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ENUMERATION OF PLANT TAXONOMY

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ABSTRACT: Plant taxonomy is the science that finds, identifies, describes, classifies, and names plants. It is one of the main branches of taxonomy (the science that finds, describes, classifies, and names living things).

Plant taxonomy is closely allied to plant systematics, and there is no sharp boundary between the two. In practice, "plant systematics" involves relationships between plants and their evolution, especially at the higher levels, whereas "plant taxonomy" deals with the actual handling of plant specimens. The precise relationship between taxonomy and systematics, however, has changed along with the goals and methods employed.

Plant taxonomy is well known for being turbulent, and traditionally not having any close agreement on circumscription and placement of taxa.

KEYWORDS: plant, taxonomy, systematic, specimens, taxa, branches

I. INTRODUCTION

Classification systems serve the purpose of grouping organisms by characteristics common to each group. Plants are distinguished from animals by various traits: they have cell walls made of cellulose, polyploidy, and they exhibit sedentary growth. Where animals have to eat organic molecules, plants are able to change energy from light into organic energy by the process of photosynthesis. The basic unit of classification is species, a group able to breed amongst themselves and bearing mutual resemblance, a broader classification is the genus. Several genera make up a family, and several families an order.^[1]

History of classification



From 1736, an illustration of Linnaean classification

The botanical term "angiosperm", from Greek words *angéion* (ἀγγεῖον 'bottle, vessel') and *spérma* (σπέρμα 'seed'), was coined in the form "Angiospermae" by Paul Hermann in 1690 but he used this term to refer to a group of plants which form only a subset of what today are known as angiosperms. Hermann's Angiospermae including only flowering plants possessing seeds enclosed in capsules, distinguished from his Gymnospermae, which were flowering plants with achenial or schizo-carpic fruits, the whole fruit or each of its pieces being here regarded as a seed and naked. The terms Angiospermae and Gymnospermae were used by Carl Linnaeus with the same sense, but with restricted application, in the names of the orders of his class Didynamia.^[2]

The terms angiosperms and gymnosperm fundamentally changed in meaning in 1827 when Robert Brown established the existence of truly naked ovules in the Cycadeae and Coniferae.^[3] The term gymnosperm was from then on applied to seed plants with naked ovules, and the term angiosperm to seed plants with enclosed ovules. However, for many



years after Brown's discovery, the primary division of the seed plants was seen as between monocots and dicots, with gymnosperms as a small subset of the dicots.^[4]

In 1851, Hofmeister discovered the changes occurring in the embryo-sac of flowering plants, and determined the correct relationships of these to the Cryptogamia. This fixed the position of Gymnosperms as a class distinct from Dicotyledons, and the term Angiosperm then gradually came to be accepted as the suitable designation for the whole of the flowering plants other than Gymnosperms, including the classes of Dicotyledons and Monocotyledons.^[4] This is the sense in which the term is used today.^[5]

In most taxonomies, the flowering plants are treated as a coherent group. The most popular descriptive name has been Angiospermae, with Anthophyta (lit. 'flower-plants') a second choice (both unranked). The Wettstein system and Engler system treated them as a subdivision (Angiospermae). The Reveal system also treated them as a subdivision (Magnoliophytina),^[6] but later split it to Magnoliopsida, Liliopsida, and Rosopsida. The Takhtajan system and Cronquist system treat them as a division (Magnoliophyta). The Dahlgren system and Thorne system (1992) treat them as a class (Magnoliopsida). The APG system of 1998, and the later 2003^[7] and 2009^[8] revisions, treat the flowering plants as an unranked clade without a formal Latin name (angiosperms). A formal classification was published alongside the 2009 revision in which the flowering plants rank as a subclass (Magnoliidae).^[9]

The internal classification of this group has undergone considerable revision. The Cronquist system, proposed by Arthur Cronquist in 1968 and published in its full form in 1981, is still widely used but is no longer believed to accurately reflect phylogeny. A consensus about how the flowering plants should be arranged has recently begun to emerge through the work of the Angiosperm Phylogeny Group (APG), which published an influential reclassification of the angiosperms in 1998. Updates incorporating more recent research were published as the APG II system in 2003,^[7] the APG III system in 2009,^{[8][10]} and the APG IV system in 2016.

