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Skeletonema potamos (Bacillariophyta) in Patos Lagoon, southern Brazil: Taxonomy and distribution

Skeletonema potamos (Bacillariophyta) en la Laguna dos Patos, sur del Brasil: Taxonomía y distribución

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Abstract

We analyzed the morphogical features of the centric diatom *Skeletonema potamos* (Weber) Hasle from Patos Lagoon, southern Brazil, using light and scanning electron microscopy. We discuss the abundance and distribution of the species along the salinity gradient in the lagoon. Samples from the water surface were taken monthly at eight stations along the longitudinal axis of the lagoon, from December 1987 to December 1988. The species were counted by the Utermöhl method, and the density (cells.mL^{-1}) was estimated based on live cells. The morphology of the specimens agrees with the type, from the Little Miami River, Ohio, U.S.A., except for the convexity and the pattern of granules on the valve face. *Skeletonema potamos* was found in the winter and spring, and was distributed in the limnetic, oligohaline and mesohaline zones of the lagoon. The cell concentration appeared to be controlled by the salinity, with a significant negative correlation observed. Light and competition probably also influence the development of *S. potamos* populations in the Patos Lagoon.

Keywords: diatoms, *Skeletonema potamos*, salinity, taxonomy

Resumen

En el presente trabajo analizamos las características morfológicas de la diatomea céntrica *Skeletonema potamos* (Weber) Hasle de la Laguna dos Patos, sur del Brasil, usando microscopia de luz y electrónica de barrido. Discutimos la abundancia y la distribución de la población a lo largo del gradiente de salinidad en la laguna. Las muestras de la superficie del agua fueron recogidas mensualmente en ocho estaciones a lo largo del eje longitudinal de la laguna, en el periodo de diciembre 1987 a diciembre 1988. Las muestras fueron contadas por el método de Utermöhl, y la densidad (cels.mL^{-1}) estimada en base de las células vivas. La morfología de los individuos concuerda con la especie-tipo del río Little Miami, localizado en Ohio, USA, a excepción de la convexidad y del patrón de gránulos en la cara valvar. *Skeletonema potamos* fue encontrada en el invierno y primavera, y distribuida en las zonas limnéticas, oligohalina y mesohalina de la laguna. La densidad de la población presenta una correlación negativa significativa con la salinidad. La luz y la competencia probablemente también influencian el desarrollo de las poblaciones de la especie *S. potamos* en la Laguna dos Patos.

Palabras clave: diatomeas, *Skeletonema potamos*, salinidad, taxonomía.

Introduction

Skeletonema potamos was first described as *Microsiphona potamos* by Weber (1970), from the Miami River, USA. The species was distinguished by its small "siphon" (strutted process) and by occurring in a lotic system. The transfer of this species to the genus *Skeletonema*, and the establishment of its synonym *Stephanodiscus subsalsus* (A. Cleve) Husted were made later by Hasle & Evensen (1976).

This species is common in the rivers and lakes of North America, Europe (England, France, Spain, Germany, Poland, Finland, Hungary, Ukrany and Russia) and Australia (Weber 1970, Belcher & Swale 1978, Nicholls et al. 1983, Chessman 1985, Kiss 1986, Chang & Steinberg 1988, Sabater & Klee 1990, Genkal & Ivanov 1990, Descy & Willems 1991, Kiss et al. 1994, Turkia & Lepistö 1997), and its abundance is related to eutrophication. In Brazil the species was first reported by Torgan (1997) in Patos Lagoon (30°23'—32°07'S, 50°41'—52°12'W) on the Coastal Plain of the state of Rio Grande do Sul. Recently it was found in the freshwater Lagoa Mirim (32°10'—33°37'S, 52°38'—53°40'W), also in Rio Grande do Sul, on the Brazil-Uruguay border (Pérez & Odebrecht 2005).

We analyzed the morphogical features of the population of *Skeletonema potamos* in Patos Lagoon. We discuss the abundance and distribution of the species along the salinity gradient in this subtropical coastal lagoon.

Material and methods

The Patos Lagoon is a large (250 km long), shallow (average depth 6,0 to 8,0 m), polymictic, circumneutral, mesotrophic to eutrophic system. It is connected to the Atlantic Ocean by a single narrow canal. The water retention time in the lagoon is relatively long, because of the low tidal oscillation from the ocean.

