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ON THE PRINCIPLES OF CLASSIFICATION AND
NOMENCLATURE OF ENTEROBACTERIACEAE

F. Kauffmann

From Statens Seruminstitut, Copenhagen
(Director J. Ørskov, M.D.)

The following abbreviated definitions are common in biology: "each distinct kind of bacterium is called a species" and "a genus is a group of related species." Therefore, it is justified to call the Salmonella group a genus and the Salmonella sero-types species as all the established sero-types according to the Kauffmann-White schema are distinct kinds of bacteria. The definition of the "Salmonella group" given by P. Bruce White in 1929 begins with the words: "A large genus of serologically related, Gram-negative and non-sporing, bacilli" and ends with the sentence: "All the known species are pathogenic for man, animals, or both."

In his 1st monograph together with W.G. Savage "An investigation of the Salmonella group, with special reference to food poisoning" P. Bruce White has said of the absorption types (page 14): "They are elementary species par excellence." This was repeated in his 2nd monograph "Further studies of the Salmonella group" in the following sentence (page 135): "There is every reason to regard these as elementary species, the products of definite phylogenetic events, there is nothing to suggest transmutability among the known types." Further in his "Remarks on the Nomenclature and Classification of Bacteria" in 1936 during the 2nd Congress of Microbiology in London, he wrote the following:

6. The level and nature of the bacterial genus and species is a matter calling for consideration.

It is reasonably clear that such an accepted genus as Salmonella, presenting types honoured with specific names, is actually of the same order as pneumococcus, treated usually as a single species enclosing numbered subtypes or varieties. Convenience, history, and the

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characters of the organisms themselves may favour the difference of treatment but the fact remains that the Salmonella type and the Pneumococcus type are of equivalent natural status and are elementary species in the sense of de Vries, and that Salmonella and Pneumococcus are natural genera roughly defined by their R variants and by their basal proteins and polysaccharides.

The Committee might usefully reach a decision as to whether the taxonomic species should be established at the level of the elementary species or whether its size in different cases should continue to be dictated by convenience.

According to the recommendations of P. Bruce White, the designations genus for the whole group and species for the sero-types were adopted by the Salmonella Subcommittee in the first publication on "The genus Salmonella Lignières, 1900," published in 1934. According to this proposal, the Nomenclature Committee in 1936 "approved the definition of the genus Salmonella Lignières as set out in the report and accepted the type-species as Salmonella cholerae-suis (Smith)."

This was approved again by the 4th International Congress of Microbiology in Copenhagen 1947 when an emended Salmonella definition was given. This definition too begins with the words: "A large genus of serologically related, Gram-negative and non-spore-forming bacilli" and ends with the sentence of P. Bruce White: "All the known species are pathogenic for man, animals, or both."

A change occurred in the Report of the 5th International Congress of Microbiology in Rio de Janeiro 1950 in which the words genera and species are substituted by the words "group" and "types." This was stressed in the Report to the 6th International Congress of Microbiology in Rome 1953 in the following way:

Since differences of opinion may arise in regard to nomenclature, and since the majority of the members of the Subcommittee prefers the terms "groups" and "types" for "genera" and "species", insofar as possible only common names are used throughout the report.

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This attitude was adopted by Kauffmann in his book "Enterobacteriaceae" and it was emphasized that the term species was applied only to biochemically defined subdivisions of genera: "Therefore, the sero-types of Salmonella, Arizona, Escherichia etc. are not to be taken as species."

Today, the author wants to eliminate this sentence as he regards only the tribes and genera as biochemically defined subdivisions of the family while the species are the sero-types, according to the definition of P. Bruce White and of the Salmonella Subcommittee. When Salmonella choleraesuis was accepted in 1936 as the type-species, all other sero-types were regarded as species too. These species are in reality large groups which consist of a lot of fermentative types and of phage-types. Therefore, these fermentative types and the phage-types should be regarded as subspecific entities, while the sero-types are species.

What is valid for the genus Salmonella is valid for all the other genera like Escherichia in which the sero-types should be regarded as species too. Consequently, all Shigella sero-types are regarded as species, while the sub-groups A, B and C (= Shigella dysenteriae, Shigella flexneri and Shigella boydii) are no species, but sub-genera, i.e., biochemically defined sub-groups. Shigella sonnei is a species as it is a distinct sero-type.