Traditionally, the flowering plants are divided into two groups,

- Dicotyledoneae or Magnoliopsida
- Monocotyledoneae or Liliopsida

to which the Cronquist system ascribes the classes Magnoliopsida (from "Magnoliaceae") and Liliopsida (from "Liliaceae"). Other descriptive names allowed by Article 16 of the ICBN include Dicotyledones or Dicotyledoneae, and Monocotyledones or Monocotyledoneae, which have a long history of use. In plain English, their members may be called "dicotyledons" ("dicots") and "monocotyledons" ("monocots"). The Latin behind these names refers the observation that the dicots most often have two cotyledons, or embryonic leaves, within each seed. The monocots usually have only one, but the rule is not absolute either way. From a broad diagnostic point of view, the number of cotyledons is neither a particularly handy, nor a reliable character.

Recent studies, as by the APG, show that the monocots form a monophyletic group (a clade) but that the dicots are paraphyletic. Nevertheless, the majority of dicot species fall into a clade, the eudicots or tricolpates, and most of the remaining fall into another major clade, the magnoliids, containing about 9,000 species. The rest include a paraphyletic grouping of early branching taxa known collectively as the basal angiosperms, plus the families Ceratophyllaceae and Chloranthaceae.

Plantae, the Plant Kingdom

The plant kingdom is divided according to the following:

Latin	Common	Notes
Bryophyta	Mosses	No vascular system, distinctive vegetative structures, spores produced for reproduction require damp conditions for survival, many mosses are important to the early stages of soil formation
Hepatophyta	Liverworts	Same as mosses
Anthocerotophyta	Hornworts	Also a member of Bryophyta
Equisetophyta	Horsetails	Identifiable root, leaf and stem systems but still produce spores instead of seed
Pteridophyta	Ferns	Same as horsetails



Latin	Common	Notes
Coniferophyta	Conifers	Includes Pinales, Taxales, Cupressaceae and hundreds of other species. Reproduce by producing seeds most often in cones, many have adaptations to tolerate water loss
Ginkgophyta	Ginkgo	Only member is the ginkgo biloba
Angiosperms	Flowering plants	Includes around 25,000 species divided into two main classes the monocotyledons and dicotyledons, produce seeds that are protected by fruits

II. DISCUSSION

Identification, classification and description of plants

Three goals of plant taxonomy are the identification, classification and description of plants. The distinction between these three goals is important and often overlooked.

Plant identification is a determination of the identity of an unknown plant by comparison with previously collected specimens or with the aid of books or identification manuals. The process of identification connects the specimen with a published name. Once a plant specimen has been identified, its name and properties are known.

Plant classification is the placing of known plants into groups or categories to show some relationship. Scientific classification follows a system of rules that standardizes the results, and groups successive categories into a hierarchy. For example, the family to which the lilies belong is classified as follows:

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Liliopsida
- Order: Liliales
- Family: Liliaceae

The classification of plants results in an organized system for the naming and cataloging of future specimens, and ideally reflects scientific ideas about inter-relationships between plants. The set of rules and recommendations for formal botanical nomenclature, including plants, is governed by the International Code of Nomenclature for algae, fungi, and plants abbreviated as ICN.

Plant description is a formal description of a newly discovered species, usually in the form of a scientific paper using ICN guidelines. The names of these plants are then registered on the International Plant Names Index along with all other validly published names.¹³

Classification systems

These include;

- APG system (*angiosperm phylogeny group*)
 - APG II system (*angiosperm phylogeny group II*)
 - APG III system (*angiosperm phylogeny group III*)
 - APG IV system (*angiosperm phylogeny group IV*)
- Bessey system (*a system of plant taxonomy*)
- Cronquist system (*taxonomic classification of flowering plants*)
- Melchior system

III. RESULTS

Botanical nomenclature is the formal, scientific naming of plants. It is related to, but distinct from taxonomy. Plant taxonomy is concerned with grouping and classifying plants; botanical nomenclature then provides names for the

results of this process. The starting point for modern botanical nomenclature is Linnaeus' *Species Plantarum* of 1753. Botanical nomenclature is governed by the *International Code of Nomenclature for algae, fungi, and plants (ICN)*, which replaces the *International Code of Botanical Nomenclature (ICBN)*. Fossil plants are also covered by the code of nomenclature.