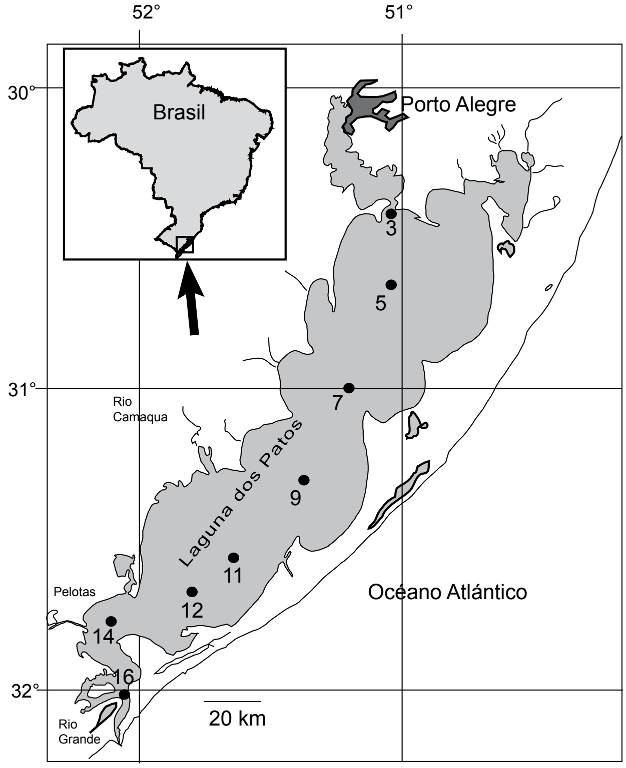

Figure 1. Map showing the sampling stations in Patos Lagoon, southern Brazil.

Figure 2—5. *Skeletonema potamos* (LM). General view of the cells in water mount. (2), (3) Chains with two cells, showing the chloroplast and oil drops (arrow). (4), (5) Chains with eight and four cells, with one and two chloroplasts and shorter and longer strutted processes, respectively.

Samples were taken monthly at eight stations along the longitudinal axis of Patos Lagoon, from December 1987 to December 1988 (Fig. 1). The samples were collected from the water surface and fixed with Lugol´s iodine solution. The species were counted by the method of Utermöhl (1958), and the density (cells mL^{-1}) was estimated based on live cells. A minimum of 100 individuals of the phytoplankton were counted in an inverted microscope, giving a counting accuracy of ±20% (95% confidence limits). The temperature and salinity were measured using a Yellow Springs Instruments Model 33. Transparency was measured with a Secchi disc, and silicate according to the method of Mullin & Riley (Aminot & Chaussepied 1983). The Spearman's correlation analyses were performed using the SYSTAT Program.

The taxonomic study of the species was based on examination of the cells and frustules. The material was cleaned according to the method of Simonsen (1974). Light micrographs were taken with phase-contrast illumination, and SEM electron micrographs were taken using a Jeol JSM-5200 at a voltage of 25 KV. The samples are preserved in the Herbarium of the Museu de Ciências Naturais - Herbário Alarich Schultz (HAS 25088, 25094, 25095, 25097, 25101, 25111, 25112, 25115, 25203, 25212).

Results and discussion

Taxonomy

Skeletonema potamos **(Weber) Hasle, J. Phycol. v. 12, p. 74, figs. 1-17.**

(Figs 2—9)

Frustules cylindrical in girdle view, joined in short chains, frequently of two cells and rarely of three, four or eight cells, separated by short strutted processes. There are 1—2 parietal chloroplast in each cell. There are two refractive, small spherical granules (libroblast or oil drops), one towards each end of the cell (Figs 2, 3). Short marginal processes on the end of the chain are usually visible in light microscopy, but other details of valvar features can be only resolved with electron microscopy.

The length of the strutted processes can vary with the salinity. At a salinity of 0‰ the processes are extremely short (Fig. 4), and at a salinity of 7,28‰ the processes are longer (Fig. 5). The influence of salinity on the length of the strutted process of *S. potamos* was first observed by Hasle & Evensen (1976).

Electron micrographs reveal a rounded valve face, convex in the middle (Fig. 6). The valvar surface is provided with radial rows of elongate areolae. These areolae extend the full length of the mantle. Small granules are present in the middle of the valvar surface. One excentric rimoportula is present on the valve (Fig. 7). There are 5—7 strutted processes located at the junction of the mantle and the valve face. These processes are tubular, with a cleft at the distal tip (Figs 8, 9).

