (both hosts used by ermine moth). Mating , feeding and egg-laying takes place on the host plant so that the two forms no longer meet in the wild. Although only 100 generations old, they have established extensive enzyme differences although reproductive isolation is not complete here.

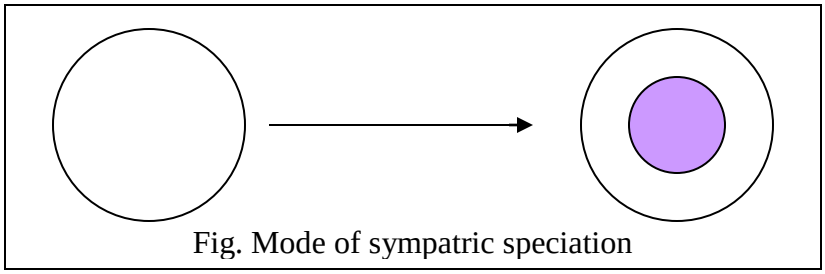

Fig. Mode of sympatric speciation

PARAPATRIC SPECIES:

Here speciation occurs where the speciating populations are contiguous and hence only partially geographically isolated. They are able to meet across a common boundary during the speciation process. Where a species occupies a large geographical range it may become adopted to different environmental conditions in different parts of that range. Intermediates or hybrids will be found but the large distances involved prevent the two types from merging completely.

Example: The herring gull (*Larus argentatus*) is a ***ring species*** whose distribution covers a large geographical area. Westwards from Britain towards North America its appearance changes gradually; but it is still recognizable as the herring gull. Further west in Siberia it begins to look more like the Lesser black-backed gull *Larus fuscus*. From Siberia to Russia and into the northern Europe it becomes progressively more like the Lesser black- backed gull. The ends of the ring meet in Europe and the two geographical extremes appear to be good biological species.

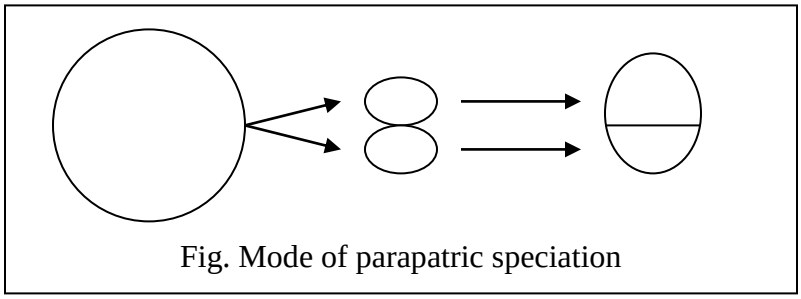

Fig. Mode of parapatric speciation

AGAMOSPECIES:

Organisms having uniparental origin are called agamospecies. Here terms like *interbreeding* and *reproductive isolation* keep no value. As such biological species concept fails to define such species.

BIOLOGICAL SPECIES	***AGAMOSPECIES***
1. Biological species are capable of interbreeding.	1. Agamospecies never interbreed.
2. Biparental mode of reproduction involving random union of male and female gametes.	2. Uniparental and asexual mode of reproduction is the rule here.
3. Rnadom mating or panmixia occur between different genotypes.	3. Panmixia absent here.
4. Offspring bear the genetic traits of both the parents.	4. Genetic traits of only one parent is transmitted to the offspring.
5. Variation is observed in greater proportion here due to frequent addition of new traits in the gene pool.	5. Little variation is attained due to less chance of addition of new traits in the gene pool.

Reference:

PRINCIPLES OF SYSTEMATIC ZOOLOGY by Ernst Mayer and P.D. Ashlock