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Stauroneis fuegiana, a new *Stauroneis* species (Bacillariophyta) from Tierra del Fuego, southern Argentina

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Abstract

During a survey of the freshwater aquatic diatom flora of two peat bog areas in Tierra del Fuego, southern Argentina, a new taxon belonging to the genus *Stauroneis* that could not be identified was observed. Based on detailed light and scanning electron microscopy observations and comparison with similar larger-celled *Stauroneis* species worldwide, the taxon is described as new: *Stauroneis fuegiana* Casa & Van de Vijver sp. nov. *Stauroneis fuegiana* can be distinguished based on the slightly raised marginal crest, the typical broadly lanceolate valve outline with subrostrate apices, the almost rectangular central area and its valve dimensions.

Comments are made on its taxonomic position and how the new taxon can be distinguished from other larger-celled *Stauroneis* species. Brief notes on the ecology and distribution are added.

Key-words: *Stauroneis*, Tierra del Fuego, peatbogs, morphology, new species

Introduction

The genus *Stauroneis* Ehrenberg (1843: 311), was erected by Ehrenberg in 1843 but later typified by Boyer (1927). The genus is characterized by naviculoid, solitary, (usually) long to very long, narrow, mostly linear-lanceolate to lanceolate valves, uniseriate striae and a thickened central area called a stauros (Round *et al.* 1990, Cox 2001). *Stauroneis* taxa are commonly found in epipelic, mossy, or aerophilic habitats (Round *et al.* 1990).

Over the past 10 years, a large number of new *Stauroneis* taxa have been described worldwide contradicting the general idea of low diversity in this genus (a.o. Lange-Bertalot *et al.* 2003, Van de Vijver *et al.* 2004, Werum & Lange-Bertalot 2004, Metzeltin & Lange-Bertalot 2007, Bahls 2010, 2012).

Recently, a survey started of the freshwater diatom communities in two peat bog areas on Tierra del Fuego (TDF), the insular southernmost Argentinian tip of Patagonia: Rancho Hambre peatbog and Upper Andorra Valley Peatbog. The Rancho Hambre peat bog (54°47'S, 68° 19'W) is a typical *Sphagnum magellanicum* Bridel dominated ombrotrophic peat bog (Roig & Roig 2004), located almost 50 km from Ushuaia city among the ridges of the Andes in the Tierra Mayor Valley. The second peatbog, the Andorra peatbog (54°45'S, 68°20'W), situated 6 km north-west of Ushuaia in the Andorra Valley, is composed of four raised bogs and a fen at an altitude of about 200 m a.s.l. The entire area has a cold-temperate climate with a monthly mean air temperature of 4.2°C and a monthly mean precipitation of 60 mm (Gonzalez Garraza *et al.* 2012). A large proportion of the surface of both systems is covered by many pools of different size, with their bottoms covered either by a layer of organic debris (clear) or by live *Sphagnum* mosses (vegetated), and showing low conductivity, nutrient and pH values characteristic of precipitation-fed ombrotrophic environments.

The number of *Stauroneis* taxa observed in TDF is very low. Frenguelli (1923) reported the presence of several taxa, mostly varieties of *Stauroneis phoenicenteron* (Nitzsch 1817: 92) Ehrenberg (1843: 311) and *S. anceps* Ehrenberg (1843: 306). Other illustrated (though not discussed) taxa include *Stauroneis acuta* W.Smith (1853: 59), *S. boudetii* (M.Peragallo 1921: 17) Frenguelli (1924: 43) and *S. quadrata* (Héribaud 1903: 14) (Frenguelli 1924). Krasske (1949) listed almost the same species in his report on the diatoms of Patagonia and added *Stauroneis legumen* Ehrenberg (1849:

444). More recently, Mataloni (1994) in her doctoral study on the TDF peatlands, only observed *S. phoenicenteron*, *S. gracilis* (Ehrenberg 1843: 386) and *S. thermicola* (Petersen 1928: 394) Lund (1946: 61). It must be noted however that most likely larger-celled *Stauroneis* taxa were either lumped in *S. phoenicenteron*, *S. gracilis* or *S. anceps*. This process of force-fitting species into European and North-American names was common practice but obscured largely biogeographical interpretations (Tyler 1996). It was only in 2003 that Lange-Bertalot *et al.* started to analyse in more detail all (European) populations of these taxa resulting in the identification and description of several new taxa, related to these three catch-all taxa.

