Taxonomic Orders

Organising nature is political

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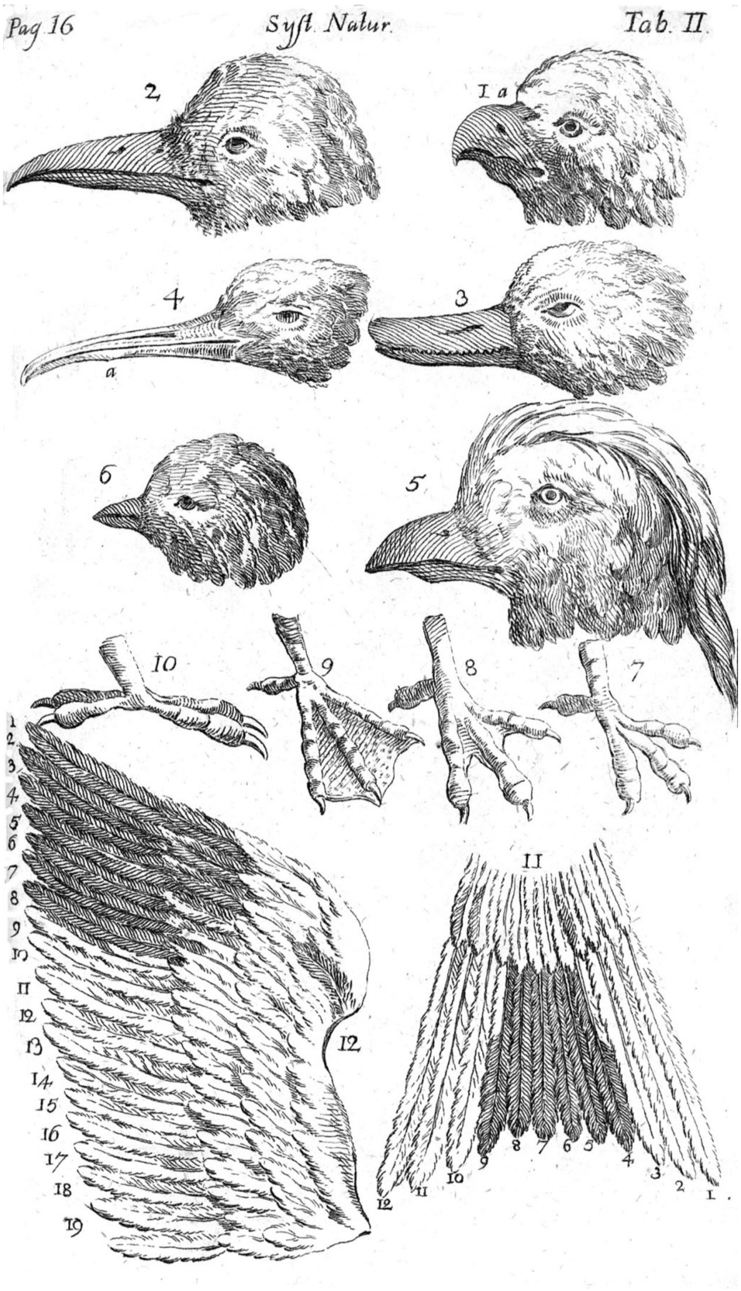


Plate 2 from Linnaeus' Systema Naturae, *6th edition, 1748.*

Taxonomy (from the Greek 'taxis', order, and 'nomos', law) refers to ways in which humans classify and categorise their reality. Broadly speaking, taxonomies can be found anywhere and can point to all sorts of things; but in biology, taxonomy has come to denote a specific system for ordering and classifying all forms of life. In this narrower biological sense, taxonomy is a formal system to name, define, and classify groups of organisms, regulated and governed by rules agreed upon by expert communities and international scientific institutions.

