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INCORRECT SPELLINGS OF SCIENTIFIC NAMES AND EPITHETS
USED FOR BACTERIA.

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Those who have the responsibility for editing publications containing scientific names of species and genera of bacteria sometimes find it difficult to determine the correct spelling to use for these names. The rules and recommendations found in the various Codes of Nomenclature appear to be worded simply and clearly. Yet, the application of these rules and recommendations involves interpretations of the meaning of words. It sometimes even involves the question whether the wording of the English or the French text of a Code is to be regarded as final or official.

The rule governing orthography (spelling) in the official English version of the Bacteriological Code of Nomenclature adopted at the Copenhagen Congress of Microbiology in 1947 reads as follows:

"Rule 27. The original spelling of a name or epithet must be retained, except in the case of a typographical error, or of a clearly unintentional orthographic error."

This wording is the same as that of the Botanical Code. The wording found in the Zoological Code differs slightly. In this Code the French text is accept-

ed as official. Article 19 of the Zoological Code calls for the correction of the original spelling of a name in case there is "une faute de transcription, d'orthographe, ou impression". The complete but less satisfactorily worded English form of this rule reads "The original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami*, or a typographical error is evident."

Certain rules in the Bacteriological Code governing the naming of genera and species also have a bearing on the correction of spelling or related errors. Thus Section 1, "Naming of groups of various ranks" in the Bacteriological Code reads:

"Rule 5. Names of genera and of sub-genera are substantives (or adjectives used as substantives) in the singular number and written with an initial capital. These names may be taken from any source whatever and may even be composed in an arbitrary manner". (Phrases that have a bearing on the spelling of names as originally proposed are italicized). Thus *Alcaligenes* and *Fusiformis* are adjectival substantives used as generic names and are correctly spelled.

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Rule 6 reads: "Names of species are binary combinations consisting of the name of the genus followed by a single specific epithet..... Specific epithets are: (a) adjectives which must agree grammatically with the generic name....(c) substantives in the genitive.." (Italics again emphasize the phrase that is important from the standpoint of this discussion). Thus *Bacterium aurantiacus* Chester (1897) should be corrected to *Bacterium aurantiacum*; *Bacillus albolactus* Migula (1900) to *Bacillus albolactis*.

Recommendation 5a (5) which states that bacteriologists who form new generic or subgeneric names should avoid making names by combining words from different languages (*nomina hybrida*) implies that when, in spite of this recommendation, such hybrid names have been proposed they are not to be rejected on this score alone.

All of these rules and recommendations express the conviction of biologists, based on long experience, that, in order to attain the primary purpose of rules of nomenclature, i.e. fixity of names, these names must be accepted as originally proposed. "Other things such as absolute grammatical correctness, regularity or euphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are rel-

atively accessory." (Principle 1 of the Bacteriological Code). Nevertheless Rule 27 calls for the correction of errors that are typographical or that are clearly unintentional and orthographic in nature.

Kirby (1), a protozoologist who has described species of parasitic bacteria in *Protozoa* (2) notes that there are important groups of taxonomists that take an extreme view in opposition to changes in spellings or other corrections of errors in scientific names. He writes:

"The Code of Nomenclature adopted by the American Ornithological Union (1908) deals with the subject of orthography in a very definite way. It is stated that the words used as names of genera and subgenera are of no definite construction, and are not to be rejected for faulty construction; and it is remarked that all that relates to grammatical and philological proprieties is not necessarily pertinent to zoological nomenclature. Variants of names resulting from recommendations by "purists" are considered untenable, and a canon of the A.O.U. Code directs that the original orthography of a name is to be rigidly preserved unless a typographical error is evident, with the exception that certain changes may be made in the termination of specific names.... Whereas this position has firm support, if not a source, in

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the A.O.U. Code, and in other sets of regulations adopted by limited groups of zoologists, its proponents often state or imply that the International Rules of Zoological Nomenclature constitute their authority."