In the new study, we observed an unknown *Stauroneis* taxon that showed some resemblance to previously described taxa but that could however not be identified using the currently available literature. Based on extensive light and scanning electron microscopy observations and comparison with all *Stauroneis* taxa described worldwide, the species is described here as new to science: *Stauroneis fuegiana* Casa & Van de Vijver sp. nov.

Material & Methods

In 2014 and 2016, sediment samples were collected from different pools (both vegetated and clear) along transects crossing the Rancho Hambre and Upper Andorra Valley peatbogs. For each sample, pH, temperature (°C) and conductivity (µS/cm) were measured in situ.

For light microscope (LM) observation, diatom samples were prepared following the method described in van der Werff (1955). Subsamples of the original material were oxidized using 37% H_2O_2 and heating to 80°C for about 1 h. The reaction was further completed by the addition of saturated $KMnO_4$. Following digestion and centrifugation (three times 10 min at 3700 × g), the material, free of organic matter, was further diluted with distilled water for sample mounting to avoid excessive concentrations of diatom valves on the slides. A subsample from the organic-free material was mounted in Naphrax®. The slides were analyzed using an Olympus BX53 microscope, equipped with differential interference contrast (DIC) optics (Nomarski) and Colorview I Soft Imaging System. Diatom samples and slides are stored at BR (Botanic Garden Meise). For scanning electron microscopy (SEM), aliquots of the oxidized suspensions were filtered through 5-µm pore size polycarbonate filters which were cut in small pieces, fixed on aluminum stubs after air-drying and sputter coated (Cressington 208HR, Watford, UK) with PtPd (10 nm). Observations and photomicrographs were performed with a Jeol® JSM-7100F SEM at 1 kV at the Botanic Garden Meise (Belgium).

Identifications and species comparisons are based primarily on Reichardt (1995), Lange-Bertalot & Genkal (1999), Rumrich *et al.* (2000), Lange-Bertalot *et al.* (2003), Van de Vijver *et al.* (2004), Metzeltin & Lange-Bertalot (2007), Metzeltin *et al.* (2009), Bahls (2010, 2012) and Joh (2014). Terminology follows mostly Ross *et al.* (1979) except for valve outline terminology that is based on Hendey (1964) and raphe morphology that follows Round *et al.* (1990).

