



Genus Paludifilum

Marie-Laure Fardeau, Jean-Luc Cayol, Bernard Ollivier

► To cite this version:

Marie-Laure Fardeau, Jean-Luc Cayol, Bernard Ollivier. Genus Paludifilum. Bergey's Manual of Systematics of Archaea and Bacteria (BMSAB), 2019, 10.1002/9781118960608.gbm01628 . hal-02883924

HAL Id: hal-02883924

<https://hal.science/hal-02883924>

Submitted on 29 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

1 **Genus *Paludifilum***

2
3 **Defining publication:** Frikha-Dammak, Fardeau, Cayol, Ben Fguira-Fourati, Najeh,
4 Ollivier and Maale 2016, 5371 ^{VP}

5
6 **Authors:** Marie-Laure Fardeau, Jean-Luc Cayol, Bernard Ollivier

7
8 Aix Marseille Université, IRD, Université de Toulon, CNRS, Mediterranean Institute of
9 Oceanography (MIO), UM 110, 13288 Marseille cedex 9, France

10
11
12
13 **Etymology:**

14 Pa.lu.di.fi'lum L. n. *palus*, -dis a marsh; L.neut. n. *filum* a thread; N.L. neut. n. *Paludifilum* a
15 thread from a marsh).

16
17 **Abstract**

18 The genus *Paludifilum* at the time of writing, comprises one validly published species,
19 *Paludifilum halophilum*, which was isolated from superficial sediment of a solar saltern in
20 Sfax, Tunisia. The species of the genus is thermotolerant, halophilic, aerobic and
21 chemoorganotrophic. Aerial and substrate mycelia are long and well-developed with long
22 chains containing fluorescent and circular spores. Phylogenetic analyses using 16S rRNA
23 gene sequences placed the species as representative of *Thermoactinomycetaceae* family.

24
25 **Keywords:** moderate thermophile, halophile, aerobe

26
27
28 **Description:**

29 Aerial and substrate mycelia are long and well-developed with long chains containing
30 fluorescent and circular spores. Cells present a typical **Gram-positive**-type cell wall structure.
31 **Mesophilic, halophile and thermotolerant, aerobic**, and fermentative growth. The major
32 cellular fatty acids are anteiso-C15: 0, iso-C15: 0 and iso-C17: 0. Yeast extract is required for
33 growth.

34 *DNA G+C content (mol %):* 51.2

35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66

Type species: Paludifilum halophilum Frikha-Dammak, Fardeau, Cayol, Ben Fguira-Fourati, Najeh, Ollivier and Maale 2016, 5371 ^{VP}

Number of species with validated names: 1.

Family classification:

Thermoactinomycetaceae

Further descriptive information

The genus *Paludifilum*, at the time of writing, is *comprised* of one validly named species, *P. halophilum*, which was isolated from the superficial sediment of noncrystallizer M1 pond of Sfax solar saltern in Tunisia (Frikha-Dammak et al., 2016). The occurrence of new genera of halophilic thermoactinomycetes has been reported in the hypersaline environments of distant geographical sites such as the Algerian salt lake (Addou et al., 2012) and the soil of hypersaline wetland in the north of Iran (Zarparvar et al., 2014). The saltern of Sfax can thus be considered as an additional geographical site harboring new members of halophilic thermoactinomycetes (Frikha-Dammak et al., 2017). Moreover, this is the first report revealing that these microbes could have an antimicrobial potential. It was shown for *Paludifilum halophilum*, that the observed antimicrobial activity is most likely explained by the production of Gramicidin S and four cyclic dipeptides identified as cyclo(L-4-OH-Pro-L-Leu), cyclo(L-Tyr-L-Pro), cyclo(L-Phe-L-Pro), and cyclo(L-Leu-L-Pro). The potent inhibitory effect of these compounds covered the growth of the plant pathogen *A. tumefaciens* and the human pathogens *S. aureus*, *S. enterica*, *E. coli*, and *P. aeruginosa*. This is the first time that the bioactivity of cyclic antimicrobial peptides from halophilic thermoactinomycete against agriculturally and medically important bacteria is reported.

Properties of the species of the genus are described in Table 1. Cells stain Gram-positive, The substrate and aerial mycelia were long and well developed on all tested media with long chains containing fluorescent and circular spores. Colonies, 4.0–8.0 mm in diameter, are circular and irregular with wrinkles between the centre and the edge of the colony. The strain forms yellow aerial mycelium on Bennett's medium.

