Haloarcula marismortui (Volcani) sp. nov., nom. rev., an Extremely Halophilic Bacterium from the Dead Sea

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An extremely halophilic red archaeabacterium isolated from the Dead Sea (Ginzburg et al., J. Gen. Physiol. 55:187–207, 1970) belongs to the genus Haloarcula and differs sufficiently from the previously described species of the genus to be designated a new species; we propose the name Haloarcula marismortui (Volcani) sp. nov., nom. rev. because of the close resemblance of this organism to “Halobacterium marismortui,” which was first described by Volcani in 1940. The type strain is strain ATCC 43049.

During his studies on the microbiology of the Dead Sea in the 1930s and 1940s Elazari-Volcani isolated a novel strain of the genus Halobacterium. This strain differed from the then known halobacterial types in its ability to form acid from glucose, fructose, mannose, and glycerol and in its production of gas from nitrate. The isolate was described as “Halobacterium marismortui” (1, 15; B. Elazari-Volcani, Ph.D. thesis, The Hebrew University of Jerusalem, 1940), but was never deposited in a culture collection. As far as we know, the strain has been lost (6).

During the 1960s a new Halobacterium strain was isolated from the Dead Sea by Ginzburg et al. (3). This strain was originally referred to as “Halobacterium of the Dead Sea.” However, the description of the new isolate closely resembled the species description of “Halobacterium marismortui,” and Volcani himself agreed that the strain was similar to the original isolate (12). From 1978 on (2) the “Halobacterium of the Dead Sea” was often called “Halobacterium marismortui,” although it was never proposed as a neotype strain and was not deposited in a culture collection until recently (as strain ATCC 43049T [T = type strain]) (6). Since no valid description has been published previously, since the old name continues to be invalid, and since in 1986 the Subcommittee on the Taxonomy of Halobacteriaceae suggested that more studies were required to determine the taxonomic position of this species (6), in this paper we remedy the situation by describing strain ATCC 43049T and proposing a name.

According to the new classification of the nonalkaliphilic halophilic archaeabacteria, the Dead Sea isolate belongs to the genus Haloarcula (5, 7, 14), as shown by its lipid composition (both the Dead Sea isolate and members of the genus Haloarcula contain phosphatidylglycerol, phosphatidylglycerolphosphate, phosphatidylglycerol sulfate, and glucosyl-mannosyl-glycosyldiether), SS and 16S rRNA nucleotide sequences (11), and ability to grow on simple carbon sources (glucose, fructose, sucrose, glycerol, acetate, succinate, and malate) (M. Mevarech, Tel Aviv University, personal communication). Recently, a thorough comparison was made of the new isolate (strain ATCC 43049T) and Haloarcula valismortis ATCC 29715 (4). Although the guanine-plus-cytosine contents of the DNAs of these organisms differ slightly, although very different patterns were observed after electrophoresis of digests of DNA preparations with different restriction enzymes (11), and although the DNA-DNA hybridization ratio of these organisms is rather low, the new isolate and strain ATCC 29715 appeared to be related, as shown by the near identity of their SS and 16S rRNAs and a large number of other common properties. However, there are distinct differences in cell morphology and in the ability to utilize different sugars and other compounds (11). Table 1 summarizes the differences between the new isolate and the previously validly described species in the genus Haloarcula. We consider these differences to be sufficiently significant to warrant a separate species for the new isolate. Morphologically, the Dead Sea isolate resembles “Haloarcula californiae” (8), a species that was never validly described.

The new isolate fits the original species description of “Halobacterium marismortui” (1), except in the properties described below.

The original description of “Halobacterium marismortui” mentions an optimum temperature of 30°C, and the new isolate grows optimally at temperatures around 40 to 50°C (11). However, the publications of Volcani (1, 15; Elazari-Volcani, Ph.D. thesis) do not present evidence that growth experiments at temperatures above 30°C were attempted. Morphologically, the new isolate was described as having flat disk-shaped or round, triangular, or square cells, and the original “Halobacterium marismortui” strain was described as nonmotile rods of variable length. In the micrographs of Elazari-Volcani (Ph.D. thesis) rod-shaped cells are seen, but most of the cells are irregular and resemble flat disks.