Observations

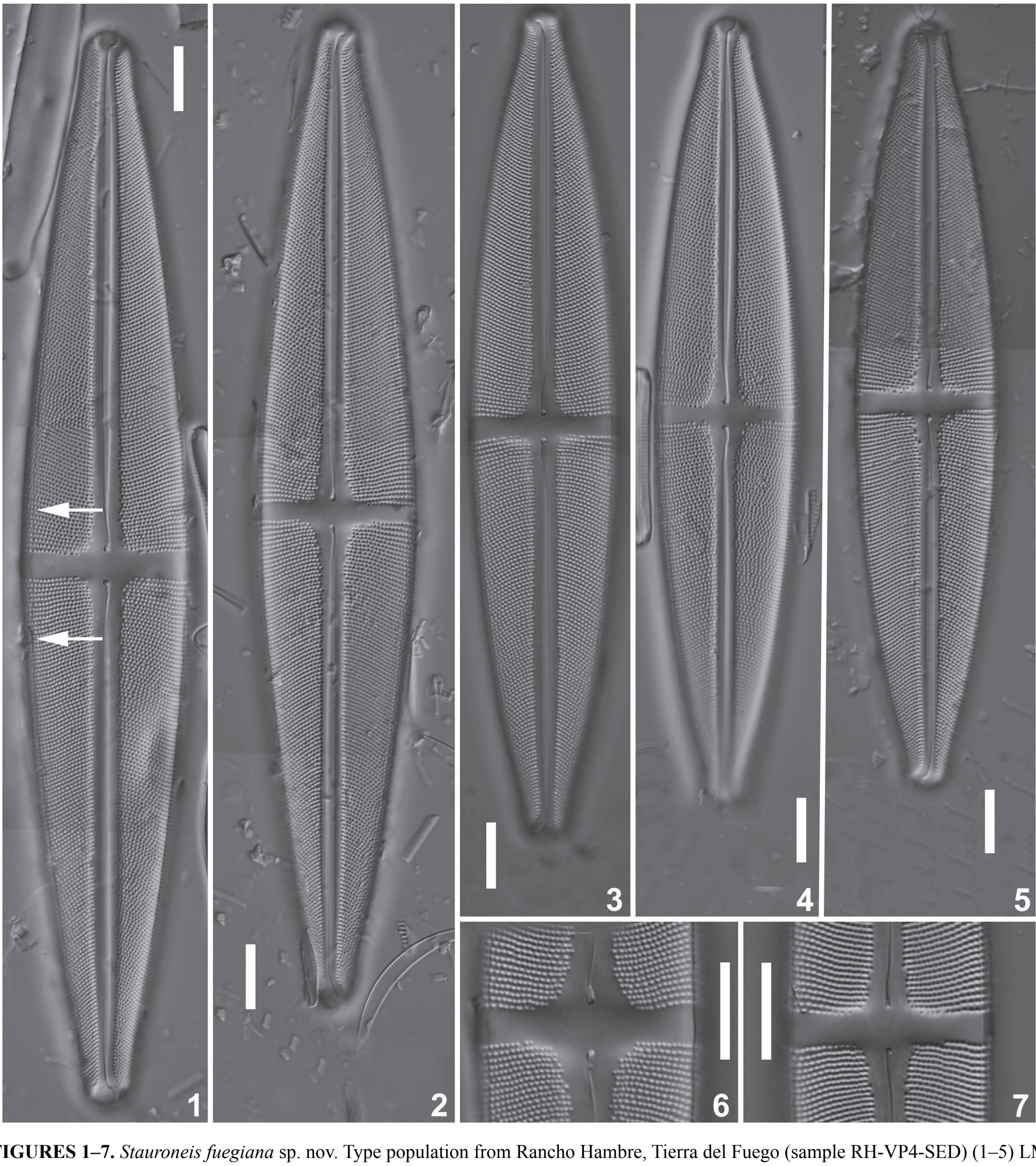
Division **Bacillariophyta**
Class **Bacillariophyceae**
Subclass **Bacillariophycidae**
Order **Naviculales**
Family **Stauroneidaceae**
Genus ***Stauroneis***

Stauroneis fuegiana **Casa & Van de Vijver sp. nov. (Figs 1–13)**

LM (Figs 1–7): Valves rather broadly lanceolate, never linear-lanceolate with clearly convex margins, gradually tapering towards the weakly protracted, subrostrate apices. Valve dimensions (n=25): length 95–165 µm, width 17–25 µm, length/width ratio 5.7–6.3. Axial area narrow, strictly linear, almost 1/5 of the total valve width, gradually widening until the central area. Central area forming a rectangular, only weakly wedge-shapedly widened stauros. Shortened striae only rarely present in the central area. Raphe clearly lateral. Branches straight with clearly deflected to weakly hooked (Figs 6, 7), droplike expanded proximal raphe endings and hooked terminal raphe fissures. Striae clearly radiate throughout the entire valve, 16–18 in 10 µm. Areolae clearly discernible in LM, 18–20 in 10 µm.

