Bacterial Nomenclature

Peter H.A. Sneath

Scope of nomenclature

Nomenclature has been called the handmaid of taxonomy. The need for a stable set of names for living organisms, and rules to regulate them, has been recognized for over a century. The rules are embodied in international codes of nomenclature. There are separate codes for animals, noncultivated plants, cultivated plants, procaryotes, and viruses. But partly because the rules are framed in legalistic language (so as to avoid imprecision), they are often difficult to understand. Useful commentaries are found in Ainsworth and Sneath (1962), Cowan (1978), and Jeffrey (1977). There are proposals for a new universal code for living organisms (see the Proposed BioCode).

The nomenclature of the different kinds of living creatures falls into two parts: (a) informal or vernacular names, or very specialized and restricted names; and (b) scientific names of taxonomic groups (taxon, plural taxa).

Examples of the first are vernacular names from a disease, strain numbers, the symbols for antigenic variants, and the symbols for genetic variants. Thus one can have a vernacular name like the tubercle bacillus, a strain with the designation K12, a serological form with the antigenic formula Ia, and a genetic mutant requiring valine for growth labeled *val*. These names are usually not controlled by the codes of nomenclature, although the codes may recommend good practice for them.

Examples of scientific names are the names of species, genera, and higher ranks. Thus *Mycobacterium tuberculosis* is the scientific name of the tubercle bacillus, a species of bacterium.

These scientific names are regulated by the codes (with few exceptions) and have two things in common: (a) they are all Latinized in form so as to be easily recognized as scientific names, and (b) they possess definite positions in the taxonomic hierarchy. These names are international; thus microbiologists of all nations know what is meant by *Bacillus anthracis*, but few would know it under vernacular names like Milzbrandbacillus or Bactéridie de charbon.

The scientific names of procaryotes are regulated by the *International Code of Nomenclature of Bacteria*, which is also known as the *Revised Code* published in 1975 (Lapage et al., 1975). This edition authorized a new starting date for names of bacteria on January 1, 1980, and the starting document is the Approved Lists of Bacterial Names (Skerman et al., 1980), which contains all the scientific names of bacteria that retain their nomenclatural validity from the past. The operation of these Lists will be referred to later. The *Code* and the Lists are under the aegis of the International Committee on Systematic Bacteriology, which is a constituent part of the International Union of Microbiological Societies. The Committee is assisted by a number of Taxonomic Subcommittees on different groups of bacteria, and by the Judicial Commission, which considers amendments to the *Code* and any exceptions that may be needed to specific Rules. An updated edition of the *Revised Code* was published in 1992 (Lapage et al., 1992).

Latinization

Since scientific names are in Latinized form, they obey the grammar of classic, medieval, or modern Latin (Neo-Latin). Fortunately, the necessary grammar is not very difficult, and the most common point to watch is that adjectives agree in gender with the substantives they qualify. Some examples are given later. The names of genera and species are normally printed in italics (or underlined in manuscripts to indicate italic font). For higher categories conventions vary: in Britain they are often in ordinary roman type, but in America they are usually in italics, which is preferable because this reminds the reader they are Latinized scientific names. Recent articles that deal with etymology and Latinization include that of MacAdoo (1993) and the accompanying article by Trüper on Etymology in Nomenclature of Procaryotes. The latter is particularly valuable because it clarifies the formation of names derived from names of persons.

Taxonomic hierarchy

The taxonomic hierarchy is a conventional arrangement. Each level above the basic level of species is increasingly inclusive. The names belong to successive **categories**, each of which possesses a position in the hierarchy called its **rank**. The lowest category ordinarily employed is that of species, though sometimes these are subdivided into subspecies. The main categories in decreasing rank, with their vernacular and Latin forms, and examples, are shown in Table 1.

Additional categories may sometimes be intercalated (e.g., subclass below class, and tribe below family). There is currently discussion on the best treatment for categories above kingdom; the BioCode (see later) uses the term, domain, above kingdom.

