NATURE AND TAXONOMY, SYSTEMS OF

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Definition/Introduction

Among early modern naturalists, “systems of nature” are the methods used by naturalists to classify living beings. Taxonomy, a word coined only in 1813 by de Candolle, refers to the classes or taxa that are obtained by applying one or another method of classification. Here I present some such methods in order to illustrate their variety (1.1). I also explain the difference between natural and artificial systems (1.2) and summarize contemporary debates on early modern taxonomy and essentialism (1.3). Early modern taxonomists are indeed not the only humans to classify natural beings (2.1). However, I try to describe the specificity of their activity (2.2 to 2.5). Finally, I review some cultural, political, and religious aspects of early modern taxonomies (3.1 to 3.5).

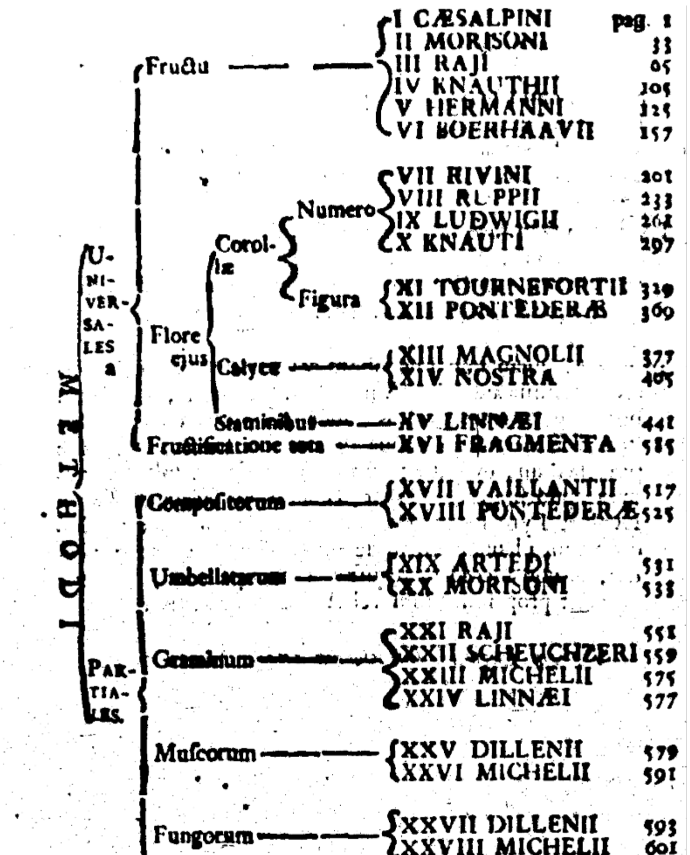
Systems and taxonomies

The variety of systems

In Greek, *sustêma* meant a set of things such as celestial bodies or political entities. In the sixteenth century, the word *system* (*systema* in Latin, *système* in French) began to cover a more specific meaning in scientific circles, namely a set of propositions forming a coherent, although not necessarily true, image of the world. It is in that sense that Galileo Galilei (1564-1642), the Italian polymath, titled his book *A Dialogue concerning the Two Chief World Systems* (1632). In that case, a system is akin to a theory or a hypothesis.

In botany or in zoology, the term “system” was sometimes used in that way. However, most of the time, until the eighteenth century, when naturalists spoke about systems, they meant methods of ordering. Thus, in his book *Classes plantarum* published in 1738, the Swedish naturalist Carl Linnaeus (1707-1778) explicitly compared systems aiming to classify plants proposed by about twenty of his predecessors (see image 1). In the preface, he underscored the practical purpose of the classificatory systems: “there are various systems, some prepared from the fruit, some from the petals, some from the calyx and stamens, yet all aim at the same purpose and target, namely to guide the amateur of botany to genera expediently" (quoted in Müller-Wille 2013, 309).

Linnaeus discussed among others the systems of Joseph Pitton de Tournefort (1656-1708), Augustus Quirirmus Rivinus (1652-1723), and John Ray (1627-1705). In his *Elements of Botany or Method for Recognizing Plants*, the Frenchman Tournefort, director of the Jardin du Roi in Paris, proposed to classify plants following the structure of the corolla (i.e. the petals of the flower). He argued that looking to other parts of the plant would lead to "great embarrassments." He thus chose that method primarily for a practical reason, namely that the petals are the most visible part of the plant (at least in those that are pollinated by animals). Thanks to its simplicity, his system encountered great success among European botanists. Rivinus, a German, born Augustus Bachmann, also proposed in his *General Introduction to Botany* (1690) a method of classification focusing on the petals. However, contrary to Tournefort, he looked at their number rather than their form. The Englishman Ray, for his part, was the first to distinguish in his classification between monocotyledons and dicotyledons, plants whose seeds contain respectively one or two embryonic leaves.



[Image 1: In *Classes plantarum* (1738), Linnaeus presented and compared some twenty systems. The table of content was at the same time a schema ordering those systems. (Extract from the edition put on the Internet by Archive, no copyright.)]

