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THE NOMENCLATURE AND TAXONOMY OF THE PROTEUS
AND PROVIDENCE GROUPS

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The classification of the genus Proteus given by Rustigian and Stuart (1943, 1945) has gained wide acceptance and is now in use in many parts of the world. In recent years, however, several suggestions and proposals have been made regarding the taxonomy and nomenclature of the Proteus group and also of the Providence group. Kauffmann (1953, 1954, 1956) proposed a classification of this general group of microorganisms in which the genus Proteus was limited to two species, P. vulgaris and P. mirabilis. P. morganii and P. rettgeri were excluded from the genus on the basis of biochemical differences and were named Morganella and Rettgerella, respectively. Providence was maintained as a separate entity under the name Providencia. Proom and Woiwod (1951) excluded P. rettgeri from the genus Proteus and Proom (1955) advised the establishment of a new genus to include both P. rettgeri and Providence. Buttiaux et al. (1954) proposed the name Proteus stuartii for members of the Providence group and suggested that they be included in the genus Proteus under this designation. Shaw and Clarke (1955) disagreed with Kauffmann's division of the Proteus group and proposed the name Proteus inconstans for members of the Providence group, which they added to the genus Proteus as a fifth species. Cowan (1956) also adopted P. inconstans. Several writers (Borman et al., 1944, Buttiaux et al., 1954, and others) have included both P. vulgaris and P. mirabilis in one species called P. vulgaris by some and Proteus hauseri by others. Lastly, it should be mentioned that Peluffo (1953) reported that the flagella of P. vulgaris, P. mirabilis, and P. rettgeri strains all had the same spiral size, while those of P. morganii cultures had a definitely longer one, and this investigator suggested that the taxonomic position of P. morganii might be rediscussed in the light of this finding. This fundamental observation of Peluffo's is ancillary evi-

dence in favor of the separate status of P. morganii. However, the writer believes that in view of the present state of knowledge of the subject, the observation might better be construed as evidence in favor of separate species status, rather than separate generic status.

Stuart et al. (1946), Buttiaux et al. (1954), Shaw and Clarke (1955), and others have pointed out the resemblance of Providence group cultures to members of the genus Proteus. Further, the fact that members of both groups produce phenylpyruvic acid from phenylalanine lends additional support to the view that the two groups are closely related. However, the writer does not believe that this fact warrants actual inclusion of members of the Providence group in the genus Proteus, as the genus is presently constituted. As pointed out by Ewing et al. (1954), members of the Providence group resemble P. morganii and P. rettgeri in many respects but are urease negative. However, members of the Providence group differ markedly from cultures of P. vulgaris and P. mirabilis in certain fundamental characteristics such as failure to liquefy gelatin and failure to produce large amounts of hydrogen sulfide. Also, Providence group strains do not swarm in the manner often observed in cultures of P. vulgaris and P. mirabilis, although many Providence cultures can be induced to swarm under certain conditions (Stuart et al., 1946). The Providence group is composed of two principal biogroups, the members of which are readily distinguishable in all but a very few instances (Ewing et al., 1954). The first of these biogroups resembles P. morganii and the second, P. rettgeri. Thus, it may be seen that members of the Providence group are similar to two species of the genus Proteus but quite different from the other two (P. vulgaris and P. mirabilis). Therefore, it is the opinion of the writer that the Providence group should not be incorporated into the genus Proteus as it is now constituted. If the modern classification of the genus Proteus (Rustigian and Stuart, 1946) is retained, then both the Proteus and Providence groups should be maintained as separate entities within a larger principal division (or tribe), which may be called the Proteus-Providence division or, if a tribal designation is required for nomenclatural purpose, the tribe Proteae. In this case the generic term for the Providence group would be Providencia (Kauffmann, 1953) and the proper specific name would appear to be Providencia inconstans.