Form of names

The form of Latinized names differs with the category. The species name consists of two parts. The first is the **genus name**. This is spelled with an initial capital letter, and is a Latinized substantive. The second is the **specific epithet**, and is spelled with a lower case initial letter. The epithet is a Latinized adjective in agreement with the gender of the genus name, or a Latin word in the genitive case, or occasionally a noun in apposition. Examples are given in the article by Trüper. Thus in *Mycobacterium*

TABLE 1. The ranking of taxonomic categories

Category	Example
Domain	*Bacteria*
Phylum in zoology or Division in botany and bacteriology	*Actinobacteria*
Class	*Actinobacteria*
Subclass	*Actinobacteridae*
Order	*Actinomycetales*
Suborder	*Actinomycineae*
Family	*Actinomycetaceae*
Genus	*Actinomyces*
Species	*Actinomyces bovis*

tuberculosis, the epithet tuberculosis means "of tubercle", so the species name means the mycobacterium of tuberculosis. The species name is called a **binominal name**, or **binomen**, because it has two parts. When subspecies names are used, a trinominal name results, with the addition of an extra **subspecific epithet**. An example is the subspecies of *Lactobacillus casei* that is called *Lactobacillus casei* subsp. biovar *rhamnosus*. In this name, *casei* is the specific epithet and *rhamnosus* is the subspecific epithet. The existence of a subspecies such as *rhamnosus* implies the existence of another subspecies, in which the subspecific and specific epithets are identical, i.e., *Lactobacillus casei* subsp. biovar *casei*.

One problem that frequently arises is the scientific status of a species. It may be difficult to know whether an entity differs from its neighbors in certain specified ways. A useful terminology was introduced by Ravin (1963). It may be believed, for example, that the entity can undergo genetic exchange with a nearby species, in which event they could be considered to belong to the same **genospecies**. It may be believed the entity is not phenotypically distinct from its neighbors, in which event they could be considered to belong to the same **taxospecies**. Yet, the conditions for genetic exchange may vary greatly with experimental conditions, and the criteria of distinctness may depend on what properties are considered, so that it may not be possible to make clear-cut decisions on these matters. Nevertheless, it may be convenient to give the entity a species name and to treat it in nomenclature as a separate species, a **nomenspecies**. It follows that all species in nomenclature should strictly be regarded as nomenspecies. They are, of course, usually also taxospecies.

Genus names, as mentioned above, are Latinized nouns, and so subgenus names (now rarely used) are conventionally written in parentheses after the genus name; e.g., *Bacillus* (*Aerobacillus*) indicates the subgenus *Aerobacillus* of the genus *Bacillus*. As in the case of subspecies, this implies the existence of a subgenus *Bacillus* (*Bacillus*).

Above the genus level most names are plural adjectives in the feminine gender, agreeing with the word *Procaryotae*, so that, for example, *Brucellaceae* means *Procaryotae Brucellaceae*.

Purposes of the codes of nomenclature

The codes have three main aims:

1. Names should be stable,
2. Names should be unambiguous,
3. Names should be necessary.

These three aims are sometimes contradictory, and the rules of nomenclature have to make provision for exceptions where they clash. The principles are implemented by three main devices: (a) priority of publication to assist stability, (b) establishment of nomenclatural types to ensure the names are not ambiguous, and (c) publication of descriptions to indicate that different names do refer to different entities. These are supported by subsidiary devices such as the Latinized forms of names, and the avoidance of synonyms for the same taxon (see Synonyms and Homonyms later in this section).

Priority of publication

To achieve stability, the first name given to a taxon (provided the other rules are obeyed) is taken as the correct name. This is the **principle of priority**. But to be safeguarded in this way a name obviously has to be made known to the scientific community; one cannot use a name that has been kept secret. Therefore, names have to be published in the scientific literature, together with sufficient indication of what they refer to. This is called **valid publication**. If a name is merely published in the scientific literature, it is called **effective publication**; to be valid it also has to satisfy additional requirements, which are summarized later.