Growth conditions. The temperature range for growth is 30–55°C, with an optimum between 40 and 45°C. The pH range for growth is 5–11, with an optimum near 8.0 and 9.0. The salinity range for growth is from 5–20% NaCl (w/v) with an optimum at 10%.

Glucose, sucrose, maltose, xylose, mannose, fructose, arabinose, inositol, starch and sorbitol are used as sole carbon sources for growth, but not mannitol. Acids and acetoin were not produced from D-glucose. Proline, lysine, glycine and ornithine can be used as sole sources of nitrogen, but not leucine, arginine, glutamine, tryptophan or phenylalanine. The strain did not reduce nitrate and nitrite. Casein, starch and gelatin were hydrolysed, while H₂S and indole were not produced. The strain was resistant to lysozyme and phenol. Casein, gelatin and starch are hydrolysed, but not lipids, cellulose, tyrosine, xanthine, hypoxanthine and DNA. (Table 1).

Enrichment and isolation procedures

Paludifilum halophilum was isolated by suspending 1 g collected superficial sediment in 9.0 ml saline water (150 g/l). After vigorous shaking by using vortex mixer, a 0.1 ml aliquot of each serial dilution (10⁻¹-10⁻⁵) was taken and spread over the surface of *Streptomyces* isolation agar medium. After incubation for 3 weeks at 37°C under aerobic conditions, colonies were picked and streaked several times on the same isolation agar medium until deemed to be axenic (Frikha-Dammak et al, 2016).

Maintenances procedures

Stock cultures can be maintained in culture medium described by Frikha-Dammak et al. (2016). Liquid cultures retain viability for several months after storage at -80°C in the basal medium containing 20% glycerol (v/v).

Phylogenetic and taxonomic comments

Phylogenetic analyses using 16S rRNA gene sequences indicated that *Paludifilum halophilum* belongs to an independent phylogenetic lineage of the family *Thermoactinomycetaceae* that is distinct from all other reference genera within the family. *P. halophilum* shows a gene

sequence similarity of 94.5% with *Kroppenstedtia eburnea* (von Jan et al., 2011) and 94.6% with *Melghirimyces algeriensis* (Addou et al., 2012). (Figure 1).

List of species of the genus Paludifilum

1. ***Paludifilum halophilum*** Frikha-Dammak, Fardeau, Cayol, Ben Fguira-Fourati, Najeh, Ollivier and Maale 2016, 5371 ^{VP}

ha.lo'phi.lum. Gr. n. *hals*, *halos* salt; Gr. adj. *philos* loving; N.L. neut. adj. *halophilum* salt loving

Thermotolerant, halophilic, aerobic bacterium. Aerial mycelia were long and well developed on all tested media with long chains containing fluorescent and circular spores. Colonies, 4.0–8.0 mm in diameter, are circular and irregular with wrinkles between the centre and the edge of the colony. Gram-staining is positive, catalase-and oxidase positive. The temperature range for growth is 30-55°C, with optimum growth at 40-45°C. The optimum pH for growth is 8-9. The salinity range for growth is 50-200 g/l (optimum 100 g/l). D-Glucose, D-xylose, sucrose, maltose, D-mannose, D-inositol and D-sorbitol are assimilated as sole carbon sources. Acids and acetoin are not produced from D-glucose. L-Proline, L-lysine and L-ornithine are used as carbon and nitrogen sources. Nitrate and nitrite are not reduced. The major cellular fatty acids are anteiso-C15:0, iso -C15:0 and iso-C17:0. The major mena-quinone is MK-7 and MK-8 is also detected. In addition of the four major known polar lipids, five minor unknown lipids were detected and identified as two phospholipids, one phosphoaminolipid, one lipid and one glycolipid. Isolated from the superficial sediment of noncrystallizer M1 pond of Sfax solar saltern in Tunisia.

DNA G+C content (mol %): 51.2

Type strain: SMBg3 (DSM 102817, CCUG 68698).

EMBL/GenBank accession number (16S rRNA gene): KP229518

REFERENCES

Addou AN, Schumann P, Spröer C, Hacene H., Cayol, J-L. & Fardeau M-L. (2012). *Melghirimyces algeriensis* gen. nov., sp. nov., a member of the family *Thermoactinomycetaceae*, isolated from a Salt Lake. *Int J Syst Evol Microbiol* **62**, 1491–1498.

Frikha-Dammak D, Fardeau M-L, Cayol J-L, Ben Fguira-Fourati L, Najeh S, Ollivier B & Maalej S (2016) *Paludifilum halophilum* gen. nov., sp. nov., a thermoactinomycete isolated from superficial sediment of a solar saltern *Int J Syst Evol Microbiol* **66**, 5371–5378.