Within the limits set by that code there is another set of rules, the *International Code of Nomenclature for Cultivated Plants (ICNCP)* which applies to plant cultivars that have been deliberately altered or selected by humans

Botanical nomenclature has a long history, going back beyond the period when Latin was the scientific language throughout Europe, to Theophrastus (c. 370–287 BC), Dioscorides (c. 40 – 90 AD) and other Greek writers. Many of these works have come down to us in Latin translations. The principal Latin writer on botany was Pliny the Elder (23–79 AD). From Mediaeval times, Latin became the universal scientific language (*lingua franca*) in Europe. Most written plant knowledge was the property of monks, particularly Benedictine, and the purpose of those early herbals was primarily medicinal rather than plant science *per se*. It would require the invention of the printing press (1450) to make such information more widely available.^{[1][2][3]}

Leonhart Fuchs, a German physician and botanist, is often considered the originator of Latin names for the rapidly increasing number of plants known to science. For instance he coined the name *Digitalis* in his *De Historia Stirpium Commentarii Insignes* (1542).

A key event was Linnaeus' adoption of binomial names for plant species in his *Species Plantarum* (1753).^[4]

In the nineteenth century it became increasingly clear that there was a need for rules to govern scientific nomenclature, and initiatives were taken to refine the body of laws initiated by Linnaeus. These were published in successively more sophisticated editions. For plants, key dates are 1867 (*lois de Candolle*) and 1906 (*International Rules of Botanical Nomenclature*, 'Vienna Rules'). The most recent is the *Shenzhen Code*, adopted in 2018.¹⁵

Another development was the insight into the delimitation of the concept of 'plant'. Gradually more and more groups of organisms are being recognised as being independent of plants. Nevertheless, the formal names of most of these organisms are governed by the (ICN), even today. Some protists that do not fit easily into either plant or animal categories are treated under either or both of the ICN and the ICZN. A separate *Code* was adopted to govern the nomenclature of Bacteria, the *International Code of Nomenclature of Bacteria*.

Botanical nomenclature is closely linked to plant taxonomy, and botanical nomenclature serves plant taxonomy, but nevertheless botanical nomenclature is separate from plant taxonomy. Botanical nomenclature is merely the body of rules prescribing which name applies to that taxon and if a new name may (or must) be coined.

Plant taxonomy is an empirical science, a science that determines what constitutes a particular taxon (taxonomic grouping, plural: taxa):¹⁷ e.g. "What plants belong to this species?" and "What species belong to this genus?". The definition of the limits of a taxon is called its 'circumscription'. For a particular taxon, if two taxonomists agree exactly on its circumscription, rank and position (i.e. the higher rank in which it is included) then there is only one name which can apply under the *ICN*.^[5] Where they differ in opinion on any of these issues, one and the same plant may be placed in taxa with different names. As an example, consider Siehe's Glory-of-the-Snow, *Chionodoxa siehei*:



Flowers of *Chionodoxa siehei*, which can also be called *Scilla siehei*, or included in *Chionodoxa forbesii* or in *Scilla forbesii*

