The Occurrence of Gallionella in Salt Water

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ABSTRACT

SHARPLEY, J. M. (Buckman Laboratories, Inc., Memphis, Tenn.). The occurrence of Gallionella in salt water. Appl. Microbiol. 9:380-382. 1961.—A Gallionella sp. is described that lives and freely multiplies in sea water. The habitat of the organism has been thoroughly investigated and the possibility of accidental occurrence has been eliminated. The appearance of the Gallionella sp. described is quite different from the similar iron bacteria occurring in fresh water.

Gallionella in salt water have been reported only in a rather obscure reference, published in 1928 by Butkevich. It is commonly assumed that either the sodium or chloride ion in high concentrations precludes the growth of iron bacteria. Some investigations in our laboratory, regarding the toxicity of ascending concentrations of sodium chloride to other species of iron bacteria, cast doubt on this concept of sodium chloride toxicity. Recent field investigations have detected Gallionella growing actively in salt water.

EXPERIMENTAL METHODS

Ecology of Gallionella in salt water. In the vicinity of Long Beach, Calif., there has been subsidence of the land bordering the sea. A portion of this geologic subsidence has caused invasion of sea water into the former

FIG. 1. Gallionella sp. isolated from salt water. Note the characteristic long strands and relative small amount of twisting. Light phase, membrane filter surface, 405X.
bed of the Los Angeles River. In recent years, there have been many water wells of approximately 150 ft drilled into the river gravel stratum. The water table in some of these wells rises and falls with the ocean tide, indicating free passage with the sea. The water produced from the wells approximates sea water in composition. From these wells, *Gallionella* are obtained in large quantities, causing operational difficulties in the subsequent use of the water.

The possibility of accidental introduction of *Gallionella* into these wells has been thoroughly investigated and discounted. Within comparatively recent geologic time, the Los Angeles River deposited gravel in a wide area as the river meandered. The area covered corresponds roughly to the Dominguez Gap. There are many water wells in this area and the subsurface geology is well known. Assuming that the river would deposit larger stones and boulders in the center and smaller gravel toward the shores, it is possible to choose wells spaced over the area of the alluvial bed.

As the tide of the sea rises and falls, there is a variable amount of fresh water in some of the wells. As might be expected, the greatest amount of fresh water occurs in the wells at the edge and the landward end of the alluvial bed. If the *Gallionella* present had been introduced via the fresh water, greater numbers would be expected in the wells receiving the larger amounts of fresh water. Samples taken from wells spaced across the former bed of the river did not support this hypothesis. In fact, such samples indicated the heaviest concentration of *Gallionella* to be in wells receiving no fresh water discernible by chemical analysis.

*Morphology.* The microorganisms observed are obviously *Gallionella* but are quite different in morphology from those commonly observed. *Gallionella* growing in salt water are characteristically quite large. Filaments are often 150 to 200 μ long and 4 to 5 μ wide. The microorganism is frequently not tightly twisted, as usually observed, but often occurs as single strands or two long filaments loosely twisted at one end. Figures 1 and 2 illustrate the organisms isolated from salt water. For comparative purposes, Fig. 3 shows normal *Gallionella* from fresh water.

Iron bacteria have previously been classified on the basis of their morphology. It is recognized that this is undesirable, and future taxonomic additions should await adequate biochemical characterization of the microorganism. In view of the confused taxonomic state

![Image](http://aem.asm.org/)
and difficulties of pure culture, no attempt has been made to speciate these salt-adapted strains of *Gal lionella*. It is recognized that a new species designation could be justified on the basis of previously described taxonomic criteria.

*Culture.* Pure cultures of the microorganisms as described by Kucera and Wolfe (1957) were attempted without success. Mixed cultures could be obtained without difficulty by simple inoculation of large containers of salt water from the source wells.

The organisms were also grown with ease on microscope slides submerged in a diverted side stream of water from the source wells.

*Oxygen relationships.* The aerobic nature of *Gallionella* is open to some question. Characteristically, source wells in the petroleum industry are designed to maintain an air-free supply water. The water from these wells contained less than 0.1 to 0.3 ppm of free oxygen, yet *Gallionella* grow prolifically. This same observation has been made in other areas where *Gallionella ferruginea* and *Sphaerotilus natans* grow in fresh water.

It appears that these microorganisms should be considered as facultative or microaerophilic in nature rather than strictly aerobic.

**DISCUSSION**

Iron bacteria is one of the groups of microorganisms having considerable economic importance in the operation of water-flooding installations in the petroleum industry. Our interest in these comparatively little-known microorganisms is of long duration. We have consistently been surprised by the environmental versatility of the group as a whole.

Although the morphology of *Gallionella* occurring in salt water is unusual, the probability is that the morphological appearance is a result of their environment. The organisms have become fully adapted to living in sea water, but this is probably a result of gradual encroachment of sea water into their normal habitat. It is believed that a new species name can be justified only if biochemical studies reveal a pronounced species difference. The habitat range should, of course, be extended to cover sea water.

**LITERATURE CITED**


**FIG. 3.** *Gallionella* sp. from fresh water illustrating the usual size and morphology. Dark phase, membrane filter surface, 978×