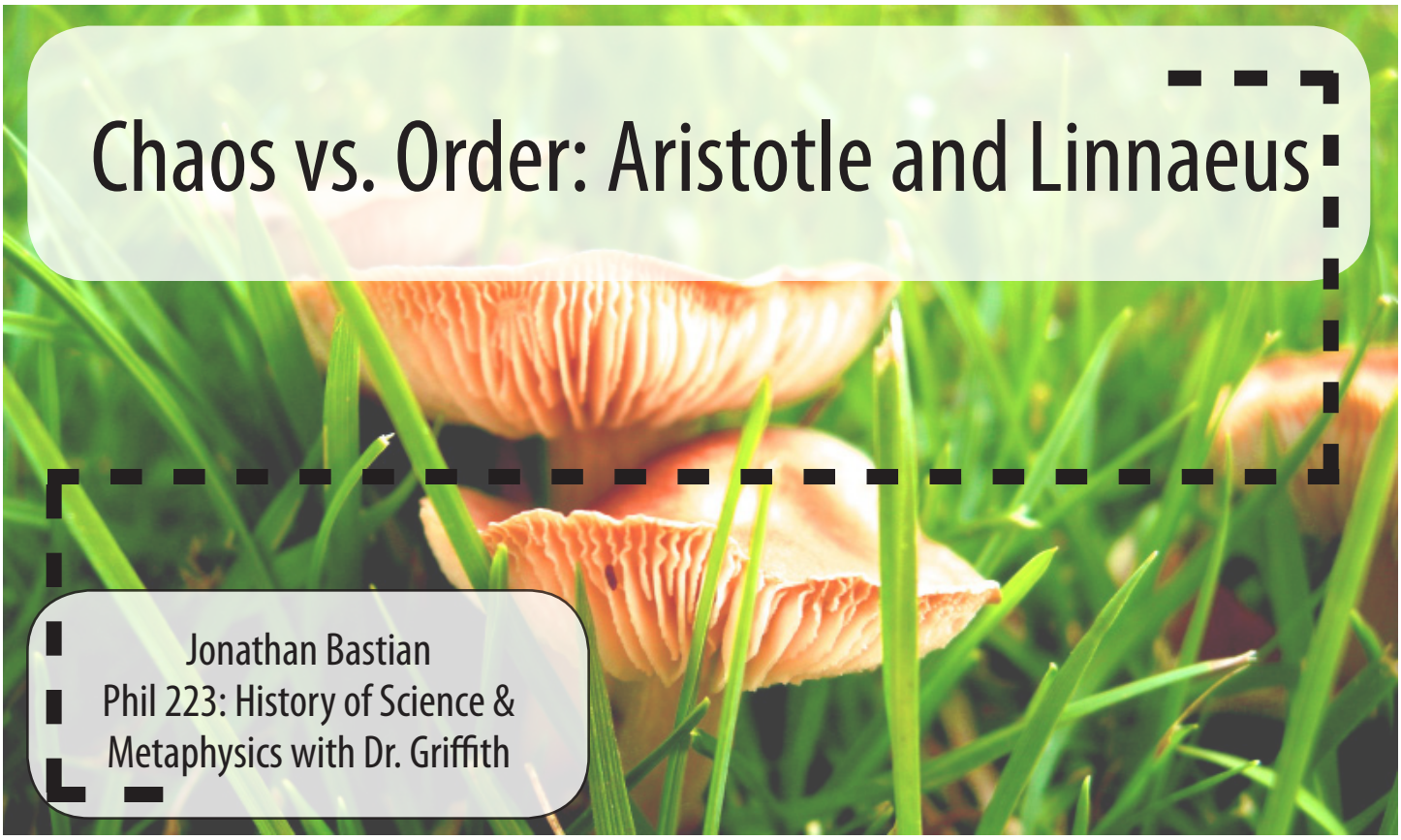

Chaos vs. Order: Aristotle and Linnaeus

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Taxonomy is man's attempt to understand the organizational structure of living organisms. It originates from the idea that there is a supreme being who created everything and, therefore, a perfect organization to living organisms must exist. With their own distinct opinions on how organisms should be classified, philosophers and scientists alike have attempted to make the perfect arrangement of organisms. These methods are all derived from previous methods; hence, we must look at Aristotle and Linnaeus for guidance and to compare what they thought to what modern science appears to tell us regarding the relationship between organisms. Linnaeus' simplistic system of organization is a clear advancement from the hectic system of Aristotle.