There are also certain statements that appear in Notes 1 to 4 of Rule 27 of the Bacteriological Code that assume that corrections are to be made only under specified conditions. Thus under Note 4 occurs the statement "The liberty of correcting a name must be used with reserve, especially if the change affects the first syllable, and above all, the first letter of the name."

Some of the many cases where authors or editors of bacteriological publications must decide whether "original spellings" are to be followed or whether "typographical and clearly unintentional orthographic errors" are to be corrected will now be examined.

Bacterial Generic Names and Specific Epithets that Show Typographical or Unintentional Orthographic Errors as They Were Originally Printed.

It is natural that many typographical errors are found in generic names and specific epithets of bacteria as they have been printed in our voluminous literature. Those that concern us at this time, however, are those that have occurred in

these names as they were first printed. Sometimes it cannot be determined whether the error arose because of a fault of transcription in the manuscript furnished the printer, faulty proofreading, or whether the printer was responsible for the error. Hence, no attempt is made definitely to classify these mistakes. The first two cases discussed will illustrate this point.

There is an evident error in the specific epithet used by Wright (3) for a non-motile, and therefore, inactive water organism named by him *Bacillus decidiosus* (L. *desidiosus*. idle, inactive). Chester (4) corrected this spelling in the combination *Bacterium desidiosum*. However, the use of "c" in this epithet instead of "s" misled Bergey et al (5) into changing the spelling of this specific epithet to *deciduosum* possibly thinking it derived from L. *deciduus*, falling away. This appears in the combination *Flavobacterium decuduosum*. The spelling was, however, corrected by Bergey et al. in 1939 (6) to *Flavobacterium desidiosum*. This correction is of the type that is now sanctioned by Rule 27.

The use of the Latin word *desidiosus* caused a similar error in another specific epithet. The original spelling used by McBeth (7) for a cellulose digesting organism from soil that is relatively inactive is *Bacillus desiduosus*. This incor-

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rect spelling again misled Bergey *et al.* (8) into changing the spelling in a way that was probably not intended by McBeth. Bergey *et al.* changed the spelling of the specific epithet to *deciduosa* in the combination *Cellulomonas deciduosa*. This was finally corrected to *Cellulomonas desidi-iosa* in Bergey's Manual (9). This is in accordance with Rule 27 of the present Bacteriological Code.

A few errors of a similar type occur in the names proposed by Migula (10). Migula noted nearly all of these in the final reading of the proof and they were corrected by him on page V of the Preface of this book. Occasionally, however, the incorrect spelling is still found in the literature. Thus, *Micrococcus pemphici* Migula, p. 191, is corrected on page V to *M. pemphigi*; *Bacillus cantextus* Migula, p. 522 to *B. contextus*; *Bacillus albolactus* Migula, p. 577 to *B. albolactis*; *Bacillus niustelae* Migula, p. 756 to *B. mustelae*; and *Bacillus butyris* Migula, p. 811, to *B. butyri*. All of these changes in spelling accord with Codes then in current use and with the present Rule 27 of the Bacteriological Code.

In fact, it might be argued that, because page V, on which the correct spelling is used, occurs before all of the other pages noted, the correct spellings were published earlier

than the incorrect spellings.

When Hefferan (11) described the red chromogen that she isolated from water as *Bacillus utilis* it is fairly evident that the letter "r" dropped so low that it did not print. This is shown by the use of the spelling 'rutilus' for the specific epithet in two other places (p. 313 and 457) in the paper by Hefferan. Unfortunately the 'utilis' spelling was carried over into the first edition of Bergey's Manual (1923,89). The correction of this typographical error is in accord with Rule 27 except that some who feel that original names should stand, regardless of errors, may point out that the change of the first letter produces a situation where it may (and has) cost workers wasted time hunting through an index for a name they cannot find. There is reason for the statement under Rule 27 that the "liberty of correcting a name must be used with reserve especially if the change affects the first syllable, and above all the first letter of a name." In future editions of Bergey's Manual, both spellings will be found in the index.

