THE TAXONOMY AND NOMENCLATURE OF THE GENUS
AEROMONAS KLUYVER AND VAN NIEL 1936

Part III. Suggestions on the definition of the genus
Aeromonas Kluyver and van Niel 1936.

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ABSTRACT. Aerobacter liquefaciens Beijerinck 1900 was originally proposed as the only species and type species of the genus Aeromonas Kluyver and van Niel 1936. The description of this species differs in some important properties from all species currently recognized as members of the genus Aeromonas. In accordance with the provisions of Rule 9c(3c) of the International Code of Nomenclature of Bacteria, it is proposed that the generic name Aeromonas Kluyver and van Niel 1936 and the species name Aeromonas liquefaciens Beijerinck) Kluyver and van Niel 1936 be designated as nomina rejicienda and without standing in nomenclature, and that the generic name Aeromonas be conserved with the type species Aeromonas punctata (Zimmermann) Snieszko 1957. The definition of the genus Aeromonas is emended. The official request to the Judicial Commission will be published later.

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INTRODUCTION

Kluyver and van Niel (1936) based the creation of the genus Aeromonas on fundamental considerations of bacterial taxonomy. The authors' considerations that led to the introduction of the genus Aeromonas are summarized by quoting the following passages:

"In our opinion the binomial nature of nomenclature accentuates the demand that genera be systematic units which are characterized as well by a more or less complete morphological homogeneity as by a fundamental agreement in metabolic properties (page 386).

"The principles underlying this system would logically imply creation of new generic names for all actually occurring combinations of fundamental morphological characters and special katabolic types (page 389).

"It is only self-evident that in a number of cases we have been obliged to establish new genera. Zymomonas has been chosen as a suitable name for polarly flagellated bacteria causing alcoholic fermentation like Pseudomonas lindneri (Thermobacterium mobile Lindner), Aeromonas for similar organisms which ferment sugars in a way probably closely related to the fermentation type characteristic of the genera Aerobacter and Aerobacillus (page 389)."

The original genus definition of Aeromonas Kluyver and van Niel (1936) reads as follows:

Aeromonas nov. gen.

Short rod-shaped bacteria, motile by means of cephalotrichous flagella. No endospores formed. Chemo-heterotrophic, oxydizing various organic compounds, and capable of fermenting carbohydrates with the production of carbon dioxide and hydrogen, and 2,3 butylene glycol (?). Gram-negative. The type species is Aeromonas liquefaciens (Beijerinck). Syn.: Aerobacter liquefaciens Beijerinck.

Bergey's Manual 6th ed. still lists all species belonging to the family of Pseudomonadaceae fermenting glucose with production of gas and which are polarly flagellated as members of the genus Pseudomonas. Not until the 7th ed. of Bergey's Manual are the genera Aeromonas and Zymomonas listed as separate genera of the family Pseudomonadaceae "in which the species ferment glucose, usually with the production of H₂ and CO₂." Here the definition of the genus reads as follows:

Genus IV. Aeromonas Kluyver and van Niel, 1936. (Zbl. f. Bakt., II Abt., 94, 1936, 398.) A. e. ro. mo' nas. Gr. mas. n. aer air, gas; Gr. fem. n. monas unit, monad; M. L. fem. n. Aeromonas gas (-producing) monad.

Short (rarely more than 3μ), rod-shaped cells. Motile by means of polar flagella, usually monotrichous; occasionally nonmotile. Gram-negative. Heterotrophic, oxidizing various organic compounds. Carbohydrates fermented with the production of H_2 , CO_2 and 2,3-butylene glycol. Methyl red negative. Slow or no fermentation of lactose. The majority of the species thus far described are from water or are known to be pathogenic to marine and fresh-water animals such as fish and amphibians.

Physiologically these organisms appear to be identical with certain species found in the family Enterobacteriaceae. The chief differences between the species in Aeromonas and those in Paracolibactrum Borman, Stuart and Wheeler are found in the arrangement of their flagella, in the less active fermentation of carbohydrates by the former, and in their pathogenicity. The type species is Aeromonas liquefaciens (Beijerinck) Kluyver and van Niel.

DISCUSSION

The author's suggestions on the taxonomy and nomenclature of the species belonging to the genus Aeromonas require the revision of the genus definition. The main reason for such a revision is given through the paradoxical fact that one species, i. e. Bacterium salmonicida which has been transferred recently into the genus Aeromonas by Griffin, Snieszko and Friddle (1952), does not correspond to the genus definition (production of 2,3-butanediol from glucose). In the meantime it was found that in correspondence to A. salmonicida, A. punctata does not produce acetoin and 2,3-butanediol from glucose either. Furthermore this property was not mentioned as a safe character of the genus in the original genus description given by Kluyver and van Niel (1936). For these reasons the production of 2,3-butanediol can not be considered as a common property of the genus.

The genus definition has also to be extended in view of the anaerogenic members of the genus. Anaerogenic Aeromonas strains were isolated that correspond with the aerogenic members of the genus in all essential properties. These have to be taken as anaerogenic subspecies of the aerogenic species (see the second of this series of papers (Schubert 1967b)). It is therefore evident that not the gas production from carbohydrates but the "fermentative" versus "oxidative" breakdown of carbohydrates is the criterion for the demarcation of aeromonads from the members of the

genus Pseudomonas showing only oxidative breakdown of carbohydrates.

