

***Frankophila sudamericana* sp. nov., a new diatom species (Bacillariophyta) found in Salar de Aguas Calientes and Salar de Huasco, high altitude Andean localities in northern Chile**

***Frankophila sudamericana* sp. nov., una nueva especie de diatomea (Bacillariophyta) encontrada en el Salar de Aguas Calientes y Salar de Huasco, localidades Andinas de gran altitud en el norte de Chile**

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RESUMEN

Se describe a *Frankophila sudamericana* Rivera & Cruces como una nueva especie de diatomea. El taxón se caracteriza por poseer valvas linear-elípticas, estrías (10 en 10 μm , raramente 9) formadas por tres hileras de aréolas, espinas huecas y no bifurcadas, y por su área axial plana y carente de depresiones. Se señalan las principales diferencias existentes con las restantes especies del género, especialmente con *F. wayqechae* Furey *et al.*

The genus *Frankophila* was established by Lange-Bertalot (1997) to include small pennate chain-forming cells bearing a short raphe on the apices of the valves. The type species, *F. similioides* Lange-Bertalot & Rumrich, was described from material collected in the Chilean Patagonia, and other five species are currently known: *F. loetschertii* (Lange-Bertalot) Lange-Bertalot (Lange-Bertalot 1997), *F. maillardii* (Le Cohu) Lange-Bertalot (Lange-Bertalot 1997), *F. horstii* Rumrich & Rumrich (Rumrich, *et al.* 2000), *F. biggsii* Lowe, Morales & Kilroy (Lowe *et al.* 2006) and *F. wayqechae* Furey, Mayama, Lowe & Catenazzi (Furey *et al.* 2012). The genus *Hygropetra* Krammer & Lange-Bertalot (in Krammer 2000) is closely related to *Frankophila*, but can be distinguished by its longer raphe branches and by the absence of marginal spines. Continuing with our study on diatoms from the Chilean Altiplano (Rivera & Cruces 2009a, 2009b), we describe here *Frankophila sudamericana* sp. nov. from material collected in Salar de Aguas Calientes. The new species, also found in Salar de Huasco, is characterized by linear-elliptical valves and axial area, striae (10 in 10 μm , rarely 9) composed of three rows of areolae, very short raphe slits not visible in light microscopy, and non-bifurcate and hollow marginal spines.

The type locality, the saline deposit called Salar de Aguas Calientes (23°30' S, 67°33' W) is located at 4200 m.a.s.l. in the central part of the Altiplano in the Western Chilean Cordillera, Second Region of Chile (Antofagasta, Province of Loa). The Salar occupies a surface of 134 km², with an annual precipitation of 150 mm and a mean temperature of

1° C (Risacher *et al.* 1999). The saline deposit is composed of several lagoons of variable extent which show hard saline crusts of calcium sulphate and sodium chloride (Vila 1986) and receive superficial water mainly from Río Pili and Quebrada de Chamaca rivers. The Salar de Huasco is located in the First Region of Chile, Tarapacá (20°18' S - 68°52' W), at 3778 m.a.s.l. With a surface of 51 km², this saline deposit receives an annual precipitation of 150 mm/year and a mean temperature of 5° C (Risacher *et al.* 1999). The samples analysed are deposited at the Diatom Collection of the University of Concepción, Chile. Information provided from the Collection for these sample refers exclusively to the name of the locality, location, habit and collecting date, lacking data about pH, temperature, conductivity, between others.

Only individual cells were found in the samples, isolated, rinsed with distilled water, and critical point-dried following the method of Anderson (1951). The diatom material was treated to remove organic matter according to the methods of Hasle & Fryxell (1970) and Teubner (1995). About 70 frustules or isolated valves were found and analysed in light and electron microscopy. A Zeiss Photomicroscope III was used for light microscopy. Electron microscopy observations were made at the Spectroscopy and Electron Microscopy Center, University of Concepción, Chile, and photographs were taken using a Jeol JSM-6380LV scanning electron microscope and Jeol 1200 Ex II transmission electron microscope. Morphological terminology follows Anonymous (1975) and Ross *et al.* (1979).

Frankophila sudamericana Rivera & Cruces sp. nov. (Figs. 1 A-J).

Typus: Salar de Aguas Calientes, II Región de Antofagasta, Chile, 23°30' S, 67°33' W, 20.07.2002, 4.200 m.a.s.l. (Holotype, circled specimen, slide DIAT-CONC 7128, Colección Diatomológica de la Universidad de Concepción,

Concepción, Chile; Isotype, here designated, circled specimen, slide DIAT-CONC 7127).