In one curious instance, a difference in spelling, quite probably typographical in nature, has produced a genus name that has been generally accepted in bacteriology. However, it would become a homonym and therefore invalid if the origi-

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nal spelling is used. Details of the description of the algal genus, *Gaillonella* Bory de St. Vincent (1823), are given by Buchanan (12). He also traces the various modifications of the original arrangement proposed later by Bory de St. Vincent, Ehrenberg and others. When Ehrenberg included the genus in his 1838 classification, he spelled the name *Gaillonella* and it has since been widely used in bacteriology as a name different from *Gaillonella* with the type species *Gaillonella ferruginea* Ehrenberg. After this early work, there never has been confusion between this genus of well known iron bacteria and the genus of diatoms known as *Gaillonella* Bory de St. Vincent. Buchanan concludes that if *Gaillonella* Ehrenberg is rejected as invalid then *Didymohelix* Griffith (1853) becomes the valid name of the genus with *Didymohelix ochracea* Griffith as type species. The latter names have never been generally used. It will require action by the Judicial Commission to settle this problem.

An evident error, probably of transcription, occurs in the specific epithet of the following binomials proposed by Holland (13): *Bacillus hoffmannii* and *Corynebacterium hoffmannii*. These were evidently proposed to recognize the work of G. von Hofmann-Wellenhof who first recognized the pseudodiphtheria organism. The valid name for

this species appears to be *Corynebacterium pseudodiphtheriticum* as given by Lehmann and Neumann (1896).

The genus name *Borrelia* is incorrectly spelled as *Borrellia* in the original description by Paillet (14). Formed from the name of the French scientist A. Borrel, it has been corrected by Holmes (15) in Bergey's Manual to *Borrelia* in accordance with Rule 27.

In the case of *Rhodorrhagus* Bergey et al. (16) the original authors discovered and corrected this unintentionally incorrect transliteration to *Rhodorrhagus* Bergey et al. (17).

Names whose Spellings have been Changed by Subsequent Authors, Apparently without Adequate Justification.

Perhaps the best known case where the original spelling of a species name was changed by a subsequent author (whose changed spelling was then generally followed) occurred in connection with the binomial *Bacillus megaterium* De Bary (1884). This forms the basis for Opinion 1 issued by the Judicial Commission of the International Committee on Bacteriological Nomenclature (18). Here it is concluded that the original spelling must stand under Rule 27, there being no conclusive evidence that Schroeter's (19) change of spelling was made because of a typo-

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graphical or unintentional orthographic error. It is unfortunate that Schroeter did not give his reason for changing the spelling of this species name to *Bacillus megatherium*.

In several instances where the spellings of names have been changed by subsequent authors, the changed spellings are clearly due to typographical or unintentional orthographic errors in the publication of the second author or authors. The following appear to fall in this grouping:

The specific epithet in the binomial, *Micromyces hofmanni*, is spelled by Gruber (1891) in accordance with the spelling used by G. von Hofmann-Wellenhof for his name. The name Hofmann is spelled incorrectly by Sauvageau and Radais (2) in the combination *Actinomyces hoffmanni*. Other authors have subsequently had trouble with the spelling of this species name.

The specific epithet, *thermophilus*, in *Bacillus thermophilus* Miquel (21) is incorrectly spelled as *termophilus* in *Bacterium termophilus* by Migula (22). However, *Thermobacterium* Fuhrmann (23) is a misprint for *Termobacterium* Zeidler (24). In these cases there appears to have been confusion between the two Greek words *terma*, end, and *therme*, heat, although the misprints may have been typographical in nature.

Zaogalactina imetrofa Sette (25) is more correctly transliterated from the Greek as *Zaogalactina imetropha* (Montague, 1853; Schroeter, 1872; Trevisan, 1879. See Breed and Breed (26)). The epithets in this binomial have, however, been more frequently spelled incorrectly because of typographical errors or errors of transcription. Thus we have *Zoogalactina immetrophia* Chester (27) and *Bacillus impetrophus* Bergey et al. (28). Other authors have sometimes copied these incorrect spellings.

