Biological Nomenclature

Special Topics in Biology Series

Biological Nomenclature

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For the Systematics Association

Foreword by

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Edward Arnold

First published 1973
by Edward Arnold (Publishers) Limited,
25 Hill Street,
London, W1X 8LL
in conjunction with
The Systematics Association

Boards edition ISBN 0 7131 2431 8
Paper edition ISBN 0 7131 2432 6

Printed in Great Britain by
The Camelot Press Ltd, London and Southampton

Foreword

Although scientific names are very widely used by the biological community and many others in non-biological fields, few people, apart from professional taxonomists, have more than a passing understanding of the principles governing biological nomenclature. The official Codes of Nomenclature are forbidding documents and daunting to use without special training or guidance. It is largely for these reasons that various approaches have been made to the Systematics Association in recent years to sponsor the production of a relatively simple guide to the principles of biological nomenclature and the workings of the various Codes.

The Council of the Systematics Association willingly agreed to sponsor such a work and was fortunate in being able to persuade Mr. C. Jeffrey, of the Herbarium, Royal Botanic Gardens, Kew, to prepare a suitable text. Mr. Jeffrey's book is a lucid and highly readable account of the subject and he is to be warmly congratulated on providing an eminently practical guide to a highly complex field. In addition, his first chapter, which outlines the general context of systematics, is one of the clearest expositions available, and the glossary/index will be widely consulted.

In sponsoring this work the Systematics Association is confident that Mr. Jeffrey's book will go a long way towards clarifying one of the most intimidating areas of biological systematics and will be a major contribution to communication and understanding between biologists in many disciplines.

1973

V. H. Heywood
President, Systematics Association

Preface

The purpose of this handbook is to provide a practical guide to the use of the nomenclatural parts of taxonomic literature, to promote understanding of the problems, principles and practice of biological nomenclature and to act as an introduction to the Codes of Nomenclature themselves. It is not intended to be used as a substitute for the Codes and the interpretation of any provision of any Code is in no way to be taken as authoritative or definitive. Every effort has been made, however, to ensure factual accuracy and to present what were at the time of writing nomenclaturally orthodox views. Even so, since the Codes are subject to modification, it is inevitable that a few of the details will in time become obsolete. This is especially likely in the fields of virology and bacteriology; the first has as yet no definitive Code of Nomenclature, and a new edition of the Bacteriological Code will be published within the next two years. The Zoological and especially the Botanical Codes are unlikely to be subjected to much alteration, and general principles are in all cases unlikely to be changed.

To the following, who kindly read through the draft text, I am grateful for corrections and helpful suggestions: G. C. Ainsworth, R. K. Brummitt, J. S. L. Gilmour, J. Lewis, S. P. Lapage, K. McKenzie, R. J. Pankhurst, P. H. A. Sneath, B. T. Styles, P. Whitehead and P. F. Yeo. To J. G. Sheals and J. D. Turton I am indebted for helpful advice and comments. John Lewis I wish also to thank for general help and for liaison with the Systematics Association and the Institute of Biology. Responsibility for all errors and omissions remains, however, entirely mine. To A. J. Boyce I am indebted for duplication and distribution of the draft text. Finally, my best thanks are given to my colleague, Mrs. J. S. Page, for typing my manuscript, for reading the proofs and for eliminating much that was obscure, verbose, repetitive and tedious.

C. J.

Kew
1973

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*NOTE

Certain additional information, supplementing but not essential to the main thesis, is given in a section 'Notes to the Text' (p. 49). The small 'superior' figures ([1], [2], . . .) given in the main text refer to the corresponding numbers of these notes.

I The Systematic Background

1.1 Systematics

The earth is unique among the planets we know in supporting a vast array of *living organisms* of the most diverse kinds. Together with the non-living components of their environment with which they inter-react they have produced and maintain the planetary *ecosphere*. Man himself is a part of the ecosphere and his survival depends upon its continued operation. We are more directly dependent upon some living organisms—e.g. the major food crops and the species of commercial fisheries—than others, but all are important as components of the ecosphere, and have become the objects of study of the field of human endeavour known as *biology*.

