**TAXONOMIC
NOTE****Suggestions for avoiding on-going confusion
from the Bacteriological Code**

J. M. Young

e-mail: youngj@landcare.cri.nz

Landcare Research, Private
Bag 92170, Auckland,
New Zealand

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For the publication of a valid bacterial name, the International Code of Nomenclature of Bacteria (the Code – 1990 Revision; Lapage *et al.*, 1992) requires proposal of a name, a description of the taxon, and the designation of a 'nomenclatural type'. In the case of a species the nomenclatural type is the type strain. At taxonomic levels above species, the nomenclatural type is one of the included taxa at the next level below that which is to be named. Thus, for genera, a type species is designated; for a family, a type genus is designated, and so on.

The role of nomenclatural types has been elaborated comprehensively by Starr & Heise (1969) and more succinctly by Sneath (1984). The type strain, as the nomenclatural type of the species (the Code, Rule 15), is the '... element of the taxon with which the name is permanently associated'. The type strain is the name-bearer or *nominifer* of the species. In revisions of the classification of the species, the allocation of the type strain of a taxon determines the fate of the name. Thus, if a species is divided into two new species, that taxon which includes the type strain is the one which retains the species name. If the type strains of two species are included in a single species, then the type strain associated with the oldest name takes priority. In a similar way for higher taxa, the allocation of their nomenclatural types determines the fate of their names. The type strains of species are, however, the only non-abstract forms of types (Cowan, 1978), and form the basis of typification of all taxa.

The absence of a connection between the type strain as name bearer and the strains most representative of the taxon follows naturally as a consequence of the way in which bacterial taxa are characterized. The type strain is usually designated before a representative collection of strains has been made, before the ecological diversity of the species is fully understood, and may well lie at an extremity of the variation of the taxon. The

type strain is a nomenclatural concept and it should not be expected to be representative of the taxon (Sneath, 1984). The Code (Rule 15) states 'The nomenclatural type is not necessarily the most typical or representative element of the taxon'. However, type strains are sometimes chosen for research purposes in the mistaken belief that they are modally representative of the species. In many instances this selection is immaterial. However, mistaken conclusions can be drawn in cases where the type strain is specifically selected as the single strain representative of the taxon. Where taxa are under investigation for the presence or absence of a small number of characters, and deductions are made in relation to the taxa based on the type alone, the likelihood of error is high. It is in this regard, where studies are of single characters, or of small numbers of characters, that bacterial investigations commonly differ from studies of other disciplines, such as mycology or botany. In these disciplines, the use of type material is almost entirely confined to taxonomic studies by systematists. Although the role of bacterial types has been widely explained (Bousfield, 1993; Cowan, 1978; Lapage *et al.*, 1992; Sneath, 1984; Trüper & Schleifer, 1992; Young *et al.*, 1992), this misunderstanding in the bacteriological community continues.

The proposal of Starr & Heise (1969) for the application of the term 'nominifer' [sic] in place of 'type' was not accepted by the Judicial Commission of the ICSB in 1970 because this term was considered to be too little used (Editorial Secretary of the Drafting Committee on Behalf of the Judicial Commission of the International Committee on Nomenclature of Bacteria, 1970). The term *nominifer* was deleted from the 1976 revision of the Code (Lapage *et al.*, 1976) in draft. In retrospect this may be seen to have been a mistake. At that time, bacterial nomenclature was a domain largely for systematists and the application of types was not mandatory. The authors of the Code may not have fully appreciated the extent to which bacteria would come to be widely used as micro-

biological tools and their nomenclature would be the subject of misunderstandings by non-systematists. The use of the term 'type' or 'type strain' has been, and will continue to be, an on-going source of confusion in this context.

This confusion can be remedied significantly by the use of another term in place of 'type'. The proposed term by the Interim Commission on Bionomenclature for the harmonization of bionomenclature is 'name-bearing type' (Hawksworth, 1996). Other alternatives are 'name-bearer' or 'nominifer'. These terms have been used in the past as in the explanation of the ambiguity described above (Cowan, 1978). For species, the term referring to the type strain could be 'name-bearing strain' or 'species nominifer'. The Judicial Commission of the ICSB should consider this matter in relation to the development of the Code of Bionomenclature, and make a determination as to whether there is a need for a change of term in the Code and the choice of such a term. A revision of the Code would also need to take account of the Rules (18b and 18c) relating to the little-used terms holotype and neotype.

Names of taxa are not descriptive

The Bacteriological Code was derived from the of Botanical and Zoological Codes (Lapage *et al.*, 1992). For higher organisms, following Linnaeus, emphasis in the ascription of binomials, especially the species epithet, was that it be descriptive of the taxon. Similarly for bacteria, there has been a strong tradition of ascribing names which are descriptive of a significant character of the taxon. The Code has given support for this tradition by recommending [Recommendation 12c(1)] that specific epithets should give some indication of a property or source of a species and by avoiding [Recommendation 12c(2)] those that express a character common to most or all species of a genus. The intention is that names should give reference to specific characters of taxa. Furthermore in requiring that names be in grammatically correct Latin (Rules 6, 8 and 10) and therefore accurately reflecting the intended *meaning* of the name, the Code has further reinforced the idea of names as having a descriptive intention. Necessarily, descriptive terms refer to one or a few characters often regulated by small numbers of genes and therefore not present in all members of the taxon (for examples: not all members of *Agrobacterium tumefaciens* cause tumours; not all members of *Pseudomonas putida* are fetid; *Pseudomonas saccharophila* is not unique in its carbohydrate utilization pattern; not all members of *Xanthomonas* are yellow; and so on). However, Heise & Starr (1969) and Sneath (1984) explained that names of taxa should not be regarded as descriptive of their taxon. Names of taxa may be derived from a descriptive character when first proposed, in the same way that European

surnames, as proper names (De Ley, Fletcher, Schmitt, Stackebrandt), have their origins in the characteristic of some ancestor. However, in the same way that the proper names lose descriptive sense as their application is made to a larger population (the progeny of the ancestor) so the descriptive character of names of taxa lose descriptive sense as the taxon is redefined to include subpopulations which do not reflect the original description. In many cases, revisions of the descriptions, especially of species, results in a complete, or almost complete, dissociation between the species description and its name. Indeed, as the extent of bacterial heterogeneity becomes more apparent, so the expectation is diminished that the members of taxa established using natural phenetic or polyphasic classifications will share any particular common characters.

Properly, names are not descriptive, but are referred to taxa which comprise those members which are considered to share the overall circumscription indicated by a range of indicative characteristics reported in the taxon description. The requirement for correct orthography has had the effect of causing confusion when well-established names are revised to give a sense in Latin (Trüper & de' Clari, 1997; Euzéby, 1998). There is no utility in on-going revisions of well-established names such as *Streptomyces scabies* (correctly *scabiei*) and *Erwinia ananas* (correctly *ananatis*). Recently, the Judicial Commission of the ICSB decided to change the Code to fix names at the time of their validation. This overthrows the past permission to correct orthographic errors and is a step towards the recognition of taxonomic names as general names. However, the perception that names are descriptive is widespread, as exemplified in examples such as a recent Request for an Opinion to conserve an 'informative' name over a validly published earlier synonym (Logan *et al.*, 1998). Consideration should be given to a revision of Recommendation 12c with the removal of clauses (1) and (2). Indeed, for the reasons given above the recommendation could usefully be amended to encourage the use of names which are specifically *not* descriptive of proposed taxa.

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