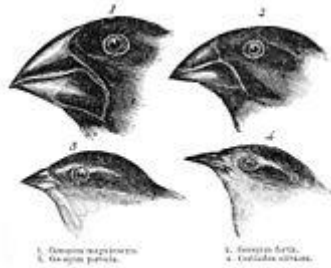


For other uses, see [Scientific classification \(disambiguation\)](#).

Part of a series on

[Evolutionary biology](#)



[Darwin's finches](#) by [John Gould](#)

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In [biology](#), **taxonomy** (from [Ancient Greek](#) [τάξις](#) (*taxis*) 'arrangement' and [-νομία](#) (*-nomia*) 'method') is the [scientific](#) study of naming, defining ([circumscribing](#)) and classifying groups of biological [organisms](#) based on shared characteristics. Organisms are grouped into [taxa](#) (singular: taxon) and these groups are given a [taxonomic rank](#); groups of a given rank can be aggregated to form a more inclusive group of higher rank, thus creating a taxonomic hierarchy. The principal ranks in modern use are [domain](#), [kingdom](#), [phylum](#) (*division* is sometimes used in botany in place of *phylum*), [class](#), [order](#), [family](#), [genus](#), and [species](#). The Swedish botanist [Carl Linnaeus](#) is regarded as the founder of the current system of taxonomy, as he developed a ranked system known as [Linnaean taxonomy](#) for categorizing organisms and [binomial nomenclature](#) for naming organisms.

With advances in the theory, data and analytical technology of biological systematics, the Linnaean system has transformed into a system of modern biological classification intended to reflect the [evolutionary](#) relationships among organisms, both living and extinct.

Definition

The exact definition of taxonomy varies from source to source, but the core of the discipline remains: the conception, naming, and classification of groups of organisms.^[1] As points of reference, recent definitions of taxonomy are presented below:

1. Theory and practice of grouping individuals into species, arranging species into larger groups, and giving those groups names, thus producing a classification.^[2]
2. A field of science (and a major component of [systematics](#)) that encompasses description, identification, [nomenclature](#), and classification^[3]
3. The science of classification, in biology the arrangement of organisms into a classification^[4]
4. "The science of classification as applied to living organisms, including the study of means of formation of species, etc."^[5]
5. "The analysis of an organism's characteristics for the purpose of classification"^[6]
6. "Systematics studies [phylogeny](#) to provide a pattern that can be translated into the classification and names of the more inclusive field of taxonomy" (listed as a desirable but unusual definition)^[7]

The varied definitions either place taxonomy as a sub-area of systematics (definition 2), invert that relationship (definition 6), or appear to consider the two terms synonymous. There is some disagreement as to whether [biological nomenclature](#) is considered a part of taxonomy (definitions 1 and 2), or a part of systematics outside taxonomy.^{[8][9]} For example, definition 6 is paired with the following definition of systematics that places nomenclature outside taxonomy:^[6]

- *Systematics*: "The study of the identification, taxonomy, and nomenclature of organisms, including the classification of living things with regard to their natural relationships and the study of variation and the evolution of taxa".

In 1970, Michener *et al.* defined "systematic biology" and "taxonomy" (terms that are often confused and used interchangeably) in relation to one another as follows:^[10]

Systematic biology (hereafter called simply systematics) is the field that (a) provides scientific names for organisms, (b) describes them, (c) preserves collections of them, (d) provides classifications for the organisms, keys for their identification, and data on their distributions, (e) investigates their evolutionary histories, and (f) considers their environmental adaptations. This is a field with a long history that in recent years has experienced a notable renaissance, principally with respect to theoretical content. Part of the theoretical material has to do with evolutionary areas (topics e and f above), the rest relates especially to the problem of classification. Taxonomy is that part of Systematics concerned with topics (a) to (d) above.

A whole set of terms including taxonomy, systematic biology, [systematics](#), scientific classification, biological classification, and [phylogenetics](#) have at times had overlapping meanings – sometimes the same, sometimes slightly different, but always related and intersecting.^{[1][11]} The broadest meaning of "taxonomy" is used here. The term itself was introduced in 1813 by [de Candolle](#), in his *[Théorie élémentaire de la botanique](#)*.^[12] [John Lindley](#) provided an early definition of systematics in 1830, although he wrote of "systematic botany" rather than using the term "systematics".^[13] Europeans tend to use the terms "systematics" and "biosystematics" for the study of biodiversity as a whole, whereas North Americans tend to use "taxonomy" more frequently.^[14] However, taxonomy, and in particular [alpha taxonomy](#), is more specifically the identification, description, and naming (i.e., nomenclature) of organisms,^[15] while "classification" focuses on placing organisms within hierarchical groups that show their relationships to other organisms.

