Species and Speciation

ARE SPECIES REAL IN NATURE?

- Arbitrary creations of humans?
- Fundamental units of living things?
- Who recognizes species and how?
- How do you define a species with incontrovertible limits?
Species Concepts

- Typological
- Morphological
- Biological
- Evolutionary

Typological Species Concept

- Clusters of individuals closely resembling each other reflecting God’s plan of nature.
- A fixed group of organisms that vary from an ideal “type” that was God’s original blueprint.
- Recognition of such things as sexual dimorphism and life stages
- Recognition of groups more closely related such as genera
- Over-splitting tendency
Pertinence of Typological Concept

- Linneas’s concept
- International codes of zoological and botanical nomenclature require a type specimen, illustrated.
- Concrete reference point for systematics and identification of species.

Holotype of *Ynezidinium malloyi*
Morphological Species Concept

A diagnosable cluster of individuals within which there is a pattern of ancestry and descent, and beyond which there is not.

Morphological Concept of Species

- Similarity of form; inference of ancestry
- Must recognize sexual dimorphism and other variations
- Use of the population concept of a species lessens oversplitting
Pertinence of Variations within Species

- Darwin’s view of species
- Species viewed as part of a population that varied continuously.
- When group varies enough from ancestor, new species (speciation)
- Variation is the stuff of evolution
- Some species continually split into new species

Darwin’s illustration of splitting from a single stem in two species
Biological Species Concept

- An array of populations that are actually or potentially interbreeding, and that are reproductively isolated from other such arrays under natural conditions.
- Wider than population.
- Interbreeding in fact.
- Test of interbreeding - hybrids, fossils
Evolutionary Species Concept

- Lineage evolving separately from others with its own unitary evolutionary role and tendencies.
- Branching points in the “family tree” or evolution.
- Key characteristics that separate the species while allowing for variation and for unity with the genus.

Two species of dinoflagellate cyst *Areosphaeridium*
Process variations between species of dinoflagellate cyst *Areosphaeridium*
Branching Bush with Gradualism

SPECIATION

- How do you get from one species to another - “The origin of species” (Darwin doesn’t tell you exactly)
- Sympatric – change within a population
  - Example: *Areosphaeridium*
- Allopatric – change only with isolation of part of population
Sympatric Speciation

- Darwin’s view plus genetics
- Mutation and “mutation pressure”
- High competition and selective pressure eliminating the unfit - “survival of the fittest”
- The “gene pool” is altered through time.

Sympatric evolution corresponding to environmental change
The Problem of Dilution

- Gene flow within an interbreeding population
- Advantageous mutations would be diluted by interbreeding with normal individuals of the population and disappear.
- Importance of the “peripherally isolated population” – studies of 1940’s, 1950’s

Allopatric speciation corresponding to isolation
Allopatric Speciation

“Widespread Agreement”

4 Stages (see p. 42 text)

1. Large population in homogeneous environment
2. Differentiation of environment or migration leads to subspecies
3. Further D and M leads to geographic isolation of subsp. or race
4. Reintroduction of isolated and main pop. – can’t interbreed.

Founders, Clines and Rings

- Founder species – Individuals isolated by chance that create a new gene pool which may diversify e.g. Darwin’s finches
- Clines – Gradient in features within a species over space or time
- Ring species – Cline over space (biogeographic) that results in failure of end members to interbreed, e.g. European gulls.
Types of Isolation

- Geographic – oceans, mountain ranges
- Behaviors
- Distinct niches
- Feeding habits (Darwin’s finches)
- Small gene pool (e.g. tide pools)
- Parasites

SPECIES IN PALEONTOLOGY

- “any of that large class of objects of organic origin that are of sufficiently distinctive and consistent morphology so that a competent paleontologist could define them so that another competent paleontologist could recognize them.”
  
  Alan Shaw, 1964
  
  *Time in Stratigraphy*
Problems of Species in Paleontology

- Can’t demonstrate interbreeding
- Can’t use behavioral criteria (sibling species)
- Sexual dimorphism
- The dimension of time in Paleontology

The Dimension of Time

- Anagenesis - Phyletic evolution within a lineage.
- Phyletic Gradualism - Gradual change with time of one species to another (speciation)
  - End members are clearly different species
  - Gradual changes make it difficult (impossible?) to draw the line between the two species
- Biologists (neontologists) don’t have this problem
A selection of *Micrasters* (species) viewed apically.

**The Dimension of Time**

**Biostratigraphy**

Donald Weaver:
- “The finer you can cut your taxonomy, the finer you can cut your stratigraphy”
The Dimension of Time

- Evolutionary Species concept of G.G. Simpson
  - Species defined by branching points
  - A single lineage = species
  - Branch points relatively objective

Punctuated Equilibrium

Niles Eldredge
1943-

Stephen J. Gould
1941-2002
Punctuated Equilibrium

- Paleontologists had been conditioned to look for anagenetic series of changes and blame the imperfection of the record when they did not appear. (Darwin)
- Phyletic Gradulaism (anagenesis of species) is actually rare.

Stasis is the rule
- Species remain the same for long periods of time.
- Suddenly a new species appears.
- If anagenesis is rare (or doesn’t exist), then problem of dividing species disappears.
Phyletic Gradualism vs. Punctuated Equilibrium

(a) Phyletic Gradualism

(b) Punctuated Equilibrium

Y. malloyi

I. cingulatum

Phyletic Gradualism

Punctuated Equilibrium
I. cingulatum

Y. malloyi