The earliest names that must be considered are those published after an official starting date. For many groups of organisms this is Linnaeus' *Species Plantarum* of 1753, but the difficulties of knowing to what the early descriptions refer, and of searching the voluminous and growing literature, have made the principle of priority increasingly hard to obey.

The *Code* of nomenclature for bacteria, therefore, established a new starting date of 1980, with a new starting document, the Approved Lists of Bacterial Names (Skerman et al., 1980). This list contains names of bacterial taxa that were recognizable and in current use. Names not on the lists lost standing in nomenclature on January 1, 1980, although there are provisions for reviving them if the taxa are subsequently rediscovered or need to be reestablished. To prevent the need to search the voluminous scientific literature, the new provisions for bacterial nomenclature require that for valid publication new names (including new names in patents) must be published in certain official publications. Alternatively, if the new names were effectively published in other scientific publications, they must be announced in the official publications to become validly published. Priority dates from the official publication concerned. At present the only official publication is the *International Journal of Systematic Bacteriology* (now the *International Journal of Systematic and Evolutionary Microbiology*).

Nomenclatural types

To make clear what names refer to, the taxa must be recognizable by other workers. In the past it was thought sufficient to publish a description of a taxon. This has been found over the years to be inadequate. Advances in techniques and in knowledge of the many undescribed species in nature have shown that old descriptions are usually insufficient. Therefore, an additional principle is employed, that of **nomenclatural types**. These are actual specimens (or names of subordinate taxa that ultimately relate to actual specimens). These type specimens are deposited in museums and other institutions. For procaryotes (like some other microorganisms that are classified according to their properties in artificial culture) instead of type specimens, **type strains** are employed. The type specimens or strains are intended to be typical specimens or strains that can be compared with other material when classification or identification is undertaken,

hence the word "type". However, a moment's thought will show that if a type specimen has to be designated when a taxon is first described and named, this will be done at a time when little has yet been found out about the new group. Therefore, it is impossible to be sure that it is indeed a typical specimen. By the time a completely typical specimen can be chosen, the taxon may be so well known that a type specimen is unnecessary; no one would now bother to designate a type specimen of a bird so well known as the common house sparrow.

The word "type" thus does not mean it is typical, but simply that it is a **reference specimen for the name**. This use of the word "type" is a very understandable cause for confusion that may well repay attention by the taxonomists of the future. For this reason, the *Code* discourages the use of terms like serotype and recommends instead terms formed from -var, e.g., serovar.

In recent years other type concepts have been suggested. Numerical taxonomists have proposed the hypothetical median organism (Liston et al., 1963), or the centroid; these are mathematical abstractions, not actual organisms. The most typical strain in a collection is commonly taken to be the **centrotype** (Silvestri et al., 1962), which is broadly equivalent to the strain closest to the center (centroid) of a species cluster. Some workers have suggested that several type strains should be designated. Gordon (1967) refers to this as the "population concept". One strain, however, must be the official nomenclatural type in case the species must later be divided. Gibbons (1974b) proposed that the official type strain should be supplemented by reference strains that indicated the range of variation in the species, and that these strains could be termed the "type constellation". It may be noted that some of these concepts are intended to define not merely the center but, in some fashion, the limits of a species. Since these limits may well vary in different ways for different characters, or classes of characters, it will be appreciated that there may be difficulties in extending the type concept in this way. The centrotype, being a very typical strain, has often been chosen as the type strain, but otherwise these new ideas have not had much application to bacterial nomenclature.

Type strains are of the greatest importance for work on both classification and identification. These strains are preserved (by methods to minimize change to their properties) in culture collections from which they are available for study. They are obviously required for new classificatory work, so that the worker can determine if he has new species among his material. They are also needed in diagnostic microbiology, because one of the most important principles in attempting to identify a microorganism that presents difficulties is to compare it with authentic strains of known species. The drawback that the type strain may not be entirely typical is outweighed by the fact that the type strain is by definition authentic.