Linnaeus himself became famous for defending the "sexual system," a method of classification based on the observation and comparison of the number, form, proportion and disposition of the reproductive organs of plants, the stamen and the pistil. However, he was not the first to use it: the Italian naturalist Andrea Cesalpino (1519-1603) had a direct influence on Linnaeus's choice that Charles Darwin (1809-

1882), the English father of the evolutionary thought, was to approve one century later. Notwithstanding, Linnaeus and Darwin had different rationales justifying the use of the sexual method. The former selected the sexual parts because they are essential not to the individual but to the kind. Indeed, without sexual organs, even if the individual could survive, the kind could not be perpetuated. Moreover, the sexual organs have two additional advantages: they are fairly stable in a given species, but highly variable between species, two important features for any classificatory character (Richards 2016). Finally, on an even more practical level, the sexual organs are in general easy to observe in plants. For his part, Darwin defended the sexual system with his evolutionary theory in mind. For him, a trait that emerged as a superficial adaptation to the milieu did not constitute a useful feature for classification. However, he argued in *The Origin of Species* (1859, ch. 13) that reproductive traits, unlike skin color or height for instance, are not likely to be adaptive to a particular environment and could thus serve as a good key for taxonomy. As we see, historians and philosophers of the sciences should not only look to the superficial similarities in the methods used; one must also study the various underlying justifications for those methods.

Artificial and natural systems

As a matter of definition, one can distinguish systems from taxonomies in that the one is a means for the other. Thus if a system is a method for classifying plants or animals, a taxonomy would be the whole set of categories or taxa obtained by following a given method. Even if this is a useful distinction, it should, however, be noted that early modern naturalists often used “system” for the resulting classification, since the term “taxonomy” only appeared in 1813, under the pen of the Swiss naturalist **Augustin Pyrame de Candolle** (1778-1841).

Following the system used, the resulting taxonomy can vary significantly. It is in this sense that Linnaeus spoke of “artificial systems.” Ideally, taxonomists should uncover the “natural order” based on all the traits of the plants or animals. The “natural system” corresponds more to the intuitive way of classifying plants and animals, where overall appearances, not separated aspects, are taken into account. However, according to Linnaeus, as long as that intuitive classification lacks a clear justification, it cannot be used at a scientific level because it could lead to confusion as a result of its subjectivity. The artificial systems, among which Linnaeus counted his own sexual method, are only provisional, for lack of anything better. The French author **George-Louis Leclerc, Comte de Buffon** (1707-1788) adopted a harsher stand toward the natural systems. In a nominalist vein, he maintained that only individual organisms exist, while taxa such as genera, orders, and classes are only “in our imagination.” Therefore, according to Buffon, even if all the traits could be compared at the same time, this would not yield a natural system. However, as Phillip Sloan (1976) has argued, Buffon was less Lockean than Leibnizian. Contrary to the English philosopher **John Locke** (1632-1704), the French naturalist did not reject all categories. Like the German thinker **Gottfried Wilhelm Leibniz** (1646-1716), he would accept a category as real if it is grounded on an underlying reality. He believed that the various species, but not the other orders, were real in that sense, because the analogies between the individuals of a same species were based on the reproductive lineages they form. We could apply to Buffon what Justin Smith (2015, 236) says about Leibniz: a species is “a relatively isolated reproductive community, all of whose members may be said to be members of the same species not in virtue of any morphological resemblances (though they generally have these as well) but rather in virtue of shared origins.”

Thus Buffon proposed a species concept, still used today in some contexts, not based on particular visible traits, but on the capacity of the organisms to give birth to non-sterile offspring. He did experiments with matings of donkeys and horses that yield mules, unable to give birth in their turn, thence the non-sterile provision in his definition of species. The French naturalist argued that if two organisms can interbreed, then they are part of a same lineage, i.e. a same species. However, that criterion was much less practical than the artificial systems based on visible traits. It is for instance difficult to test for interfertility in non-domesticated organisms. Buffon himself found it hard to test for it in foxes and dogs, for instance, because the former did not wish to approach the latter.

Essentialism

The distinction between natural and artificial systems was an important one for Linnaeus's contemporaries. However, historians and philosophers of science also draw a distinction between essentialist and non-essentialist taxonomies, a distinction that was not explicitly present in early modern naturalists' controversies, even if it is somewhat linked with the distinction between natural and artificial systems. In 1965, David Hull published an article in two parts entitled "The Effect of Essentialism on Taxonomies - Two Thousand Years of Stasis." In it, he argues that prior to Darwin, all naturalists, from Aristotle to Linnaeus, looked for the immutable essence of species and other taxa. Following essentialism as conceived by Hull, in each species (or other taxon), we could find criteria that are "severally necessary and jointly sufficient." For instance, to be considerate chordate an animal must have: (a) a notochord, (b) a hollow dorsal nerve cord, (c) a post-anal tail, (d) a metameric segmentation and (e) a circulatory system. These features are severally necessary to define a chordate, which means that each one must be present. Inversely, if an animal possesses all these features, it must be a chordate. It is to say that those criteria are jointly sufficient to define that taxon. On the contrary, because evolutionary thought emphasises changes, a criterion present at a given moment could disappear some generations later. Therefore, for Darwin, there are no essential criteria that define a species. We can use some features provisionally in order to facilitate communication between scientists, but they are not a reality as such. Moreover, in the evolutionary thought, there are no essential differences but only gradual ones. Curiously, Hull does not discuss Buffon who is also anti-essentialist in a rather similar way to Darwin, even if writing a century earlier (note however that Buffon, contrary to Darwin, did not conceive the transformation of one species into another).

