A TAXONOMIC STUDY OF THE
MEMBERS OF THE GENUS SERRATIA

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SUMMARY: A study of the morphological, cultural, and biochemical characteristics of 12 strains of different species of the genus Serratia indicates that most strains of species thus far recognized are identical with Serratia marcescens.

The names S. piscatorum (Lehmann and Neumann) Breed, S. pyoseptica (Fortineau) Bergey, S. fuschsina (Boeckhout et de Vries) Bergey, S. anolium (Duran-Reynals et Clausen) are to be regarded as synonyms of S. marcescens Bizio and Serratia marinorubra as a synonym of Serratia marcescens var. kiliensis.

The strains S. saponaria I and II Markov should be removed from the genus Serratia and placed provisionally in the genus Alcaligenes.

For our studies of the species of the genus Serratia, we have obtained from various collections cultures of strains without designation of species or with obsolete names. Among these cultures were strains names, e.g. Serratia pyoseptica (Fortineau) Bergey, Serratia anolium Duran-Reynals and Clausen, Serratia fuchsina (Boeckhout and de Vries) Bergey and others. Breed (1948) regards most of these names as synonyms of Serratia marcescens, while Krasilnikov (1949) includes them in his Manual as names of accepted species.

In the 1957 edition of Bergey's Manual neither of the two new strains of Serratia, isolated and described by Markov (1956) as Serratia saponaria I and II, is included.

In our present work we have studied whether the several aforesaid "species" have taxonomic significance and whether some of them belong to the genus Serratia at all.

MATERIAL AND METHODS

In our work we have thoroughly studied 12 strains of Serratia acquired from various collections. The list of strains is given in Table 1.

The methods used were the same as in our previous work (Martinec and Kocur, 1960).

Table 1.

No. of strain	Source of strain
<u>Serratia anolium</u>	ATCC 6065
<u>S. anolium</u> B 1700	W.C. Haynes, NRRL, Peoria, Illinois
<u>S. pyoseptica</u> S 4	Dept. of Appl. Biol. NRC, Ottawa, Canada
<u>S. pyoseptica</u> 523	J. Simpson, Prairie Reg. Lab., Saskatoon, Canada
<u>S. saponaria</u> I. II.	W. Markov, Sofia, Bulgaria
<u>S. fuchsina</u> 150	B. Hampl, Dept. of Biol. Sci. Prague
<u>S. marinorubra</u> 318	C.E. Zobell, La Jolla, Calif.
<u>S. piscatorum</u> 415	Inst. of Plant Product., Prague
<u>Serratia sp.</u> S 13, S 26	J. Simpson, Prairie Reg. Lab. Saskatoon, Canada
<u>Serratia sp.</u> 846	C.B. van Niel, Stanford Univ., California
<u>Alcaligenes faecalis</u> 09	Inst. of Epidemiology and Microbiol., Prague

RESULTS

Morphology. All studied strains were short, gram-negative rods occurring singly and in clumps. Size of individual cells $0.8-1 \times 1.5-2.5 \mu$. All strains were motile except Serratia saponaria II.

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Cultural characteristics. Colonies of most strains were round, with undulate margin, slightly convex, smooth. Eight strains were at first creamy or slightly rose colored, later red, very slightly pigmented was S. saponaria I. and there were three non-pigmented strains S. saponaria II., no. 6065 and B 1700. In nutrient broth all strains produced turbidity and sediment except S. saponaria I. and II. which grew very poorly. S. saponaria I. and II., however, grew well in nutrient broth at pH 9.6. The mentioned strains did not grow on potato. On the medium recommended by Dewey and Poe (1943) 6 strains only were pigmented.

Biochemical characteristics. The ascertained biochemical characteristics are shown in Table 2.

DISCUSSION

The results indicated that all the strains with the exception of Serratia saponaria I and II agreed with the characteristics of Serratia marcescens Bizio. The differences as shown in Table 2 (lactose fermented by strain 318, gas not formed from glucose by strains 523, 318, S 26, maltose not fermented by strain S 4 and adonitol not fermented by strain 527) are characteristic for Serratia marcescens. Serratia marinorubra BS 318 (acethylmethylcarbinol not formed) is identical with Serratia marcescens var. kiliensis.

We conclude that the aforesaid species S. anolium Duran-Reynals and Clausen, S. pyoseptica (Fortineau) Bergey, Serratia fuchsina (Boeckhout and de Vries) Bergey are to be regarded as synonyms of Serratia marcescens Bizio and Serratia marinorubra as a synonym of Serratia marcescens var. kiliensis.