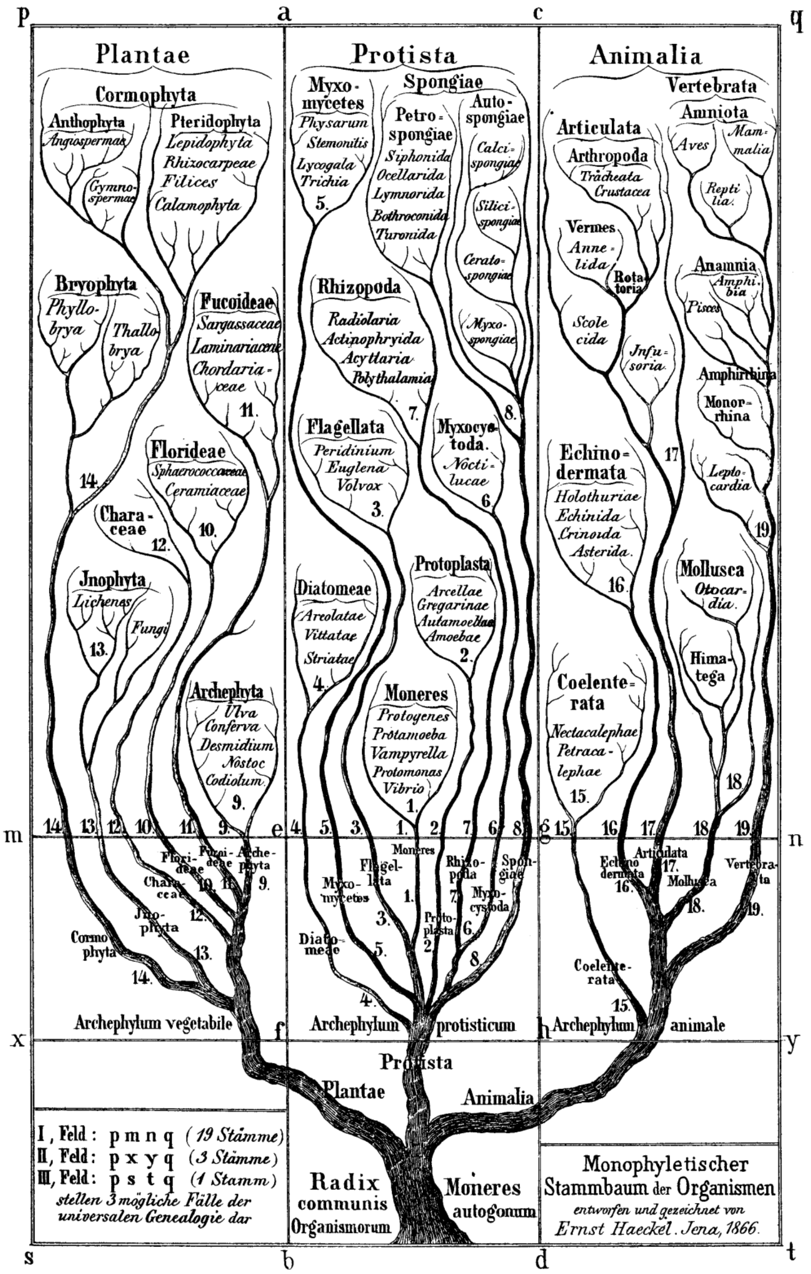
This formal system has its origins in the work of the Swedish botanist Carl Linnaeus, in the 18th century.[1] Like many other early naturalists, Linnaeus intended to build a classification that could encompass all of God's creatures. While he did imagine some of the categories he identified as natural classes, he consciously created an artificial system – designed with practical organisational concerns in mind. He introduced the standard ranks of kingdom, class, order, genus, and species, and another important standard, the binomial nomenclature – referring to the use of two Latin names to define species. Thanks to these features, and to Linnaeus' own vast compilatory work, his system was extremely successful – and it is still in use today, at least in some crucial formal respects. In fact, two different books published by Linnaeus are officially considered the starting point of contemporary botanical and zoological taxonomy, the 1753 *Species Plantarum*, and the 10th edition of the *Systema Naturae* published in 1758.

A Changing System

Despite the success of the Linnaean system, biological taxonomy has never been stable nor universal. From its inception, the system has been accompanied by controversies. Even today classifications continue to change, as can be seen from Cycladophora davisiana or the common seadragon. For instance, the traditions of botany and zoology began to diverge already with Linnaeus, resulting in two different codes regulating animal and plant nomenclatures – the *International Code of Zoological Nomenclature*, and what used to be the botanical code. Especially from the 20th century onward, organisms that did not fit the Linnaean ranks began to be described, like fungi, protists, and other (often microscopic) groups of life forms.[2] This complicated the regulation of taxonomic nomenclature even more. Consequently, the botanical code became the *International Code of Nomenclature for algae, fungi, and plants*. After the 1960s, two more codes were added, the *International Code of Nomenclature of Bacteria* and the *International Committee on Taxonomy of Viruses*.[3]

Despite their early divergence, both plant and animal systematics underwent a significant, parallel transformation over the course of the 19th century, which radically changed taxonomy. Taxonomic orders developed into powerful systems for naturalising differences.[4] In fact, as ranks were often presented graphically as trees (dendrograms), the idea of taxonomic differences as evidence of the natural transmutation of species became increasingly popular. By the end of the 1850s, when Charles Darwin and Alfred Russel Wallace presented their theories about the origin of species,[5] the classification of organisms started representing relations of descent within the scope of the emerging theory of evolution by natural selection. From an order based on explicitly artificial categories, taxonomy was increasingly understood to be a natural system, grounded in evolutionary change.