More recently, Mary Winsor (2003) has criticized the historical analysis of Hull and others such as Ernst Mayr or Marc Ereshefsky. Following Winsor, we may affirm that taxonomies before Darwin were not as essentialist as those scholars describe them. Indeed, as a methodological stance, Linnaeus defended for instance that the naturalists should select within a species one individual and describe it as precisely as possible. The same within a genus: one should select a species and describe it in all its details. After that, other individuals or other species should only be compared with the paradigmatic individual or species. Similarities would never be perfect, but the individuals of a same species or the species of a same genus form what Winsor calls a "polythetic group" akin to the concept of family resemblance in Ludwig Wittgenstein. By using a method of exemplars, the naturalists did not consider the categories totally hermetic. Lorraine Daston (2004) notes that the nineteenth century botanists would continue to use a similar method, even if instead of looking for a paradigmatic type, which needed the comparison of multiple plants to find the best exemplar, they would begin to follow the rule of priority: the first type used in publication would be considered the type specimen, what is now called the "holotype." Darwin's non-essentialist conception of species matched thus, according to Winsor, a well-established practice among naturalists.

The difference between Hull's and Winsor's interpretations of early modern taxonomists could be linked to their respective practices in the history of science. Hull focused on the theoretical aspects of the scientists whereas Winsor followed the "practice turn" in science studies proposed by, among others, Steven Shapin and Bruno Latour. The latter recommends that, instead of looking to what scientists say they do, scholars should look to what they concretely do. The practical turn pushed historians to pay more attention to the methodologies used, as Winsor did when reading Linnaeus. In fact, it could be that Linnaeus defended a kind of essentialism at a theoretical level (as studied by Hull) while following a non-essentialist method in his practice (Latour [1988] argues that such "double-talk" is a recurrent feature of scientific endeavours).

Here, we may add that Linnaeus also wanted to construct a taxonomy of minerals, a project that he never carried out (even today, no such classification exists). **Louis Daubenton** (1716-1799), a protégé of Buffon, noted that minerals lack both individuality and sexual reproduction. Consequently, he argued that in mineralogy "there is no such thing as essential resemblance," referring to analogies based on an underlying reality as explained in the previous section (quoted in Laudan 1989, 226). The method based on exemplars was thus not functional.

The specificity of early modern taxonomies

The classificatory mind

Is there something particular about the seventeenth- and eighteenth-century enthusiasm for taxonomies? Anthropologists and psychologists argue that the classificatory mind is innate and universal. In an evolutionary understanding, it seems beneficial for survival to distinguish one plant or animal species from another. Even animals appear to classify beings in order to adapt their reactions: a rabbit, for instance, runs away from a fox, but not from a sheep. The rabbit is thus able to distinguish those two species. The same is true for humans who must be able to distinguish, say, an edible from a noxious plant.

In that broad sense, classifications bear a practical and survival value. Based on his observations among the Itza Maya of Mexico and on others collected by ethnotaxonomists (i.e. anthropologists studying the taxonomies of non-Western societies), Scott Atran (1990) has shown that all human languages distinguish between 250 and 800 different plant species. Moreover, in all languages, there seems to be an analogous structure of classification with at least two classificatory levels that correspond to the vernacular species and the super-classes, such as birds or mammals, that include the lower classes.

Those numbers agree with what we find in the *Natural History* of **Pliny the Elder** (23-79 CE). This treatise, which became important during the Renaissance, counted around 500 different plant species. In 1551, the German **Hieronymus Bock** (1498-1554) published an herbal with 806 species, attaining then the upper level of folk-taxonomies. Because of that concordance in numbers, some ethnotaxonomists such as Brent Berlin (1992) supposed that the taxonomical works of the Renaissance simply put on paper the folk-taxonomies of their time and culture. However, the next generations of taxonomists arrived at the limits of human cognitive capacities by cataloging more than 1,000 species. In his 1623 thesaurus, the Swiss author **Caspar Bauhin** (1560-1624) distinguished more than 6,000 plant species. However, some, such as **Antoine-Laurent de Jussieu** (1748-1836), tried to collect various species together in order to obtain a classification of about 100 categories, coming back, as ethnotaxonomists emphasise, to a memorisable number similar to the numbers found in folk-taxonomies.

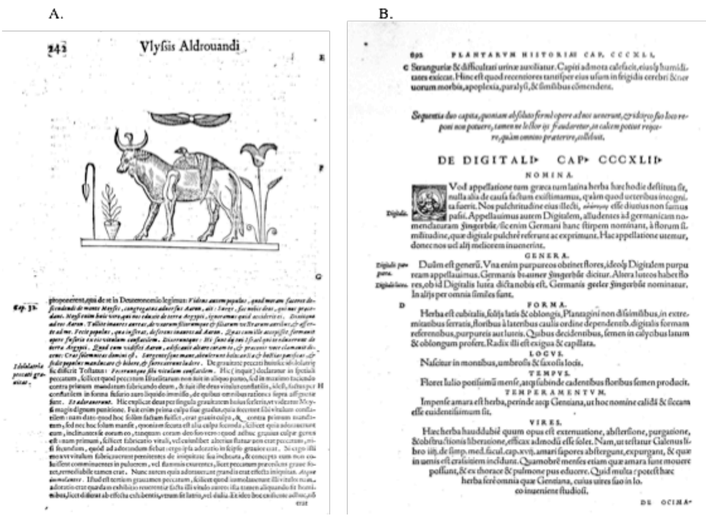
The lack of a communal experience

However, even if there are underlying cognitive processes and evolutionary impulses for classifying natural beings, it is important to stress the specificity of the early modern taxonomic endeavours. Ironically, by aiming to show the universality of the classificatory mind, ethnotaxonomists are particularly helpful for pointing out the specificities of the early modern classifications of natural beings.

