

**STROMBOMONAS CARINATA SP. NOV. AND STROMBOMONAS FERRAZI SP. NOV.,
TWO NEW EUGLENOPHYCEAE FROM THE STATE OF
RIO GRANDE DO SUL, SOUTHERN BRAZIL**

Sandra Maria Alves-da-Silva¹
Carlos Eduardo de Mattos Bicudo²

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RESUMO – (*Strombomonas carinata* sp. nov. e *Strombomonas ferrazi* sp. nov., duas novas Euglenophyceae do Estado do Rio Grande do Sul, sul do Brasil). Duas espécies de *Strombomonas* (Euglenaceae, Euglenophyceae), *S. carinata* e *S. ferrazi*, são descritas e propostas como novas. As unidades amostrais em que foram encontrados os espécimes estudados foram coletadas de um reservatório (reservatório n. 7) localizado no Parque de Proteção Ambiental do Pólo Petroquímico do Sul (29° 53'S, 51° 22'W), em Triunfo, Estado do Grande do Sul, sul do Brasil. Características físicas e químicas da água do reservatório onde ambas as espécies foram coletadas são apresentadas.

Palavras-chave – *Strombomonas carinata* sp. nov., *Strombomonas ferrazi* sp. nov., Euglenophyceae, Rio Grande do Sul, Brasil

ABSTRACT – (*Strombomonas carinata* sp. nov. and *Strombomonas ferrazi* sp. nov., two new Euglenophyceae from the state of Rio Grande do Sul, southern Brazil). Two species of *Strombomonas* (Euglenaceae, Euglenophyceae), *S. carinata* and *S. ferrazi*, are described and proposed as new to science. Sample units from which specimens were studied were collected from a reservoir (reservoir n. 7) located in an Environment Protection Park ("Parque de Proteção Ambiental") in the South Petrochemical Station ("Pólo Petroquímico do Sul") (29° 53'S, 51° 22'W), in Triunfo, state of Rio Grande do Sul, southern Brazil. Physical and chemical data of the water of the system from which the two species were collected are presented.

Key words – *Strombomonas carinata* sp. nov., *Strombomonas ferrazi* sp. nov., Euglenophyceae, Rio Grande do Sul State, Brazil

¹ Museu de Ciências Naturais, Núcleo de Vegetais Inferiores, C. Postal 1188, CEP 90610-000, Porto Alegre, RS, Brazil (gcferraz@cpovo.net)

² Instituto de Botânica, Seção de Ficologia, C. Postal 4005, CEP 01061-970, São Paulo, SP, Brazil.

Introduction

Deflandre (1930) proposed separation of the species at that time classified in the Subsection *Acuminatae* Deflandre 1926 of Section *Caudatae* Deflandre 1926 of genus *Trachelomonas* to constitute the new genus *Strombomonas*. According to the original proposition, both diagnostic characteristics of *Strombomonas* referred to the lorica, *i.e.* collar without a clear-cut distinction from the remainder of the lorica, and the posterior pole ending in a tail-like projection (Deflandre 1930). There is no difference between the protoplasts of representatives of both genera. Comparison of the ultrastructure and chemical composition of the loricas of the two genera demonstrated the common existence of many particles adherent to the surface of the loricas of *Strombomonas*, in contrast with their total absence in *Trachelomonas* (Tell & Conforti 1984; 1988; Conforti *et al.* 1994). Dunlap *et al.* (1986) concluded that the microarchitecture and the chemical composition of the lorica of *S. conspersa* (Pascher) Deflandre are very similar to those of many species of *Trachelomonas*.

Variation of the shape of the lorica in sample populations of *Strombomonas* is of somewhat common occurrence in nature and may include certain forms that could be understood intermediate between the two genera above, to such an extent that Balech (1944) and Bourrelly (1970) stated that separation of both genera may be very difficult or at least obscure. The present moment thus calls for an urgent need for a suitable revision of the boundaries of the circumscriptions of both *Strombomonas* and *Trachelomonas* through definition of the diagnostic features of each genus.

The present work aims to provide a description of two species of *Strombomonas*, which are simultaneously proposed as new to science.

Material and methods

Monthly gatherings were made from February 1995 to March 1996 by using a 49 µm mesh phytoplankton net at approximately 30 cm below the water surface and at two collecting stations located in an accumulation reservoir, reservoir n. 7 (Fig. 1), located in an Environment Protection Park in the South Petrochemical Station ($29^{\circ} 53' S$, $51^{\circ} 22' W$), in Triunfo, state of Rio Grande do Sul, southern Brazil.