Not all microorganisms can be cultured, and for some the function of a type can be served by a preserved specimen, a photograph, or some other device. In such instances, these are the nomenclatural types, though it is commonly considered wise to replace them by type strains when this becomes possible. Molecular sequences are increasingly being used as important aspects of organisms, and sometimes they assume the functions of nomenclatural types, although they are not yet explicitly mentioned in the *Code*. Authors should, however, bear in mind the limitations of sequences for distinguishing very closely related organisms.

Sometimes types become lost, and new ones (**neotypes**) have to be set up to replace them; the procedure for this is described in the *Code*. In the past it was necessary to define certain special classes of types, but most of these are now not needed.

Types of species and subspecies are type specimens or type strains. For categories above the species, the function of the type—to serve as a point of reference—is assumed by a *name*, e.g., that of a species or subspecies. The species or subspecies is tied to its type specimen or type strain.

Types of genera are **type species** (one of the included species) and types of higher names are usually **type genera** (one of the included genera). This principle applies up to and including the category, order. This can be illustrated by the types of an example of a taxonomic hierarchy shown in Table 2.

The type specimen or type strain must be considered a member of the species whatever other specimens or strains are excluded. Similarly, the **type species of a genus must be retained in the genus even if all other species are removed from it**. A type, therefore, is sometimes called a **nominifer** or **name bearer**; it is the reference point for the name in question.

Descriptions

The publication of a name, with a designated type, does in a technical sense create a new taxon, insofar as it indicates that the author believes he has observations to support the recognition of a new taxonomic group. But this does not afford evidence that can be readily assessed from the bald facts of a name and designation of a type. From the earliest days of systematic biology, it was thought important to describe the new taxon for two reasons: (a) to show the evidence in support of a new taxon, and (b) to permit others to identify their own material with it—indeed this antedated the type concept (which was introduced later to resolve difficulties with descriptions alone).

It is, therefore, a requirement for valid publication that a description of a new taxon is needed. However, just how full the description should be, and what properties must be listed, is difficult to prescribe.

The codes of nomenclature recognize that the most important aspect of a description is to provide a list of properties that distinguish the new taxon from others that are very similar to it, and that consequently fulfill the two purposes of adducing evidence for a new group and allowing another worker to recognize it. Such a brief differential description is called a **diagnosis**, by analogy with the characteristics of diseases that are associated with the same word. Although it is difficult to legislate for adequate diagnoses, it is usually easy to provide an acceptable one; inability to do so is often because insufficient evidence has been obtained to support the establishment of the new taxon. It is generally unwise to propose a new taxon unless one can provide at least a few properties that distinguish it with good reliability from closely similar taxa.

The *Code* provides guidance on descriptions, in the form of recommendations. Failure to follow the recommendations does not of itself invalidate a name, though it may well lead later workers to dismiss the taxon as unrecognizable or trivial. The code for bacteria recommends that as soon as minimum stan-

TABLE 2. An example of taxonomic types

Category	Taxon	Type
Family	*Pseudomonadaceae*	*Pseudomonas*
Genus	*Pseudomonas*	*Pseudomonas aeruginosa*
Species	*Pseudomonas aeruginosa*	ATTC 10145

dards of description are prepared for various groups, workers should thereafter provide that minimum information; this is intended as a guide to good practice, and should do much to raise the quality of systematic bacteriology. For an example of minimum standards, see the report of the International Committee on Systematic Bacteriology Subcommittee on the Taxonomy of *Mollicutes* (1979).

Classification determines nomenclature

The student often asks how an organism can have two different names. The reason lies in the fact that a name implies acceptance of some taxonomy, and on occasion no taxonomy is generally agreed upon. Scientists are entitled to their own opinions on taxonomies; there are no rules to force the acceptance of a single classification.