A first novel aspect of early modern taxonomies is the absence of any communal experience. Normally, a child learns what a dog is at the moment he sees a dog with an adult, who points at it while saying the name of the vernacular species. The users of folk-taxonomies thus presuppose a communal experience: the speaker and the hearer are together pointing to an observable reality. This was still the case when Pliny and Dioscorides (who lived approximately between 30 and 90 CE) wrote their medical treatises. As Brian Ogilvie (2003) explains, those authors presupposed that their potential readers already knew the plants they spoke about. It is therefore that they did not provide any detailed botanical descriptions.

The first generation of Renaissance botanists, however, did not share that knowledge. The Germans **Euricius Cordus** (1486-1535) and **Leonhart Fuchs** (1501-1566), for instance, explicitly tried to find which plants those ancient authors had in mind. Early modern naturalists, thus, became sensitive to the fact that their readership would not necessarily know which plants or animals they were writing about. Those Renaissance botanists did not provide taxonomies strictly speaking, they only proposed more precise descriptions of the plants mentioned in the ancient books. Ogilvie argues that the descriptions were meant to facilitate the designation of the plants for someone who has not seen any of them previously. So, contrary to Berlin’s assumption as seen in the previous section, early botanical works did not simply put on paper the oral knowledge of their period.

The next generation, constituted among others by Bock and **Valerius Cordus** (1515-1544), the son of Euricius Cordus, described additional plants that were not in the Ancient books. Still more species of plants appeared from Western Europe, but also from other continents through colonial enterprises. Taxonomies fulfilled a new function, that of facilitating recognition in commercial exchanges. The descriptions provided by naturalists allowed physicians, tradesmen, or collectors to recognise a specimen of a plant or animal he has not seen before. Daniel Margócsy (2014) argues that this commercial use of natural descriptions explains the difference between the descriptions of plants and small animals that were commonly exchanged and those of big animals such as elephants that were rarely sold. The latter contained more mythological and cultural aspects than the former. Margócsy illustrates that contrast by comparing the description by the Italian author **Ulisse Aldrovandi** (1522-1605) of the Egyptian bull and the botanical descriptions by Fuchs (see image 2). More specifically, the medical usage of plants can explain why the taxonomies were first and better developed in botany than in zoology.



[Image 2 : Margócsy (2014) compares the description of the Egyptian bull by Aldrovandi (a) and the botanical descriptions of Fuchs (b). The former were in full sentences and comprised heterogeneous information, some physical, other related to cultural habits or mythical considerations. Even the illustration did not serve identification. In contrast, in the botanical treatise by Fuchs, the presentation is standardized and sticks to the physical description. On the pages that follow, Fuchs provides two realistic pictures of the *digitalis*. Image (a) is extracted from Aldrovandi, *Quadrupedum omnium bisulcorum historia* (1642), p. 242 (digitized by Google, no copyright). Image (b) is extracted from Fuchs, *De historia stirpium commentarii insignes* (1542), p. 892 (digitized by Google, no copyright).]

Abstraction from the environment

Another specificity of early modern taxonomies, linked to the lack of communal experience, is the progressive abstraction of the environment. Traditionally, animals and plants were described at the same time as their environment. The habitat could serve as an indicator of the species. However, early modern taxonomists excluded explicitly the environment from their descriptions. In that fashion, Tournefort explains that the resemblances used to classify plants "should be deduced solely from the closest sign of relationship, i.e. from the structure of one of the parts of the plant, and must pay no attention to more distant signs of relationship that can be found between certain plants, such as the possession of similar [medicinal] virtues, or the place in which they occur" (as quoted in Sloan 1972, p. 40).

Cetaceans constituted a case in point. As Aldemaro Romero (2012) explains, **Aristotle** (384-322 BCE) made observations on marine animals during his stay in Lesbos. He noted that whales and dolphins fulfill their functions in a way similar to "quadrupeds." He classified them in a category separated from the fish. However, he did not put it in the same as the "quadrupeds" (at that time, the class "mammals" did not exist). Pliny the Elder sometimes classified whales and dolphins as fish, sometimes he distinguished them. The French author **Pierre Belon** (1517-1564) provided descriptions of the placenta, the hair, and the teats of a dolphin, but he did not compare it to the terrestrial animals. The Englishman **Edward Wotton** (1492-1555) and the Frenchman **Guillaume Rondelet** (1507-1566) classified the dolphins with the fish explicitly because of their habitat. In the next century, both **Edward Tyson** (1651-1708) and Ray dissected a porpoise. The former was not interested in taxonomies. In contrast, Ray tried to classify all living beings. In 1693, he categorically separated cetaceans from the fish: "For except as to the place on which they live, the external form of the body, the hairless skin [*sic*] and progressive swimming motion, they have almost nothing in common with fishes, but remaining characters agree with the viviparous quadrupeds" (quoted in Romero 2012, p. 21, in fact, cetaceans do have hairs as Belon already knew).