The new isolate is generally described as nonmotile, and so was the original “Halobacterium marismortui” isolate. However, under special conditions a small number of the cells of the new isolate were seen to actively rotate around their axes.

The new isolate did not produce acid from mannose (although mannose stimulated growth) (11), while the original “Halobacterium marismortui” strain reportedly produced acid on mannose. On glucose, fructose, and glycerol both isolates produced acid.

A very slow and weak hydrolysis of starch was observed with the new isolate, while the original “Halobacterium marismortui” strain reportedly did not hydrolyze starch.

Because of the great resemblance between the new isolate and the lost organism “Halobacterium marismortui” (a name that has lost validity according to Rule 24a of the

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**TABLE 1. Comparison of strain ATCC 43049T with the previously validly described *Haloarcula* species**

<table>
<thead>
<tr>
<th>Organism</th>
<th>Cell size (µm)</th>
<th>Morphology</th>
<th>Motility</th>
<th>Starch hydrolysis</th>
<th>Acid produced from:</th>
<th>Growth stimulation by:</th>
<th>Guanine-plus-cytosine content (major component) (mol%)</th>
<th>Level of DNA-DNA hybridization with strain ATCC 43049T (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead Sea isolate (strain ATCC 43049T)</td>
<td>1–2 by 2–3</td>
<td>Pleomorphic, mostly flat disk shaped</td>
<td>-a</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>62</td>
<td>100</td>
</tr>
<tr>
<td><em>Haloarcula vallismortis</em></td>
<td>0.6–1 by 3–5</td>
<td>Irregular rods</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>65</td>
<td>39</td>
</tr>
<tr>
<td><em>Haloarcula hispanica</em></td>
<td>0.3 by 0.5–1</td>
<td>Short rods</td>
<td>+</td>
<td>+</td>
<td>NR#</td>
<td>NR</td>
<td>63</td>
<td>NR</td>
</tr>
</tbody>
</table>

# Data are from references 4, 9, 11, 13, and 14.
# Sometimes a small number of motile cells were observed.
# NR, Not reported.

**International Code of Nomenclature of Bacteria** 10, we propose the name *Haloarcula marismortui* (Volcani) sp. nov., nom. rev.

*Haloarcula marismortui* (Volcani) sp. nov., nom. rev. *Haloarcula marismortui* (ma.ris.rn0r'tu.i. L. n. mare, the sea; L. gen. n. maris, of the sea; L. adj. mortuus, dead; M. L. gen. n. maris.mortui, of the Dead Sea). Cells are pleomorphic, flat, and disk-shaped (1 to 2 by 2 to 3 µm). Nonmotile (but rarely cells are observed to rotate around their axes).

Growth occurs in media containing 1.7 to 5.1 M NaCl (optimum NaCl concentration, 3.4 to 3.9 M). Optimum temperature, 40 to 50°C.

Aerobic chemoorganotroph. Oxidase and catalase positive. Can grow anaerobically with nitrate as an electron acceptor. Utilizes a range of compounds as sole carbon and energy sources (glucose, fructose, sucrose, glycerol, acetate, succinate, and malate). Produces acid from glucose, fructose, ribose, xylose, maltose, sucrose, mannitol, sorbitol, and glycerol. Starch is very slowly hydrolyzed. Indole is not produced. Nitrate is reduced with production of gas and nitrite. Susceptible to bacitracin and novobiocin.

Isolated from the Dead Sea.

The guanine-plus-cytosine content of the major DNA component is 62 mol%, and the guanine-plus-cytosine content of the minor component is 55 mol%.

The type strain is strain ATCC 43049.

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**LITERATURE CITED**