Furthermore it seems appropriate to separate a group of bacteria lacking strong exoferments such as diastase, lipase and proteinases, characteristic for all aeromonads against the latter genus; this group was transferred into the newly proposed genus Plesiomonas Habs and Schubert 1962.

On the other hand there is no necessity to follow the proposal of Smith (1963) who suggests the transfer of bacteria of the "salmonicida-group" into a separate genus Necromonas. Although earlier investigations (Schubert 1961) seemed to come close to this idea, more recent results led only to conclusions contradictory to Smith's suggestion. Since Leclerc (1961) isolated nonmotile aeromonads which have been classified as A. hydrophila and A. hydrophila subsp. anaerogenes (Schubert 1964b) the immobility of the bacteria of the "salmonicida-group" is no longer a distinguishing property. The appearance of the brown water-soluble pigment on trypticase-soy media can no longer be regarded as characteristic since achromogenic strains of A. salmonicida have been isolated by Smith (1963). Moreover negative KCN tests and no formation of indol and hydrogen sulfide were found in nonmotile A. hydrophila strains. As to the production of acetoin it was shown that apart from A. salmonicida, other members of the genus Aeromonas are likewise unable to form acetoin from glucose. Contrary to these Voges-Proskauer-negative bacteria, A. salmonicida is able to dehydrogenate meso-2,3-butanediol (Schubert and Kexel 1964). Furthermore it has been shown by studies on the antigenic properties of the lipases of Aeromonas hydrophila, Aeromonas salmonicida and some Vibrio strains that the lipolytic enzymes of the two Aeromonas species are serologically closely related or even identical whereas the antilipase formed after immunization with Vibrio lipases does not neutralize the lipases of the two Aeromonas species and vice versa (González 1964). These results are confirmed by investigations on the antigenicity of "extracellular antigens" of A. hydrophila and A. salmonicida strains (Liu 1961, Bullock 1966). Another fact of importance is that GC values of A. hydrophila and A. salmonicida are not significantly different. According to Véron (1966) the highest GC value found in A. salmonicida (58.5%) is only 0.5 below the lowest GC value determined in A. hydrophila (59.0%). Therefore the growth at low temperatures remains the only important characteristic to separate the "salmonicida-group"

from aberrant strains of the other Aeromonas species. It is however known that species with different temperature optima are recognized as members of the same genus, e.g. Pseudomonas, but growth at different temperatures has hitherto never been used to separate genera.

The conclusions on the systematic position of Aerobacter liquefaciens (Beijerinck) which have been presented in Part I of this series of papers (Schubert 1967a), are of decisive importance for the nomenclatural status of the genus Aeromonas. It was demonstrated that the description of Aerobacter liquefaciens differs in some important properties from the other species currently recognized as members of this genus. As to the nomenclature of the genus Aeromonas it is evident that according to the provisions of Rule 9c(3c) of the International Code of Nomenclature of Bacteria, the species Aeromonas liquefaciens (Beijerinck) Kluyster and van Niel 1936 should be rejected as unrecognizable, and that this species name together with the generic name Aeromonas Kluyster and van Niel 1936 be designated as nomina rejicienda and without standing in nomenclature. As, however the generic name Aeromonas has persisted for several well known species, it is proposed to conserve the generic name Aeromonas. It is proposed that the oldest specific epithet punctata in A. punctata (Zimmermann 1890) Snieszko 1957 be recognized as the type species of the genus Aeromonas. For this, however, the issue of an Opinion by the Judicial Commission under the rules is necessary.

Suggestions on the Revision of the Definition of the Genus Aeromonas

A.e.ro.mo'nas. Gr.mas.n., aer air, gas; Gr.fem.n. monas unit, monad; M.L.fem.n. Aeromonas gas (-producing) monad.

Short, rod-shaped, nonsporeforming cells. Motile by means of polar flagella; generally monotrichous; occasionally nonmotile. Gram-negative. Aerobic, facultative. Heterotrophic, various organic substances are oxidized. Breakdown of carbohydrates under aerobic and anaerobic conditions with production of acid and gas (CO₂ and H₂) or acid only. Cytochrome oxidase-, oxidase- and catalase reactions positive. Production of diastase, lipase, lecithinase (egg yolk reaction) and proteinases (gelatinase and digestion of casein); no breakdown of inositol; positive arginine dehydrogenase reaction. No growth in peptone media containing

7.5% sodium chloride. Not sensitive to the vibriostatic agent 2-4 diamino 6-7 diisopropylpteridin (0/129).

The majority of the species are from water or are known to be pathogenic to marine and fresh water animals such as fish and amphibians. At least one of the species is pathogenic for man and rodents. These organisms resemble certain species of the family Enterobacteriaceae.

Type species is Aeromonas punctata (Zimmermann 1890) Snieszko 1957.

The following species should be included in the genus Aeromonas.

Aeromonas punctata (Zimmermann 1890) Snieszko 1957

A. punctata subsp. caviae (Scherago 1936) Schubert 1964

A. hydrophila (Chester 1901) Stanier 1943

A. hydrophila subsp. anaerogenes Schubert 1964

A. salmonicida (Lehmann and Neumann 1896) Griffin, Snieszko and Friddle 1953.

A. salmonicida subsp. achromogenes (Smith 1963) Schubert 1967

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