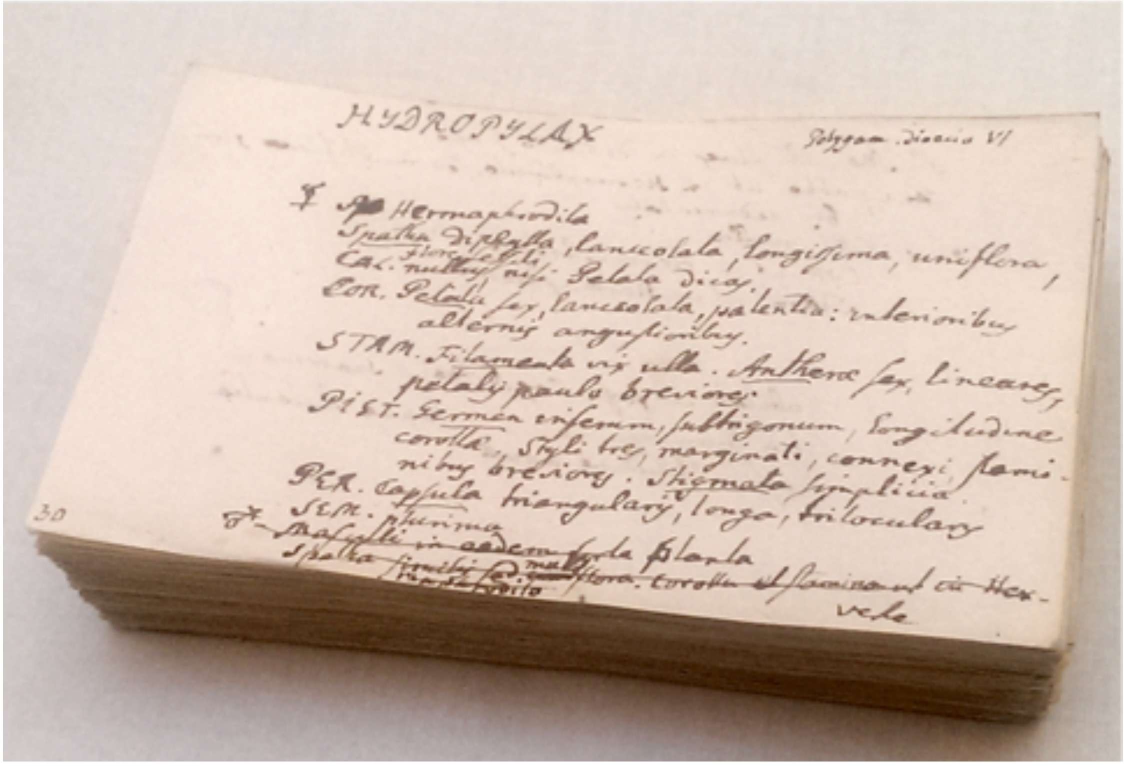
Finally, based on the work of the Swedish **Peter Artedi** (1705-1935) that he met in Amsterdam, Linnaeus classified the cetaceans and some terrestrial animals in the same category by inventing the taxon *Mammelia* or mammals (on that category, see section 3.4 on gender).

The history of the classification of cetaceans shows how difficult it was to abstract the animals from their natural environment. Moreover, for, say, fishermen, putting cetaceans in the same category as terrestrial animals makes no sense. For their use, cetaceans are prey just as sharks are. If the taxonomists could bypass the fishermen's intuition, it is because they studied specimens in their cabinets. The specimens were thus already abstracted from their environment. That was also the case for the plants or insects that were exchanged. A botanist could study a plant from a country to which he never went. Thus, for taxonomists, abstraction was concrete before being theoretical – when they described their specimens, these were already physically abstracted from their environment.

The overload of information and the terminological confusion

As we have seen above, another important difference between folk taxonomies and early modern taxonomies is a quantitative one. Due to a new social and material context, the number of known animal and vegetal beings grew rapidly. In early modern Europe, the epistolary culture permitted the collaboration of scholars across national borders. Moreover, printing allowed the circulation of much more information more rapidly. In addition, the colonial enterprise and the Christian missions also made new knowledge available. Specimens from previously unknown species were regularly sent from the Indies or the Americas. Often European scholars would try to subsume novelties in already known classes: in that fashion maize would become "corn" and cougars "lions" (Smith 2015, p. 114). However, as **Pedro Franco Dávila** (1711-1786), an Ecuadorian savant that would become the first director of the Royal Cabinet of Natural History in Madrid, lamented: "one is confronted by Species that do not fit into any established Genus, or that seem to belong to several at once" (quoted in Earle 2016, p. 428). The colonial exchanges sharply increased the number of known species which were not always easy to classify.

As Staffan Müller-Wille and Isabelle Charmantier (2012) argue, Linnaeus was very conscious of the information overload. He invented and tried out techniques to cope with that problem. For instance, he left blank spaces in his tables in case new species were discovered. However, those spaces were often so rapidly filled that they did not prove a very useful tool. It is so that Linnaeus became the first scientist to use index cards similar to those that librarians were then beginning to use (see image 3). He put those separated index cards in boxes ordered by genus. New information could easily be added with a new card. In a paradoxical movement, such techniques did not only passively gather information, but encouraged the multiplication of information. As the historians note, "the very people who suffered from information overload tended to be the same people who created it" (Müller-Wille and Charmantier 2012, p. 4).



[Image 3 : As explained by Müller-Wille and Charmantier (2012), Linnaeus was the first scientist to use index cards to manage, but also to contribute to, the overload of information. (Image from the page « The Linnaean Society Library » on Frank Norman's blog : < **http://occamstypewriter.org/trading-knowledge/2014/02/13/the-linnaean-society-library/** >, under Creative Common license.)]