One of the first tasks of biology was to make meaningful generalizations about living organisms so that useful knowledge could be passed on from person to person and human behaviour regulated in its light. Early in human history it was found useful to know in advance, for example, what animals were dangerous, what were good to hunt for food, what plants were poisonous and so on. It was soon noticed that living organisms possessed certain consistent features by which they could be reliably identified and sorted into constantly and recognizably distinct groups. Properties like dangerousness, edibility and poisonousness could thus be reliably inferred and the possibly unpleasant consequences of a trial and error approach avoided.

The refinement of this process of recognition and grouping into the scientific study of the diversity of living organisms has given rise to the branch of biology known as *systematics*.[1] The task of systematics is to produce systems of classification which best express the various degrees of overall similarity between living organisms. Such systems are used in biology for the storage, retrieval and communication of information and for the making of reliable predictions and generalizations. They are based on as broad as possible study of the variation of living organisms and aim to establish groups, the members of which possess the largest number of common features and exhibit therefore the greatest overall similarity.

The possibility of constructing such systems, of course, depends upon the occurrence of different features associated in definite combinations in different living organisms. If features all varied independently of one another, then each feature considered would produce a different way of

grouping organisms and no one grouping based on greatest overall similarity would be possible. However, this is not so and it is possible to construct systematic groupings that are based on multiple correlations of common features and which reflect greatest overall similarity. This is in general a result of the fact that all living organisms are related to one another to a greater or lesser degree by way of evolutionary descent, and it is this evolutionary relationship that makes possible the establishment of meaningful systematic groupings.

1.2 Classification and nomenclature

Two major fields of systematics are *classification* and *nomenclature*. Classification is the process of establishing and defining systematic groupings.[2] Nomenclature is the allocation of names to the groups so produced. In carrying out their researches, systematists first complete their classificatory work. Only when they are sure they have achieved, on the basis of the information available, the best possible systematic arrangement of the organisms they have studied, do they begin to ascertain the correct names for the groups they have established. In other words, classification precedes naming, and nomenclature is to this extent independent of classification. Nevertheless, it is necessary first to consider certain aspects of the classification of living organisms which are essential to the understanding of the way in which they are named.

1.3 The taxonomic hierarchy

If we study the living organisms existing in a particular place at a particular time, we find that they occur as series of similar individuals showing certain common features. Such series of recognizably similar individuals, recognizably distinct from other such series, are in general what the systematists call *species*. In sexually reproducing organisms it is also found, in general, that individuals of a species are inter-fertile with one another but reproductively isolated from individuals of other species. When species are compared with one another, it is found convenient to group together those with most features in common into larger, more inclusive groups which are called *genera*. Genera are in their turn grouped likewise into yet more inclusive groups called *families*, and so on. Such an arrangement of groups into an ascending series of ever-increasing inclusiveness forms what is known as an *hierarchical*[3] *system* of classification. In an hierarchical system we start at the bottom with individuals and end up at the top with one all-embracing group. In between we have various groups of organisms at different levels

Table 1 The categories of the taxonomic hierarchy

This shows the categories of the taxonomic hierarchy usually employed in Botany, Bacteriology and Zoology. They are given their recognized Latin names (often anglicized as in the right-hand column) and are arranged in the relative order in which they must be employed. The most important categories are given in CAPITALS, those seldom used are enclosed in parentheses (Divisio). The categories *Divisio* and *Subdivisio* of the Botanical and Bacteriological Codes correspond to, and are used in place of, the categories *Phylum* and *Subphylum* respectively of zoological usage