Monograph and taxonomic revision

A **taxonomic revision** or **taxonomic review** is a novel analysis of the variation patterns in a particular [taxon](#). This analysis may be executed on the basis of any combination of the various available kinds of characters, such as morphological, [anatomical](#), [palynological](#), [biochemical](#) and [genetic](#). A [monograph](#) or complete revision is a revision that is comprehensive for a taxon for the information given at a particular time, and for the entire world. Other (partial) revisions may be restricted in the sense that they may only use some of the available character sets or have a limited spatial scope. A revision results in a conformation of or new insights in the relationships between the subtaxa within the taxon under study, which may lead to a change in the classification of these subtaxa, the identification of new subtaxa, or the merger of previous subtaxa.^[16]

Taxonomic characters

Taxonomic characters are the taxonomic attributes that can be used to provide the evidence from which relationships (the [phylogeny](#)) between taxa are inferred.^{[17][18]} Kinds of taxonomic characters include:^[19]

- [Morphological](#) characters
 - General external [morphology](#)
 - Special structures (e.g., [genitalia](#))
 - Internal morphology ([anatomy](#))
 - [Embryology](#)
 - [Karyology](#) and other [cytological](#) factors
- [Physiological](#) characters
 - [Metabolic factors](#)
 - Body secretions
 - Genic sterility factors

- [Molecular](#) characters
 - Immunological distance
 - Electrophoretic differences
 - Amino acid sequences of proteins
 - DNA hybridization
 - DNA and RNA sequences
 - Restriction endonuclease analyses
 - Other molecular differences
- [Behavioral](#) characters
 - Courtship and other ethological isolating mechanisms
 - Other behavior patterns
- [Ecological](#) characters
 - Habit and habitats
 - Food
 - Seasonal variations
 - Parasites and hosts
- [Geographic](#) characters
 - General [biogeographic distribution](#) patterns
 - [Sympatric-allopatric](#) relationship of populations

Alpha and beta taxonomy

Not to be confused with [Alpha diversity](#).

The term "**alpha taxonomy**" is primarily used to refer to the discipline of finding, describing, and naming [taxa](#), particularly species.^[20] In earlier literature, the term had a different meaning, referring to morphological taxonomy, and the products of research through the end of the 19th century.^[21]

[William Bertram Turrill](#) introduced the term "alpha taxonomy" in a series of papers published in 1935 and 1937 in which he discussed the philosophy and possible future directions of the discipline of taxonomy.^[22]

... there is an increasing desire amongst taxonomists to consider their problems from wider viewpoints, to investigate the possibilities of closer co-operation with their cytological, ecological and genetics colleagues and to acknowledge that some revision or expansion, perhaps of a drastic nature, of their aims and methods, may be desirable ... Turrill (1935) has suggested that while accepting the older invaluable taxonomy, based on structure, and conveniently designated "alpha", it is possible to glimpse a far-distant taxonomy built upon as wide a basis of morphological and physiological facts as possible, and one in which "place is found for all observational and experimental data relating, even if indirectly, to the constitution, subdivision, origin, and behaviour of species and other taxonomic groups". Ideals can, it may be said, never be completely realized. They have, however, a great value of acting as permanent stimulants, and if we have some, even vague, ideal of an "omega" taxonomy we may progress a little way down the Greek alphabet. Some of us please ourselves by thinking we are now groping in a "beta" taxonomy.^[22]

Turrill thus explicitly excludes from alpha taxonomy various areas of study that he includes within taxonomy as a whole, such as ecology, physiology, genetics, and cytology. He further excludes phylogenetic reconstruction from alpha taxonomy.^[23]

Later authors have used the term in a different sense, to mean the delimitation of species (not subspecies or taxa of other ranks), using whatever investigative techniques are available, and including sophisticated computational or laboratory techniques.^{[24][20]} Thus, [Ernst Mayr](#) in 1968 defined "**beta taxonomy**" as the classification of ranks higher than species.^[25]

An understanding of the biological meaning of variation and of the evolutionary origin of groups of related species is even more important for the second stage of taxonomic activity, the sorting of species into groups of relatives ("taxa") and their arrangement in a hierarchy of higher categories. This activity is what the term classification denotes; it is also referred to as "beta taxonomy".

Microtaxonomy and macrotaxonomy

Main article: [Species problem](#)

How species should be defined in a particular group of organisms gives rise to practical and theoretical problems that are referred to as the [species problem](#). The scientific work of deciding how to define species has been called microtaxonomy.^{[26][27][20]} By extension, macrotaxonomy is the study of groups at the higher [taxonomic ranks](#) subgenus and above,^[20] or simply in clades that include more than one taxon considered a species, expressed in terms of [phylogenetic nomenclature](#).^[28]

History

While some descriptions of taxonomic history attempt to date taxonomy to ancient civilizations, a truly scientific attempt to classify organisms did not occur until the 18th century, with the possible exception of Aristotle, whose works hint at a taxonomy.^{[29][30]} Earlier works were primarily descriptive and focused on plants that were useful in agriculture or medicine.

There are a number of stages in this scientific thinking. Early taxonomy was based on arbitrary criteria, the so-called "artificial systems", including [Linnaeus](#)'s system of sexual classification for plants (Linnaeus's 1735 classification of animals was entitled "[Systema Naturae](#)" ("the System of Nature"), implying that he, at least, believed that it was more than an "artificial system").

Later came systems based on a more complete consideration of the characteristics of taxa, referred to as "natural systems", such as those of [de Jussieu](#) (1789), [de Candolle](#) (1813) and [Bentham and Hooker](#) (1862–1863). These classifications described empirical patterns and were pre-[evolutionary](#) in thinking.

The publication of [Charles Darwin](#)'s [On the Origin of Species](#) (1859) led to a new explanation for classifications, based on evolutionary relationships. This was the concept of [phyletic](#) systems, from 1883 onwards. This approach was typified by those of [Eichler](#) (1883) and [Engler](#) (1886–1892).

