

TYPIFICATION IN BACTERIOLOGY

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ABSTRACT. The Bacteriological, Botanical and Zoological Codes as well as several authors have proposed or recognized the use of terms to designate the nature of the relationship between the "type" of a species, a subspecies or an infrasubspecific form on the one hand, and related specimens, cultures or strains on the other. Twenty-one terms are listed, defined and some possible relationship to bacteriological nomenclature indicated. The terms discussed are archecultype, cotype, holocultype, holotype, homocultype, graphocultype, lectotype, lectocultype, merocultype, metacultype, monocultype, nomenclatural type, paracultype, paratype, syncultype, syntype, thanocultype, type, type culture, type specimen, and type strain.

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Sneath and Cowan (1958) have emphasized the importance in modern bacteriological taxonomy of having reference strains which give fixed points for comparison and can serve as bench marks in taxonomic surveys. They note that type cultures (or strains) are lacking for most species of bacteria, and designate for the purpose of their study of the application of "Adansonian principles" to taxonomy a series of "temporary working type strains" of organisms studied for which authentic type strains were not available. They state: "The importance of type strains is that they determine the application of names whenever taxa are rearranged." They also note that in the absence of designated type strains of bacteria the Judicial Commission of the International Committee on Bacteriological Nomenclature may approve neotype strains

or cultures. They state further: "There are various names for types used in botany which indicate different degrees of reliability when a type has not been designated." An equivalent statement would be that nearness or degree of relationship to true type strains is shown by the names of such a series. The International Code of Nomenclature of Bacteria and Viruses (1958, 56) recognizes only "type" and "neotype."

Sneath and Cowan suggest the use of six categories following the "convenient nomenclature" of Ainsworth and Bisby (1945), namely holotype, paratype, cotype, isotype, lectotype and neotype. The Botanical Code of Nomenclature authorizes the use of three names, holotype, lectotype and neotype, and makes optional the use of an additional three, isotype, paratype and syntype. The long expected issue of the emended Zoological Code has not yet appeared at the time of this writing, but it is assumed that the Bradley Draft (1957) presented at the London International Zoological Congress (1958) reasonably represents zoological practice. This draft recognizes four names applicable to typification, namely holotype, lectotype, syntype and neotype.

The question raised inferentially by Sneath and Cowan is whether the Bacteriological Code adequately treats the typification of species, subspecies and infrasubspecific forms of the bacteria. This communication is an effort to assess the possible usefulness of the various terms proposed in the several codes and by certain authors to the solution of the problems of typification in the bacteria.

Typification in all three disciplines, Botany, Zoology and Bacteriology is dependent (with some noted exceptions) upon the recognition under international rules of "type specimens" which are the standards with which other "specimens" are compared for purpose of identification.

One of the reasons why it was deemed advisable to develop a code of nomenclature for the bacteria distinct from the Botanical Code was the refusal of the Taxonomic Section of the International Congresses adequately to recognize that with some groups of plants the "type specimen" must be a living specimen. The Botanical Code explicitly states (Recommendation 8B) "When living material is designated as a type, appropriate parts of it should be immediately preserved." This might have been interpreted to mean that a subculture of a type culture (strain) of bacteria could be said to "preserve" the type strain. This interpretation was

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definitely disapproved by the decision of the 1958 Montreal Botanical Congress that a type specimen must be "non-living." The votes of the various committees (except that of the Committee on Fungi) were against recognition of a continuing "living type specimen." But bacteria that have been dried or "pickled" have proved to be wholly unsatisfactory as types. The recognition that descriptions and illustrations may be recognized as types when living types are unavailable is helpful, but not sufficient in many cases. The Bacteriological Code is unique in that it includes a directive that wherever possible the type specimen should be a living culture, but that if one is not available the original description is the "type" until a suitable neotype has been discovered, proposed and approved.

The designation of type cultures of bacteria presents many problems. The problem with which we are immediately concerned has to do primarily with the terms used to identify a bacteriological type specimen and the terms used to designate related specimens. Though these terms are of importance in nomenclature, there exists some confusion in the three disciplines of botany, bacteriology and zoology as to the terms to be used. The fact that bacterial "type specimens" must be living (viable) requires special care in the definition of these explanatory terms.