Serratia marcescens differs significantly from Serratia saponaria I and II. The differences in the biochemical activity of these two strains in comparison with the strain Serratia marcescens are so substantial, that we conclude that these two strains should not be placed in the genus Serratia. We have compared biochemical characteristics of Serratia saponaria I and II with one strain of Alcaligenes faecalis 09 and with the characteristics of this species in Bergey's Manual (1957). We have ascertained that biochemical features of Serratia saponaria I and II and Alcaligenes faecalis are very similar (liquefaction of gelatin, no fermentation of carbohydrates, growth at pH 9.6). On the

Diagnostic Tests Used	<u>S. anolium</u> 6065	<u>S. anolium</u> B 1700	<u>S. pyoseptica</u> S 4	<u>S. pyoseptica</u> 523	<u>S. saponaria</u> I.	<u>S. saponaria</u> II.	<u>S. fuchsina</u> 150	<u>S. marinorubra</u> 318	<u>S. piscatorum</u> 415	<u>Serratia</u> sp. S 13	<u>Serratia</u> sp. S 26	<u>Serratia</u> sp. 846
Gelatin liquefaction	+	+	+	+	+	-	+	+	+	+	+	+
Casein hydrolysis	+	+	+	+	-	-	+	+	+	+	+	+
Nitrate reduction	+	+	+	+	-	+	+	+	+	+	+	+
Hydrogen sulfide I.	+	+	+	+	-	-	+	+	+	+	+	+
Hydrogen sulfide II.	+w	+w	-	-	-	-	-	-	-	-	-	-
Indole	-	-	-	-	-	-	-	-	-	-	-	-
Milk	+	+	+	+	-	-	+	+	+	+	+	+
Hemolysis	-	-	-	-	-	-	-	-	-	-	-	-
Glucose	+	+	+	+	-	-	+	-	+	-	-	+
Gas from glucose	+	+	+	-	-	-	+	-	+	-	-	+
Lactose	-	-	-	-	-	-	+	+	-	-	-	-
Sucrose	+	+	+	+	-	-	+	+	+	+	+	+
Maltose	+	+	-	+	-	-	+	+	+	+	+	+
Galactose	+	+	+	+	-	-	+	+	+	+	+	+
Fructose	+	+	+	+	-	-	+	+	+	+	+	+
Rhamnose	-	-	-	-	-	-	-	-	-	-	-	-
Mannose	+	+	+	+	-	-	+	+	+	+	+	+
Inulin	-	-	-	-	-	-	-	+	-	-	-	-
Xylose	-	-	-	-	-	-	-	-	-	-	-	-
Arabinose	-	-	-	-	-	-	-	-	-	-	-	-
Glycerol	+	+	+	-	-	-	+	+	+	+	+	+
Adonitol	+	+	+	-	-	-	-	+	+	-	-	+
Sorbitol	+	+	+	+	-	-	+	-	+	+	+	+
Mannitol	+	+	+	+	-	-	+	+	+	+	+	+
Dulcitol	-	-	-	-	-	-	-	-	-	-	-	-
Starch	-	-	-	-	-	-	-	-	-	-	-	-
Esculin	+	+	+	+	-	-	+	+	+	+	+	+
Koser's citrate	+	+	+	+	-	-	+	+	+	+	+	+
Simmons' citrate	+	+	+	+	-	-	+	+	+	+	+	+
Acethylmethylcarbinol	+	+	+	+	-	-	+	-	+	+	+	+
Methyl red	-	-	-	-	-	-	-	-	-	-	-	-
KCN	+	+	+	+	+	-	+	+	+	+	+	+
Phenylalanine	-	-	-	-	-	-	-	-	-	-	-	-
Catalase	+	+	+	+	+	+	+	+	+	+	+	+
Urease	-	-	-	-	-	+	-	-	-	-	-	-
Lipase	+	+	+	+	-	-	+	+	+	+	+	+
5% NaCl	+	+	+	+	+	+	+	+	+	+	+	+
7.5% NaCl	+	+	-	+	+	+	+	+	+	+	+	+
Pigment	-	-	+	+	+	-	+	+	+	-	-	-

w = weak

Hydrogen sulfide I. = lead acetate papers

Hydrogen sulfide II. = modified Kliger medium

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basis of this observation we recommend placing Serratia saponaria I and II provisionally in the genus Alcaligenes. The definitive placing of this species will be possible only after having compared it with other species of the genus Alcaligenes.

Special attention should be given to the species S. piscatorum (Lehmann and Neumann) Breed. This species has been recognized both by Krasilnikov (1949) and Breed (1957). But this species is not deposited in any collection and therefore it cannot be compared with Serratia marcescens. The only strain assigned to S. piscatorum, which we could compare, was isolated several years ago from soil (see Table 1). We have ascertained that this strain is identical with Serratia marcescens. On comparison of the original characteristics (1884) as well as the description in Bergey's Manual (1957) with the features of Serratia marcescens, we find only small differences. The fact that S. piscatorum can produce pigment at 37° and that this pigment is soluble in water, cannot be taken for such an essential feature, on the basis of which it would be possible to acknowledge S. piscatorum a valid species, because this feature can be found also in some strains of Serratia marcescens. We have ascertained that out of 68 strains studied at 37°C only 15 strains produced pigment (unpublished data). Also the fact pigment of some heavily pigmented strains of Serratia marcescens is soluble in water, was stated already in 1948 by Breed and recently it has been experimentally proven by Williams et al. (1958). For these reasons we regard Serratia piscatorum (Lehmann and Neumann) Breed as a synonym of S. marcescens.

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