Occasionally, narrow hyaline line visible at the valve face/mantle junction (Fig. 1, arrows). SEM (Figs 8–13): Striae uniseriate composed of transapically elongated areolae (Figs 9, 10). Striae continuing uninterruptedly onto the mantle (Fig. 10). External proximal raphe endings clearly deflected terminating in large, droplike expanded pores (Fig. 9). Small silica ridge bordering the raphe (Figs 8, 9). Terminal raphe fissures strongly hooked, continuing onto the mantle (Fig. 10). Narrow silica ridge present near the central area at the valve face/mantle junction, not continuing up to the apices (Fig. 9, arrows). Internally, stauros well-developed (Fig. 11). Internal proximal raphe endings terminating on the stauros (Fig. 12). Distal raphe endings terminating on small helictoglossae (Fig. 13). Stria foramina transapically elongated (Fig. 12).

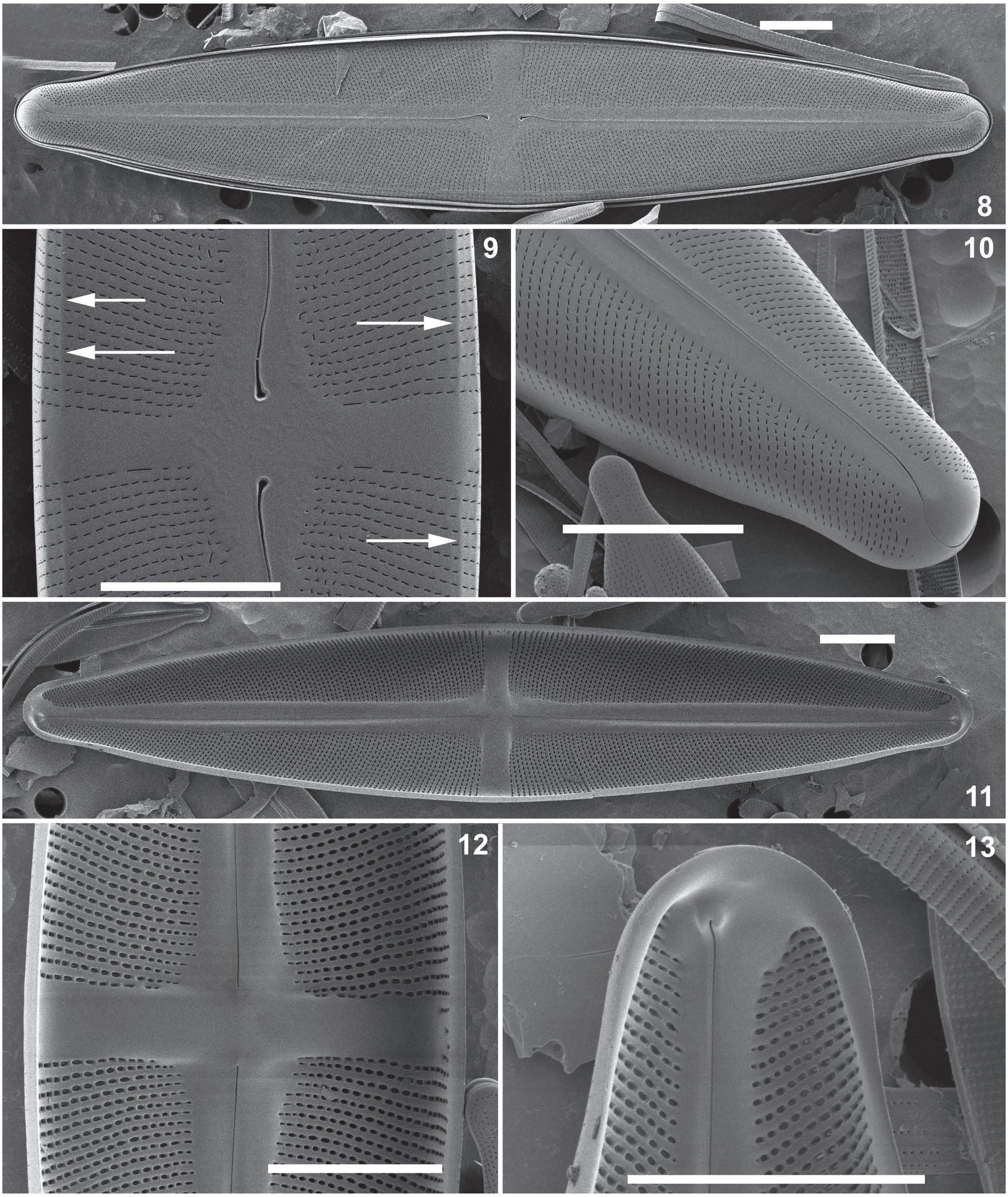
Type:—Rancho Hambre, Tierra del Fuego, ARGENTINA: sample RH-VP4-SED, V. Casa, 21/11/2016 (holotype BR! slide no. 4480, isotype PLP! slide 325, University of Antwerp, Belgium).