To formulate a conclusion of Aristotle's taxonomy method is in some regards quite difficult. The philosopher died 2,331 years ago; consequently, he cannot continue to defend his method against modern methods and science. No one can fully understand another person's thought process, and therefore, we cannot make assumptions regarding a philosopher's methods. Yet, if there is a desire, whether out of necessity or pure casual interest, to understand the development of modern science, one must look at and analyze the ideas and beliefs of the first scientists--philosophers or others--to the best of our ability. Whether modern science confirms it or disputes it, all modern conclusions and scientific philosophies have been influenced by those earliest thinkers.

An extensive component of a philosopher's thoughts is definition. Yet what is definition but merely man's attempt at using words to describe another word? This creates an endless process of attempting to find the definition of a word and then the definition of each word in the first definition. However, Aristotle developed definitions of

numerous words in an attempt to create an organized structure or method of arranging organisms into something called taxonomy. The modern definition of taxonomy is an orderly classification of organisms. Aristotle felt that in order to classify something, it first had to be defined. Based on his philosophy, defining something required a two-step process. First, a broad picture must be taken, meaning, "What kind is it?" This generalization determines if it is a bird, fish, insect, etc. The second step requires detailed information, such as characteristics and properties, for the differentia must be determined. The differentia is defined in the context of Aristotle as, "A particular element or feature that defines one entity from another."[1] An example of this definition would be limbs, whether they are wings, fins, or forelegs. A definiendum is a set of characteristics or differentiae which defines an organism. Additionally, a definiendum must "reveal the object's nature or substance."[1] The final statement means that a definiendum is a method of not only organizing and comparing organisms, but also defining or describing them.

According to the interpretation of Aristotle's writings, he believed the use of a dichotomy to organize organisms put limitations on the system's ability to distinguish organisms. The method of organization using dichotomy is a process of using only one comparative statement at a time. In other words, for every division there are two options. Aristotle believed there were severe logical consequences to utilizing such a method. As an example, an animal can be divided into blooded and bloodless. Blooded animals can be further divided into egg laying and viviparous, meaning a bird is an egg laying, blooded animal. The logical arguments arise by following basic logic. If a bird is a blooded animal and animals are egg laying or viviparous, then birds are either egg laying or give birth to live young, but birds cannot be viviparous.[1] Aristotle used the following example to defend his point: "Dichotomy splits natural kinds. If we divide animals into terrestrial and aquatic, then we cannot go on to divide either side into blooded/bloodless or polypod/footless, since there would have to be some of each on each side."[2] The supporting example of his argument has validity to a certain degree. It is true that dichotomy splits organisms, but the problem lies in the differentiae he uses to organize his taxonomy, such as blooded and bloodless. Also, labyrinth-like organization would be created if a system never split natural kinds. The reason behind this statement is the fact that living organisms have many similarities with other organisms. In defense of Aristotle's method of organization, the knowledge which modern science has revealed to us helps us better understand the design of organisms, and therefore we can better organize and categorize different organisms.[2]

Since Aristotle disagreed with the dichotomy system, he devised a system in which there are at least three differentiae simultaneously. There were three rules which Aristotle used to organize his taxonomy of organisms. First, a "Genus is in the category of substance, while differentiae are qualities."[1] The second rule was "successive differentiation," which is where each differentia is an addition to the previous one.[1] The third rule goes back to the issue of a dichotomy where a genus must be divided multiple times simultaneously and not one at a time.[1] Moreover, generic differentiae are used, which means that feathers, scales,

and hair are all one differentiae based on the outer surface of the organism. By using his three rules, he determined that the best way to compare organisms is by analyzing four different classes of characteristics: body parts, life histories, actions, and disposition or psychology. By using those characteristics, an optimal scientific picture of an organism could be created. Once a complete definiendum is determined for an organism, each living thing is placed into one of ten main groups or categories: man, viviparous quadrupeds, oviparous quadrupeds, birds, fishes, cetaceans, molluscs, crustaceans, testaceans, or insects.[1] The first six are in the larger category of blooded and the last four are in the larger category of bloodless.[1] Though vague, the understanding of intermediate differentiae is that it encompasses many categories without direct order. Based on a comparative review of numerous scholarly resources and the conclusions of the author, the organizational structure of Aristotle's taxonomy includes a genus and multiple differentiae.