Thus opinions may be divided on whether the bacterial genus *Pectobacterium* is sufficiently separate from the genus *Erwinia*. The soft-rot bacterium was originally called *Bacterium carotovorum* in the days when most bacteria were placed in a few large genera such as *Bacillus* and *Bacterium*. As it became clear that these unwieldy genera had to be divided into a number of smaller genera, which were more homogeneous and convenient, this bacterium was placed in the genus *Erwinia* (established for the bacterium of fireblight, *Erwinia amylovora*) as *Erwinia carotovora*. When further knowledge accumulated, it was considered by some workers that the soft-rot bacterium was sufficiently distinct to merit a new genus, *Pectobacterium*. The same organism, therefore, is also known as *Pectobacterium carotovorum*. Both names are correct in their respective positions. If one believes that two separate genera are justified, then the correct name for the soft-rot bacterium is *Pectobacterium carotovorum*. If one considers that *Pectobacterium* is not justified as a separate genus, the correct name is *Erwinia carotovora*.

Classification, therefore, determines nomenclature, not nomenclature classification. Although unprofitable or frivolous changes of name should be avoided, the freezing of classification in the form it had centuries ago is too high a price to pay for stability of names. Progress in classification must reflect progress in knowledge (e.g., no one now wants to classify all rod-shaped bacteria in *Bacillus*, as was popular a century ago). Changes in name must reflect progress in classification; some changes in name are thus inevitable.

Changes of name

Most changes in name are due to moving species from one genus to another or dividing up older genera. Another cause, however, is the rejection of a commonly used name because it is incorrect under one or more of the Rules. A much-used name, for example, may not be the earliest, because the earliest name was published in some obscure journal and had been overlooked. Or there may already be another identical name for a different microorganism in the literature. Such problems are now rare because of the Approved Lists and the lists of new names in the *International Journal of Systematic Bacteriology* (see Proposal of New Names). Changes can be very inconvenient if a well-established name is found to be illegitimate (contrary to a Rule) because of a technicality. The codes of nomenclature therefore make provision to allow the organizations that are responsible for the codes to make exceptions if this seems necessary. A name thus retained by international agreement is called a **conserved name**, and when a name is conserved the type may be changed to a more suitable one.

When a species is moved from one genus into another, the specific epithet is retained (unless there is by chance an earlier name that forms the same combination, when some other epithet must be chosen), and this is done in the interests of stability. The new name is called a **new combination**. An example has been given above. When the original *Bacterium carotovorum* was moved to *Erwinia*, the species name became *Erwinia carotovora*. The gender of the species epithet becomes the same as that of the genus *Erwinia*, which is feminine, so the feminine ending, *-a*, is substituted for the neuter ending, *-um*.

Names should be necessary

The codes require that names should be necessary, i.e., there is only one correct name for a taxon in a given or implied taxonomy. This is sometimes expressed by the statement that an organism with a given position, rank, and circumscription can have only one correct name.

Names are labels, not descriptions

In the early days of biology, there was no regular system of names, and organisms were referred to by long Latin phrases that described them briefly, such as *Tulipa minor lutea italica folio latiore*, "the little yellow Italian tulip with broader leaves". The Swedish naturalist Linnaeus tried to reduce these to just two words for species, and in doing so he founded the present binominal system for species. This tulip might then become *Tulipa lutea*, just "the yellow tulip". Very soon it would be noted that a white variant sometimes occurred. Should it then still be named "the yellow tulip"? Why not change it to "the Italian tulip"? Then someone would find it in Greece and point out that the record from Italy was a mistake anyway. Twenty years later an orange or yellow form would be found in Italy after all. Soon the nomenclature would be confused again.

After a time it was realized that the original name had to be kept, even if it was not descriptive, just as a man keeps his name Fairchild Goldsmith as he grows older, and even if he becomes a farmer. The scientific names or organisms are today only labels, to provide a means of referring to taxa, just like personal names.

A change of name is therefore only rarely justified, even if it sometimes seems inappropriate. Provisions exist for replacement when the name causes great confusion.

