A DESCRIPTION OF THE TYPE STRAIN OF
*PSEUDOMONAS MALTOPHILIA*¹

R. Hugh and E. Leifson

The George Washington University
School of Medicine Department of Microbiology
Washington, D.C.

and

Loyola University
School of Medicine Department of Microbiology
Chicago, Illinois

Research Collaborators, American Type Culture Collection

SUMMARY. A morphological and physiological description of the type strain of *Pseudomonas maltophilia* Hugh and Ryschenkow 1960 is presented. Photomicrographs record formalin treated and nontreated polar multitrichous flagella in stained preparations. A brief review is presented of several nomenclaturally unacceptable names which have been applied to strains of *P. maltophilia*.

- - - - -

Pseudomonas maltophilia was first described in an abstract (Hugh and Ryschenkow 1960). The description was later amended by Hugh and Ryschenkow (1961). A type strain was designated in the latter report. The type strain carries several corresponding numbers: 810-2, RH 1168, ATCC (American Type Culture Collection, Washington, D.C.) 13637, NRC (Canadian National Research Council, Ottawa) 729, NCTC (National Collection of Type Cultures, London) 10257, NCIB (National Collection of Industrial Bacteria, Aberdeen) 9203, MDB (Microbiology Department, Faculty of Natural Sciences, Brno) BS 1640.

¹ This work was supported in part by research grant E-3186 from the National Institutes of Health, Department of Health, Education and Welfare, U. S. Public Health Service to the American Type Culture Collection.

The type strain was isolated by the senior author in Washington, D C. on 30 April 1958 from an oropharyngeal swab taken from a patient with nonulcerated, epidermoid cancer of the floor of the mouth. The patient had not received antibiotic therapy. It was a Gram-negative rod about $0.5 \times 2.5 \mu$. A capsule was not conspicuous. Spores were not formed. It was motile with a tuft of polar flagella. The number of flagella per cell varied from 1 to 6. Generally the cells showed 3 or 4 polar flagella. Photomicrographs illustrate the polar multitrichous flagellation of P. maltophilia ATCC 13637, the type strain. Figure 1 shows a broth culture cell with 4 flagella stained without formalin fixation. Figure 2 shows a broth culture cell with 3 flagella stained after formalin fixation. The wavelength of the flagella was approximately 2.4μ . Formalin appeared to increase the amplitude of the flagella. Eight photomicrographs illustrate the flagellar morphology of P. maltophilia ATCC 13843 (RH 611), see Hugh and Ryschenkow 1961.

Figure 1. Pseudomonas maltophilia ATCC 13637 showing the polar multitrichous flagellation characteristic of the organism in broth culture without formalin fixation. Leifson flagella stain, X 2,000.

Figure 2. Pseudomonas maltophilia ATCC 13637 showing the polar multitrichous flagellation characteristic of the organism in broth culture after formalin fixation. Leifson flagella stain, X 2,000.

BACTERIOLOGICAL NOMENCLATURE
AND TAXONOMY

The type strain was a strict aerobe which produced a dense turbidity in peptone broth in 18 to 24 hours at temperatures of 22° and 37°. Growth on agar medium after two days of incubation had an opaque grey appearance with a faint yellow cast. The yellow color appeared in the growth but not in the medium. The pigment was not chloroform soluble. The colonies on desoxycholate agar were discrete and grey. Sheep erythrocytes in infusion agar base around isolated surface colonies were not hemolysed. Peptone broth at pH 4.5 did not support significant growth at 22° or 37°.

Alkali accumulated in OF base medium (Hugh and Leifson, 1953 - Difco 0688) with the following carbon compounds: adonitol, arabinose, cellobiose, dulcitol, 3% ethanol, galactose, glycerol, inositol, inulin, lactose, mannitol, melezitose, melibiose, raffinose, rhamnose, d-ribose, salicin, sorbitol, sucrose, trehalose, and xylose. The indole, methyl red, acetylmethyl carbinol, Simmons' citrate, indophenol oxidase, hydrogen sulfide (Kligler's), nitrate reduction to nitrogen gas, phenylalanine deaminase, urea (Christensen's), and lysine, arginine, and ornithine (Moller's) tests were negative.

Acid promptly accumulated at the unsealed surface of OF base medium containing fructose, maltose, and mannose. Acid was not apparent in the presence of these three carbohydrates when the medium was sealed with petrolatum. The unsealed surface of OF dextrose medium was alkaline after 24 hours but slowly became weakly acid after 5 days' incubation. Christensen's citrate, catalase, charcoal gelatin, lysine decarboxylase (ninhydrin), nitrate reduction to nitrite, and malonate tests were positive. Potassium cyanide broth was moderately turbid after 2 days' incubation. The organism failed to grow in the 2-ketogluconate medium. The above description of the type strain of P. maltophilia was based on procedures described and referred to by Hugh and Ryschenkow (1961).

Apparently the first name applied to organisms conforming to the above description was Xanthomonas maltophilia proposed by Hugh (1953) in an unpublished dissertation. However, under these conditions the name X. maltophilia must be regarded as not effectively published, and without standing in bacteriological nomenclature. Dr. A. C. Hayward, at the Commonwealth Mycological Institute in England, on 9 January 1963, in a personal communication, stated that

this species is correctly placed in the genus Pseudomonas rather than Xanthomonas.