The advent of [cladistic](#) methodology in the 1970s led to classifications based on the sole criterion of [monophyly](#), supported by the presence of [synapomorphies](#). Since then, the evidentiary basis has been expanded with data from [molecular genetics](#) that for the most part complements traditional [morphology](#).^{[31][page needed][32][page needed][33][page needed]}

Pre-Linnaean

Early taxonomists

Naming and classifying human surroundings likely began with the onset of language. Distinguishing poisonous plants from edible plants is integral to the survival of human communities. Medicinal plant illustrations show up in Egyptian wall paintings from c. 1500 BC, indicating that the uses of different species were understood and that a basic taxonomy was in place.^[34]

Ancient times

Further information: [Aristotle's biology & Classification](#)



Description of rare

animals (写生珍禽图), by [Song dynasty](#) painter [Huang Quan](#) (903–965)

Organisms were first classified by [Aristotle](#) ([Greece](#), 384–322 BC) during his stay on the [Island of Lesbos](#).^{[35][36][37]} He classified beings by their parts, or in modern terms *attributes*, such as having live birth, having four legs, laying eggs, having blood, or being warm-bodied.^[38] He divided all living things into two groups: [plants](#) and [animals](#).^[36]

Some of his groups of animals, such as *Anhaima* (animals without blood, translated as [invertebrates](#)) and *Enhaima* (animals with blood, roughly the [vertebrates](#)), as well as groups like the [sharks](#) and [cetaceans](#), are commonly used.^{[39][40][41]}

His student [Theophrastus](#) ([Greece](#), 370–285 BC) carried on this tradition, mentioning some 500 plants and their uses in his *Historia Plantarum*. Several plant [genera](#) can be traced back to Theophrastus, such as [Cornus](#), [Crocus](#), and [Narcissus](#).^[36]

Medieval

Taxonomy in the [Middle Ages](#) was largely based on the [Aristotelian system](#),^[38] with additions concerning the philosophical and existential order of creatures. This included concepts such as the [great chain of being](#) in the Western [scholastic](#) tradition,^[38] again deriving ultimately from Aristotle.

The Aristotelian system did not classify plants or [fungi](#), due to the lack of microscopes at the time,^[37] as his ideas were based on arranging the complete world in a single continuum, as per the *scala naturae* (the Natural Ladder).^[36] This, as well, was taken into consideration in the great chain of being.^[36]

Advances were made by scholars such as [Procopius](#), [Timotheus of Gaza](#), [Demetrios Pepagomenos](#), and [Thomas Aquinas](#). Medieval thinkers used abstract philosophical and logical categorizations more suited to abstract philosophy than to pragmatic taxonomy.^[36]

Renaissance and early modern

During the [Renaissance](#) and the [Age of Enlightenment](#), categorizing organisms became more prevalent,^[36] and taxonomic works became ambitious enough to replace the ancient texts. This is sometimes credited to the development of sophisticated optical lenses, which allowed the morphology of organisms to be studied in much greater detail.

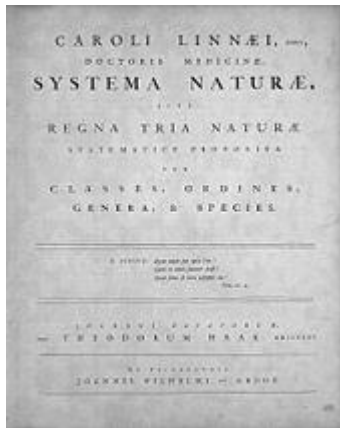
One of the earliest authors to take advantage of this leap in technology was the Italian physician [Andrea Cesalpino](#) (1519–1603), who has been called "the first taxonomist".^[42] His [magnum opus](#) *De Plantis* came out in 1583, and described more than 1500 plant species.^{[43][44]} Two large plant families that he first recognized are in use: the [Asteraceae](#) and [Brassicaceae](#).^[45]

In the 17th century [John Ray](#) ([England](#), 1627–1705) wrote many important taxonomic works.^[37] Arguably his greatest accomplishment was *Methodus Plantarum Nova* (1682),^[46] in which he published details of over 18,000 plant species. At the time, his classifications were perhaps the most complex yet produced by any taxonomist, as he based his taxa on many combined characters.

The next major taxonomic works were produced by [Joseph Pitton de Tournefort](#) (France, 1656–1708).^[47] His work from 1700, *Institutiones Rei Herbariae*, included more than 9000 species in 698 genera, which directly influenced Linnaeus, as it was the text he used as a young student.^[34]

Linnaean era

Main article: [Linnaean taxonomy](#)



Title page of [Systema Naturae](#), Leiden, 1735

The Swedish botanist [Carl Linnaeus](#) (1707–1778)^[38] ushered in a new era of taxonomy. With his major works [Systema Naturae](#) 1st Edition in 1735,^[48] [Species Plantarum](#) in 1753,^[49] and [Systema Naturae 10th Edition](#),^[50] he revolutionized modern taxonomy. His works implemented a standardized binomial naming system for animal and plant species,^[51] which proved to be an elegant solution to a chaotic and disorganized taxonomic literature. He not only introduced the standard of class, order, genus, and species, but also made it possible to identify plants and animals from his book, by using the smaller parts of the flower (known as the [Linnaean system](#)).^[51]