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The work of Proom (1955), who regarded the Providence group as nutritionally homogeneous and different from Proteus in certain nutritional aspects, tends to support the concept of a separate Providence group. However, it should be said that not enough is known about fundamental nutritional differences to assess their taxonomic value at present. Undoubtedly, nutritional studies eventually will be made with large numbers of cultures belonging to each of the groups of Enterobacteriaceae and the results of such investigations may prove to be of value in taxonomy. Proom and Woiwod (1951) and Proom (1955) advocated the exclusion of P. rettgeri from the genus Proteus because P. rettgeri cultures fermented mannitol, produced only traces of hydrogen sulfide (as measured by a lead acetate paper method), failed to produce gas from glucose, failed to produce volatile amines, and differed from other Proteus species with respect to nicotinic acid requirements. The writer regards this proposal (per se) as untenable, since at least 10 per cent of P. rettgeri strains produced gas from glucose (Rustigian and Stuart, 1945, and author's unpublished data). Also, it may be noted that one of the 10 P. rettgeri cultures examined by Proom and Woiwod (1951) produced gas. The fact that three Proteus species fail to ferment mannitol while P. rettgeri strains do so does not seem to be a valid reason for removal of the latter species from the genus, since mannitol positive and mannitol negative species and varieties are known to exist in certain other recognized genera and species of Enterobacteriaceae, e.g. Shigella and Shigella flexneri. Furthermore, it is known that certain cultures otherwise like P. rettgeri fail to produce acid from mannitol (unpublished data). As regards tests for hydrogen sulfide production Proom (1955) states that "it seems clear that the conditions of the test can be arranged to produce almost any desired effect." It is probable that all Enterobacteriaceae produce at least small amounts of hydrogen sulfide from organic or inorganic substrates if sufficiently sensitive methods are used to detect its presence, but the writer believes that in this instance the most sensitive method is not necessarily the best for taxonomic purposes. Rather, it is felt that for a hydrogen sulfide test to be of value in taxonomic work within the family Enterobacteriaceae, it should be poised at a certain level of sensitivity. TSI agar, or a medium of similar composition but without lactose and sucrose, serves this purpose admirably and may be recommended because it gives results comparable to classical

descriptions and permits easy primary group differentiation within the family. If a lead acetate paper method is used it should be employed as it is with Brucella cultures, i.e. in a semi-quantitative way. The papers should be replaced with new ones each day for four days and records kept as to weak, moderate, or marked hydrogen sulfide production. If this is done, the results obtained are comparable to those obtained with TSI agar, or other medium of similar sensitivity, except that cultures giving weakly positive paper tests may be negative in TSI agar. Nicotinic acid requirements and other criteria of similar nature need to be studied further before their importance and value in taxonomy can be accurately assessed. For these reasons the writer cannot agree to the exclusion of P. rettgeri only from the genus Proteus. Nor can he agree to the suggestion of Proom (1955) that a new genus should be created to include only P. rettgeri and the Providence group.

The above-mentioned considerations regarding the taxonomy and nomenclature of the Proteus and Providence groups seem to resolve themselves into the following questions:

Should the modern classification of the genus Proteus be retained, or should the genus be split, and if the genus is to be divided, how should the division be made?

Something may be said in favor of each of the proposals and suggestions made by Kauffmann (1953, 1954, 1956), Proom and Woiwod (1951), Proom (1955), and Shaw and Clarke (1955). Also, certain aspects of each may be adversely criticized. It is possible that a compromise may be desirable in this particular situation. For example, two genera might be recognized, the first of which would be Proteus and would include P. vulgaris and P. mirabilis as distinct species, since it appears that there are sufficient differences between these to warrant species status for each. The second genus might be called Morganella, (Fulton, 1943) since this name appears to have priority, and would include Morganella morganii, M. rettgeri, and M. inconstans. (Table 1.) If it is granted that there are sufficient differences between P. vulgaris and P. mirabilis on the one hand, and P. morganii, P. rettgeri, and the Providence group on the other, to warrant generic status for each, then the above-mentioned compromise

Table 1
Biochemical reactions given by members of the Proteus and Providence groups
(Compromise schema of nomenclature and taxonomy)

