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[In *The Scientific Revolution: An Encyclopedia*, edited by Wilbur Applebaum (New York & London: Garland Publishing, 2000), pp. 611-612.]

SPECIES

The scientific revolution of the sixteenth and seventeenth centuries was a crucial period in the historical development of the "species" concept. It is impossible to give an accurate account of this concept in its biological use apart from its origin and development in the context of attempts to construct a *classification* of living things. Classifications of living things prior to this period were largely utilitarian in character. The *De materia medica* of the first century physician Dioscorides, for example, which was the basis for numerous medieval herbals, classified herbs according to their supposed medicinal value. In his *Historia animalium* of 1551, Conrad Gesner (1516-1565) simply arranged animals in alphabetical order according to the common Latin name of each. In neither case was any attempt made to develop a rigorous system of biological classification. A desire to accurately identify the organisms mentioned in the classical writings of antiquity, as well as a desire to bring order to the mass of novel organisms introduced by the voyages of discovery, led Renaissance naturalists to devise new approaches to classification. Critical discussions of the nature of "species" arose from attempts to construct a "natural" classification of living things.

Foremost amongst these naturalists was Andrea Cesalpino (1519--1603). In his *De Plantis Libri XVI* of 1583, Cesalpino rejected the "medicinal" approach to classifying plants by insisting instead on a knowledge of their *essences*, i.e., their similarities and differences of form. Starting from the "main genera" recognized by Aristotle's student Theophrastus (trees, shrubs, undershrubs, herbs), Cesalpino divided each group of plants on the basis of certain features (typically those associated with their reproductive parts) assumed to be essential, terminating in the *infimae species* recognized by herbalists and others. Characters such as color, smell, taste, and those produced by climatic variation were all considered to be accidental properties, and thus could not be employed in distinguishing species. The same sort of approach, he suggested, could be extended to animals as well. For Cesalpino, as for Aristotle, species are eternal and unchanging. In determining species identity by selecting features associated with the reproductive parts, Cesalpino explicitly focused on those structures most directly connected with the propagation of the form of each kind of living thing.

Cesalpino's approach became the conceptual foundation for seminal works in classification by John Ray (1626--1705), Joseph Pitton de Tournefort (1656--1708) and, most famously, Carl von Linné (Linnaeus) (1708--1778). These writers were united in their view that (1) a correct biological classification is representative of

the actual order of created nature; (2) the essential characteristics of organisms can be distinguished from accidental ones; and (3) the term "species" refers to the essences of existent particulars. For example, in his *Historia Plantarum* (1686), Ray proposed logical criteria for determining species identity by separating accidental from essential variations in plants. For Ray, the true forms of nature (i.e., species) are disclosed by the propagation of "seeds". Whatever characters are constant in such propagation comprise the true specific differentiae signifying the essence. Ray was quite liberal in his understanding of characters related to propagation, including similarity in parts of the flower, the number and structure of protective leaves surrounding the flower, the structure of seed cases, etc. All of these characters, however, he considered to be non-accidental. Tournefort, likewise, in his *Institutiones Rei Herbariae* (1719), adopted the Cesalpian distinction between essential and accidental characteristics, but simplified botanical classification by focusing exclusively on external variations in flowers. Although simpler and more rigorous than previous systems of classification, it had the disadvantage of providing at best a definitional criterion for distinguishing essential from accidental characters, in contrast to the systems devised by Cesalpino and Ray, which included an experimental criterion of species membership based on the propagation of seeds.

Although the work of Cesalpino, Ray, and Tournefort was instrumental in the development of biological classification and in the refinement of the species concept, it was Linnaeus' work which ultimately had the greatest impact. In his *Systema Naturae*, originally published in 1735, he undertook a thorough reform of biological classification, including the introduction of the familiar binomial nomenclature (identifying organisms by *Genus species* designations) used today. For Linnaeus, to know a thing amounts to knowing how to name it correctly, and this requires knowledge of the two terms that define the essence: the proximate genus and the essential difference.

The Cesalpian tradition of biological classification, culminating in Linnaeus's work, came under fire in the eighteenth century from George Louis de Clerc, Comte de Buffon (1707--1788), who argued that it is the total morphological resemblance between organisms, rather than just a few "essential" characters, that defines species membership. Prominent French biologists after Buffon, including Antoine-Laurent de Jussieu (1748--1846) and George Cuvier (1769--1832), largely accepted this view of species. It was not until the work of Charles Darwin (1809-1882) that the species concept would be placed on an entirely new foundation.

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