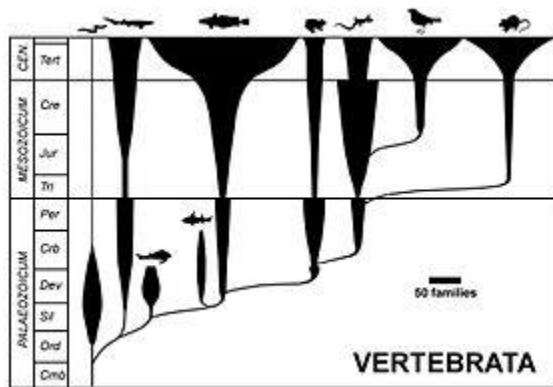
Plant and animal taxonomists regard Linnaeus' work as the "starting point" for valid names (at 1753 and 1758 respectively).^[52] Names published before these dates are referred to as "pre-Linnaean", and not considered valid (with the exception of spiders published in [Svenska Spindlar](#)^[53]). Even taxonomic names published by Linnaeus himself before these dates are considered pre-Linnaean.^[34]

The digital era of taxonomy

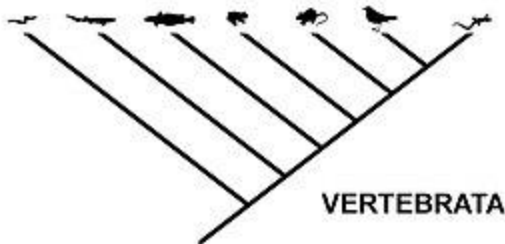
Modern taxonomy is heavily influenced by technology such as [DNA sequencing](#), [bioinformatics](#), [databases](#), and [imaging](#).

Modern system of classification

Main articles: [Evolutionary taxonomy](#) and [Phylogenetic nomenclature](#)



Evolution of the [vertebrates](#) at class level, width of spindles indicating number of families. Spindle diagrams are typical for [evolutionary taxonomy](#).



The same relationship, expressed as a [cladogram](#) typical for [cladistics](#)

A pattern of groups nested within groups was specified by Linnaeus' classifications of plants and animals, and these patterns began to be represented as [dendrograms](#) of the animal and plant [kingdoms](#) toward the end of the 18th century, well before Charles Darwin's *On the Origin of Species* was published.^[37] The pattern of the "Natural System" did not entail a generating process, such as evolution, but may have implied it, inspiring early transmutationist thinkers. Among early works exploring the idea of a [transmutation of species](#) were *Zoonomia* in 1796 by [Erasmus Darwin](#) (Charles Darwin's grandfather), and [Jean-Baptiste Lamarck's Philosophie zoologique](#) of 1809.^[20] The idea was popularized in the Anglophone world by the speculative but widely read [Vestiges of the Natural History of Creation](#), published anonymously by [Robert Chambers](#) in 1844.^[54]

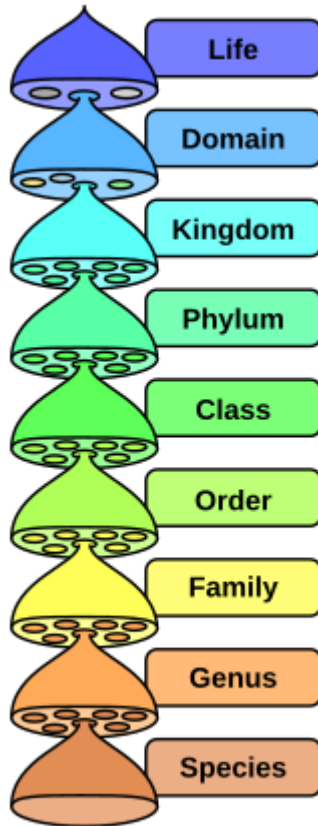
With Darwin's theory, a general acceptance quickly appeared that a classification should reflect the Darwinian principle of [common descent](#).^[55] [Tree of life](#) representations became popular in scientific works, with known fossil groups incorporated. One of the first modern groups tied to fossil ancestors was birds.^[56] Using the then newly discovered fossils

of *Archaeopteryx* and *Hesperornis*, [Thomas Henry Huxley](#) pronounced that they had evolved from dinosaurs, a group formally named by [Richard Owen](#) in 1842.^{[57][58]} The resulting description, that of dinosaurs "giving rise to" or being "the ancestors of" birds, is the essential hallmark of [evolutionary taxonomic](#) thinking. As more and more fossil groups were found and recognized in the late 19th and early 20th centuries, [palaeontologists](#) worked to understand the history of animals through the ages by linking together known groups.^[59] With the [modern evolutionary synthesis](#) of the early 1940s, an essentially modern understanding of the evolution of the major groups was in place. As evolutionary taxonomy is based on Linnaean taxonomic ranks, the two terms are largely interchangeable in modern use.^[60]