Dr. Bradley (1957, 138) in his foreword to the Draft Proposal for Article 20 "Types of species and of lower categories" of the Zoological Code classified words ending in "-type" into two groups as follows:

"The term type forms part of many compound words used by taxonomists to designate categories of specimens that are useful to them but have no nomenclatural significance, are not "name-bearers." Topotype, homotype, metatype, morphotype, allotype are examples. This Code is concerned only with those types that are "name bearers" in the sense that each determines to what taxonomic group the name for which it stands applies. Amongst species and lower categories these are only holotype, lectotype, neotype and syntype."

The Bacteriological Code also recognizes a list of "types" whose status as "name-bearers" is questionable, namely biotype, serotype, morphotype and phagotype. These are not included in the following discussion.

The Botanical Code (1956, Art. 7, p. 14-15) recognizes and defines holotype, lectotype and neotype, and in Recommendation 8A further recommends for specimens of special interest isotype, paratype and syntype.

Ciferri (1957) proposed an interesting series of names introduced by the following statement:

"The recommendations of the International Code (Botanical) on the nomenclature of types can only rarely be applied to microorganisms growing in culture in laboratory media: it is only incompletely and with difficulty that they can be transposed from higher to lower plants and from herbarium specimens to laboratory cultures."

Ciferri later in a similar discussion states:

"While the terms proposed may be regarded as particularly appropriate to the fungi, they may have real application also in the field of microbiology, particularly bacteriology."

To avoid conflict with the Botanical Code (which insists that type specimens be non-living), he suggests that a type culture of an organism be designated a "cultype" and proposes the following compounds of cultype for particular needs:

Archecultype, Holocultype, Paracultype, Syncultype, Homocultype, Lectocultype, Merocultype, Monocultype, Metacultype, Graphocultype and Thanotocultype.

Sneath and Cowan (l. c.) follow Ainsworth and Bixby (1950, 343) in the use of holotype, paratype, cotype, isotype, lectotype and neotype.

The terms proposed or used by the several authors noted above may appropriately be assessed as to their appropriateness and usefulness in bacteriology. They are listed alphabetically below with a view to possible utilization in a revision of Rule 9 of the Bacteriological Code which concerns the designation of nomenclatural types and type specimens.

The restrictions of the Botanical Code do not apply in Bacteriology. Therefore the use of the stem "cult" in formulation of the words seems unnecessary in this discipline.

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The Ciferri terms are listed below because they in some cases have meanings that might be useful in bacteriological nomenclature and because the prefixes used might well be employed in compounds that did not include the stem "cult."

The Ciferri definitions given below are direct quotations.

Archecultype. (Ciferri) "A strain cultivated by the author of the botanical taxon but lost or suffering an irreversible modification before an exhaustive study. The taxon cannot be recognized with a reasonable certainty."

Cotype. (Ainsworth and Bisby) "Any specimen (when more than one) of the author's material (when no type (holotype)) has been named." (Sneath and Cowan) "Any specimen of the describing author's collection if he did not designate a holotype strain." A synonym of syntype. The Zoological Code (Bradley Draft p.140) Recommendation 6 reads "To avoid misunderstanding zoologists should not use the term cotype." Bradley's "Glossary" reads "A word formerly in use for syntype but which should be avoided." The word cotype is a nomen hybridium.

Holocultype. (Ciferri) "A strain cultivated by the author of the taxon, and the culture fully described and cited as type by the same taxonomist. The original strain is still maintained in culture without evident modification." The term Holotype (q. v.) is probably preferable in bacteriology.

Holotype. This term is not specifically included in the rules of the Bacteriological Code but might well be. In bacteriology the equivalent is "type culture" q. v. It is recognized in both Botanical and Zoological Codes. (Botanical Code 1956, Art. 7, p.14.). "A "holotype" (type) is the one specimen or other element used by the author or designated by him as the nomenclatural type. For so long as a holotype is extant, it automatically fixes the application of the name concerned." (Bradley Draft copy, Zoological Code). "The single specimen, if any, designated or indicated as "the type" by the original author at the time of the publication of the original description."