Reservoir n. 7 was dammed in 1982 and is maintained by pipe-lined rain water, the excess of water being deviated to the Caí River. The reservoir is bordered by "maricás", grasses, and sedges and shows many species of aquatic

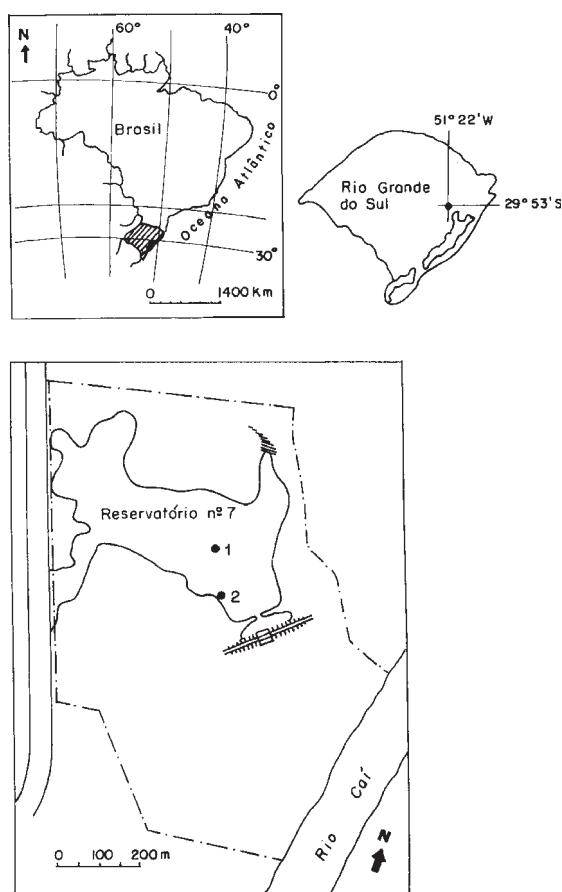


Figure 1. Map showing the reservoir n. 7 and location of collecting stations 1 and 2.

macrophytes, among which *Salvinia* sp. and *Ludwigia* sp. are dominant.

Still in the field, all 48 sample units collected were divided into two halves, one of which was immediately fixed and preserved with 4% formalin and the other one kept alive for further study of the morphological features that can be damaged with fixation. Simultaneously, water from the sampling site was collected for physical and chemical analyses. Biological samples were deposited in the Prof. Dr. Alarich R.H. Schultz Herbarium (HAS) of the Rio Grande do Sul Zoobotanical Foundation (Fundação Zoobotânica do Rio Grande do Sul). From the 48 sample units gathered, six contained specimens of *S. carinata* and only one of *S. ferrazzi*. The herbarium access numbers of the last seven sample units are HAS26680, HAS26684, HAS26685, HAS26735, HAS26745, HAS26761, and HAS26785.

Methodology of preparation of the loricas for observation at the scanning electron microscope included the following: (1) isolation of loricas by micropipeting under an inverted microscope Wild M40; (2) placing of the loricas on a regular microscope cover slip, which was fixed to the stub with nail polish (Dr. Alain Couté, pers. comm. in January 1994); (3) drying up of the cover slip containing the isolated loricas under a fluorescent bulb; and (4) metalization of the stub with gold-palladium in a Sputtering Bal-Tec SCD-005. Photographs were taken by using a Jeol JSM-5200 scanning electron microscope.

Results and discussion

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Fig. 2-10, 15-18.

Loricae irregulariter trapeziformes, 29,6-30,5 μm longae, 16,5-19,4 μm latae, $R\ c/l = 1,5-1,8$; scissura optica transversali sub-rectangulari, angulis rotundatis, polo posteriore abrupte attenuato in processum caudalem brevem, mamillatum, ca. 2 μm longum; collario

cylindraceo, humile, margine irregulari 2-4 μm alto, 5,3-7,4 μm lato; pariete hyalina usque viridiana, rugosa usque verrucosa, 2 carinae bene notatae, leviter torsae secundum longitudinem loricas; chloroplasti numerosi, discoidei, usque 4 μm diametro; flagellum tertiam partem cellulae attingens; pyrenoidea et stigmata non notata.