The [cladistic](#) method has emerged since the 1960s.^[55] In 1958, [Julian Huxley](#) used the term *clade*.^[20] Later, in 1960, Cain and Harrison introduced the term *cladistic*.^[20] The salient feature is arranging taxa in a hierarchical [evolutionary tree](#), with the desideratum that all named taxa are monophyletic.^[55] A taxon is called monophyletic if it includes all the descendants of an ancestral form.^{[61][62]} Groups that have descendant groups removed from them are termed [paraphyletic](#),^[61] while groups representing more than one branch from the tree of life are called [polyphyletic](#).^{[61][62]} Monophyletic groups are recognized and diagnosed on the basis of [synapomorphies](#), shared derived character states.^[63]

Cladistic classifications are compatible with traditional Linnean taxonomy and the Codes of [Zoological](#) and [Botanical nomenclature](#), to a certain extent.^[64] An alternative system of nomenclature, the [International Code of Phylogenetic Nomenclature](#) or *PhyloCode* has been proposed, which regulates the formal naming of clades.^{[65][28][9]} Linnaean ranks are optional and have no formal standing under the *PhyloCode*, which is intended to coexist with the current, rank-based codes.^[28] While popularity of phylogenetic nomenclature has grown steadily in the last few decades,^[9] it remains to be seen whether a majority of systematists will eventually adopt the *PhyloCode* or continue using the current systems of nomenclature that have been employed (and modified, but arguably not as much as some systematists wish)^{[66][67]} for over 250 years.

Kingdoms and domains



The basic scheme of modern classification. Many other levels can be used; domain, the highest level within life, is both new and disputed.

Main articles: [Kingdom \(biology\)](#) and [Domain \(biology\)](#)

Well before Linnaeus, plants and animals were considered separate Kingdoms.^[68]^[unreliable source?] Linnaeus used this as the top rank, dividing the physical world into the vegetable, animal and mineral kingdoms. As advances in microscopy made the classification of microorganisms possible, the number of kingdoms increased, five- and six-kingdom systems being the most common.

[Domains](#) are a relatively new grouping. First proposed in 1977, [Carl Woese's three-domain system](#) was not generally accepted until later.^[69] One main characteristic of the three-domain method is the separation of [Archaea](#) and [Bacteria](#), previously grouped into the single kingdom Bacteria (a kingdom also sometimes called [Monera](#)),^[68] with the [Eukaryota](#) for all organisms whose cells contain a [nucleus](#).^[70] A small number of scientists include a sixth kingdom, Archaea, but do not accept the domain method.^[68]

[Thomas Cavalier-Smith](#), who published extensively on the classification of [protists](#), in 2002^[71] proposed that the [Neomura](#), the clade that groups together the Archaea and [Eucarya](#), would have evolved from Bacteria, more precisely from [Actinomycetota](#). His 2004 classification treated the [archaeobacteria](#) as part of a subkingdom of the kingdom Bacteria, i.e., he rejected the three-domain system entirely.^[72] Stefan Luketa in 2012 proposed a five "dominion" system, adding [Prionobiota](#) (acellular and without [nucleic acid](#)) and [Virusobiota](#) (acellular but *with* nucleic acid) to the traditional three domains.^[73]

[Linnaeus](#) [Haeckel](#) [Chatton](#) [Copeland](#) [Whittaker](#) [Woese](#) et al. [Cavalier-Smith](#)

1735 ^[74]	1866 ^[75]	1925 ^[76]	1938 ^[77]	1969 ^[78]	1990 ^[79]	1998, ^[72] 2015 ^[80]
2 kingdoms	3 kingdoms	2 empires	4 kingdoms	5 kingdoms	3 domains	2 empires, 6/7 kingdoms
(not treated)	Protista	Prokaryota	Monera	Monera	Bacteria Archaea	Bacteria Archaea (2015)
			Protoctista	Protista		"Protozoa"
Vegetabilia	Plantae	Eukaryota	Plantae	Plantae	Eucarya	Plantae
				Fungi		Fungi
Animalia	Animalia		Animalia	Animalia		Animalia

Recent comprehensive classifications

Partial classifications exist for many individual groups of organisms and are revised and replaced as new information becomes available; however, comprehensive, published treatments of most or all life are rarer; recent examples are that of Adl et al., 2012 and 2019,^{[81][82]} which covers eukaryotes only with an emphasis on protists, and Ruggiero et al., 2015,^[83] covering both eukaryotes and [prokaryotes](#) to the rank of Order, although both exclude fossil representatives.^[83] A separate compilation (Ruggiero, 2014)^[84] covers extant taxa to the rank of Family. Other, database-driven treatments include the [Encyclopedia of Life](#), the [Global Biodiversity Information Facility](#), the [NCBI taxonomy database](#), the [Interim Register of Marine and Nonmarine Genera](#), the [Open Tree of Life](#), and the [Catalogue of Life](#). The [Paleobiology Database](#) is a resource for fossils.