The following twelve strains, which have been encountered in the literature, were obtained and subsequently identified as P. maltophilia. None of these cultures are type strains.

It is generally agreed that motile species of the genus Alcaligenes have peritrichous flagella; therefore, the name Alcaligenes faecalis is unsuitable for strains to which the name Pseudomonas maltophilia has been applied. The history of the name Alcaligenes bookeri has been reviewed and this organism was considered to be a species incertae sedis (Hugh and Ryschenkow 1961). Therefore, the epithet bookeri should not be applied to Pseudomonas maltophilia. The name Pseudomonas alcaligenes was applied to five strains of the taxon under consideration (Komagata 1961, Iizuka and Komagata 1962). These workers did not give a literature reference for the name Pseudomonas alcaligenes.

It appears that Monias (1928) was the first to use the name Pseudomonas alcaligenes. He applied this name to Gram-negative rod-shaped organisms with polar flagella which did "not ferment ANY carbohydrates." This suggests that Monias did not detect acid production from maltose by his 10 strains of Pseudomonas alcaligenes. Pseudomonas maltophilia ATCC 13637, the type strain, and the five strains of Pseudomonas alcaligenes (P-1, P-7, P-7-2, P-19, P-31-2) received from Komagata are polar multitrichous and readily produced oxidative acidity from maltose. Komagata's strains have been identified as P. maltophilia. The name Pseudomonas alcaligenes Monias 1928 is not an earlier synonym of Pseudomonas maltophilia Hugh and Ryschenkow 1961. Komagata now agrees that the 5 strains labelled Pseudomonas alcaligenes should be named Pseudomonas maltophilia (personal communication dated 20 February 1963).

RH Number	Received with the following designations	Other Strain Numbers	Reference
1395	<i>Pseudomonas</i> ?	K-7, M215	Moore and Pickett 1960
1410	<i>Pseudomonas</i> sp.	K-8, M237	Moore and Pickett 1960
431	<u><i>Alcaligenes faecalis</i></u>	K-8, M275, Ulrich 282	Moore and Pickett 1960, Ulrich and Needham 1953
430	<u><i>Alcaligenes faecalis</i></u>	K-10, M274, Ulrich 249	Moore and Pickett 1960, Ulrich and Needham 1953
229	<u><i>Bacterium bookeri</i></u>	NCTC 6572	National Collection of Type Cultures, London
1929	<u><i>Alcaligenes faecalis</i></u>	MDB 09, IEB 1/48	Microbiology Department, Faculty of Natural Sciences, University of J. E. Purkyne, Brno; Institute of Epidemiology and Bacteriology, Prague, Czechoslovakia.
1875	<u><i>Pseudomonas alcaligenes</i></u>	P-1	Komagata 1961, Iizuka and Komagata 1962
1876	<u><i>Pseudomonas alcaligenes</i></u>	P-7	Komagata 1961, Iizuka and Komagata 1962
1877	<u><i>Pseudomonas alcaligenes</i></u>	P-7-2	Komagata 1961, Iizuka and Komagata 1962
1878	<u><i>Pseudomonas alcaligenes</i></u>	P-19	Komagata 1961, Iizuka and Komagata 1962
1879	<u><i>Pseudomonas alcaligenes</i></u>	P-31-2	Komagata 1961, Iizuka and Komagata 1962
139	<u><i>Alcaligenes faecalis</i></u>		Phillips and Hanel 1950

REFERENCES

- Hugh, R. 1953. The genus Alcaligenes and related organisms. Ph.D. Dissertation, Stritch School of Medicine, Loyola University, pp.168-170.
- _____ and E. Leifson. 1953. The taxonomic significance of fermentative versus oxidative metabolism of carbohydrates by various Gram negative bacteria. Jour. Bacteriol. 66:24-26.
- _____ and E. Ryschenkow. 1960. An Alcaligenes-like Pseudomonas species. The Society of American Bacteriologists Bacteriological Proceedings, Abstracts of the 60th Annual Meeting, Philadelphia, Penna. p.78.
- _____ and _____. 1961. Pseudomonas maltophilia, an Alcaligenes-like species. Jour. gen. Microbiol. 26:123-132.
- Iizuka, H. and K. Komagata. 1962. "An attempt for the grouping of genus Pseudomonas." (Japanese) Jour. Agr. Chem. Soc. Japan. 36:663-674.
- Komagata, K. 1961. Differentiation of genus Pseudomonas and related aerobic bacteria. Jour. gen. Appl. Microbiol. 7:282-299.
- Monias, B.L. 1928. Classification of Bacterium alcaligenes, pyocyaneum, and fluorescens. Jour. Infect. Dis. 43: 330-334.
- Moore, H.B. and M.J. Pickett. 1960. Organisms resembling Alcaligenes faecalis. Can. Jour. Microbiol. 6:43-52.
- Phillips, G.B. and E. Hanel, Jr. 1950. Control of mold contaminants on solid media by the use of actidione. Jour. Bacteriol. 60:104-105.
- Ulrich, J.A. and G.M. Needham. 1953. Differentiation of Alcaligenes faecalis from Brucella bronchiseptica by biochemical and nutritional methods. Jour. Bacteriol. 65:210-215.