Multiple differentiae was Aristotle's method of using categories to organize organisms. However, the issue of defining multiple differentiae is difficult and subjective according to a person's conclusions on interpretations. Within Aristotle's works regarding this subject, he makes mention of numerous groups of organisms. However, what is not clear is whether these groups were meant to be a sub-genus classification. Moreover, it is challenging to differentiate between notes about organisms he dissected and notes pertaining to his method of taxonomy. According to his records, he dissected hundreds of organisms and recorded thousands of observations by investigating the comparative anatomy of those organisms where they were similar. Whether these groups of similar characteristics were used in the organization of species, no one will know. The important principle of his taxonomy structure is that he used categories to organize and group organisms based on similarities.

Understandably thought provoking, the properties that Aristotle used to compare organisms are quite peculiar and for some, rather ludicrous. In the History of Animals, Aristotle states, "Animals differ from one another in their modes of subsistence, in their actions, in their habits, and in their parts."[3] When this statement is taken out of context, it is a valid statement. However, by using an organism's habits as a method of comparative organization, there are no definitive and unchanging habits of a species of organisms. As individuals and species adapt and evolve to live in adverse conditions, their habits change. Additionally, the organizational pattern does not appear suited to organize millions of species in one universal method. However, the primitive scientific knowledge of organisms greatly limited Aristotle in his ability to understand the relationship between organisms.

As years progressed and knowledge of the scientific field expanded, the methods of organizing organisms became clearer and easier. Additionally, the knowledge gained allowed the entire system to be greatly simplified. A Swedish man, Carolus Linnaeus, was born in 1707 as a poor man. He was a religious man and one who strongly supported his creationist beliefs. These beliefs carried through into his development of a classification system for organisms. He began his career as a medical doctor, but the love and fascination of plants caused him to become consumed

by the world of plants. He soon began to notice a hierarchy within organisms, especially plants.[4]

His system ignored slight variations within species and instead used the "perfect specimen" to enable him to organize his system. Linnaeus was influenced by John Ray, a naturalist who died a few years before Linnaeus' birth. Carolus disagreed with Ray more than he agreed with him, but knowledge of the deceased naturalist helped Linnaeus to develop a more perfected system by looking at other systems which had flaws in them. Linnaeus concluded that the ideal distinguishing characteristic is the behavior of the fruit on plants. By using the position of the fruit on a plant, he developed 1,000 genera by which plants could be grouped. He then grouped genera or genus into "ordos" or orders based on the number of female flower parts. Next, the orders were grouped into 24 classes based on the number of male flower parts. By using the four level hierarchy system, not only did he classify thousands of plants, but he also classified 4,235 species of animals.[4]

He also developed the broader picture of a classification system. He believed that there were three kingdoms: animals, plants, and minerals. The idea of minerals being part of the overall system was from the influence of Aristotle. He stated, "'The whole world, animate and inanimate, must stand in some natural order as a hierarchy.' (*Systema Natura*, 1758)."[4] The animals were part of six classes: Mammalia, Aves, Amphibia, Pisces, Insecta, and Vermes.[4] The rather simple method of organization received both criticism and praise.

Most of the criticism derived from the lack of flexibility in adding new organisms and species which do not follow typical biological standards. Yet, in Linnaeus' later writings he discussed the issue of flexibility by declaring that species have a lot of variation and there are many factors which cause this variation, such as soil conditions. He also accepted the fact that hybridization between two different species is possible. This long enduring system has apparently been flexible enough to withstand hundreds of years of tests against modern science. Nevertheless, Linnaeus was not content with his system and made futile attempts at developing alternative methods without success. He also developed the current naming system of using the genus and species by using the Latin terms. The majority of criticism has since left as the biological field sees how adaptable his system was to new and different species.

The development of a taxonomy structure from Aristotle to Linnaeus is quite clear. The simplistic yet comprehensive system of Linnaeus makes up for the hectic and selective system of Aristotle. The inability to directly compare the two great biologists is the fact that they lived two thousand years apart. We cannot compare the knowledge and the philosophies of these two without giving them the same knowledge of plants and animals. The advancement in the understanding of these organisms had exponential growth. Having stated this, we must also look at the influence which Aristotle had on Linnaeus. First, Linnaeus was able to study these historical methods and look that the flaws based on the current knowledge of organisms. Additionally, Linnaeus did use some of Aristotle's ideas, including the idea of minerals being part of the organizational structure.

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