Application

Biological taxonomy is a sub-discipline of [biology](#), and is generally practiced by biologists known as "taxonomists", though enthusiastic [naturalists](#) are also frequently involved in the publication of new taxa.^[85] Because taxonomy aims to describe and organize [life](#), the work conducted by taxonomists is essential for the study of [biodiversity](#) and the resulting field of [conservation biology](#).^{[86][87]}

Classifying organisms

Main article: [Taxonomic rank](#)

Biological classification is a critical component of the taxonomic process. As a result, it informs the user as to what the relatives of the taxon are hypothesized to be. Biological classification uses taxonomic ranks, including among others (in order from most inclusive to least inclusive): [Domain](#), [Kingdom](#), [Phylum](#), [Class](#), [Order](#), [Family](#), [Genus](#), [Species](#), and [Strain](#).^{[88][note 1]}

Taxonomic descriptions

See also: [Species description](#)



[Type](#) specimen for *Nepenthes smilesii*, a tropical [pitcher plant](#)

The "definition" of a taxon is encapsulated by its description or its diagnosis or by both combined. There are no set rules governing the definition of taxa, but the naming and publication of new taxa is governed by sets of rules.^[8] In [zoology](#), the [nomenclature](#) for the more commonly used ranks ([superfamily](#) to [subspecies](#)), is regulated by the [International Code of Zoological Nomenclature \(ICZN Code\)](#).^[89] In the fields of [phycology](#), [mycology](#), and [botany](#), the naming of taxa is governed by the [International Code of Nomenclature for algae, fungi, and plants \(ICN\)](#).^[90]

The initial description of a taxon involves five main requirements:^[91]

1. The taxon must be given a name based on the 26 letters of the Latin alphabet (a [binomial](#) for new species, or uninomial for other ranks).
2. The name must be unique (i.e. not a [homonym](#)).
3. The description must be based on at least one name-bearing [type specimen](#).
4. It should include statements about appropriate attributes either to describe (define) the taxon or to differentiate it from other taxa (the diagnosis, *ICZN Code*, Article 13.1.1, *ICN*, Article 38, which may or may not be based on morphology^[92]). Both codes deliberately separate defining the content of a taxon (its [circumscription](#)) from defining its name.
5. These first four requirements must be published in a work that is obtainable in numerous identical copies, as a permanent scientific record.

However, often much more information is included, like the geographic range of the taxon, ecological notes, chemistry, behavior, etc. How researchers arrive at their taxa varies: depending on the available data, and resources, methods vary from simple [quantitative](#) or [qualitative](#) comparisons of striking features, to elaborate computer analyses of large amounts of [DNA sequence](#) data.^[93]

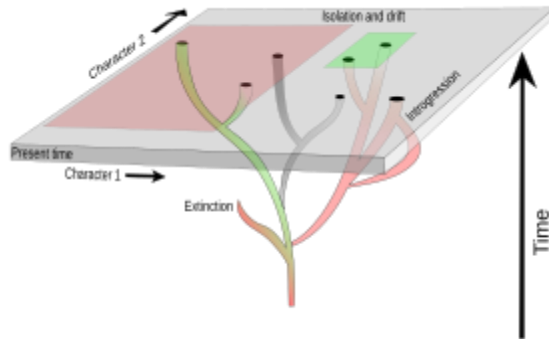
Author citation

Main articles: [Author citation \(botany\)](#) and [Author citation \(zoology\)](#)

An "authority" may be placed after a scientific name.^[94] The authority is the name of the scientist or scientists who first validly published the name.^[94] For example, in 1758 Linnaeus gave the [Asian elephant](#) the scientific name *Elephas maximus*, so the name is sometimes written as "*Elephas maximus* Linnaeus, 1758".^[95] The names of authors are often abbreviated: the abbreviation *L.*, for *Linnaeus*, is commonly used. In botany, there is, in fact, a regulated list of standard abbreviations (see [list of botanists by author abbreviation](#)).^[96] The system for assigning authorities differs slightly between [botany](#) and [zoology](#).^[8] However, it is standard that if the

genus of a species has been changed since the original description, the original authority's name is placed in parentheses.^[97]

Phenetics



A comparison of phylogenetic and phenetic

(character-based) concepts

Main article: [Phenetics](#)

In phenetics, also known as taximetrics, or numerical taxonomy, organisms are classified based on overall similarity, regardless of their phylogeny or evolutionary relationships.^[20] It results in a measure of hypergeometric "distance" between taxa. Phenetic methods have become relatively rare in modern times, largely superseded by [cladistic](#) analyses, as phenetic methods do not distinguish shared ancestral (or [plesiomorphic](#)) traits from shared derived (or [apomorphic](#)) traits.^[98] However, certain phenetic methods, such as [neighbor joining](#), have persisted, as rapid estimators of relationships when more advanced methods (such as [Bayesian inference](#)) are too computationally expensive.^[99]

Paramaecium (sometimes typeset as **Paramæcium**) was an

Australian [death/doom](#) metal band formed in 1991. There is use of instrumentation like [flutes](#), [cellos](#) and [violins](#) on some albums. Paramaecium is one of the few doom metal bands that focus on Christian lyrical themes and Christian [concepts](#). According to Doom-metal.com, "what sets Paramaecium apart from other bands in the doom metal scene, is the fact that they are the only Christian death/doom band that made it to the top of the genre."^[3]

History

[\[edit\]](#)

In 1993, Paramaecium released their debut album, [Exhumed of the Earth](#). The band consisted of Andrew Tompkins on vocals and bass, [Jason De Ron](#) on guitar, and [Jayson Sherlock](#) on drums.^[4] The music was inspired by [Cathedral](#), early [My Dying Bride](#) and [Anathema](#).^{[2][5]} The band incorporated flute and violin sounds as well as a soprano alongside the usual musical offerings of death and [doom metal](#).