Botanical	Bacteriological	Zoological	English Equivalent
REGNUM		REGNUM	Kingdom
		Subregnum	Subkingdom
		(Superphylum)	Superphylum
DIVISIO	(Divisio)	PHYLUM	Division/Phylum
Subdivisio	(Subdivisio)	Subphylum	Subdivision/ Subphylum
		Superclassis	Superclass
CLASSIS	CLASSIS	CLASSIS	Class
Subclassis	(Subclassis)	Subclassis	Subclass
		Infraclassis	Infraclass
(Superordo)		Superordo	Superorder
ORDO	ORDO	ORDO	Order
(Subordo)	(Subordo)	Subordo	Suborder
		Infraordo	Infraorder
		Superfamilia	Superfamily
FAMILIA	FAMILIA	FAMILIA	Family
Subfamilia	(Subfamilia)	Subfamilia	Subfamily
		(Supertribus)	Supertribe
Tribus	Tribus	Tribus	Tribe
Subtribus	(Subtribus)	Subtribus	Subtribe
GENUS	GENUS	GENUS	Genus
Subgenus	(Subgenus)	Subgenus	Subgenus
Sectio			Section
Subsectio			Subsection
Series			Series
Subseries			Subseries
SPECIES	SPECIES	SPECIES	Species
Subspecies	(Subspecies) (=Varietas)	Subspecies	Subspecies
Varietas			Variety
(Subvarietas)			Subvariety
Forma			Form
(Subforma)			Subform

of the hierarchy, each of which is subordinate to one and only one immediately higher group and each of which (except the lowest) includes one or more subordinate lower groups.

The arrangement of systematic groups into an hierarchical system had its origin in the logical theory of classification. It functions primarily as an aid to memory, but it also has a biological basis, in so far as the various levels in the hierarchy can be said to reflect different degrees of evolutionary divergence. The number of levels in the hierarchy, needed conveniently to accommodate the variation of the living world, has none the less been decided quite arbitrarily as a result of practical experience over the past two hundred years. Those generally employed are shown in Table 1. Additional levels may be employed if required. The levels are given conventional names and arranged in a conventional order which must be strictly adhered to. The framework thus formed is known as the *taxonomic hierarchy*. The different levels are known as *taxonomic ranks*. The groups of organisms themselves are known as *taxonomic units*. All such groups as stand at any given level (or rank) in the hierarchy are said to belong to the same *taxonomic category*.

The taxonomic hierarchy can be envisaged as a series of pigeon-holes placed vertically one above another. The bottoms of the pigeon-holes then represent the taxonomic ranks. The pigeon-holes themselves represent the taxonomic categories. The contents of the pigeon-holes—the groups of organisms we place in them—represent the taxonomic units. This analogy also makes it easier to appreciate that taxonomic ranks and categories are purely abstract concepts. It is the taxonomic units—groups consisting ultimately of individual living organisms—that alone have any concrete reality. Thus all the primroses form a group which is considered to be of specific rank and is therefore assigned to the category species. This group is the species known as *Primula vulgaris*.

Similarly, *Primula* is a genus, a taxonomic group of generic rank, and *Primulaceae* is a family, a taxonomic group of family rank. However, if we wish to consider taxonomic groups in general, irrespective of rank, we use the term *taxon* (plural, *taxa*). A taxon is defined as a taxonomic group of any rank.[4] The term taxon will be used henceforth in this handbook to denote what have hitherto been called, more clumsily, taxonomic groups or taxonomic units.[5]

2 Names and Codes

2.1 The purpose of names

A name is merely a conventional symbol or cipher, which serves as a means of reference and avoids the need for continuous use of a cumbersome descriptive phrase. The purpose of names is to act as vehicles of communication. Like the ciphers of any code, names can effectively fulfil this function only if they are understood by, and have the same meanings for, all who use the code. Names, however communicated, should immediately and unequivocally call to mind the concepts intended by the transmitter of the names. This is the fundamental principle of nomenclature and it is the sole criterion by which the efficiency of any system of nomenclature can be judged. It implies that names must be unambiguous and universal.