	<u>Proteus</u>		<u>Morganella</u>			
	<u>P. vulgaris</u>	<u>P. mirabilis</u>	<u>M. morganii</u> (<u>P. morganii</u>)	<u>M. rettgeri</u> (<u>P. rettgeri</u>)	<u>M. inconstans</u> Biogroup 1	(Providence) Biogroup 2
Gas from glucose	+	+	+	d	+	-
Lactose	-	-	-	-	-	-
Sucrose	+	x	d	d	d	d
Mannitol	-	-	-	+	-	d
Dulcitol	-	-	-	-	-	-
Salicin	+	d	-	d	-	-
Adonitol	-	-	-	+	+	-
Inositol	-	-	-	+	-	+
Indol	+	-	+	+	+	+
Methyl red	+	+	+	+	+	+
Voges-Proskauer	-	d	-	-	-	-
Simmons' citrate	d	d	-	+	+	+
H ₂ S (TSI agar)	+	+	-	-	-	-
Urease	+	+	+	+	-	-
Gelatin	+	+	-	-	-	-
KCN	+	+	+	+	+	+
Motility	+	+	+	+	+	+
Lysine decarboxylase (ninhydrin)	-	-	-	-	-	-
Phenylalanine deaminase	+	+	+	+	+	+

+, positive 1 or 2 days. x, late and irregularly positive. -, no reaction. d, different biotypes

might be satisfactory to those who would divide the genus Proteus. In this way, biochemically similar species are grouped together and the species rank of each of the five species is maintained. P. morganii and P. rettgeri are placed in the same genus because it is felt that there are not enough known differences between them to warrant their being given separate generic status. Members of the Providence group are given separate status as a species and certainly this is necessary at this time for practical reasons, if for no other. However, it is possible that future studies may indicate that members of the Providence group should be considered as urease negative varieties of either P. morganii (M. morganii) or P. rettgeri (M. rettgeri), according to reactions given by individual strains.

The compromise mentioned above is presented for consideration along with suggestions already made and proposals which undoubtedly will be made in the future. Since it may be decided that the classification of the genus Proteus given by Rustigian and Stuart (1943, 1945) should be retained, that classification should remain in use until such time as agreement on the taxonomy and nomenclature of the group is reached. Until that time the Providence group should be maintained as a separate entity.

REFERENCES

- Buttiaux, R., R. Osteau, R. Fresnoy, J. Moriamez. 1954. Les propriétés biochimiques caractéristiques du genre Proteus. Inclusion souhaitable des Providencia dans celui-ci. Ann. Inst. Pasteur, 87:375.
- Cowan, S. T. 1956. Taxonomic rank of Enterobacteriaceae "Groups". Jour. Gen. Microbiol. 15:345.
- Ewing, W. H., K. E. Tanner, and D. A. Dennard. 1954. The Providence group: and intermediate group of enteric bacteria. Jour. Infect. Dis. 94:134.
- Fulton, M. 1943. The identity of Bacterium columbensis Castellani. Jour. Bact. 46:79.
- Kauffmann, F. 1953. On the classification and nomenclature of the Enterobacteriaceae. Riv. Inst. Sieroter. Ital. 28:485.

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- Kauffmann, F. 1954. Enterobacteriaceae, 2nd Ed., Einar Munksgaard, Copenhagen.
- Kauffmann, F. 1956. Zur biochemischen und serologischen Gruppen-und Typen-Einteilung der Enterobacteriaceae. Zentrabl. f. Bakt., Parasitenk., Infektionskr. u. Hyg., I Orig. 165:344.
- Peluffo, C. A. 1953. Significance of the spiral period of bacteria flagella. Proc. VI Internatl. Congress Microbiol. 1:370.
- Proom, H. and A. J. Woiwod. 1951. Amine production in the genus Proteus. Jour. Gen. Microbiol. 5:930.
- Proom, H. 1955. Amine production and nutrition in the Providence group. Jour. Gen. Microbiol. 13:170.
- Rustigian, R. and C. A. Stuart. 1943. Taxonomic relationships in the genus Proteus. Proc. Soc. Exptl. Biol. Med. 53:241.
- Rustigian, R. and C. A. Stuart. 1945. The biochemical and serological relationships of the organisms of the genus Proteus. Jour. Bact. 49:419.
- Shaw, C. and P. H. Clarke. 1955. Biochemical classification of Proteus and Providence cultures. Jour. Gen. Microbiol. 13:155.
- Stuart, C. A., K. M. Wheeler, and V. McGann. 1946. Further studies on one anaerogenic paracolon organism, type 29911. Jour. Bact. 52:431.