

## ENCYCLOPEDIA ARTICLE

## Species concept

The idea that the diversity of nature is divisible into a finite number of definable species. In general, species concepts grow out of attempts to understand the very nature of biological organization above the level of the individual organism. There are two basic questions: (1) What does it mean to be a species in general? Do all species have certain characteristics, such as forming genealogical lineages, just as all atoms have certain characteristics, such as the ability to undergo chemical reactions? (2) What does it mean to be a particular species? The first question addresses species concepts. The second question addresses how to apply a species concept to living organisms of the world. Does the name *Homo sapiens* apply to a group of organisms existing in nature? If so, does it belong, as a member, to a natural kind that can be characterized by some set of properties? The difference between the questions of what it is to be a species in general versus what does it mean to be a particular species represents the dividing line between what it is to be a natural kind and what it is to be a natural individual. To understand this distinction, we must first take up the more general question of the nature of kinds. We can then return to the question of species concepts. See also: Speciation

### Kinds and particulars

Kinds are attempts to divide the world of particulars according to a definition that specifies properties that separate individuals into two classes: those particulars that have the properties are members of the kind, and those particulars that do not have the properties belong to another kind. What do we mean when we say "particulars"? Particulars are individual things in nature. We can usually point to particulars, such as pointing to a cat or pointing to a truck. A particular belongs to a kind if the particular has the properties that define the kind. For example, we might define the kind "black cat" as those cats that have the property of being covered with black fur. My black cat belongs to this kind, but my gray cat does not since it lacks the property of the kind. In fact, black cats in general (every black cat that has ever lived or will live in the future) belong to the kind "black cat."

As it turns out, there are at least two types of kinds: nominal kinds and natural kinds. The difference between nominal and natural kinds lies in how the kind functions. Natural kinds function in scientific theories of how nature operates, because the theory asserts that certain particulars (individuals) have certain properties. For example, the kind "atom" functions in theories of physics and chemistry as the smallest kind of matter whose members (particular individual atoms) can take part in chemical reactions (the property). In turn, hydrogen is a kind of atom whose members have one proton (property), while helium is a kind of atom whose members have two protons (another property). Kinds such as hydrogen and helium are natural kinds because members of each kind (individual atoms of hydrogen and helium) are predicted to exist under the right circumstances and have their properties as an assertion of our theories of chemistry and physics. In contrast to natural kinds, most of our language is filled with nominal kinds. Nominal kinds are not predicted by scientific theories, but function to allow us to communicate ideas. For example, no scientific theory predicts the kinds "truck" and "bicycle." Yet, nominal kinds have properties (trucks have four wheels, bicycles have two) that allow us to distinguish trucks from bicycles. Thus, nominal kinds may have useful functions in communication, but they are not directly derived from scientific theories. See also: Scientific methods

### Concepts and theories

Since Aristotle, biologists have attempted to develop a concept of "species" that will function in biology as a natural kind in a manner similar to natural kinds in other disciplines such as "quark" in physics and "atom" in chemistry. This search was inhibited because philosophers have traditionally thought of particular species (*Homo sapiens*, *Pinus ponderosa*, etc.) as natural kinds, or sets; or they thought that particular species were nominal—arbitrary but useful inventions of taxonomists to organize the real entities, that is, individual organisms. However, work by Michael Ghiselin, David Hull, and others asserted that particular species were, in fact, particulars that function in evolutionary theory in the same manner as individual atoms function in chemical theory—as interactors or participants in process. If this is so, then each of these individual species would be members of a natural kind, "species," that had properties predicted from evolutionary theory. Attempts to capture the properties of the kind "species" result in a species concept.

The ideas that organisms could be grouped into more or less discrete units, and the idea that some of these units were more similar to each other than to other units, long predated ideas about evolution. That there was a pattern to life's diversity gave rise to the first species concept: members of one species are different in their physical characteristics from members of other species, and their offspring look like them (like begets like). This concept was the basis for both folk taxonomies (names of different groups of individual organisms in common language) and scientific taxonomies (formal names meant to have scientific import). As the practice of scientific taxonomy developed, species were gathered into larger groups based on similarities and differences. These groupings were hierarchical and seemed to reflect patterns of similarities and differences seen in nature. Current evolutionary theories seek to explain why life's diversity seems to be arranged in the hierarchical manner that we see in nature. See also: Taxonomic categories; Taxonomy; Zoological nomenclature

