Leptospirillum gen. nov. (ex Markosyan 1972), nom. rev., including Leptospirillum ferrooxidans sp. nov. (ex Markosyan 1972), nom. rev. and Leptospirillum thermoferrooxidans sp. nov. (Golovacheva et al. 1992)

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The name Leptospirillum ferrooxidans is not in the Approved Lists of Bacterial Names (1980), nor has it been subsequently validly published. In accordance with the rules of the International Code of Nomenclature of Bacteria, the name Leptospirillum for the genus (gen. nov., nom. rev.) and Leptospirillum ferrooxidans for the species (sp. nov., nom. rev.) is revived here. The type species is Leptospirillum ferrooxidans strain L15T (= DSM 2705T). The second species in the genus is Leptospirillum thermoferrooxidans (Golovacheva et al. 1992) (type strain L-88T; Institute of Microbiology, INMI, Moscow, Russia).

Keywords: Leptospirillum ferrooxidans, Leptospirillum thermoferrooxidans, revived name, iron(II) oxidation

Markosyan (1972) described a new acidophilic, ferrous-iron-oxidizing, vibrio-shaped bacterium, isolated from mine water of the Alaverda copper deposit in Armenia, for which he proposed the name Leptospirillum ferrooxidans. The genus and species name L. ferrooxidans was, however, not included in the Approved Lists of Bacterial Names (Skerman et al., 1980), nor has it been subsequently validly published. Markosyan sent the type strain, designated L15T, to the Institute of Microbiology (INMI), Moscow, Russia, where it was used in studies on the autotrophic growth, morphogenesis and fine structure of cells (Balashova et al., 1974; Pivovarova et al., 1981). In 1983, G. A. Zavarzin, Moscow, received another culture of L. ferrooxidans strain L15T from Markosyan, and sent subcultures to the DSMZ, where it was deposited as DSM 2705T, and to A. P. Harrison, University of Missouri, Columbia, USA, who designated a derivative strain Z-2. Harrison used this in comparative studies with other isolates for DNA G + C content determinations and DNA–DNA hybridizations (Harrison, 1984; Harrison & Norris, 1985). Phylogenetic studies on strain L15T have demonstrated its unique position, separate from Thioacillus ferrooxidans as well as from any other division of the Bacteria, such as the Proteobacteria, Gram-positive bacteria and spirochaetes (Lane et al., 1992; Ehrich et al., 1995; De Wulf-Durand et al., 1997). Subsequently, additional strains were isolated which are morphologically and physiologically similar to L. ferrooxidans strain L15T and were designated Leptospirillum-like bacteria. DNA–DNA hybridization studies and 16S rDNA analyses revealed, however, that the new isolates were not identical to strain L15T, but may represent different species (Groudev et al., 1978; Harrison, 1984; Harrison & Norris, 1985; Helle & Onken, 1988; Merrettig et al., 1989; Sand et al., 1992; Hallmann et al., 1992; Goebel & Stackebrandt, 1994; Battaglia et al., 1994). The important role of leptospirilli in bacterial leaching of sulphidic minerals in acidic environments is well documented (Norris & Kelly, 1982; Merrettig et al., 1989; Sand et al., 1992; Hallmann et al., 1992; De Wulf-Durand et al., 1997; Battaglia et al., 1998).

Although the inability to utilize sulphur or thiosulphate is a common property of L. ferrooxidans and Leptospirillum-like bacteria, pyrite is used for growth by Leptospirillum-like bacteria as shown, for example, by Sand et al. (1992) and Schippers et al. (1996) for strain R3 isolated from Ilba Mine in Romania, Helle & Onken (1988) for strain P5A isolated in Peru, Merrettig et al. (1989) for a strain isolated from the Rammelsberg Mine in Germany and Battaglia et al. (1994) for strains...
L6 and L8 isolated from a cobaltiferous pyrite enrichment culture. In contrast, L. ferrooxidans strain L15T was originally described to be unable to oxidize iron of pyrite and chalcopyrite, but was capable of growth and oxidation of pyritic iron in mixed culture with sulphur-oxidizing thiobacilli only (Balashova et al., 1974; Norris & Kelly, 1978). However, subsequently subcultures of strain L15T were found to oxidize pyrite and chalcopyrite in pure culture after several weeks of adaptation (Norris & Kelly, 1982; W. Sand, personal communication).