FIGURES 1–7. *Stauroneis fuegiana* sp. nov. Type population from Rancho Hambre, Tierra del Fuego (sample RH-VP4-SED) (1–5) LM views of an entire valve. The arrows in Fig. 1 indicate the marginal crest on the valve face/mantle junction (6–7) LM views of the central area with the deflected proximal raphe endings. Scale bars represent 10 µm.

Ecology and distribution:—*Stauroneis fuegiana* is regularly observed in the peat bogs pools of Tierra del Fuego. It is possible that the species has been identified in the past as *S. phoenicenteron* or *S. gracilis*. The species is usually found in sediment and moss samples from several shallow, dystrophic, acid to slightly acid (pH 3,6–6,8) waterbodies with low conductivity (<200 µS/cm) and DOC ranging between 5,1 to 35,1 mg/l.

Etymology:—The specific epithet *fuegiana* refers to the type locality in Tierra del Fuego.



FIGURES 8–13. *Stauroneis fuegiana* sp. nov. Type population from Rancho Hambre, Tierra del Fuego (sample RH-VP4-SED) (8) SEM external view of an entire valve. (9) SEM external detail of the central area showing the deflected proximal raphe endings. The arrows indicate the marginal crest. (10) External detail of the valve apex showing the terminal raphe fissures. (11) SEM internal view of an entire valve. (12) SEM internal detail of the central area with the well-developed stauros and the proximal raphe endings. (13) Internal detail of the valve apex with a distal raphe endings and the helictoglossa. Scale bars represent 10 µm.

TABLE 1. Comparison table between *Stauroneis fuegiana* and several larger-celled *Stauroneis* species.

	gracilis	*subaustralis*	*supergracilis*	*kochiae*	*respectabilis*	*heinii*	*indianopsis*	*regina*	*submarginalis*	*superkuelbsii*	*phoenicenteron*	*fuegiana*
	Van de Vijver et al. (2004)	Van de Vijver et al. (2004)	Van de Vijver et al. (2004)	Metzeltin & Lange-Bertalot (2007)	Lange-Bertalot et al. (2003)	Van de Vijver et al. (2004)	Bahls (2010)	Bahls (2010)	Bahls (2010)	Bahls (2010)	Van de Vijver et al. (2004)	this study
valve length	75-114	85-165	120-140	113-137	85-125	125-167	105-163	142-213	140-186	80-156	>150	95-165
valve width	15-19	16.5-24	20-22	20-23	20-24	23-27	20-27	22-33	23-35	18-30	>30	17-25
valve outline	lanceolate to slightly linear-lanceolate	narrowly lanceolate	linear-lanceolate	strictly lanceolate	strictly lanceolate	lanceolate	linear-lanceolate	narrowly lanceolate	broadly lanceolate	lanceolate to linear-lanceolate	lanceolate	broadly lanceolate
marginal crest	no	yes	no	no	no	no	no	no	yes	no	yes	yes, only weakly developed
central area	no shortened striae present	occasionally shortened striae present	occasionally shortened striae present	no shortened striae present	occasionally shortened striae present	no shortened striae present	occasionally shortened striae present	occasionally shortened striae present	often shortened striae present	occasionally shortened striae present	no shortened striae present	rarely shortened striae present
apices	not protracted, subrostate	bluntly rounded, weakly protracted	bluntly rounded, very weakly protracted	clearly protracted, subrostrate	slightly protracted	slightly protracted	slightly protracted	slightly protracted	slightly protracted, broadly rounded	clearly protracted, subrostrate	slightly protracted	weakly protracted, subrostrate
proximal raphe endings	deflected	slightly deflected	deflected	straight	straight	strongly curved	slightly deflected	slightly deflected	slightly deflected	slightly deflected	straight	slightly deflected
number of striae in 10 µ	16-18	16	16-17	12-15	14-16	15-16	16-17	15-17	15-17	15-18	15	16-18
number of areolae in 10 µ	18	16-18	17-18	18	14-16	16-17	16-18	15-18	16-20	13-17	14-17	18-20
striation pattern	radiate throughout	radiate throughout	strongly radiate throughout	radiate throughout	radiate throughout	moderately radiate throughout	radiate throughout	radiate throughout	radiate throughout	curved and radiate throughout	moderately radiate throughout	radiate throughout

