

Linnaeus: The Great Arranger

“The urge to classify is a fundamental human instinct; like the predisposition to sin, it accompanies us into the world at birth and stays with us to the end”

A Tindell Hopwood, 1959

Karl von Linné, better known by the latinized version of his name, Carolus Linnaeus is widely regarded as the father of taxonomy, the science of naming and classifying living organisms. The present practice of identifying species by a binomial label consisting of a generic and a specific name, like *Homo sapiens* for ourselves, is based upon the taxonomic system developed by Linnaeus. Yet, we must realize that people were classifying living organisms for millennia before Linnaeus, and that taxonomy has come a long way in the couple of centuries since him. What, then, was his special contribution to taxonomy that makes his name – a familiar one to most biologists, while others from Theophrastus to de Candolle to Hennig are not so well known outside the realm of taxonomy?

The roots of taxonomy in Europe like most other disciplines go back to Aristotle. Theophrastus (ca. 370-287 BC), a student of Aristotle compiled information on 480 kinds of plants in a book that today exists only in its latin translation, *De Historia Plantarum*. Theophrastus classified plants into groups largely based on habit, e.g. into trees, shrubs, undershrubs and herbs. He also used floral characters such as whether the corolla was polypetalous or gamopetalous, or the ovary superior or inferior. One of the major purposes of studying plants in most ancient civilizations, whether Greek, Indian, Chinese or Egyptian, was to use them for medicinal purposes. In the first century AD, another Greek herbalist, Discorides described 600 species of crops and medicinally important plants in his book *De Materia Medica*. He was also able to group plants into categories based on overall similarity of various features. During the medieval period, the classification of animals was also on similar lines: for example, different animals were grouped into flying, swimming and running animals.

De Materia Medica remained the mainstay of European botany till the 16th century, when many well illustrated herbals appeared, often in the form of illustrated commentaries on Discorides' text. Also in the 16th century, some important advances in classification were made, especially in the use of life history characteristics, odour and taste in classifying plants, in contrast to the earlier emphasis on morphology alone. A great advance in plant classification in the pre-Linnaean era was the publication of *De Plantis* by Andrea Caesalpino, a professor at the University of Pisa, in 1583. Caesalpino provided the first methodical classification of plants based on numbers of parts, their positions and their forms, with special emphasis on fruit characteristics. Many of his groupings correspond to orders and families of angiosperms recognized today, e.g. Fagales, Brassicaceae, Asteraceae. The sub-family Caesalpinoideae, which includes many well-known trees of India such as gulmohar is named after this pioneering Italian taxonomist. The English philosopher and naturalist John Ray described and classified 18,000 plants in his book *Methodus Plantarum*, first published in 1682. He formulated two very important principles still followed in taxonomy:

- (i) All parts of the plant should be used for taxonomic purposes.
- (ii) Species must be delimited such that species breed true within their own limits (*“nulla certior occurit quam distincta propogatione ex semine”*).



Ray also provided indented synoptic keys to genera, ensuring that his book could be used as a ready practical reference manual. Around the same time, the French botanist Caspar Bauhin introduced the concept of a genus, a group containing a number of more or less similar species.

Classification of plants was therefore already quite well developed when Linnaeus was born in Sweden in 1707. Linnaeus studied in Lund, and later studied medicine at the University of Uppsala. During his student days, he also accompanied botanical expeditions to Lapland. He spent some time in the Netherlands, finishing his medical studies, and then worked as a practising medical doctor in Stockholm before settling down as Professor of Medicine and Botany at Uppsala. Sexuality in plants had recently been discovered by Rudolf Jacob Camerarius, working at Tübingen, in 1694 and this discovery had a great effect on Linnaeus who decided to base his system of plant classification on sexual characteristics. More importantly, Linnaeus also attempted to develop a coherent approach to not only identifying and naming species, but also to classifying them into a hierarchical series of categories. Linnaeus was a staunch creationist, who believed that different species were created by god and that by grouping them according to shared similarities and differences, he was in a way interpreting the orderliness of god's creation for his fellow humans, all for the "greater glory of god". Linnaeus was also a somewhat pompous and self-important person, reflected in his own phrase describing his activities: "*deus creavit, Linnaeus disposuit* (god creates, Linnaeus arranges)".