A 2262 bp chromosomal DNA fragment from L. ferrooxidans strain Z-2, containing a chemoreceptor gene, has been cloned, sequenced and expressed in Escherichia coli (Delgado et al., 1998).

The qualitative chemical composition of the LPS of Leptospirillum-like bacterium strain BU-1 was examined by Yokota et al. (1988), and 2-keto-3-deoxyoctanoate, rhamnose, heptoses and glucosamine, but not phosphorous, were found. The exopolymers substances (EPS) excreted by strain R3 after growth on pyrite or iron sulphate, were shown to consist mainly of neutral sugars, some uronic acids and iron substances (EPS) excreted by strain R3 after growth on pyrite or iron sulphate, were shown to consist mainly of neutral sugars, some uronic acids and iron species (Gehrke et al., 1995). As suggested by Sand et al. (1995), the EPS with ferric ions bound are a prerequisite for the attachment of leaching bacteria to the metal sulphide surface and the chemical attack.

Cell-free extracts of L. ferrooxidans strain L15T contain ribulose bisphosphate carboxylase activity, demonstrating the autotrophic nature of this organism (Balashova et al., 1974). In ultrastructural studies, however, carboxysomes were not detected (Sand et al., 1992).

Recently, a moderate thermophilic Leptospirillum-like strain (L-88T), exhibiting a low level of DNA homology with L. ferrooxidans strain L15T, was isolated from an acidic, iron-containing hydrothermal spring on Kunashir Island, Kuril Islands, Russia, and described as a new species, Leptospirillum thermoferrooxidans (Golovacheva et al., 1992). Another moderate thermophilic strain, C-L30A, capable of growth up to 45 °C, has been isolated from a bioleaching reactor in Australia by Goebel & Stackebrandt (1994). A possible relationship to L. thermostoferrooxidans has not been explored.

Here, the name Leptospirillum for the genus and the name Leptospirillum ferrooxidans for the species are revived, for the same organism for which this name was originally used by Markosyan (1972), in accordance with Rules 27, 28a and 33c of the International Code of Nomenclature of Bacteria (Lapage et al., 1992).

**Description of Leptospirillum ferrooxidans sp. nov. (ex Markosyan 1972), nom. rev.**

**Leptospirillum ferrooxidans** (fer.ro.ox.i.dans. L. n. ferrum iron; M.L. v. oxido oxidize; M.L. part. adj. ferrooxidans iron-oxidizing).

The description is based on the data for strain L15T as reported by Markosyan (1972), Balashova et al. (1974), Harrison (1984) and Harrison & Norris (1985). Cells are small, curved rods measuring 0.3–0.6 by 1.0–3.3 μm. A peculiar growth cycle with the formation of pseudococci, vibrios and spirilla was observed. Non-spore-forming. Motile by means of a single polar flagellum. Gram-negative. Growth in acidic environment (pH 1.5–4.0) on mineral medium containing iron(II). Energy for growth gained from the oxidation of iron(II). Use of organic compounds for growth not observed. Sulphur compounds not used as an energy source. Aerobic, mesophilic, pH optimum at 2.5–3.0. The G + C content of the DNA is 51.7 mol % (HPLC). The type strain L15T (= ATCC 29047 = DSM 2705T = VKM B-1339T), from which strain Z-2 of Harrison (1984) is derived, was isolated from mines of the Alaverda copper deposit in Armenia.

**Description of Leptospirillum thermostoferrooxidans sp. nov. (Golovacheva et al.)**

**Leptospirillum thermostoferrooxidans** (ther.mo.fer.ro.ox.i.dans. Gr. n. therma warm; L. n. ferrum iron; M.L. v. oxido oxidize; thermostoferrooxidans warm iron-oxidizing).

The description of Leptospirillum thermostoferrooxidans is identical to that given by Golovacheva et al. (1992). The type strain is strain L-88T, maintained in the collection of the Institute of Microbiology (INMI), RAS, Moscow, Russia.

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References