2.2 Codes of nomenclature

Common names of living organisms in vernacular languages are, in general,[6] so far from meeting these conditions that they are quite unsatisfactory for use in biological nomenclature. Quite apart from the multiplicity of languages, many using different alphabets, even within a single language the same name is often used in different senses to denote different kinds of organisms, or the same kind of organism is known by more than one name. Biological nomenclature tries to avoid such defects, and for this reason sets of rules called *Codes of Nomenclature* have been drawn up. The formation and use of the scientific names of organisms classified as animals are governed by the International Code of Zoological Nomenclature (ICNZ); of those classified as plants (including fungi) by the International Code of Botanical Nomenclature (ICBN); and of those classified as bacteria (including actinomycetes) by the International Code of Nomenclature of Bacteriology (ICNB).

The three codes differ in approach and format but the operative core of each consists of a series of numbered *rules* or *articles*, some of which are supplemented by *recommendations*. The provisions of rules are mandatory and must be followed whenever names are given or employed. Recommendations deal with subsidiary points and indicate the best procedure to be followed. Names contrary to a recommendation may not be rejected on that count, but they are not examples to be followed. The rules of the Codes

do not, of course, have any legal status in national or international law. Their enforcement depends solely on the voluntary agreement of systematists to observe their provisions. The only sanctions that can be employed against those who do not are disapproval by their colleagues and disregard of their work. Nevertheless, non-observance of the provisions of the Codes can lead only to instability of nomenclature. All systematists should therefore understand the provisions of the appropriate Code and follow them even if, personally, they disagree with some of them. This does not preclude the proposal of modifications or exceptions to the rules through the appropriate established procedure.

2.3 Modification of the codes

The Botanical Code may be modified only by a decision of a plenary session of an International Botanical Congress on a resolution made by the Nomenclature Section of the Congress. Permanent Nomenclature Committees are elected by a Congress and are established under the auspices of the International Association for Plant Taxonomy to deal with various nomenclatural matters referred to them. Of these, the Editorial Committee is charged with the preparation and publication of the Code in conformity with the decisions adopted by a Congress. Proposals for modification of the Code must be submitted to the Nomenclature Section of a Congress and are voted on in accordance with a set procedure.

The Bacteriological Code may be modified only by action of the permanent International Committee on Systematic Bacteriology[7] approved by a General Meeting of an International Congress for Microbiology convened by the International Association of Microbiological Societies. A Judicial Commission elected from the membership of the International Committee is responsible through an Editorial Board for the editing and production of the Code. Proposals for modification of the Code must be submitted to one of the Permanent Secretaries of the International Committee at least one year in advance of the next International Congress.

The Zoological Code may be modified only by an International Congress of Zoology, acting on a recommendation from the International Commission on Zoological Nomenclature presented through and approved by the Section on Nomenclature of the Congress. The Code is prepared on behalf of the International Commission by an Editorial Committee appointed by the Congress. Proposals for the modification of the Code should be submitted to the Secretary of the International Commission at least one year in advance of the next International Congress.

3 Scientific Names

3.1 Alphabet and language

The Codes of Nomenclature differ in detail but certain basic features are common to all three. To be universal, scientific names must be written in the same alphabet and the same language. The Codes of Nomenclature require that all scientific names be *Latin* in form, written in the Latin alphabet and subject to the rules of Latin grammar. The scientific names of living organisms are therefore Latin or are treated as Latin, even if, as is often the case, they are derived from other languages. The Codes also lay down a number of conventions which must be observed in the formation and use of scientific names so that uniformity is as far as possible ensured.

3.2 Names of taxa above the rank of genus

The names of taxa above the rank of genus consist of one term only and are therefore called *uninomial*, *uninominal* or *unitary*. They are plural nouns (or adjectives used as nouns) and are written with a capital initial letter. So that the rank of a taxon may be apparent from its name, in many cases the Codes stipulate a standardized ending for the names of all taxa of a given taxonomic rank. For example, under the Botanical Code, the names of plant families must end in *-aceae*,[8] while under the Zoological Code, the names of animal families must end in *-idae*. Such standardized endings as are required by the Codes are listed in Table 2. It should be noted that the names of taxa above the rank of *Superfamilia* are not governed by the Zoological Code (see Table 1).