Frikha-Dammak D, Zarai Z, Najah S, Abdennabi R, Belbahri L, Rateb M E, Mejdoub H & Maalej S (2017) Antagonistic properties of some halophilic thermoactinomycetes isolated from superficial sediment of a Solar Saltern and production of cyclic antimicrobial peptides by the novel isolate *Paludifilum halophilum*. *Biomed Res Int*. doi: 10.1155/2017/1205258. Epub 2017 Jul 27.

Tamura K, Stecher G, Peterson D, Filipski A & Kumar S (2013) MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. *Mol Biol Evol* **30**: 2725-2729.

von Jan M, Riegger N, Pötter G, Schumann P, Verbarg S, Spröer C, Rohde M, Lauer B, Labeda DP & Klenk HP (2011) *Kroppenstedtia eburnea* gen. nov., sp. nov., a thermoactinomycete isolated by environmental screening, and emended description of the family *Thermoactinomycetaceae* Matsuo *et al.* 2006 emend. Yassin *et al.* 2009. *Int J Syst Evol Microbiol* **61**, 2304–2310.

Zarparvar P, Amoozegar MA, Nikou MM, Schumann P. & Ventosa A (2014) *Salinitrix halophila* gen. nov., sp. nov., a halophilic bacterium in the family *Thermoactinomycetaceae*. *Int J Syst Evol Microbiol* **64**: 4115–4119.

FIGURE CAPTIONS

Figure 1 Phylogenetic tree based on 16S rRNA gene sequences showing the relationship of *Paludifilum halophilum* with the type strains of related genus of the family *Thermoactinomycetaceae*. The consensus tree was constructed with mega 6 software (Tamura *et al.*, 2013) using the Neighbor-Joining, Maximum-Parsimony and Maximum-Likelihood methods. There were a total of 1364 positions in the final dataset. GenBank accession numbers are given in parentheses. *Alicyclobacillus acidoterrestris* DSM 3922^T (GenBank accession no. AJ133631) was used as the outgroup. Bar, 2 substitutions per nucleotide position.

169

170 **Table 1.** Descriptive characteristics of the species of the genus *Paludifilum*, and the type
 171 strains of two phylogenetically related species of the family *Thermoactinomycetaceae*:
 172 *Kroppenstedtia eburnea* (von Jan et al., 2011) and *Melghirimyces algeriensis* (Addou et al.,
 173 2012); PE, phosphatidylethanolamine; PG, phosphatidylglycerol; PS, phosphatidylserine;
 174 DPG, diphosphatidylglycerol; PME, phosphatidylmethylethanolamine; UL, unknown lipid;
 175 UPL, unknown phospholipid; UPN, unknown phosphoaminolipid; UGL, unknown glycolipid.
 176 2).

177

Characteristics	<i>Paludifilum halophilum</i>	<i>Kroppenstedtia eburnea</i>	<i>Melghirimyces algeriensis</i>
Morphology	pale yellow aerial mycelium	white aerial mycelium	yellow aerial mycelium
Optimum temperature (°C)	40-45	45	40-55
Optimum pH	8-9	5-8.5	6-8
Optimum NaCl (%)	10	ND	10
G + C content (mol%)	51.2	54.6	52.6
Main substrates used	glucose, xylose, sucrose, maltose, mannose, inositol, sorbitol	sucrose, i-inositol, mannitol, rhamnose	Glycerol, maltose, cellobiose, rhamnose, sucrose, myo-inositol, fructose, ribose, mannose, glucose, raffinose and amino-acids
Polar lipids	PE, PG, DPG, PME, UPN, 2UPLs, UGL, UL	DPG, PE, PG	. PG, DPG, PE, PME, 5UPLs, UL

178

179

180

181

182 **Table 2** Main cellular fatty acids of *Paludifilum halophilum* and the type strains of two
 183 phylogenetically related species of the family *Thermoactinomycetaceae*: *Kroppenstedtia*
 184 *eburnea* (von Jan et al., 2011) and *Melghirimyces algeriensis* (Addou et al., 2012).

Fatty acids	<i>Paludifilum halophilum</i>		<i>Melghirimyces algeriensis</i>
iso-C14 : 0	1.7	3.9	8.5
iso-C15 : 0	24.3	73.3	59.1
Anteiso-C15 : 0	29.2	13.1	18.2
Iso-C16 : 0	7.3	4.5	1.8
C16 : 0	5.4	ND	4.6
Iso-C17 : 0	17.2	ND	6.7
Anteiso-C17 : 0	8.9	ND	1.5