Taxonomy and Phylogenetics



One of the earliest representations of a phylogenetic tree, indicating the evolutionary relations between different classes of organisms, according to Ernst Haeckel.6

This transformation of taxonomy is well depicted in Ernst Haeckel's illustration of the evolutionary descent relationships linking all life, which appeared in his 1866 book *Generelle Morphologie der Organismen*. With the book, Haeckel also successfully introduced a new rank, that of phylum, an intermediary between kingdom and class. However, the tension between a purely morphological or descriptive interest in taxonomy, and an evolutionary and phylogenetic interest in natural classes, was never solved: taxonomic orders are about organising, describing and identifying species, but also about understanding their genealogical and evolutionary relations. This tension is somewhat reflected in the distinction between alpha and beta taxonomy that emerged at the beginning of the 20th century – the first supposedly concerned with the description of taxa, and the latter with higher ranks and broader questions. This distinction continues to highlight an implicit strain between natural history's systematic effort to (catalogue) all of nature, and evolutionary biology's desire to characterise the relation of descent of all living things. Even the Modern Evolutionary Synthesis,[7] which appeared in the 1950s to reconcile Darwinian evolutionary theory and Mendelian genetics, did not manage to stabilise a universal approach to taxonomy.

Even as molecular and computational biology came to revolutionise the life sciences especially since the 1980s, taxonomy failed to be fully standardised. Cladistics – the systematisation of phylogenetic differences – came to dominate the classificatory effort, but the nomenclature code specifically developed for this approach called PhyloCode has never fully replaced the various other codes in existence.[8] As a practical tool for scientists, taxonomy continues to include a number of different approaches, traditions, and concerns, which are reflected in the variety of taxonomic orders used by different parts of the scientific community. In fact, many scientists prefer to use particular taxonomies that fit their research interests, rather than attempting a holistic and universalist combination of various systems. More than a conceptual synthesis, pragmatic tools, such as digital databases, seem to be effective in bringing divergent taxonomic orders together and resolving (or circumventing) ongoing controversies.[9]

Digitizing Orders

Digital databases have proliferated and they allow easier access, more democratic community participation, and most importantly, more standardisation, precision, and computational power. The *Encyclopedia of Life*, the *Global Biodiversity Information Facility*, the *NCBI taxonomy database*, the *Open Tree of Life*, the *Catalogue of Life*, and even the *Zoological Information Management System* (ZIMS) are only some of the most significant databases; the more they are used, the more successful and established they become – in a positive feedback loop that is transforming taxonomy's practices. These digital resources for biological taxonomy help scientists who might not always have the opportunity to keep up with ever-expanding and changing classifications. They have, in a way, revolutionised taxonomy. Yet, privileging computational and statistical approaches, databases have also been criticised for further endangering an already threatened taxonomic expertise: fewer and fewer biologists study detailed, complex, changing, and historically muddy taxonomic classifications, as molecular techniques are often more readily accessible, and maintain an aura of being scientific. To counter this tendency, taxonomic experts collaborate and experiment with methods to preserve taxonomic knowledge, for instance through initiatives like the *European Distributed Institute of Taxonomy*, which aims to defend taxonomic knowledge by teaching it to new generations of scientists, but also by engaging in the design and management of data infrastructures – in particular in conjunction with scientific collections in museums and research institutes.[10]

Like all sorts of classifications, biological taxonomies are entangled with power: the power to define categories, to include and exclude, as well as the power to enforce these orders. These orders are clearly made visible and tangible in their effects on the architectures of displays and collections, as can be seen in the record-keeping practices of the Museum für Naturkunde Berlin, the Humboldt-Universität zu Berlin's Zoological Teaching Collection or the history of the Berlin Zoo. Changes in taxonomic orders often result in changes in the display and organisation of animals in zoological collections and their architecture. In this sense, taxonomic orders are never neutral, but have significant real-life consequences.[11] This is particularly evident in the contemporary articulation of the technocratic governmentality emerging around climate change and the pressing need for quantifying and managing biodiversity loss.[12] If different approaches to taxonomy can result in different interpretations of data, different thresholds, and hence different policies to handle environmental problems, the ordering practices of taxonomy have an important role in how we will manage to navigate the challenges offered by a transforming planet and our efforts in recording worlds.