In the genera Klebsiella and Cloaca the sero-types are the species, while biochemically defined sub-groups are no species, but sub-genera.

The same is valid for the genera Arizona, Citrobacter, Serratia and Providencia.

The species of the genus Proteus are the sero-types according to Kauffmann and Perch, while Morganella, Retterella and Providencia are not species, but biochemically defined genera.

Table 1. Family Enterobacteriaceae

Tribes	Genera	Type-Species
I. Salmonelleae	1. <i>Salmonella</i> 2. <i>Arizona</i>	<i>Salmonella cholerae-suis</i> <i>Arizona</i> 1,2:1,2,5
II. Escherichieae	3. <i>Escherichia</i> 4. <i>Shigella</i>	<i>Escherichia coli</i> (1:1:7) <i>Shigella dysenteriae</i> (A1)
III. Klebsielleae	5. <i>Citrobacter</i> 6. <i>Klebsiella</i> 7. <i>Cloaca</i> 8. <i>Hafnia</i> 9. <i>Erwinia</i> 10. <i>Serratia</i>	<i>Citrobacter freundii</i> (1:1,2) <i>Klebsiella pneumoniae</i> (1:1) <i>Cloaca</i> <i>Hafnia</i> <i>Erwinia</i> <i>Serratia</i>
IV. Proteae	11. <i>Proteus</i> 12. <i>Morganella</i> 13. <i>Rettgerella</i> 14. <i>Providencia</i>	<i>Proteus hauseri</i> (1:1) <i>Morganella</i> <i>Rettgerella</i> <i>Providencia</i> 1:1

In Table 1 a classification and nomenclature of Enterobacteriaceae is given in which the subdivision into 4 tribes is based on a biochemical basis:

Tribes	KCN	Glutamic acid decarboxylase
I. Salmonelleae	-	-
II. Escherichieae	-	+
III. Klebsielleae	+	-
IV. Proteae	+	+

While the genera are biochemically defined (see Kauffmann: "Enterobacteriaceae"), the species are the sero-types. One of these sero-types is regarded as the type-species, e.g., *Salmonella cholerae-suis* in the genus *Salmonella* or *Arizona* 1,2:1,2,5 in the genus *Arizona*, a special sero-type with the O antigens 1, 2 and the H antigens 1, 2, 5 or *Escherichia coli* 1:1:7 = a special sero-type with O antigen 1, K antigen 1 and H antigen 7.

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In the International Bacteriological Code of Nomenclature (Jour. Bact. 55:287, 1948) it is suggested in Recommendation 8a (page 293) "that the terms serotype (or serological type), biotype (or physiological type) and morphotype (or morphological type) may appropriately be substituted for type as a designation of a subdivision of a species." While it is correct to designate biotypes and morphotypes as subdivisions of a species, it is wrong to regard the serotypes as subdivisions. Therefore it is requested to change the International Code of Nomenclature and to permit the designation of serotypes as species.

I should like to ask the Judicial Commission for an Opinion.

SUMMARY

Tribes and genera are biochemically defined subdivisions of the family Enterobacteriaceae, while species are serologically defined subdivisions of the genera, they are, according to P. Bruce White, "elementary species par excellence."

To reach an international agreement, it is necessary to accept the above principles and to abandon the conception of the species as a biochemically defined subdivision of the genus.

In contrast to tribes and genera which are biochemically defined groups, the species are the sero-types. These sero-types which are of fundamental importance for rapid diagnosis in routine-work, for epidemiological, genetical and chemical investigations, are the basis for classification and nomenclature.

REFERENCES

- Kauffmann, F. 1954. Enterobacteriaceae. 2nd ed. E. Munksgaard, Copenhagen.
- Salmonella Subcommittee. 1934. Jour. Hyg. 34:333.
- Savage, W.G. and P. Bruce White. 1945. An investigation of the Salmonella group, with special reference to food poisoning. Spec. Rep. Ser. 91. Med. Res. Council, London.

White, P. Bruce. 1926. Further studies of the Salmonella group. Spec. Rep. Ser. 103. Med. Res. Council, London.

_____. 1929. The Salmonella group, in "A System of Bacteriology." London.

_____. 1937. Remarks on the nomenclature and classification of bacteria. Repts. Proc., Second Internatl. Cong. for Microbiology, London, page 547.

_____. 1937. Zentr. Bakteriол. II, 96:145.