Like all scientific theories, theories of evolution predict natural kinds with attendant properties that are found in individuals. Theories of evolution can be generally divided into two basic themes. Microevolutionary theory is concerned with evolutionary change within and between populations of individual organisms. Processes include natural selection, gene flow, and stochastic processes such as genetic drift. These theories do not address the hierarchical patterns that predate Darwin and have fascinated biologists since Linnaeus. Rather, they predict that populations of individual organisms will change through mutation, selection, and drift in predictable ways. Macroevolutionary theory is concerned with the origin and fate of species. It directly addresses the hierarchical nature of diversity. Process theories that purport to explain the hierarchy include speciation and extinction. These two themes, micro- and macroevolution, intersect at the level of species. From the macroevolutionary perspective, species are those particulars that originate from various processes of speciation and disappear through extinction. Macroevolutionary processes follow the "rules" of microevolutionary processes, but add an extra level of processes such as response to a physical barrier that divides a once continuous population into two populations. Thus, the natural kind "species" has members (particular species) that undergo such processes. See also: Macroevolution; Organic evolution

The problem with species concepts derives from the problem with changing ideas of the world in general. Our concepts of natural kinds, and indeed whether we think that a certain kind is real (has members in the world) or unreal (properties can be listed, but nothing exists that has the properties, like unicorns or fairies), depend on our current theories. The recent controversy concerning the definition of the kind "planet" is an example. Pluto has been rejected (at least for the moment) as being a planet based on current theory, and a new kind, dwarf planet, has been proposed that includes not only Pluto but other smaller bodies in the solar system, such as the asteroid Ceres. The hope is that the closer the theory is to nature, the more predictive will be the kinds and their properties. So it is with species concepts.

### **Types of species concepts**

Species concepts, in one form or another, have been around for several hundred years. Each concept (and there are over 20 current ones) is an attempt to capture the properties of the largest (or smallest) kind and thus permit a search for particulars (*Homo sapiens*, etc.) that are members of the kind. Of the plethora of species concepts, evolutionary biologists (including systematists and taxonomists) seem to be converging on the concept of species-as-lineages, the Evolutionary Species Concept—species are those things that exist between speciation events and that originate through speciation events (Henning, 1996; Wiley and Mayden, 2000). Other concepts capture part of this more general concept. For example, the venerable Morphological Species Concept claims that different species have different or slightly different physical characteristics. This is true for many species (humans versus chimpanzees), but not true for others where speciation has resulted in behavioral or genetic changes with little or no detectable change in physical characteristics (as in some closely related fruit flies). The popular Biological Species Concept asserts that species have the property of reproductive isolation. This seems to be true for a great number of species, but not for all species and especially not for many species of recent origin. This has led workers such as Richard Mayden to assert that all currently valid species concepts (kinds for which examples can be found in nature) are different reflections of the more general natural kind, that is, the Evolutionary Species Concept. Of course, even if all evolutionary biologists agreed with Mayden, this does not end controversies as to whether a particular species is real. For example, is *Pinus ponderosa* (a pine tree) real? We might vigorously disagree as to whether or not a speciation event has occurred, based on the evidence presented. We might argue that *Pinus ponderosa* is not a species but is actually two or more species, or simply a population of another species. However, if we can agree, our agreement will be founded both on the empirical data and on a species concept that applies in an unambiguous manner, leading to a consilience (a synthesis of knowledge) between practice and theory.

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## Bibliography

- M. T. Ghiselin, A radical solution to the species problem, *Systematic Zool.*, 23:536–544, 1974
- W. Hennig, *Phylogenetic Systematics*, University of Illinois Press, Urbana, 1966
- D. L. Hull, Are species really individuals?, *Systematic Zool.*, 25:174–191, 1976
- R. L. Mayden, A hierarchy of species concepts: The denouement in the saga of the species problem, pp. 381–424 in *Species, the Units of Biodiversity*, ed. by M. F. Claridge, H. A. Dawah, and M. R. Wilson, Chapman and Hall, London, 1997
- G. G. Simpson, *Tempo and Mode in Evolution*, Columbia University Press, New York, 1944
- E. O. Wiley and R. L. Mayden, The evolutionary species concept, pp. 70–89 in *Species Concepts and Phylogenetic Systematics*, ed. by Q. D. Wheeler and R. Meier, Columbia University Press, New York, 2000

## Additional Readings

- Biological Species Concept
- Species Concept: Selected Definitions

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