Footnotes

1. For more about Linnaeus, see "Who was Linnaeus?". *The Linnean Society of London*, no date. https://www.linnean.org/learning/who-was-linnaeus (01.07.2021).↩
2. See, for instance, the changing classification of Infusoria in micropaleontology.↩
3. To learn more about the history of these codes, see Dan H. Nicolson. "A History of Botanical Nomenclature". *Annals of the Missouri Botanical Garden* 78, no. 1 (1991): 33-56. https://doi.org/10.2307/2399589.↩
4. See, for instance, Staffan Müller-Wille. "Reproducing Difference: Race and Heredity from a Longue Durée Perspective". In *Race, Gender and Reproduction: Philosophy and the Early Life Sciences in Context*. S. Lettow (ed.). Albany (NY): SUNY Press, 2014: 217-235.↩
5. There are many resources to learn more on C. Darwin, A.R. Wallace, and evolutionary thought: "Natural Selection: Charles Darwin & Alfred Russel Wallace". 22.08.2008, https://evolution.berkeley.edu/evolibrary/article/0_0_0/history_14 (01.07.2021); J. Norman. "Darwin & Wallace Issue the First Printed Exposition of the Theory of Evolution by Natural Selection". *History of Information*, 25.11.2014. https://www.historyofinformation.com/detail.php?id=1655 (01.07.2021); *Darwin Correspondence Project*, 2020. https://www.darwinproject.ac.uk (01.07.2021); Alexandra Stober. "Charles Darwin: Revolutionär und Gentleman". *Planet Wissen*, 02.06.2020. https://www.planet-wissen.de/natur/forschung/evolutionsforschung/pwiecharlesdarwinrevolutionaerundgentleman100.html (01.07.2021). For a more in-depth history, see James T. Costa. *Wallace, Darwin, and the Origin of Species*. Cambridge: Harvard University Press, 2014, http://www.jstor.org/stable/j.ctt6wprf8 (22.06.2021).↩
6. Ernst Haeckel. *Generelle Morphologie der Organismen: Allgemeine Grundzüge der organischen Formen-Wissenschaft, mechanisch begründet durch die von C. Darwin reformirte Decendenz-Theorie*. Berlin: 1866.↩
7. To learn more about the Modern Synthesis, see Chia-Yi Hou. "Modern Synthesis, 1937". *The Scientist*, 01.09.2019. https://www.the-scientist.com/foundations/modern-synthesis-1937-66322 (01.07.2021). Also see Ernst Mayr and William B. Provine. *The Evolutionary Synthesis*. Cambridge: Harvard University Press, 2013. https://doi.org/10.4159/harvard.9780674865389. An alternative historical interpretation can be found in Maurizio Esposito. "Utopianism in the British Evolutionary Synthesis". *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 42, no. 1 (2011): 40-49. https://doi.org/10.1016/j.shpsc.2010.11.007. For the ongoing effort to extend and amend this synthesis, see Tim Lewens. "The Extended Evolutionary Synthesis: What is the Debate About, and What Might Success for the Extenders Look Like?" *Biological Journal of the Linnean Society* 127, no. 4 (2019): 707-721. https://doi.org/10.1093/biolinnean/blz064.↩
8. For more on cladistics, see "An Introduction to Cladistics". 1996, https://ucmp.berkeley.edu/clad/clad1.html (01.07.2021); Q. Wheeler, L. Assis, and O. Rieppel. "Heed the Father of Cladistics". *Nature* 496 (2013): 295-296. https://doi.org/10.1038/496295a.↩
9. More on the importance of databases, digitisation, and data in Recording Worlds. Also see Sabina Leonelli and Niccolò Tempini. *Data Journeys in the Sciences*. Cham: Springer, 2020. https://doi.org/10.1007/978-3-030-37177-7.↩
10. An example of this digitisation of taxonomic expertise can be found in the NSB Database.↩
11. This can be seen in other stories on this website, like that of Moving Horseshoe Crabs, of Cycladophora davisiana, but also of the Zoological Teaching Collection.↩
12. A useful example to understand this complex dynamic between taxonomic orders and real-life consequences can be found in the role of zoos and museums in conservation sciences. Databases and lists like ZIMS organise conservation efforts along specific taxonomic orders, shaping who gets to live on our planet.↩