Homoculture. (Ciferri) "A strain as far as possible identified with the archeculture, but from another source or isolate." The possibility that an analogue of this term in the form "homotype" might be useful in bacteriology merits some consideration.

Graphoculture. (Ciferri) "The first description or photograph or drawing of the holoculture, in the absence of the culture." The Bacteriological Code (1958) states (Rule 9a, p.53) that the "nomenclatural type of a species or subspecies is preferably an authentic culture, but it may be a specimen or preparation, illustration or description." A note to Rule 9d reads: "For a species that cannot be maintained in laboratory cultures or for which neither type cultures nor neotype cultures exist, the type is the original description, preparation or illustration." An analogue to the form "graphotype" might be considered as to its possible usefulness in bacteriology.

Lectoculture. (Ciferri) "A strain cultivated by the author of the taxon, and selected as holoculture by another student." Presumably equivalent to lectotype, q.v.

Lectotype. This term has been little used in bacteriology. Its usefulness may be worthy of consideration. The following definitions are extant:

(Ainsworth and Bisby 1950) "A type taken later for a group for which the author names no type."

(Botanical Code 1956, Art.7, p.15) "A lectotype is a specimen or other element selected from the original material to serve as nomenclatural type when the holotype was not designated at the time of publication for so long as it is missing."

The glossary of Bradley's Draft Zoological Code (1957) reads: "A single specimen selected from a series of syntypes, subsequent to the establishment of the nominal species, to be "the type." A lectotype has the nomenclatural value of a holotype."

Meroculture. (Ciferri) "A strain derived from a mixed or impure (contaminated) holotype." The usefulness of this term or its analogue in bacteriology seems questionable.

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Metaculture. (Ciferri) "A strain permanently modified but derived from the holotype." Perhaps in a modified form (as metatype) this might be useful in bacteriology to designate a variant or mutant strain derived from a type culture.

Monoculture. (Ciferri) "A monosporial (monogenetic or monocyto-genetic) strain derived from the holotype." Perhaps in a modified form (as monotype) this might be useful in bacteriology in designating a strain from a single cell isolation, including strains from single spores, as from Bacillus or Streptomyces.

Neotype. (Bacteriological Code 1958, Rule 9d, Note C) "A neotype culture is one which has been accepted by international agreement to replace a type culture which is no longer in existence. It should agree with the diagnosis given by the original describer and should be recommended by those workers familiar with the species, and their agreed recommendation approved by the Judicial Commission."

(Bradley Glossary, Draft Zoological Code, 1957) "A single specimen, identified with a described nominal species and designated in accordance with the provisions of Article 20 as a unique standard of reference to replace a holotype or lectotype that is believed to have been lost or destroyed."

(Botanical Code, Article 7) "A neotype is a specimen selected to serve as nomenclatural type for so long as all of the material on which the name of the taxon was based is missing."

Nomenclatural Type. (Bacteriological Code, Principle 11) "A nomenclatural type is that constituent element of a taxon to which the name of the taxon is permanently attached." The Botanical Code is somewhat more explicit in that there is added the phrase "whether as an accepted name or as a synonym." The Zoological Code uses quite a different terminology.

Paraculture. (Ciferri) "A strain cultivated by the author of the taxon and quoted in the original description but not the selected holotype." See Paratype.

Paratype. (Ainsworth and Bisby) "Any specimen other than the holotype on which the first account of a species or other group is based."

Syncultype. (Ciferri) "Any strain cultivated by the author of the name of the taxon and quoted in the original description when a holotype has not been selected." See Syntype.

Syntype. (Botanical Code Recommendation 8A) "A syntype is one of two or more specimens used by the author when no holotype was designated, or one of two or more specimens simultaneously designated as type."

(Bradley's Glossary Draft Zoological Code) "One of a number of specimens of equal nomenclatural rank which formed all or part of the material of a nominal species before the original author, in case he did not designate or indicate a holotype." Syntypes are not recognized in the Bacteriological Code. A study should be made as to possible usefulness.

