Biological Species Concept

According to the biological species concept, a biological species is a unit not of resemblance but of reproduction. Male and female organisms that are capable of producing fertile offspring are members of the same species. Otherwise, they are not. No amount of resemblance can override reproductive isolation. This concept defines a biological species as a maximum reproductive unit and thus as a real and discrete segment of nature. As discussed elsewhere, species naturally tend to lose cohesion and disintegrate into genetically incommunicative subgroups.

According to this perspective, a species is an individual and a particular, not a class or natural kind. Wiley (1981) describes a phylogenetic taxon as a group to which a proper name could be given. A species is not defined by its Aristotelian essence, and individual organisms are not variations of a Platonic ideal. An organism is to its species as a part is to a whole. A species is the sum of its constituent organisms. Philosophers like to discuss the induction problem associated with the diachronic phrase "All swans are white." But the synchronic assertion can, in principle, be made that the species "swan" is currently composed exclusively of white organisms.

Suppose a paleontologist says that the same species of frog has existed for 50 million years because fossil skeletons of that age look the same as those of extant frogs (*Xenopus laevis* is said not to have changed much in 125 million years). The following scenario is based on the example of the California salamander, *Ensatina californica* (Stebbins, R. C., 1949. Speciation in salamanders of the Plethodontid genus *Ensatina*. Univ. Calif. Publ. Zool., 48: 377. cited in Milkman, R.. *Perspectives on Evolution*. Sinauer Associates Inc., 1982).

Consider a species of frog consisting of a sequence of populations (demes) specified A through Z distributed around the periphery of a mountain range in a horseshoe pattern. Frogs usually mate with other frogs in the same pond, forming a local deme. Occasionally, a frog will hop over to a neighboring pond and mate with a frog in the adjacent deme. When a male and female frog from the same deme mate, they produce fertile offspring. When a male and a female frog from different demes are mated, the probability of producing fertile offspring declines with the distance between the demes involved.

Suppose that George is a male frog in deme A and Martha is a female frog in deme Z. If George and Martha mate, they will be unable to produce fertile offspring. Are George and Martha part of the same species? They can be considered to be of the same species as long as some route exists by which genetic information can make its way back and forth between demes A and Z over the course of many generations. Indirect genetic linkage suffices, as cohesion does not require panmixus.

Invoking vicariance biogeography, suppose a volcano erupts, destroying all of the species in question except the terminal demes (A and Z) such that there is no longer any possible genetic interaction between these remaining groups. George and Martha are the same frogs that they were yesterday, but their respective demes are now reproductively isolated, such that George and Martha are can no longer be regarded as members of the same species. They cannot share the same specific name because that would signify being part of the same species, which they are not. Maybe one should retain the name of the old species and the other should be given a new name. But this would imply that the species with the new name changed and the other did not, when in fact neither changed. The frogs have not changed since the time when they belonged to the same species, but the species itself has changed because most of its component no longer exist. That original species must now be considered the ancestral species. George is no longer part of that ancestral species because that species included Martha, while the species to which George currently belongs does not. The same goes for Martha. Both species must be given a new name. The difference between George and Martha was part of the structure of the old species and caused it to be poised for speciation.

If George and Martha can look the same and yet go from the same to different species overnight, then the phylogenetic status of a frog 50 million years ago cannot be judged conclusively. It is wrong to assume, based on gross morphological resemblance alone, that fertile offspring would result if a time machine brought together skeletally similar frogs separated by 50 million years. Phenetic relationships lack the power to determine phylogenetic ones. Further, Martha's situation reflects the fossil record in microcosm, given the impossibility of an intermediate between Martha and herself.

Subpanmictic populations such as those cited above contain incipient sibling species. As with the earlier discussion of reducibly complex penultimacy, this example demonstrates the potential for building down to sibling species by selecting them from within a larger ensemble.

Alternatively, maintenance of species identity according to the evolutionary species concept is based on phenotypic similarity. By this standard, gross morphology suffices to diagnose fossil and extant frogs as being of the same species even if they would be reproductively isolated if coexistent. This isolation can arise via forms of gradualism accommodated even by the punctuated equilibrium model, for it may only be gross morphology, not phylogenetic status, that experiences long periods of stability. Molecular clocks keep right on anagenetically ticking whether gross morphology changes or not. Instead of a missing link, there can be a missing gap when, during a single lifetime, one organism can span two species, and two organisms can belong to three species, as in the example above. Mosaic evolution may also occur, in which traits take turns being static such that their periods of stasis are staggered. Additionally, even asexual species are subject to epigenetic homeostatic forces that are independent of gene flow. Also recall that gaps in the fossil record could reflect the large morphological transformations that can result from subtle regulatory changes. Finally, let there be a reminder that species should be evaluated holomorphologically. In other words, the total spectrum of characters expressed throughout the life of an organism should be considered.

Helpful resources:

Dennett, D.. *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. Simon and Schuster, 1995. (see especially chapter four, section 3: "Retrospective Coronations: Mitochondrial Eve and Invisible Beginnings.")

Brooks, D.R. and E.O. Wiley. *Evolution as Entropy: Toward a Unified Theory of Biology*. University of Chicago Press, 1986.

Weber, B.H., D.J. Depew and J.D. Smith, eds. *Entropy, Information, and Evolution: New Perspectives on Physical and Biological Evolution*. MIT Press, 1988. (see also: http://chemsrvr2.fullerton.edu/DeptWebsite/Weber.html and http://nsmserver2.fullerton.edu/departments/chemistry/evolution_creation/web/)

Wiley, E.O.. *Phylogenetics: The Theory and Practice of Phylogenetic Systematics*. John Wiley and Sons, 1981.