The frustules are rectangular, with bevelled corners in girdle view (Fig. 1 A). Each cingulum have two to three open bands: a broad valvocopula (Fig. 1 B, white arrow), 1-2 μm wide, with a row of slits (2-3 in 1 μm) on the advalvar side,

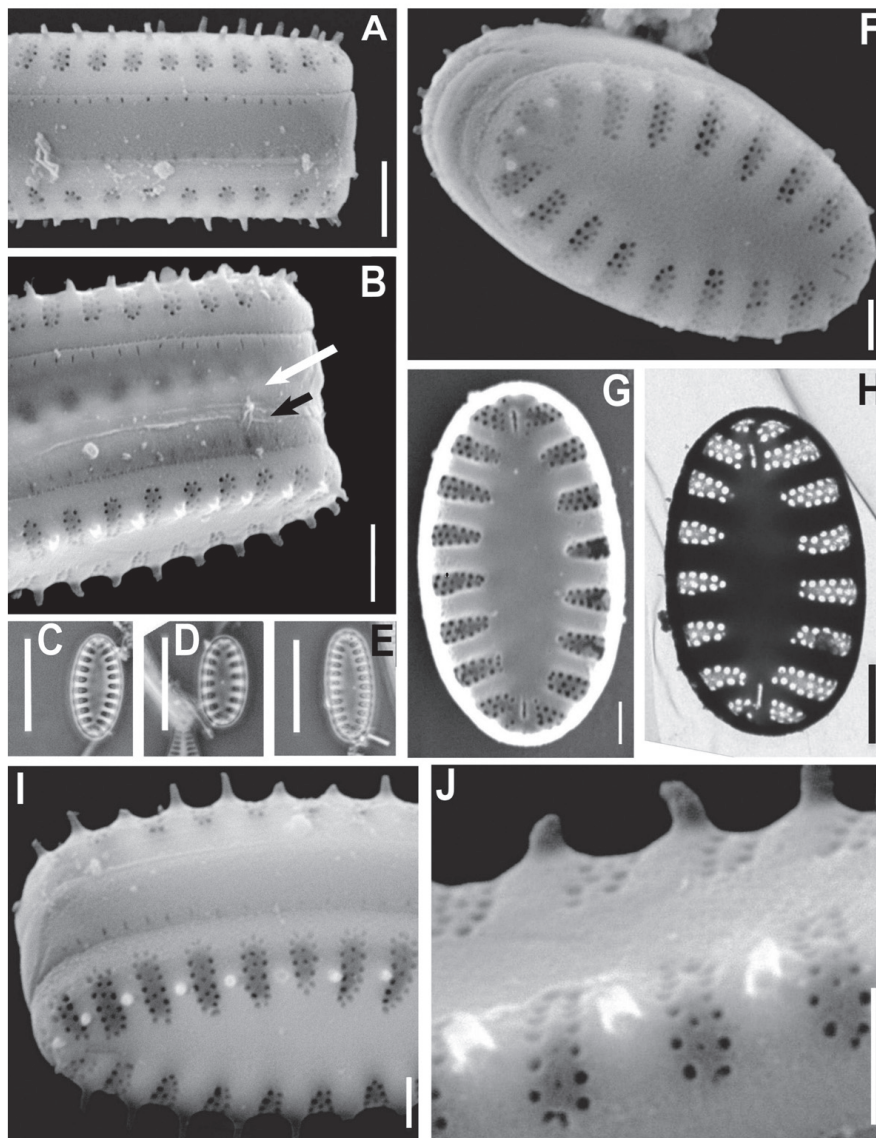


FIGURE 1. A-J. *Frankophila sudamericana*. Type material, excepting Fig 1 E= Salar de Huasco. A-B, F-G, I-J, SEM, C-E, LM. C-D, Holotype slide DIAT-CONC 7128, H, TEM. A-B. Girdle view of frustules, valvocopula (white arrow) with elongated pores on the advalvar side and a narrow pleura (black arrow). C-E. Linear-elliptic valves. F-H. Striae with three rows of areolae, raphe slit short and at the end of the valves. Axial area lacking external surface depressions. I. Cone-shaped spines located at the interstriae. J. Opened, hollow and non-bifurcate marginal spines. Scale bars: A-B, H = 2 μm ; C-E = 10 μm ; F-G, I-J = 1 μm .

FIGURA 1. A-J. *Frankophila sudamericana*. Material tipo, excepto Fig 1 E= Salar de Huasco. A-B, F-G, I-J, MEB, C-E, MO. C-D, Holotipo DIAT-CONC 7128, H, MET. A-B. Frústulos en vista conectival, valvocopula (flecha blanca) con poros alargados en el lado advalvar y una pleura angosta (flecha negra). C-E. Valvas linear-elípticas. F-H. Estrías con tres hileras de aréolas, fisura del rafé corta, en los extremos de las valvas. Área axial sin depresiones sobre la superficie externa. I. Espinas en forma de cono, situadas en las interestrias. J. Espinas marginales abiertas, huecas, no bifurcadas. Escalas: A-B, H = 2 μm ; C-E = 10 μm ; F-G, I-J = 1 μm .

