

Genetics and Evolution IB 201 06- Lecture 12

Species and Speciation

SPECIES

All cultures, early and modern, group organisms based on similarities and differences in:

1. morphology
2. behavior
3. ecology
4. reproductive compatibility

Species are the units of biodiversity; they are the basis of our classification systems. Thus we are interested in grouping organisms based on **evolutionary history**. The tree of life is the result of millions of speciation events over time.

I. What is a species?

A. Most usable definitions converge on *two major principles*

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B. Differences among species concepts arise because

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C. General criteria of species concept

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II. Species concepts

A. Evolutionary pattern-based concepts (taxonomic/phylogenetic)

1. Darwinian species concept (Wallace 1865, Darwin, 1859)

Criterion:

Problem:

2. Morphological species (Cronquist, 1978)

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Criterion:

Problems:

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3. Phylogenetic species (Cracraft, 1989)

Criterion:

Problems:

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B. Evolutionary process-based concepts (biological)

4. **Biological Species** concept, Mayr, 1963 (also known as the Isolation concept)

Criterion:

Problems:

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5. **Mate Recognition** (Paterson, 1985)

Criterion:

Problems:

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Additional References

- Futuyma, D. J. 2005. *Evolution*. Sinauer, Sunderland, Mass.
- Cracraft, J. 1989. Speciation and its ontology: the empirical consequences of alternative species concepts for understanding patterns and processes of differentiation. (pp. 28-37, 55-59). In Otte, D. and J.A. Endler. *Speciation and Its Consequences*. Sinauer, Sunderland, MA.
- Cronquist, A. 1978. Once again, what is a species? Beltsville Symp. Agricult. Res. 2: 3-20.
- Hey, J. 2001. The mind of the species problem. *Trends in Ecology and Evolution* 16: 326-329.
- Harrison, R.G. 1998. Linking evolutionary pattern and process: the relevance of species concepts for the study of speciation, pp. 19-31. In *Endless Forms: Species and Speciation*, (Eds. Howard, D.J and S.H. Berlocher), Oxford University Press, NY and Oxford.
- Howard, D.J and S.H. Berlocher. 1998. *Endless Forms: Species and Speciation*. Oxford University Press, NY and Oxford.
- Mayr, E. 1963. *Animal Species and Evolution*. Harvard University Press, Cambridge, MA.
- Mayr, E. and P.D. Ashlock. 1991. *Principles of Systematic Zoology*. 2nd Edition. McGraw Hill, NY. (Chap. 5, pp. 86-109, Speciation and taxonomic decisions)
- Paterson, H.E.H. 1985. The recognition concept of species. In Vrba, E.S., ed., *Species and Speciation*, pp. 21-29. Transvaal Museum Monograph No. 4. Transvaal Museum, Pretoria.
- Templeton, A.R. 1989. The meaning of species and speciation: a genetic perspective. In Otte, D. and J.A. Endler. *Speciation and Its Consequences*., pp. 3-27. Sinauer, Sunderland, MA.

SPECIATION: The *process* of how species evolve

I. General

Species as taxa: Nonetheless, species are real entities, living in interbreeding populations and communities in time and space—they are *real taxa*, which often exhibit greater or lesser amounts of variation. These subdivisions of a species into different populations (assumed to be actually or potentially interbreeding) are known variably as subspecies, races, varieties, etc. Such a subdivided species is known as a polytypic or polymorphic species. The subdivisions are useful only as a means of categorizing the amount of variability within a species, and do not necessarily represent incipient species. The species as groups of interbreeding populations cannot accommodate asexual organisms

Species as a category: A species is also a *rank* in the Linnaean hierarchy (e.g., phylum, class, order, family, genus, species). The species rank includes all forms of organisms that have been described and given names, including asexual species.

Maintenance of species. A species is maintained via gene flow—exchange of genes between interbreeding neighboring populations.

Species are isolated *physically* and/or *biologically*

Species isolating mechanisms refer to the *biological* properties of the organism that prevent them from interbreeding. Isolating mechanisms are especially relevant to sympatric species that overlap in the same area and therefore whose populations are exposed to the potential of interbreeding. Because most interbreeding between animal species often leads to inviable (sterile) or inferior offspring, species isolating mechanisms maintain the unity of a species.

II How do new species form?

In spite of the fact that a species has unifying mechanisms, such as gene flow, it nonetheless can give rise to new descendent forms.

Speciation is distinct from phyletic evolution (anagenesis)

- speciation leads to multiplication of species from a single parental species
- phyletic evolution leads to changes over time (generations) of a single species

Speciation is ultimately dependent on _____.

- 1.
- 2.
- 3.
- 4.

- Premating mechanisms—
- Postmating mechanisms

A. Modes of Speciation

1. Allopatric speciation

Traditional allopatric:

Problem:

2. Sympatric speciation:

Problems

3. Parapatric speciation:

Problem:

4. **Peripatric:**

5. **Allochronic:**

Problem:

B. Stages in Speciation Process

Speciation takes place in basically 3 stages:

1.

2.

3.

Additional References

SHoward, D.J and S.H. Berlocher. 1998. *Endless Forms: Species and Speciation*. Oxford University Press, NY and Oxford.

Otte, D. and J.A. Endler. 1989. *Speciation and Its Consequences*. Sinauer, Sunderland, MA.