Citation of names

A scientific name is sometimes amplified by a citation, i.e., by adding after it the author who proposed it. Thus the bacterium that causes crown galls is *Agrobacterium tumefaciens* (Smith and Townsend) Conn. This indicates that the name refers to the organism first named by Smith and Townsend (as *Bacterium tumefaciens*, in fact, though this is not evident in the citation) and later moved to the genus *Agrobacterium* by Conn, who therefore created a new combination. Sometimes the citation is expanded to include the date (e.g., *Rhizobium*, Frank 1889), and more rarely to include also the publication, e.g., *Proteus morganii* Rauss 1936 *Journal of Pathology and Bacteriology* Vol. 42, p. 183.

It will be noted that citation is only necessary to provide a suitable reference to the literature or to distinguish between inadvertent duplication of names by different authors. A citation is not a means of giving credit to the author who described a taxon; the main functions of citation would be served by the bibliographic reference without mentioning the author's name. Citation of a name is to provide a **means of referring** to a name, just as a name is a means of referring to a taxon.

Synonyms and homonyms

A homonym is a name identical in spelling to another name but based on a different type, so they refer to different taxa under the same name. They are obviously a source of confusion, and the one that was published later is suppressed. The first published name is known as the **senior homonym**, and later published names are **junior homonyms**. Names of higher animals and plants that are the same as bacterial names are not treated as homonyms of names of bacteria, but to reduce confusion among microorganisms, bacterial names are suppressed if they are junior homonyms of names of fungi, algae, protozoa, or viruses.

A synonym is a name that refers to the same taxon under another scientific name. Synonyms thus come in pairs or even swarms. They are of two kinds:

1. **Objective synonyms** are names with the same nomenclatural type, so that there is no doubt that they refer to the same taxon. These are often called nomenclatural synonyms. An example is *Erwinia carotovora* and *Pectobacterium carotovorum*; they have the same type strain, American Type Culture Collection strain 15713.
2. **Subjective synonyms** are names that are believed to refer to the same taxon but that do not have the same type. They are matters of taxonomic opinion. Thus *Pseudomonas geniculata* is a subjective synonym of *Pseudomonas fluorescens* for a worker who believes that these taxa are sufficiently similar to be included in one species, *P. fluorescens*. They have different types, however (American Type Culture Collection strains #19374 and 13525, respectively), and another worker is entitled to treat them as separate species if he or she so wishes.

There are senior and junior synonyms, as for homonyms. The synonym that was first published is known as the **senior synonym**, and those published later are **junior synonyms**. Junior synonyms are normally suppressed.

Proposal of new names

The valid publication of a new taxon requires that it be named. The *Code* insists that authors should make up their minds about the new taxon; if they feel certain enough to propose a new taxon with a new name, then they should say they do so propose; if they are not sure enough to make a definite proposal, then the name of their taxon will not be afforded the protection of the *Code*. They cannot expect to suggest provisional names—or possible names, or names that one day might be justified—and then expect others to treat them as definite proposals at some unspecified future date. How can a reader possibly know when such vague conditions have been fulfilled?

If a taxon is too uncertain to receive a new name, it should remain with a vernacular designation (e.g., the marine form, group 12A). If it is already named, but its affinities are too uncertain to move it to another genus or family, it should be left where it is. There is one exception, and that is that a new species should be put into some genus even if it is not very certain which is the most appropriate, or if necessary a new genus should be created for it. Otherwise, it will not be validly published, it will be in limbo, and it will be generally overlooked, because no one else will know how to index it or how to seriously consider it. If it is misplaced, it can later be moved to a better genus. Names of procaryotic genera should not end in -myces, -phyces, -phyta, or -virus to avoid confusion with mycology, botany, or virology.

The formation of names is considered at length by Trüper in the accompanying section on Etymology in Nomenclature of Procaryotes. This gives advice on Latinization. He recommends that names should be short and easy to pronounce and should be formed from Latin or Greek roots where possible. He discusses the difficulties of forming names of taxa from the names of persons. Authors should refrain from naming taxa after themselves.