Holotypus: Lacus artificialis n. 7, leg. Sandra Maria Alves da Silva, II/1995 (HAS26685); figurae nostrae 15-18.

Loricas irregularly trapezoidal, 29.6-30.5 μm long, 16.5-19.4 μm wide, $R\ l/w\ 1.5-1.8$; optical section transversally sub-rectangular, angles rounded; posterior pole suddenly attenuated in a short, mammillate, tail process, ca. 2 μm long; collar cylindrical, short, border irregular, 2-4 μm tall, 5.3-7.4 μm wide; wall hyaline to greenish, rugulose to verrucose, 2 well marked keels slightly twisted along the length of the lorica; chloroplasts numerous, disc-shaped, up to 4 μm in diameter; pyrenoids, flagella, and stigma not observed.

Holotype: Reservoir n. 7, col. Sandra Maria Alves da Silva, February 1995 (HAS26685); SEM photographs n. 15-18.

Summarizing (Tab. 1), the diagnostic features of *S. carinata* are the following: (1) presence of two keels in the lorica wall which are somewhat twisted; (2) transverse section of lorica sub-rectangular, with rounded angles; and (3) chloroplasts large (ca. 4 μm diam.) and numerous which give a greenish color to the cell. The species differs from *S. spiralis* (Playf.) Defl. in the trapezoidal shape of the lorica which shows two somewhat twisted keels. *Strombomonas spiralis* has elliptic lorica, and symmetric helicoidal keels. *Strombomonas carinata* differs from *S. tetraptera* Bal. & Dast. var. *tetraptera* for in the latter the lorica wall is rugulose and its transverse section quadrangular, with all angles more pronouncedly rounded, while in the former the lorica wall is rugulose-granulose and its transverse section also quadrangular, but with the angles irregularly and relatively less rounded; and from the var. *gallica*

Table 1. Comparison of the descriptive characteristics of the lorica and protoplast of *Strombomonas carinata* sp. nov., *S. spiralis* (Playfair) Deflandre, *S. tetraptera* Balech & Dastugue, and *S. subcurvata* (Proschkina-Lawrenko) Deflandre var. *africana* Bourrelly & Gayral, and *S. tetraptera* Balech & Dastugue var. *gallica* Bourrelly & Couté.

Characteristic	<i>S. carinata</i>	<i>S. spiralis</i>	<i>S. subcurvata</i> var. <i>africana</i>	<i>S. tetraptera</i> var. <i>tetraptera</i>	<i>S. tetraptera</i> var. <i>gallica</i>
Dimensions	29.6-30.5 × 16.5-19 µm	36 × 21 µm	24-26 × 16-17 µm	43-47 × 25-26 µm	32-40 × 18-20 µm
R l/w	1.5-1.8	1.7	1.4-1.5	1.7-1.9	1.7-2.2
Shape	Trapezoidal	Ellipsoidal	Ovoid	Angular with wing-like expansions	Ellipsoidal
Collar	1.8 µm tall, 6-7.4 µm wide	3 µm tall, 6 µm wide	—	Short, inclined	Short, inclined
Tail process	1.8 µm long	Short	Short	Short	Short, rounded
Keels	2, twisted	3-4, helicoidal	—	4, wing-like, longitudinal	2, helicoidal
Color	Colorless	Colorless	Yellowish, brownish	Colorless	Colorless to yellowish
Texture	Rugulose	Smooth	Smooth	Rugulose	Scabrous, irregularly granulate
Transverse section	Quadrangular, angles rounded	—	Transversally elliptical	Quadrangular, angles rounded	Quadrangular, angles rounded
Chloroplast	Numerous, disc-shaped, ca. 4 µm diam.	—	Numerous, rod-shaped, with double pyrenoids	Oval, small	—

Bourr. & Couté of the same species in its somewhat smaller lorica dimensions and in the quadrangular, with rounded angles transverse section. Finally, *Strombomonas subcurvata* (Proschk.-Lawr.) Defl. var. *africana* Bourr. & Gayr. is clearly distinct from *S. carinata* in its transversely elliptical cross section of the lorica.

Scanning electron microscopy indicated the presence of a conspicuous and irregularly rugulose lorica wall which invariably has some spherical incrustations that give the wall a rugulose-granulose appearance.

