

NOTICE OF INTENDED USE

The following article is an example of content, form, and style for a paper assigned to students in the class BIOC 318 (Laboratory in Microbiology) at Rice University. To the best of the author's knowledge the information is accurate, however the work is not intended to substitute for a scholarly article on the species *Serratia marcescens*.

Enteriobacteriaceae: *Serratia marcescens*

David R. Caprette, Rice University

Source of isolate

The isolate was recovered on Oct 24 2012 from an R2A plate that had been spread with a 1:1000 of water sample from Pond 5B and incubated at 36°C for two days.

Description of isolate

Very small straight rods, between 0.5 and 1 µm in diameter and < 2 µm in length, arranged singly. Motile, facultatively anaerobic. In Gram stains from cultures grown at 36°C rods were <1 µm in length and resembled diplococci at 1000x. Typical colonies were 1-2 mm in size when not crowded, round, glabrous, convex and slightly umbonate with entire margins, and opaque. New colonies were red in color, fading to white with red centers with age and eventually losing all red pigmentation. Cultures produced an unpleasant somewhat sweet odor.

Oxidase negative, strongly catalase positive. Negative for indole production and mixed acid fermentation on glucose (methyl red test). Positive for acetoin production (Voges-Proskauer test). Lysine and ornithine decarboxylase positive. Liquifies gelatin at 22°C. No acid or gas production on lactose, L-arabinose, or D-xylose.

All observations were consistent with the description of the genus in Bergey's Manual p. 477 (Holt, 1984) and characteristics noted for *S. marcescens* in tables 5.30 and 5.31 except for lack of mention of fading of pigmentation in older colonies and description of the odor as "fishy to urinary." The species name *marcescens*, meaning "fading away," suggesting that the fading of the red color is characteristic of the species. The odor is difficult to describe, more suggestive of flatulence than a fish or urine smell. Different observers may have different perceptions of the odor.

Identification

The Gram stain result (negative rod) and relationship to oxygen (facultative anaerobe) place the isolate among the Enterobacteriaceae, Vibrionaceae, Pasteurellaceae, and several other genera. Motility ruled out the Pasteurellaceae and the negative oxidase test and red color ruled out all but one species of Vibrionaceae (*V. gazogenes*), which is negative for acetoin production. These characteristics combined to rule out all other genera of Gram negative facultatively anaerobic rods not assigned to one of these three families, placing the isolate in family Enterobacteriaceae.

The combination of indole, methyl red, and Voges-Proskauer tests left sixteen candidate species out of the sixty-seven species of Enterobacteriaceae listed in Table 5.3 of Bergey's Manual (Holt, 1984). Only six of these species are listed as positive for both lysine and ornithine decarboxylase. Three of the six liquefy gelatin at 22°C, all in the genus *Serratia*. All other species of *Serratia*, including *S. liquefaciens* and *S. odifera*, produce gas on L-arabinose and on D-xylose, and *S. odifera* also produces gas on lactose.

Natural history and importance

Older literature may refer to this species by the alternative names *Monas prodigiosus* or *Bacillus prodigiosus*. The generic name *Serratia* used since the 1920s, refers to the physicist Serafino Serrati. It was coined in 1819 by the Venetian pharmacist Bartolomeo Bizio, who gave the name *marcescens* ("fading away") to a species of bacteria that proved to be responsible for a case of food contamination (Sehdev (1999). Contamination of food products by *S. marcescens* is indicated by a pink to red discoloration due to its production of the pigment prodigiosin. *S. marcescens* is reputed to be responsible for stories from Medieval times of the occasional appearance of blood in or on the Eucharist during Mass (Bennett, 2000).

S. marcescens is recognized as an opportunistic pathogen and strains of it are now resistant to commonly used antibiotics (Hejazi, 1997). However, up to 1950 the species was thought to be a harmless saprophytic organism (Anía, 2008). Because its characteristic red color made it easy to trace its distribution it was used to trace possible routes of infection and to follow wind patterns. *S. marcescens* was released by the U. S. Navy into the atmosphere over the Bay area of San Francisco, California in 1950, apparently causing eleven cases of a severe urinary tract infection including one death, and an increase in the occurrence of pneumonia for some time after the release (Cole, 1988).

Well publicized incidents involving *S. marcescens* include a recall by the Food and Drug Administration of a batch of Pre-Filled Heparin Lock Flush Solution USP and a report from King Abdulaziz University's Medical College (arabnews.com) that a contaminated shampoo had led to illness in over a dozen infants, including one death.

Glossary

<i>Diplococci</i>	Round or nearly round bacterial cells occurring in pairs.
<i>Entire</i>	Unbroken, smooth, without serrations, undulations, lobes, or filaments
<i>Glabrous</i>	In the context of colony morphology, smooth and glossy.
<i>Margin</i>	The edge of a colony
<i>Umbonate</i>	Having a raised center, or bump

Literature Cited

Anía BJ. Serratia: overview. <http://emedicine.medscape.com/article/228495-overview>. Retrieved 24-Apr 09

Arabnews.com. Rolana shampoo kills baby. <http://www.arabnews.com/?page=1§ion=0&article=118988&d=8&m=2&y=2009>. Retrieved 24-Apr 09

Bennett JW, Bentley R. Seeing red: The story of prodigiosin. *Adv Appl Microbiol* 47: 1–32. 2000

Cole, Leonard A.. *Clouds of Secrecy: The Army's Germ-Warfare Tests Over Populated Areas*. (Foreword by Alan Cranston). Totowa, New Jersey: Rowman & Littlefield. 1988

Food and Drug Administration. AM2 PAT, Inc. Issues Nationwide Recall of Pre-Filled Heparin Lock Flush Solution USP (5 mL in 12 mL Syringes).

http://www.fda.gov/oc/po/firmrecalls/am2pat12_07.html. Retrieved 24-Apr 09

Hejazi A, Falkiner FR. *Serratia marcescens*. *J Med Microbiol* 46 (11): 903–12. 1997

Holt, John G. (editor-in-chief) and Noel R. Krieg (editor, volume 1). (1984). *Bergey's Manual of Systematic Bacteriology, Volume 1*. New York: Lippincott Williams & Wilkins.

Sehdev PS, Donnenberg MS. Answer to Arcanum. *Clin Infect Dis* 29 (4): 925. 1999

Additional reference

Serratia marcescens http://en.wikipedia.org/wiki/Serratia_marcescens#History. Retrieved 23-Apr 09

IMAGE OF *S. MARCESCENS* GROWN ON AGAR PLATE

Fig. 1. Colonies of *Serratia marcescens* grown on tryptic soy agar 48 h at 23°C. Individual colonies show typical heterogenous pattern of pigmentation.

GRAMS STAIN OF *S. MARCESCENS*

PHOTOGRAPHED AT 1000X

Fig. 2. Gram stain of *Serratia marcescens* shows typical "short rod" morphology. Due to limits of resolution using a light microscope, single rods often resemble pairs of cocci or coccoidal cells.