Thanotocultype. (Ciferri) "A dried or preserved, not living, specimen, or a microscopic slide prepared from the holocultype." The usefulness of such a term (perhaps as thanototype) is rather doubtful, but might well be explored.

Type. (Bradley's Glossary, Draft Zoological Code) "The standard reference for determining the meaning of the name of a nominal taxon, the name-bearer. The type of a species or lower taxon is a specimen, that of a genus, a species." See Nomenclatural Type.

Type Culture. (Bacteriological Code Rule 9d, Note b) "A type culture is a living culture of an organism which is a descendent of the original culture or isolation from which the author who first described the organism made his original description, which culture has been maintained pure, and which agrees in its characters with the original description." This term is not recognized in the Botanical or Zoological Codes.

Type Strain. The term "type strain" is found with increasing frequency in the literature of taxonomic bacteriology, usually with the same meaning as type culture. It is a convenient designation of the type specimen.

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One of the problems that needs consideration by the taxonomist in bacteriology is what shall be the interpretation of the term "individual." The Bacteriological Code (Principle 7) states that "Every individual is treated as belonging to a number of categories of consecutive rank and consecutively subordinate; of these the species is the basic one." The corresponding statement in the Botanical Code is "Every plant is treated as belonging to a number of taxa of consecutively subordinate ranks of which the species is basic." From the standpoint of bacteriology, what do the botanists regard as a "plant" when they study bacteria? What do bacteriologists recognize as an "individual"? In bacteriology there seem to be at least five kinds of individuals to be considered.

1. An individual may be defined as a single bacterial cell, usually, but not always separated from other similar cells and functioning independently. A large proportion of individuals in the bacteria conform to this definition.

2. An individual is that which develops from a single spore or reproductive body with the formation of branched hyphae and a mycelium in which the cells remain united during vegetative growth. The individual may be multicellular or coenocytic. Most of the actinomycetes belong in this category.

3. An individual consists of a chain of cells which remain united during vegetative growth, forming a filament (sometimes termed a trichome), in some forms there may be some morphological differentiation among the cells. Here may be placed organisms belonging to such genera as Crenothrix.

4. An individual is a population resulting from the multiplication of a single cell or group of cells showing independent metabolism but coordinated motion and striking cooperation in the formation of fruiting bodies. Here belong the myxobacters.

5. An individual is a pure culture of any organism or a strain perpetuated in pure culture.

What is the most used and useful of these suggested definitions of an individual? From a point of view both practical and utilitarian, implicit in the rules of bacteriological nomenclature, a pure culture of an organism or strain is treated as an individual. Such a pure culture constitutes, when properly designated, the type specimen of a species of bacteria. Since the type specimen can be indefinitely duplicated and made generally available, careful study of the Bacteriological Code seems advisable to ensure that full advantage is taken of this distinguishing characteristic of bacterial types.*

REFERENCES

- Ainsworth, G.C. and G.R. Bisby. 1950. A Dictionary of the Fungi. 3rd ed. The Commonwealth Mycological Institute, Kew, Surrey, England.
- Bradley, J.C. 1957. Draft of the English Text of the International Code of Zoological Nomenclature as amended by the Paris (1948) and Copenhagen (1953) Congresses. Bull. Zool. Nomen. 14:31-285.
- Ciferri, R. 1957. Type nomenclature of microorganisms in culture. Taxon 6:154.
- International Code of Botanical Nomenclature adopted by the Eighth International Botanical Congress, Paris, July, 1954. Utrecht, Netherlands, 1956. 338 pp.
- International Code of Nomenclature of Bacteria and Viruses. 1958. Iowa State University Press, Ames, Iowa, U.S.A. 186 pp.
- Sneath, P.H.A. and S.T. Cowan. 1958. An electro-taxonomic survey of bacteria. Jour. Gen. Microbiol. 19:551-565.

* A proposal to reword certain rules and recommendations of the International Code of Nomenclature of Bacteria and Viruses will be published in the April, 1962 issue of the International Bulletin for consideration by the Judicial Commission and the International Committee on Bacteriological Nomenclature at the International Microbiological Congress at Montreal in August, 1962.