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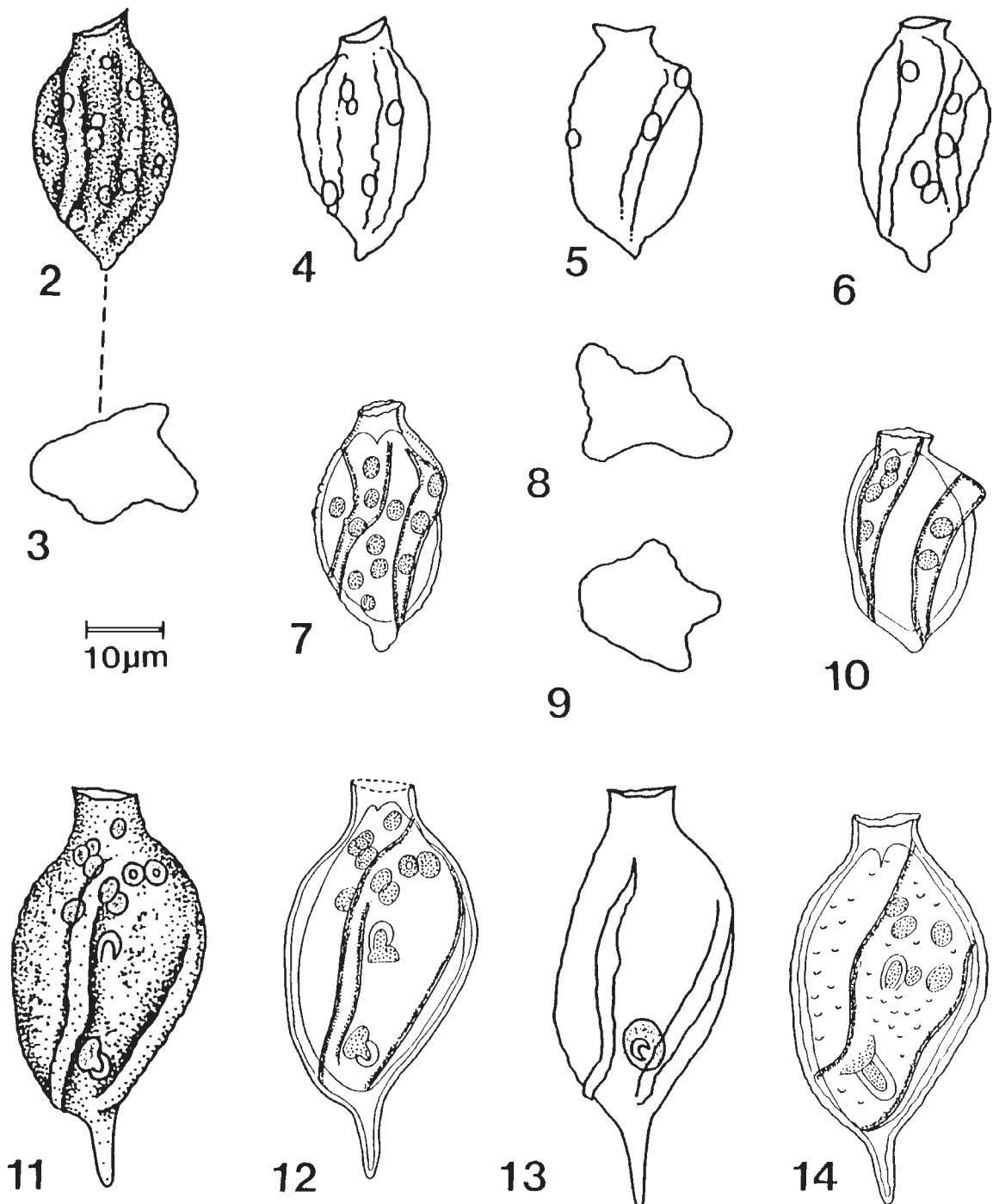
Fig. 11-14.

Loricae irregulariter obovatae, 46,2-51,2 µm longae, ca. 21,3 µm latae, R c/l ca. 2,2; polo posteriore abrupte attenuato in processum

caudalem, ca. 9,2 µm longo; collario cylindraceo, margine irregulari, ca. 3,7 µm alto, ca. 7,4 µm lato; pariete castanea, rugosa, 2 carinae longitudinales et leviter obliquae; chloroplasti discoidei, ca. 3 µm diametro, pyrenoidea interna presentia; flagellum et stigma non notata.

Holotypus: Lacus artificialis n. 7, leg. Sandra Maria Alves da Silva, VII/1995 (HAS26735); figurae nostrae 11-14.