- Taxonomists can disagree as to whether two groups of plants are sufficiently distinct to be put into one species or not. Thus *Chionodoxa siehei* and *Chionodoxa forbesii* have been treated as a single species by some taxonomists or as two species by others.^[6] If treated as one species, the earlier published name must be used,^[7] so plants previously called *Chionodoxa siehei* become *Chionodoxa forbesii*.
- Taxonomists can disagree as to whether two genera are sufficiently distinct to be kept separate or not. While agreeing that the genus *Chionodoxa* is closely related to the genus *Scilla*, nevertheless the bulb specialist Brian Mathew considers that their differences warrant maintaining separate genera.^[6] Others disagree, and would refer to *Chionodoxa siehei* as *Scilla siehei*. The earliest published genus name must be used when genera are merged,^[7] in this case *Scilla* was published earlier and is used (not *Chionodoxa*).
- Taxonomists can disagree as to the limits of families. When the Angiosperm Phylogeny Group (APG) first published its classification of the flowering plants in 1998, *Chionodoxa siehei* would have been placed in the family Hyacinthaceae.^[8] In the 2009 revision of their classification, the APG no longer recognize the Hyacinthaceae as a separate family, merging it into a greatly enlarged family Asparagaceae.^[9] Thus *Chionodoxa siehei* moves from the Hyacinthaceae to the Asparagaceae.
- Taxonomists can disagree as to the rank of a taxon. Rather than allow the Hyacinthaceae to disappear altogether, Chase et al. suggested that it be treated as a subfamily within the Asparagaceae.^[10] The ICN requires family names to end with "-aceae" and subfamily names to end with "-oideae".^[11] Thus a possible name for the Hyacinthaceae when treated as a subfamily would be 'Hyacinthoideae'. However, the name Scilloideae had already been published in 1835 as the name for a subfamily containing the genus *Scilla*, so this name has priority and must be used.^[10] Hence for those taxonomists who accept the APG system of 2009, *Chionodoxa siehei* can be placed in the subfamily Scilloideae of the family Asparagaceae. However, a taxonomist is perfectly free to continue to argue that Hyacinthaceae should be maintained as a separate family from the other families which were merged into the Asparagaceae.

In summary, if a plant has different names or is placed in differently named taxa:²⁰

- If the confusion is purely nomenclatural, i.e. it concerns what to call a taxon which has the same circumscription, rank and position, the ICN provides rules to settle the differences, typically by prescribing that the earliest published name must be used, although names can be conserved.
- If the confusion is taxonomic, i.e. taxonomists differ in opinion on the circumscription, rank or position of taxa, then only more scientific research can settle the differences, and even then only sometimes.

Accepted names

Various botanical databases such as Plants of the World Online and World Flora Online make determinations as to whether a name is accepted, eg accepted species. If a name is not accepted, it may be because the name is a synonym for a name that is already accepted, and is listed as such. Another term is ambiguous to denote a name that is not accepted because its separate existence cannot be reliably determined. For instance, specimens that are damaged,

immature or the necessary information or expertise is not available. This can lead to abundances, multiple published names for the same entity.^[12]

IV. CONCLUSIONS

Cultivated plant taxonomy is the study of the theory and practice of the science that identifies, describes, classifies, and names cultigens—those plants whose origin or selection is primarily due to intentional human activity. Cultivated plant taxonomists do, however, work with all kinds of plants in cultivation.¹⁹

Cultivated plant taxonomy is one part of the study of horticultural botany which is mostly carried out in botanical gardens, large nurseries, universities, or government departments. Areas of special interest for the cultivated plant taxonomist include: searching for and recording new plants suitable for cultivation (plant hunting); communicating with and advising the general public on matters concerning the classification and nomenclature of cultivated plants and carrying out original research on these topics; describing the cultivated plants of particular regions (horticultural floras); maintaining databases, herbaria and other information about cultivated plants.¹⁸

Much of the work of the cultivated plant taxonomist is concerned with the naming of plants as prescribed by two plant nomenclatural Codes. The provisions of the *International Code of Nomenclature for algae, fungi, and plants (Botanical Code)* serve primarily scientific ends and the objectives of the scientific community, while those of the *International Code of Nomenclature for Cultivated Plants (Cultivated Plant Code)* are designed to serve both scientific and utilitarian ends by making provision for the names of plants used in commerce—the cultigens that have arisen in agriculture, forestry and horticulture. These names, sometimes called variety names, are not in Latin but are added onto the scientific Latin names, and they assist communication among the community of foresters, farmers and horticulturists.²¹

The history of cultivated plant taxonomy can be traced from the first plant selections that occurred during the agrarian Neolithic Revolution to the first recorded naming of human plant selections by the Romans. The naming and classification of cultigens followed a similar path to that of all plants until the establishment of the first *Cultivated Plant Code* in 1953 which formally established the cultigen classification category of cultivar. Since that time the classification and naming of cultigens has followed its own path.²²

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