Paramaecium added rhythm guitarist Chris Burton in 1995 and released their second album, *Within the Ancient Forest*, which was accompanied by a fantasy novel of the same name written by Tompkins. The album was more diverse and technical, and involved female vocalists, harpsichord, piano, flute and cello.

Sherlock left the band in 1996.^[4]

The third album, *A Time to Mourn*, was released in 1999 and marked the departure of all previous band members except Tompkins. The band no longer had a touring lineup, so guest musicians were used, including guitarist [Ian Arkley](#) (formerly of [Seventh Angel](#), [Ashen Mortality](#) and *My Silent Wake*). After a five-year break, Paramaecium returned in 2004 with *Echoes from the Ground*. The album again featured Tompkins as the only original member, but held firmly to the band's doom and [death metal](#) roots while again incorporating soprano and violins.

In 2005, Tompkins started working again with guitarist De Ron on songs for a new album. Early in 2006, drummer Sherlock rejoined the band and they played a series of concerts in Melbourne and Sydney, Australia, and NordicFest in Oslo, Norway. The NordicFest appearance in November 2006 marked the official end of Paramaecium, but it was also the official launch of the band under its new name, InExordium. InExordium's name is derived from a Paramaecium song off of *Within the Ancient Forest*. After InExordium broke up, Sherlock and guitarist Sheldon D'Costa formed [Revulsed](#).^[5]

Album concepts

[\[edit\]](#)

All of Paramaecium's albums have a concept that generally revolves around Christianity and Christian life. *Exhumed of the Earth* was based around the narrative of the New Testament, particularly the canonical gospels and the Book of Acts. *Within the Ancient Forest* is based on how Andrew Tompkins became a Christian,^[6] and *A Time to Mourn* is about a life in Christ, addressing the sorts of issues one might face as a modern Christian. *Echoes from the Ground* is about a young man's journey through the Holy Lands to find a justification for his faith.

Members

[\[edit\]](#)

Last known lineup

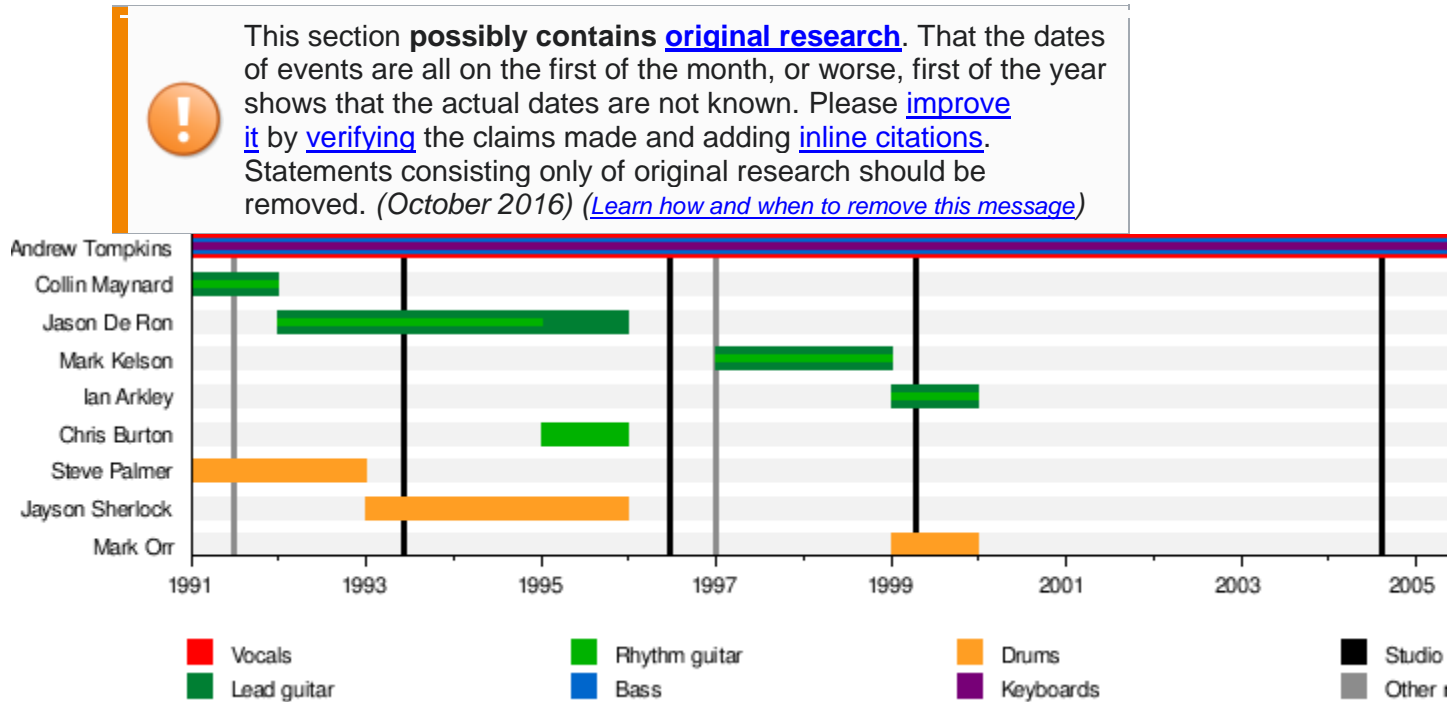
- Andrew Tompkins - bass, vocals, programming (1991–2006)^[7]
- [Jason De Ron](#) - guitar (1992–1996, 2006)^[8]
- [Jayson Sherlock](#) - drums (1993–1996,^[4] 2006)