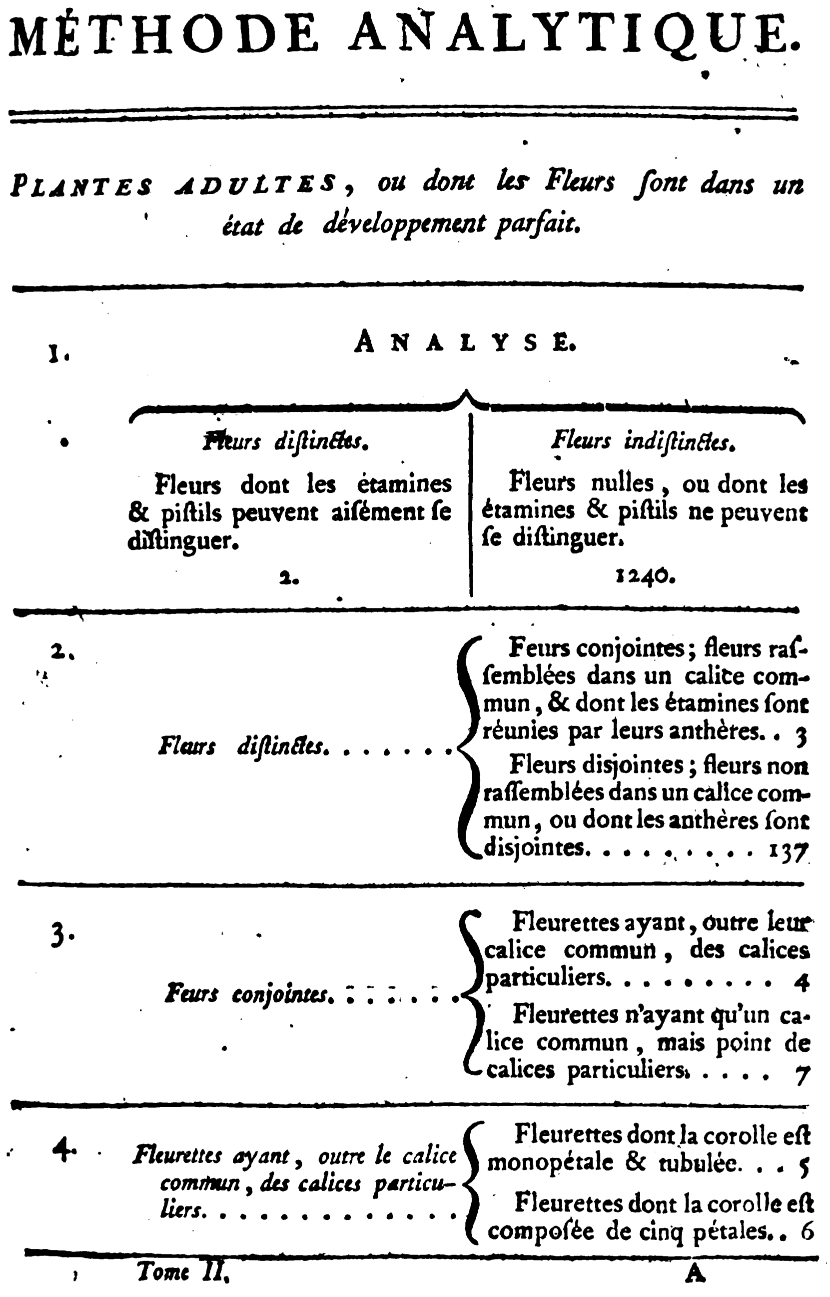
Linked to the information overload, the early modern naturalists were confronted with another problem: that of terminological confusion (Ogilvie 2003). Each new plant or animal species needed a name. Because the naturalist community was very active, the same species was often discovered in parallel by various authors who gave it different names. Faced with the terminological explosion from the mid-16th century, the botanical works began each entry with a section entitled *nomina* where the reader could find the various names given to the plant under discussion. At that moment there appeared also the first dictionaries of synonyms such as that by the Swiss **Conrad Gessner** (1416-1565) published in 1542: the *Catalogue of Plants in Latin, Greek, German and French*. However, it is Caspar Bauhin who provided the most complete list of synonyms in his 1623 *Pinax Theatri Botanici*, whose title described it as "an index to the works of Theophrastus, Dioscorides, and the botanists who have written in the last century." However, those lists of synonyms could only be useful during a short time. Scholars began to look for more standardised manners of naming species and taxa in order to avoid terminological confusion. In the tenth and most important edition of the *Systema naturae* (1758), Linnaeus proposed the binomial naming system still used today, although in an adapted form (some would argue that the exclusion of vernacular names from taxonomical nomenclatures is a form of "linguistic imperialism," as explained in section 3.3). Margócsy (2014, p. 41) argues that the generalization of illustrations in botanical treatises was another response to the terminological confusion. The drawings could be recognized by botanists speaking different vernacular languages.

The effect of printing

Jack Goody (1977) has analyzed the impact of writing on the classificatory mind. He notes that the need to classify crocodiles for instance as terrestrial or water animals appears only in societies that make written lists. In oral societies, because there is no stable material trace, it is easier to describe the animal sometimes as terrestrial and at other times as living in water without noticing the contradiction. It is the reason why some anthropologists such as Roy Ellen (2017) criticize the stance of Atran and Berlin who did not take into consideration the impact of writing and other technologies of knowledge on taxonomies.