3.3 Names of genera

The names of genera are also uninomial. They are singular nouns written with a capital initial letter, e.g. *Primula*, *Felis*, *Agaricus*, *Bacillus*.

3.4 Names of taxa intermediate in rank between genus and species

Under the Bacteriological and Zoological Codes, only one category of such taxa—the subgenus—is recognized. The names of subgenera under these

Table 2 Standardized Endings for the Names of Taxa

Endings enclosed in parentheses are only recommended and are not mandatory under the respective Code. The endings *-phyta* and *-phytina* are used for the names of taxa of green (non-fungal) plants; *-phyceae* and *-phycideae* for the names of taxa of algae; *-opsida* and *-idae* for the names of taxa of higher green plants; *-mycota, -mycotina, -mycetes* and *-mycetidae* for the names of taxa of fungi. The endings *-ales* and *-ineae* are mandatory under the Botanical Code for the names of orders and suborders respectively only if they are names based on the name of an included family. The ending *-acea*, although not recommended by the Zoological Code, is also frequently used for the names of superfamilies

Category	Botanical	Bacteriological	Zoological
Divisio	(-phyta/-mycota)		
Subdivisio	(-phytina/-mycotina)		
Classis	(-phyceae/-mycetes/-opsida)		
Subclassis	(-phycidae/-mycetidae/-idae)		
Ordo	-ales	-ales	
Subordo	-ineae	-ineae	
Superfamilia			(-oidea)
Familia	-aceae	-aceae	-idae
Subfamilia	-oideae	-oideae	-inae
Tribus	-eae	-eae	(-ini)
Subtribus	-inae	-inae	

Codes resemble in all respects those of genera. They are uninomial and are singular nouns written with a capital initial letter.

Under the Botanical Code, several categories of such taxa are recognized (see Table 1). The name of such a taxon is not a uninomial but is a *combination* of the name of the genus[9] in which the taxon is classified with another term peculiar to the taxon and preceded by a word indicating its rank, e.g. *Costus* subg. *Metacostus*, *Primula* subg. *Primula* sect. *Primula* series *Acaules*. This term may be either a singular noun or a plural adjective and is written with a capital intitial letter.

3.5 Names of species

The names of species consist of two terms and are therefore called *binomial*, *binominal* or *binary*. The name of a species consists of the name of the genus in which the species is classified followed by a second term which is peculiar to the species, e.g. *Equus caballus*, *Rosa acicularis*, *Corynebacterium fascians*.[10] The second term may be adjectival (in which case it must agree in gender with the generic name), a noun in apposition, or a noun (or rarely an adjective used as a noun) in the genitive case.[11] It is written with a small initial letter.[12]

Sometimes, especially in zoological literature, the name of the subgenus to which the species belongs may be written in parentheses between the generic name and the second term, e.g. *Anopheles* (*Myzomyia*) *gambiae*. However, this is not a part of the name of the species, which is always strictly binomial, and which in this instance is simply *Anopheles gambiae*.

The second term of the binary name of a species by itself has no standing and cannot be used alone to refer to any organism. For example, the scientific name of the domestic horse is *Equus caballus*. The horse cannot be referred to simply as '*caballus*', as there are other species with this term as part of their names. Likewise, '*japonica*' by itself simply means Japanese and can refer to no particular kind of plant. On the other hand, in combination with various generic names it forms the names of various plant species, e.g. *Anemone japonica*, *Primula japonica*, *Chaenomeles japonica*.

Once the full name of a species has been cited in a text, its first term, i.e. the generic name, is often abbreviated to its initial letter in subsequent citations, if this can be done without causing ambiguity or doubt. Here, for example, we might now write *A. japonica*, as the full name of this *Anemone* species has already been mentioned and no ambiguity would be caused by so doing.