Former

- Collin "Mosh" Mynard - guitar (1991–1992)^[8]
- [Ian Arkley](#) - guitar (1999)^[7]
- Mark Orr - drums (1999)^[7]
- [Mark Kelson](#) - guitar (1997–1999)^[1]
- Chris Burton - rhythm guitar (1995–1996)^[9]

- Steve Palmer - drums (1991–1993)^[10]

Timeline



Discography

[\[edit\]](#)

As Paramaecium

[\[edit\]](#)

Studio albums

- [Exhumed of the Earth](#) (1993)
- [Within the Ancient Forest](#) (1996)
- [A Time to Mourn](#) (1999)
- [Echoes from the Ground](#) (2004)

Demos

- [Silent Carnage](#) (1991)

EPs

- [Repentance](#) (1996)

As InExordium

[\[edit\]](#)

Studio albums

- [InExordium](#) (2008)

References

[\[edit\]](#)

- ¹ [^] [Jump up to:](#) ^a ^b ^ε ["Paramaecium". *RockDetector*. Archived from \[the original\]\(#\) on 4 April 2016. Retrieved 22 July 2016.](#)
- ² [^] [Jump up to:](#) ^a ^b ^ε ["Paramaecium". *Vibrations of Doom*. Retrieved 22 July 2016.](#)
- ³ [^] [Panagiotou, Kostas. "Paramaecium". *Doom-metal.com*. Retrieved 14 December 2007.](#)
- ⁴ [^] [Jump up to:](#) ^a ^b ^ε ["Interview with Jayson Sherlock". 4 June 2007. Retrieved 7 October 2016.](#)
- ⁵ [^] [Jump up to:](#) ^a ^b ^ε [Sherlock, Jayson \(25 October 2015\). "Jayson Sherlock of Revulsed, Mortification". Interviewed by Stephen Sarro and Trav Turner. *As the Story Grows*. Retrieved 22 July 2016.](#)
- ⁶ [^] [Within the Ancient Forest](#) CD at the Paramaecium website. Retrieved on 22 July 2016.
- ⁷ [^] [Jump up to:](#) ^a ^b ^ε [Griffin, Brian \(April 2015\). *Encyclopedia of Australian Heavy Metal*. Lulu.com. ISBN 9780994320612. Retrieved 7 October 2016.](#)
- ⁸ [^] [Jump up to:](#) ^a ^b ^ε [Jason's biography](#) at the [Wayback Machine](#) (archive index). Retrieved on 8 October 2016.
- ⁹ [^] ["Paramaecium - Within the Ancient Forest" \(in Hungarian\). *Passzio*. Retrieved 8 October 2016.](#)
- ¹⁰ [^] [Tompkins, Andrew. "Biography: Andrew Tompkins". *Spirit of Metal*. Retrieved 9 October 2016.](#)

External links

Nereis is a [genus](#) of [polychaete worms](#) in the family [Nereididae](#). It comprises many species, most of which are [marine](#). *Nereis* possess [setae](#) and [parapodia](#) for locomotion and gas exchange.^[1] They may have two types of setae, which are found on the parapodia. Acicular setae provide support. Locomotor setae are for crawling, and are the bristles that are visible on the exterior of the Polychaeta. They are cylindrical in shape, found not only in sandy areas, and they are adapted to burrow. They often cling to seagrass (posidonia) or other grass on rocks and sometimes gather in large groups.

Nereis worms are commonly known as rag worms or clam worms. The body is long, slender, and dorso-ventrally flattened, reaching a length of 5-30 cm. The head consists of two parts: a roughly triangular anterior lobe—the prostomium—and a posterior ring-like portion—the peristomium.^[2] The latter bears four pairs of tentacular cirri, dorsally two pairs of eyes, and ventrally a pair of short two-jointed palps.

Etymology

[\[edit\]](#)

The scientific Latin genus name *Nereis* derives from the Ancient Greek Νηρηΐς : Nērēís (stem Νηρηΐδ- : Nērēid), a [sea nymph](#).

Ecology

[\[edit\]](#)

Nereis are [osmoconformers](#). They are [dioecious](#) (individuals are male or female) and they release their [haploid](#) gametes into the water, a process called *spawning*. Moreover, upon fertilization and [mitotic](#) divisions of the [zygote](#), Nereids form a larval stage which is similar to that of [molluscs](#) – i.e. a [trochophore larva](#).

- [Nereis abbreviata](#) Holly, 1935
- [Nereis abyssa](#) Imajima, 2009
- [Nereis abyssicola](#) (Horst, 1924)
- [Nereis acustris](#) Linnaeus, 1767
- [Nereis aegyptia](#) (Savigny *in* Lamarck, 1818)
- [Nereis aestuarensis](#) Knox, 1951
- [Nereis aibuhitensis](#) (Grube, 1878)
- [Nereis albipes](#) Grube, 1873
- [Nereis allenae](#) Pettibone, 1956
- [Nereis amoyensis](#) (Treadwell, 1936)
- [Nereis angelensis](#) Fauchald, 1972
- [Nereis angusta](#) (Kinberg, 1866)