However, although natural philosophers wrote down treatises long before the early modern era, they never approached the systematicity of the seventeenth and eighteenth century naturalists. Some historians have tried to describe a continuous progression from Aristotle to the early modern taxonomists. However, in his *History of Animals*, Aristotle did not try to define the various living species. The aim of the Greek philosopher was to show that a particular form (*eidos*) is necessary for the good functioning of the given organism. His aim was thus not definitional but functional. In the Middle Ages, Aristotle was a leading influence for the natural philosophers. However, they tried to apply the method of logical division presented in his *Categories* to define living beings. Ironically, Aristotle himself explicitly rejected that method for describing animals and plants. In his *Part of Animals*, he states that the various species are "defined by many differences, not according to dichotomy" (as quoted in Richards 2016, p. 41). The medieval philosophers were more interested in the logical aspects of definitions than in the animals they were describing. Nevertheless, during the Middle Ages, there were bestiaries and guides for falconry with animal descriptions, but there was nothing approaching the taxonomical and systematic endeavors starting in the Renaissance. Writing alone can thus not explain the taxonomical enterprise of early modern Europe.

By prolonging and amplifying some effects of writing, printing was also an important factor in the emergence of modern taxonomies. As already mentioned in the previous section, printing participated in the creation of the information overload. However, as Walter Ong and Elizabeth Eisenstein have argued, books and journals have shaped early modern sciences in other essential ways. Ong explains for instance that printing popularized dichotomic schemas, first as a pedagogical technique but later also as a scientific tool as such. In botany, as studied by Holger Funk (2014), we also find such schemas in treatises by the **Otto Brunfels** (1488-1534), **Benoît Textor** (1520-1565) or **Mathias de l'Obel** (1538-1616). However, the most famous example of dichotomous schemas in botany are those of **Jean-Baptiste Lamarck** (1744-1829) in his 1778 *French Flora* (see image 4). This is only one example of how printing instilled a form of presentation, but also a particular way of thinking about plants and animals.



MÉTHODE ANALYTIQUE.

PLANTES ADULTES, ou dont les Fleurs sont dans un état de développement parfait.

1. ANALYSE.

Fleurs distinctes.	*Fleurs indistinctes.*
Fleurs dont les étamines & pistils peuvent aisément se distinguer. 2.	Fleurs nulles, ou dont les étamines & pistils ne peuvent se distinguer. 1240.

2. *Fleurs distinctes.* . . . . . .
- Feurs conjointes; fleurs rassemblées dans un calice commun, & dont les étamines sont réunies par leurs anthères. . 3
- Fleurs disjointes; fleurs non rassemblées dans un calice commun, ou dont les anthères sont disjointes. 137

3. *Feurs conjointes.* . . . . . .
- Fleurettes ayant, outre leur calice commun, des calices particuliers. 4
- Fleurettes n'ayant qu'un calice commun, mais point de calices particuliers. 7

4. *Fleurettes ayant, outre le calice commun, des calices particuliers.* . . . .
- Fleurettes dont la corolle est monopétale & tubulée. . . 5
- Fleurettes dont la corolle est composée de cinq pétales. . 6

Tome II. A

[Image 4: Jean-Baptiste Lamarck is famous for using dichotomic schemas in botany. However, as Funk (2014) shows, he was not the first to do so. (Image extracted from *Fleurs françaises*, 1778, digitized by Google, no copyright.)]

For economical reasons linked to the printing industry, Linnaeus also changed the underlying philosophy of systematists. Before him, taxonomists published their works at an older age, when they were considered completed. In contrast, Linnaeus defended the idea that taxonomy is essentially a collective and progressive endeavor. It is therefore important that everyone agree on terminology and methodology. Moreover, this justified his early and continuous publications that aimed to trigger gathering of information. During his life span, he published for instance no less than twelve editions of his *Systema naturae*. As Müller-Wille and Charmantier (2012) explain, Linnaeus published so many editions also in order to make a living. By constraining all naturalists to use the last edition to communicate efficiently, he was able to sell his books widely. Linnaeus thus modified the epistemological ethos of the taxonomists due, in part at least, to the economy of the printed book.

Cultural, religious and political aspects of taxonomies

I have already presented some cultural and political aspects of taxonomies. I noted for instance the influence of commercial exchanges on botanical and zoological descriptions (see section 2.3). I have also underlined the importance of the print culture and the role of colonialism on the information overload and the development of systematicity (see sections 2.4 and 2.5). Now I wish to explore more explicitly the links between society and taxonomies in early modern Europe.

Colonialism

Since the 1990s, historians of science have investigated the interconnections of knowledge and empire. James McClennal and François Regourd (2000) speaks of a "colonial machine" based on a "colonial science bureaucracy." In a similar vein, Londa Schiebinger and Claudia Swan (2007) coined the phrase "European Colonial Science Complex." These scholars emphasize that scientists, even when not intentionally participating in the colonial enterprise, facilitated it. They argue for instance that there are parallel processes of abstraction in the sciences (see section 2.3) and of commodification in the economic exchanges essential to the colonial project. Both processes produce objects, plants or animals, which are valued independently of the environment and relations that let them emerge in the first place. In addition, by intentionally ignoring the environment, early modern taxonomists participated in the colonial narrative maintaining that the "discovered" lands were previously virgin and unoccupied. Historians also recount how travelers actively eliminated from their account the local encounters that made their travels possible. The early modern taxonomists thus took part in the systematic neglect of indigenous knowledge, letting the belief that only Europeans were gifted with intelligence grow. Historians also underline the great number of royal gardens and curiosities (above I have mentioned two such scientific centers, one in Paris and another in Madrid). This shows that the colonial powers knew the importance of botanical (and to a lesser extent zoological) knowledge for their expansion and enrichment. They were even inclined to invest in such scientific activities.