In his book *Systema Naturae*, first published in 1735, Linnaeus developed ideas about classification and gave the world the notion of the *definition* of a species. The *definition* of a species, according to Linnaeus, should include characters it shares with other species of the same genus, as well as characters that set it apart from other species in the genus. Linnaeus' major preoccupation was with genera; he delimited numerous genera, divided them into species, and also grouped them hierarchically into families, orders, classes and phyla, respectively. *Systema Naturae* contained definitions of some 6000 plant and 4000 animal species. The novel features of this book were the explicit laying out of a philosophy of taxonomy and the treatment of both animal and plant species in a single work. In 1737, Linnaeus published *Genera Plantarum*, describing nearly 1000 genera recognized by him. He grouped the genera into 24 classes, based largely on the number and arrangement of stamens. Each class was then divided into orders based on pistil characteristics. In the descriptions of genera only flower characteristics were used by Linnaeus and these were summarized very succinctly. In this book, Linnaeus also introduced many terms that are now part of the botanists' lexicon to describe various aspects of floral morphology.

In *Species Plantarum*, first published in 1753, Linnaeus described about 6000 species of plants. He introduced a convention of describing species in such a way that the descriptions could act as convenient keys, and limited the length of each description to twelve words. To Linnaeus, these polynomial descriptions represented both a convenient diagnostic criterion for the species, as well as its true name. However, he also introduced a convenient 'short-hand' name for each species that was made up of the name of the genus, followed by a species name. These binomial species names provided a convenient name for day to day usage, but Linnaeus did not regard these as the true species names. For example, the first species of the genus *Carlina*. *Carlina acaulis*, was described as follows by Linnaeus in *Species Plantarum*:

CARLINA

acaulis. 1. *Carlina* caule unifloro flore brevior. *Hort. cliff.* 395. *Hort. ups.* 252. *Mat. med.* 378. *Roy. lugdb.* 135. *Sauv. monsp.* 293. *Carlina* acaulos, magno flore albo. *Bauh. Pin.* 380. *Chamaeleon* albus. *Clus. hist.*



2. p. 155. *Cam. epit.* 428. *Habitat* in Italiae, Germaniae montibus.

In this description, several references to previous publications are provided, including different polynomial descriptions published previously (for example, *Hort. ups.* is Linnaeus' *Hortus Upsaliensis*, *Bauh Pin.* is Bauhin's *Pinax*). In fact, Linnaeus rarely worked with specimens he collected himself, preferring to work with earlier literature, and saw his job as being one of ordering the already recorded information about species.

In addition to the three books mentioned above, Linnaeus also published several flora, including *Flora Lapponica* (1737), *Hortus Cliffortianus* (1738), *Flora Suecica* (1745) and *Hortus Upsalensis* (1748). Although he had earlier held the view that all species were created by god, later on he began to believe that many species arose by hybridization between a smaller, specially created set of species. These quasi-evolutionary views were first put forward in 1762 in a dissertation, *Fundamenta Fructificationis* and also included in later editions of *Species Plantarum*. It is interesting to note in this context that Linnaeus' grouping of genera into higher taxonomic categories based on overall similarities paved the way for subsequent evolutionary thinking by Darwin and others.

Linnaeus died at the age of seventy one in 1778, having left an indelible imprint on the science of classifying living organisms. Linnaeus clarified and codified certain philosophical bases of taxonomy, including principles of how genera and species need to be defined. Moreover, he arranged a lot of previously known information into a coherent system that allowed for easy identification of a species. In doing so, he provided us with binomial labels for species, which soon after him became the established norm for species nomenclature. He also developed a lot of the terminology for describing plant structure that is still in use today. He replaced the older systems of classification based on habit with a more convenient one based on floral characters. Yet, he realized that his system was also an artificial one, and stressed the importance of devising a 'natural' scheme of classification, based on overall similarities, which directly led to the development of more 'natural' classifications of plants by A L de Jussieu and A P de Candolle. In addition to all this, Linnaeus was also an inspiring teacher, and many of his students went on to become well-known botanists who made major contributions to plant taxonomy. Even though plants were described and classified before Linnaeus and the concepts of species and genus were already in use, it was he who provided taxonomy with its philosophical and methodological backbone. This has remained essentially unchanged even though the tools at the service of taxonomists have become very different in the two centuries after him.

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The universe is infinite in all directions, not only above us in the large but also below us in the small.

Emil Wiechert in 1896