Bizio's (29) name for this organism given the preceding year is *Serratia marcescens*. As this is incorrectly spelled as *Serratia marescens* in a later paper by Bizio (30) subsequent authors have sometimes copied this error that is presumably typographical in nature.

Other cases where subsequent authors have misspelled a specific epithet may be listed. The first is found in *Bacillus haumani* Soriano (31) which is spelled *Bacillus haumanni* by Arnaudi (32). Prévot (33) has copied the incorrect spelling in *Clostridium haumanni*. The second case of this sort is found in *Bacillus buccalis minutus* Sternberg (34) as the second word in the trinomial is spelled *bucallis* by Chester (35) in the binomial *Bacterium buccallis*. A third case of the same sort is found in the spe-

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cific epithet which is correctly spelled in the binomial *Actinomyces gruberi* Terni (36) and incorrectly spelled in the binomial used for the same species, *Streptothrix grueberi* Sanfelice (37). Still another case that appears to fit into the same type of error is found in *Micrococcus corallinus*. Cantani (38) uses the correct spelling for this specific epithet but it appears as *coralinus* in the combination *Rhodococcus coralinus* used for the same species by Levine and Soppeland (39).

In one case, a subsequent author has preferred a different spelling from the one used by the author that proposed the binomial. In this case it appears that Rule 27 would require that the spelling first used be the one finally accepted. Thus Fluegge (40) proposed the name *Bacillus fluorescens putidus* which Trevisan (41) changed to the binomial *Bacillus putidus*. However, Kruse (42) changed the spelling 'putidus' to 'putridus'. This spelling has been incorrectly used by many subsequent authors.

A related but not identical problem has arisen in the case of the anaerobic spore-former named *Bacillus de rossii* by Carbone and Venturelli (43). This has been renamed *Clostridium derossii* by Spray (44), while Prévot (45), feeling that the use of the 'de' in this case is ungrammatical, has renamed this species *Endosporus*

rossii. Here again Rule 27 would seem to apply. Under this rule Dr. Prévot has agreed that the original spelling in this case (personal communication) should stand, thus supporting the view of those that argue that, in the interest of stability, original spellings should be retained.

This case is interesting because in quite a series of generic and specific epithets the connectives that indicate origin or territorial estate are sometimes used and sometimes omitted. Thus we have the following where these connectives have been incorporated in the original spelling of the name or epithet: *Detoniella* Trevisan (46), *Urococcus vantieghemii* Miquel (1893), *Bacterium delleseriae* Lundestad (1928), *Bacillus lemonnieri* Lasseur (1913), *Rhodococcus vannielli* Duchow and Douglas, *Bacillus debaryanus* Klein (1889), *Bacterium lepieirrei* Chester (1901), *Pseudomonas dacunhae* Gray and Thornton (1928) from the Island d'Acunha, *Photobacterium delgadense* Fischer (1888) from Ponte del Gada. The following names also appear: *Macintoshillus* Heller (1922) from J. McIntosh, *Bacillus sanfeliceii* Migula (1900) and *Nocardia sanfeliceii* Redaelli (1928).

Titles or even phrases have also sometimes been used in the epithets applied to serotypes in the genus *Salmonella*. Thus we have *Salmonella Saint Paul*

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Edwards and Bruner (48), *Salmonella Dar-es-Salaam* Brown, Duncan and Henry (49) (arabic meaning 'Place of Peace'), *Salmonella Tel Aviv* (hebraic meaning 'Hill of our Fathers') Kauffman (50), and *Salmonella San Diego* Kauffman. (51).