The place of humans and racism

Should naturalists add humans to their zoological classifications? In the Middle Ages, humans were considered more akin to angels than animals. Aldrovandi, Gessner or Ray did not explicitly exclude humans from their taxonomies, but they did not mention them in their works. Belon underlined the similarity of birds' wings and human hands and some decades later Tyson provided a detailed comparison of the human skeleton and that of what he called an "orang-outang" (but that we call a chimpanzee today). He affirmed that both species are physically indistinguishable. Those anatomical descriptions insisted on the animal nature of the human kind. Linnaeus was the first to add the human species in a taxonomical treatise, namely, in the tenth edition of his *Systema naturae*. He chose to name it, following his binomial system (see section 2.3), *Homo sapiens*. This explicit inclusion of humans in the "tree of life" became important for nineteenth-century biology.

Once Linnaeus placed humankind among the animals, he also subdivided it into "varieties": *americanus, europaeus, asiaticus* and *afer* (for Africans). Some, such as Thierry Hoquet (2014), have argued that Linnaeus presents the first strictly speaking racial discourse even without using the word "race." Indeed, he defines the human varieties by both physical and behavioral or cultural traits. Smith believes that Linnaeus exemplifies a "double movement" proper to racial thought: "both an insertion of 'man' into a broader zoological order, and a simultaneous division of 'man' into constituent subgroups" (2015, p. 137).

Linguistic imperialism

Taxonomies bear many traces of their cultural environment, notably in the names given to taxa. For instance, Greek poetry is the etymological source for a considerable number of species names in Linnaeus. The latter invented some rules to follow while naming a species (see section 2.3). Among them, the name giver should privilege Latin or Greek etymons. That led some historians to argue that early modern taxonomies, intentionally or unconsciously, practiced a form of "linguistic imperialism." For instance, Joseph Needham (1986, p. 168) stated that "it has to be admitted that Linnaeus was the evil genius of this Europocentrism." Schiebinger would argue in the same way that the rules offered by Linnaeus promoted the denial of non-European knowledge: only Europeans seem to know and to name species. However, this thesis is perhaps excessive, as Alexandra Cook (2010) argues. She notes that Linnaeus wanted Latin names simply in order to be able to communicate with his colleagues in Europe. Notwithstanding, he did not want his nomenclature to replace the vernacular names that could continue to be used variously in each region. Moreover, Linnaeus often contravenes his professed rules, by using Chinese etymologies, for instance.

Gender

Schiebinger (1989) makes a similar argument regarding gender. By using male proper names, taxonomists engraved male domination in the development of the European sciences. She also works out how the taxon "Mammal" was coined by Linnaeus in the tenth edition of his *Systema naturae* and how that term was taken by the broader society. By calling the taxon in this way, the botanist accentuated one aspect of the animals included in that category. He was conscious that he could also call them the "hairy" or "those that have three auditory ossicles," two attributes exclusive to the individuals of that taxon. Those attributes would have been even better than *Mammalia* (to use the Latin word coined by him), which refers to the breast only half of the individuals of the taxon possess. However, if he chose to insist on that feature, it is because he was not only a botanist but also a practicing physician participating in a controversy around wet-nurses. In 1752, just six years before coining the term *Mammalia*, he published a dissertation on what he saw as the crime of these workers. He insisted on the importance of breastfeeding by the natural mother. By describing humans as breastfeeders, he hoped to incite women to breastfeed their children themselves. Moreover, it was the female part of humanity that inscribed it in the animal kingdom. In contrast, adds Schiebinger, the specificity of humans was from the male part. Indeed, by naming the human species *Homo sapiens*, Linnaeus chose intelligence as the essential difference defining the species, an attribute that was considered masculine at that time. The example of mammals and *Homo sapiens* shows how "natural" categories can be founded on cultural or political biases.

Religion

Peter Harrison has studied the interactions between the development of the sciences and the history of religion in Europe. In a 2009 article, he tries to show that the taxonomist's quest was also influenced by religious debates. Genesis 2:19 teaches that God "would bring [all the animals] to man to see what he would call them, and the man chose a name for each one." With the help of God, Adam had an intuitive knowledge of the essence of things, so he could name all species efficiently. However, that knowledge would be lost after the Fall. In the sixteenth century, Christian scholars such as **Francis Bacon** (1561-1623), deemed it a moral obligation to recover that knowledge. Some of Linnaeus's contemporaries, such as **Albrecht von Haller** (1708-1777) or **Alexander Garden** (1730-1791), compared the Swedish botanist to Adam, the first name giver. They did this in order to underline the exaggerated pretensions of his endeavour. Linnaeus never compared himself explicitly with the Biblical figure. However, he considered himself to be divinely inspired as well. Moreover, even if his system was not entirely natural or intuitive, as the Adamic system was supposed to be, it was, according to him, the one that best approximates the original taxonomy.

Cross-References

Botanical Gardens

Botany

Cetaceans

Comparative Anatomy

Discovery, Voyages of

Images in early modern natural history

Note-Taking and the Organization of Knowledge

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