Lorica irregulariter obovata, 46,2-51,2 µm long, ca. 21,3 µm wide, R l/w ca. 2,2; posterior pole suddenly attenuated in a tail-like process ca. 9,2 µm long; collar cylindrical, border irregular, ca. 3,7 µm tall, ca. 7,4 µm wide; wall brown, rugulose, 2 longitudinal to slightly twisted keels; chloroplastos disc-shaped, ca. 3 µm diam.; internal pyrenoids present; flagellum and stigma not seen.

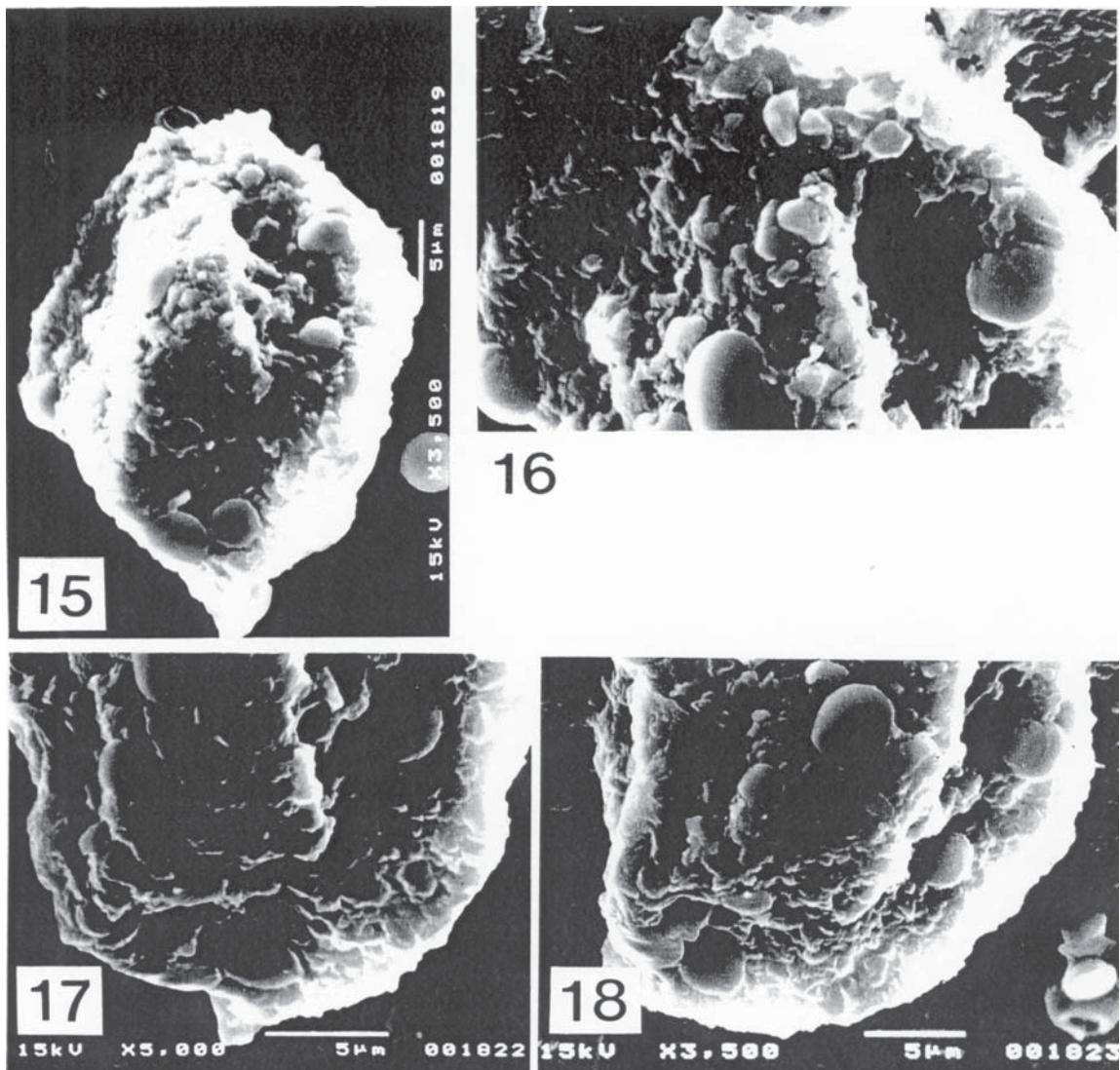


Figures 2-10. Camera-lucida drawings of the lorica of *Strombomonas carinata* Alves-da-Silva & C. Bicudo. 3, 8-9. Optical cross section of the lorica. Fig. 11-14. Camera-lucida drawings of the lorica of *Strombomonas ferrazzi* Alves-da-Silva & C. Bicudo.