Discussion

Discriminating features to separate larger-celled *Stauroneis* taxa are the presence/absence of a pseudoseptum, the general valve outline, the number of striae and areolae in 10 µm, the structure of the proximal raphe endings and the valve dimensions, including the length/width ratio. In the past, most of the larger-celled taxa were identified as *S. phoenicenteron*. Reichardt (1995) analysed the type material of *S. gracilis* and compared it to *S. phoenicenteron* concluding that the latter has typically a valve width exceeding 30 µm and a length of 150 µm. *Stauroneis gracilis* is commonly 13–20 µm wide and never exceeds 120 µm in valve length. Following this publication, a relatively large number of large-celled *Stauroneis* has been described during the past few years. Some of these taxa show some affinities to *Stauroneis fuegiana*. Table 1 shows all similar taxa with their discriminating features. It is clear that *Stauroneis fuegiana* cannot be separated based on one single morphological feature but that the new taxon shows a combination of features that is not found in any of the similar taxa. Some taxa have valve dimensions that are clearly too large. *Stauroneis phoenicenteron*, *S. regina* Bahls (2010: 123), *S. submarginalis* Bahls (2010: 157) and *S. superkuelbsii* Bahls (2010: 165) show a valve width largely exceeding 30 µm, whereas *S. fuegiana* has a maximum valve width of 25 µm. *Stauroneis gracilis* and *S. supergracilis* Van de Vijver & Lange-Bertalot (2004:73) show much smaller valve width (resp. up to 19 and 22 µm) and both also lack a marginal crest whereas *S. fuegiana* possesses a very weakly developed, but in LM still discernible crest. Similarly, *S. indianopsis* Bahls (2010: 85) and *S. heinii* Lange-Bertalot & Krammer in Lange-Bertalot & Genkal (1999: 91) also lack the marginal crest. Additionally, both species have more features that can be used to separate them from *S. fuegiana*: *Stauroneis indianopsis* can be separated by its more linear-lanceolate outline and *S. heinii* has clearly curved proximal raphe endings, features never present in *S. fuegiana*. Some taxa have straight proximal raphe endings such as *S. kochiae* Metzeltin & Lange-Bertalot (2007: 244), *S. phoenicenteron* and *S. respectabilis* Lange-Bertalot *et al.* (2003: 144). The most similar taxon is *S. subaustralis* Van de Vijver & Lange-Bertalot (2004: 69). Both taxa have similar valve dimensions, possess a marginal crest (although this feature is more developed in *S. subaustralis*) but they differ in valve outline. *Stauroneis subaustralis* has clearly lanceolate to even narrowly rhombic-lanceolate valves whereas *S. fuegiana* has broadly lanceolate valves with convex, broadly rounded, never rhombic margins. The latter shows additionally a higher stria and areola density.

Based on this combination of morphological features that is unique among the larger-celled *Stauroneis* taxa, the description of *S. fuegiana* as a new species is justified.

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