The basic needs for publication of a new taxon are four: (a) the publication should contain a new name in proper form that is not a homonym of an earlier name of bacteria, fungi, algae, protozoa, or viruses; (b) the taxon name should not be a synonym of an earlier taxon name; (c) a description or at least a diagnosis should be given; and (d) the type should be designated. A new species is indicated by adding the Latin abbreviation *sp. nov.*, a new genus by *gen. nov.*, and a new combination by *comb. nov.* The most troublesome part is the search of the literature to cover the first two points. This is now greatly simplified for bacteria, because the new starting date means that one need search only the Approved Lists of Bacterial Names and the issues of the *International Journal of Systematic Bacteriology* from January, 1980, onward for all validly published names that have to be considered. This task is made easier by the periodic cumulative updating of names in the *International Journal of Systematic Bacteriology* (e.g., Moore and Moore, 1989) and by the increasing availability of electronic online listings (e.g., Euzéby at Web site www-sv.cict.fr/bacterio/ and by the DSMZ, Braunsweig, Germany). However, the new name has to be published in that journal, with its description and designation of type, or, if published elsewhere, the name must be announced in that journal to render it validly published.

The proposed BioCode

In recent years there has been growing awareness in botany and zoology of the problems for nomenclature from the huge numbers of new organisms that are being discovered. The different biological disciplines, therefore, have started the process of unifying the nomenclature of all living organisms, and a proposal for a universal BioCode is being actively pursued. A draft has been published (Greuter et al., 1998), which is now being studied by the organizations responsible for the codes for animals, plants, microorganisms, cultivated plants, and viruses. The aim of the BioCode is to introduce changes for names of taxa published at some date after January 1, 2000.

These proposals are at present only recommendations until the reforms are complete and widely accepted. The present codes of nomenclature will continue to operate in their own subject areas but will be revised to implement the provisions of the BioCode. The International Union of Microbiological Societies (which is the body ultimately responsible for the *Bacteriological Code*) is, in principle, in favor of this development, but the practical implementation will take some time. Nevertheless, it would be wise for microbiologists to take account of the main proposals.

Registration of new names for all organisms will be introduced by mechanisms similar to those in the *Bacteriological Code*. The main differences from that *Code* can be summarized as follows:

1. Phylum will replace division (the category below kingdom and above class).
2. Provision is made for numerous intercalations, with prefixes supra-, sub-, and infra-.
3. Nomenclature types will not be living specimens, although type strains in the form of viable but metabolically inactive organisms are acceptable.

4. Generic homonyms will be prohibited across all organisms. At present generic names of animals can be the same as those of plants (thus, *Pieris* is a genus of butterflies and a genus of ericaceous plants). Whether this is practicable remains to be seen. It will be easier to achieve when lists of genus names of plants and animals are more complete and are available in electronic form. The two serial publications, *Index Zoologicus* and *Index Nomina Genericorum Plantarum*, are widely available to check animal and plant genus names. The *Bacteriological Code* already prohibits homonyms among procaryotes, fungi, algae, protozoa, and viruses, as noted earlier.
5. There will be some complex rules on the use of synonyms extending above the genus to the rank of family. These are unfamiliar to bacteriologists, and it is not clear how readily they will be accepted.
6. There will be changes in the formal usage of certain terms. Thus, *effective publication* in bacteriology will become simply *publication* and *valid publication* will become *establishment by registration*. *Legitimate names* will become *acceptable names*. Synonyms will be *homotypic* and *heterotypic* instead of *objective* and *subjective*, respectively. *Priority* will become *precedence*, and *senior* and *junior* names will become *earlier* and *later* names.
7. Prohibition of genus names ending in -myces, -phyces, -phyta, and -virus has been mentioned earlier.

It is evident that revision of the *Bacteriological Code* will be required to achieve the aims of the BioCode, although it will often be possible to make exceptions for bacteriological work. It is to be hoped that such revision will ultimately lead to a version expressed in language familiar to bacteriologists and illustrated by examples from this discipline.