Holotype: Reservoir n. 7, col. Sandra Maria Alves da Silva, July 1995 (HAS26685); figures n. 11-14.

The species was named in honor of Prof. Gilberto Ferraz, for his untiring, continuous support to the development of science in the state of Rio Grande do Sul.

From Tab. 2, the diagnostic characteristics of *Strombomonas ferrazi* are: (1) the irregularly obovate shape of the lorica; (2) the presence of two keels which are slightly twisted along the longitudinal axis of the lorica; and (3) the presence of very conspicuous internal pyrenoids. *Strombomonas ferrazi* shows some similarities



Figures 15-18. SEM photomicrographs of the lorica of *Strombomonas carinata* Alves-da-Silva & C. Bicudo. 16. Detail of the anterior pole of lorica and collar; 17-18. Detail of the posterior pole of lorica and tail-like process.

Table 2. Comparison of the descriptive characteristics of the lorica and protoplast of *Strombomonas ferrazi* sp. nov., *S. chodati* (Skvortzov) Deflandre, and *S. indica* Philipose.

Characteristic	<i>S. ferrazi</i>	<i>S. chodati</i>	<i>S. indica</i>
Dimensions	46.2-51.2 × 21.3µm	54-63 × 20-23.5µm	63.5-70.5 × 27-28µm
R l/wca.	ca. 2.2	2.2-2.6	2.3-2.6
Shape	irregularly obovate	subcylindrical to irregularly trapezoidal	elongate fusiform-rhomboïd or triangular
Tail process	ca. 9.2µm	long, curved	19.8-24.6µm
Keels	2, twisted	none	1, twisted
Color	median brown	colorless to yellowish	—
Texture	rugulose	rugulose	irregularly granulate
Transverse section	—	—	triangular, angles rounded
Chloroplast	disc-shaped, numerous	—	poliedric, numerous
Pyrenoid	internal	—	double

to *S. chodati* (Skv.) Defl. and *S. indica* Phil. However, the first one differs from *S. ferrazi* in the shape of its lorica, which varies from subcylindrical to irregularly trapezoidal, in the low and somewhat broad collar, and in the long and bent to one side caudal process. Finally, *Strombomonas indica* is distinct from *S. ferrazi* by the elongate, fusiform-rhomboïdal shape of the lorica, the presence of double-pyrenoids, the much longer tail-like process (19.8-24.6µm), the greater cell dimensions (46.2-51.2 × 21.3µm), and the presence of just one keel.

Strombomonas carinata was collected from sites with low ammonium, nitrite, and nitrate values (Tab. 3). Regarding pH, the species occurred in systems that varied from acidic (5.5-5.7) to neutral to slightly alkaline (7-7.3).

The species can tolerate a broad range of temperature which is enough to identify it as eurythermic, since it was found in temperatures that varied from 13 to 30°C. The highest densities of individuals of *S. carinata* was detected at stations 1 and 2 in February 1995, respectively, in sample units HAS26680 and HAS26684 to HAS26685. *Strombomonas carinata* was found during summer, winter, and spring.

Strombomonas ferrazi was collected just once (sample unit HAS26735) from water with higher values of nitrogen (ammonium, nitrite, nitrate, and total nitrogen) when compared to those from which *S. carinata* was gathered (Tab. 3). The species occurred during only the winter, in acidic water (pH 6.6), and low temperature (17°C).

Table 3. Physical and chemical characteristics of the water in which representative individuals of *S. carinata* and *S. ferrazi* occurred.

Variable	<i>S. carinata</i>					<i>S. ferrazi</i>
	26680	26684-5	26745	26761	26785	26735
Ammonium (µg.l ⁻¹)	15	15	117	81	25	126
Nitrite (µg.l ⁻¹)	7	7	12	9	2,8	42
Nitrate (µg.l ⁻¹)	42	56	186	149	82	222
pH	5.5	5.7	7.4	7.3	7.0	6.6
Water temperature (°C)	25	26	13	20	30	17

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