As the recommendation quoted above does not require that connectives in patronymics be used, such names as the following are also found and when proposed in this form are acceptable under Rule 27. Thus we have *Micrococcus dantecii* Chester (52) and *Bacillus danteci* Kruse (53) from le Dantec, *Hiblerillus* Heller (54) from von Hibler, *Ermengemillus* Heller (55) from van Ermengem, *Herellea* De Bord (56) from d'Herelle, *Ehrlichia* Moskovsky (57) from von Ehrlich, *Bacterium laeri* Migula (58) from van Laer. Similarly we find titles sometimes dropped as in *Eberthella pauloensis* Mello (59), *Escherichia pauloensis* Mello (60), and *Salmonella pauloensis* Gomes (61), all three from Sao Paulo, and *Salmonella luciana* Moran, Edwards and Bruner (62) from St. Lucie, Florida.

While it is quite certainly true that this discussion of typographical and unintentional orthographic errors in bacterial names is not complete, it is complete enough to show the types of problems that taxonomists meet in this field. It also shows that, in general, bacteriologists either have

proposed names in accord with or have been content to accept Rule 27. However, at times, as is natural, purists have found it distasteful to use original spellings that they do not feel are correct. In other types of orthographic variations that will be discussed later, the tendency to change names from the form used by the original author becomes more pronounced.

Summary

For the convenience of those who wish to find the names discussed in this paper, an alphabetical list has been prepared. The generic names quoted in parentheses are those used by the original author of the binomial. Where the question discussed was one of spelling the correct spelling has been used.

albolactis (*Bacillus*), p. 39, 41.
Alcaligenes, p. 38.
aurantiacum (*Bacterium*), p. 39.
Borrelia, p. 42.
buccalis minutus (*Bacillus*),
 p. 43.
butyri (*Bacillus*), p. 41.
contextus (*Bacillus*), p. 41.
corallinus (*Micrococcus*), p. 44.
dacunhae (*Pseudomonas*), p. 44.
danteci (*Bacillus*), p. 45.
dantecii (*Micrococcus*), p. 45.
Dar-es-Salaam (*Salmonella*),
 p. 45.
debaryanus (*Bacillus*), p. 44.
delesseriae (*Bacterium*), p. 44.
delgadense (*Photobacterium*), p. 44.
derossii (*Clostridium*), p. 44.
Detoniella, p. 44.

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- desidiosus* (*Cellulomonas*),
 p. 40.
desidiosum (*Flavobacterium*),
 p. 40.
Ehrlichia, p. 45.
Ermengemillus, p. 45.
Fusiformis, p. 38.
Gallionella, p. 42.
gruberi (*Actinomyces*), p. 44.
haumani (*Bacillus*), p. 43.
Herellea, p. 45.
Hiblerillus, p. 45.
hofmanni (*Corynebacterium*),
 p. 42.
hofmanni (*Micromyces*), p. 42.
imetrofa (*Zaogalactina*),
 p. 43.
laerii (*Bacterium*), p. 44.
lemonnieri (*Bacillus*), p. 44.
lepieirrei (*Bacterium*), p. 44.
luciana (*Salmonella*), p. 45.
Macintoshillus, p. 44.
marcescens (*Serratia*), p. 43.
megaterium (*Bacillus*), p. 42.
mustelae (*Bacillus*), p. 41.
pauloensis (*Eberthella*), p. 45.
pauloensis (*Escherichia*), p. 45.
pauloensis (*Salmonella*), p. 45.
pemphigi (*Micrococcus*), p. 41.
pseudodiphtheriticum (*Coryne-
 bacterium*), p. 42.
putidus (*Pseudomonas*) p. 44.
Rhodorrhagus, p. 42.
rutilis (*Bacillus*), p. 41.
Saint Paul (*Salmonella*), p. 44.
San Diego (*Salmonella*), p. 45.
sanfelicei (*Bacillus*), p. 44.
sanfelicei (*Nocardia*), p. 44.
Tel Aviv (*Salmonella*), p. 45.
Termobacterium, p. 43.
thermophilus (*Bacillus*), p. 43.
vannielii (*Rhodomicrobium*), p. 44.
vantieghemii (*Urococcus*), p. 44.
Zaogalactina, p. 43.

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