and one or two narrow and non-perforated pleurae (Fig. 1 B, black arrow). The valves are flat with a broad mantle which first orientates at 45 degree with respect to the valve face and then becomes perpendicular to it (Figs. 1 A-B). The valves are linear-elliptical in shape with rounded ends (Figs. 1 C-H), the length of the apical and transapical axes ranging from 8.5 to 12.5, and 4.5 to 6.0 μm , respectively. The striae are short on the valve face and extend continuously onto the mantle, leaving a linear elliptical axial area clearly visible in light microscopy (Figs. 1 C-E) and lacking depressions (Figs. 1 F-I). The striae density is 10 in 10 μm , rarely 9 in 10 μm , each one composed of three rows of areolae (Figs. 1 F-J). Marginal spines are visible at the valve face-mantle junction of each interstria, 10 in 10 μm (Figs. 1 A-B, F). Spines are cone-shaped, non-bifurcate at the distal ends, with an empty space inside, subcircular or circular in section (Figs. 1 I-J). A short raphe slit, 0.4 to 0.6 μm in length, not visible in light microscopy (Figs. 1 C-E), is present at the ends of both valves (Figs. 1 F-H).

ETYMOLOGY: The epithet refers to the continent where the diatom material was collected.

HABITAT: On wet rock.

ADDITIONAL STUDIED MATERIAL: CHILE, Región de Iquique, Prov. del Tamarugal, Salar de Huasco, 20°18' S; 68°52' W, 3800 m.a.s.l., wet rock, 14-IX-2002, Slide DIAT-CONC 7137.

In the material examined, there is only a small variability of some frustule features related to the cingulum structure (number of bands and slits of the valvocopula). The shape of

the valves and the axial area, striae density and length of the raphe slits are very stable.

Frankophila sudamericana and *F. wayqechae* differ from all other known species of the genus by having striae composed by three rows of areolae (*F. biggsii*, *F. korstii*, *F. loetschertii* and *F. similioides* have two rows of areolae, and *F. maillardii* have only one). Additional biometric data and morphological features of these species have been tabulated by Furey *et al.* (Table 2, 2012). The main differences between *F. sudamericana* and *F. wayqechae* are in relation to the size and valve outline, the number of striae, the length of the raphe slits, the shape and structure of the marginal spines, and with a particular feature of the axial area (Table I). *Frankophila wayqechae* has elliptical valves with broad rounded apices, but *F. sudamericana* has a linear-elliptical valve shape with rounded apices, and the valves are longer in length and width, features that can easily be recognized. *Frankophila wayqechae* has a broad axial area with a variable number of shallow depressions on the external surface, while in *F. sudamericana* the axial area is narrower in width and totally lacks the external surface depressions. The valves of *F. sudamericana* have a shorter raphe than *F. wayqechae* and their striae are less dense. Finally, *F. wayqechae* has solid spines, dichotomously branched. However, in *F. sudamericana*, the spines are cone shaped, tubular (with an empty space inside), circular or subcircular in section, and non-bifurcate at the distal end.

In addition to its type locality (Torres del Paine, Patagonia, Chile), *F. similioides* has been later reported from the Chilean Altiplano: Lauca National Park and Putre (Rumrich *et al.* 2000) and Salar de Punta Negra (Díaz & Maidana 2005). This latter record could be correspond to

TABLE I. Comparison of some morphometric and morphological features of *Frankophila wayqechae* and *F. sudamericana* sp. nov.

TABLA I. Comparación de algunos caracteres morfométricos y morfológicos de *Frankophila wayqechae* y *F. sudamericana* sp. nov.

	<i>Frankophila wayqechae</i>	<i>Frankophila sudamericana</i> sp. nov.
Type locality	Manu National Park, Perú	Salar de Aguas Calientes, Chile
Shape	Elliptical, broadly rounded apices	Linear elliptical, rounded apices
Length (μm)	4.5-8.0	8.5-12.5
Width (μm)	3.0-4.6	4.5-6.0
Striae in 10 μm	11-12	10 (9)
Stria arrangement	Three rows of areolae	Three rows of areolae
Axial area	Broad, with shallow depressions	Broad, without shallow depressions
Raphe length (μm)	<1	<0.6
Spine structure	Solid, bifurcate	Hollow, non-bifurcate
Cingulum	Broad valvocopula with slits near the mantle; three pleurae narrow	Broad valvocopula with slits (2-3 in 1 μm) near the mantle; one or two pleurae narrow

the new species *F. sudamericana* (a description or biometric data were not given). The valve illustrated in p. 75 has a linear elliptic outline. Seeligmann *et al.* (2008) recorded specimens of *F. similioides* from the province of Jujuy, in Argentina (Fig. 5 F). The valves are linear-elliptic in shape, with 9-10 striae in 10 µm composed of three rows of areolae, characteristics that belong to *F. sudamericana*. Further investigations must be carried out on their material to clarify the taxonomy of these representatives of *Frankophila*.

In Salar de Aguas Calientes *F. sudamericana* sp. nov. was common in the sample, which was dominated by species of the genus *Denticula* Kuetzing. In Salar de Huasco, the species was scarce, and the diatom community was dominated by the genus *Staurosira* (Ehr.) Williams & Round.

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