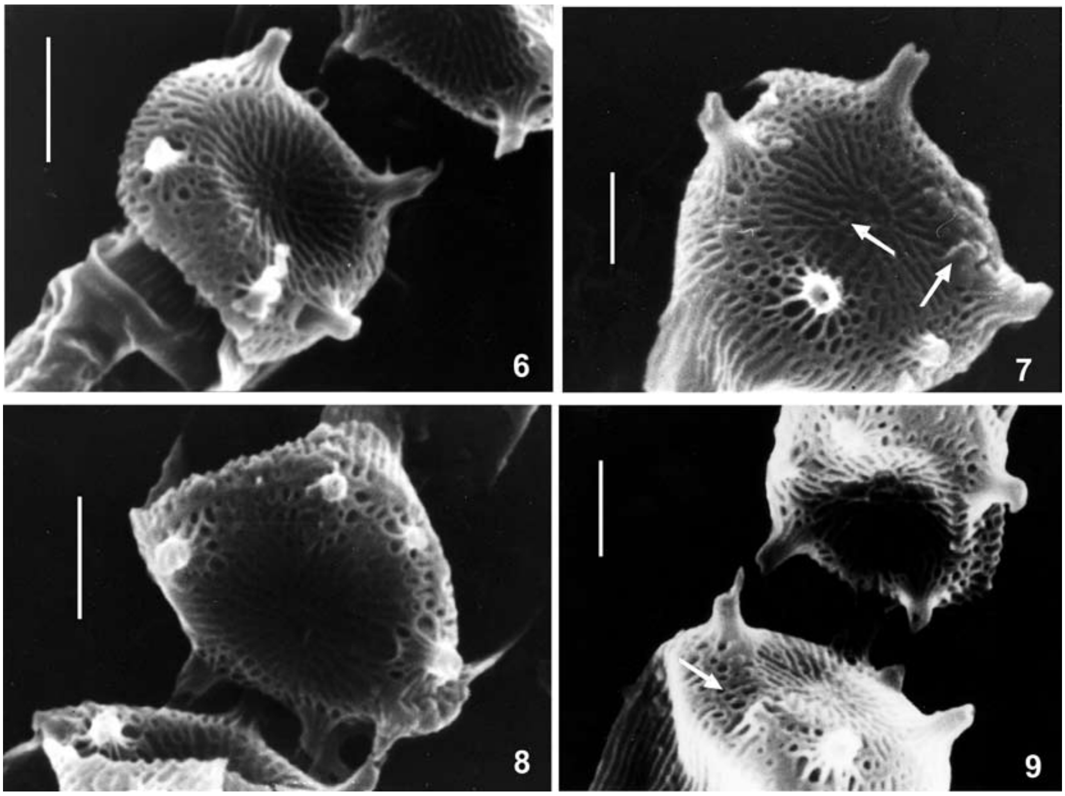

Figure 6—9. *Skeleletonema potamos* (SEM). View of the valvar surface and mantle. (6) Valve face convex at middle with a ring of strutted processes. (7) Single valve, showing the rimoportula (arrow) and the small granules (arrow). (8) Seven strutted processes at the junction of mantle and the valve face. (9) Valvar surface with radial rows of elongate areolae that extend the full length of the mantle.

Table 1. Features of *Skeletonema potamos* observed in the population in Patos Lagoon, and previously reported in the literature.

Features	Observed	Weber (1970)	Hasle & Evensen (1976)	Belcher & Swale (1978)
Chloroplast	1–2	several	1–2 (4)	1–2
Frustule diameter (µm)	3–4,5	3–4	3–4	3–4
Pervalvar axis (µm)	6–10	4–8	-	6–10
Areolae in 10 µm	8	-	-	8
Number of processes	5 –7	5–8	6–8	5–6
Rimoportula	1	-	1	1

The morphology of the specimens agrees with the type, from the Little Miami River, Ohio, USA (Weber, 1970), except for the convexity and the pattern of granules on the valve face. The small granules of the specimens from the Patos Lagoon are limited to a middle area of the valve face. While such granules are rare in the Skeletonemataceae, granulations are usually interpreted as an ecophenotypic variation, probably caused by differences in the availability of silica (Tuchman et al. 1984). Other features observed in *S. potamos* were similar to the specimens described in the literature (Table 1).

The frustule of *S. potamos* is thin, weakly silicified, and breaks easily in oxidation. It may be confused with some species of *Aulacoseira,* because of the filamentous habit and the narrow space separating the cells in the chain. These features make the correct identification of *S. potamos* difficult, and it is possible that the species may sometimes be overlooked. This may be the reason that this species is not more widely reported.

Spatial and temporal distribution

Skeletonema potamos was found in the winter and spring of 1988 in the Patos Lagoon, and occurred in the limnetic (stations 3, 5, 9) oligohaline (station 11) and mesohaline (station 16) regions.

The population density ranged between 1 and 442 cells.mL^{-1} and the species reached its highest concentration in August, at station 3, where the salinity was 0 ‰ and the temperature was 15,8 ºC (Fig. 10). On this occasion, *S. potamos* shared high abundance with *Aulacoseira ambigua* (Grunow) Simonsen (566 cells. mL^{-1}) both reached 22% of total phytoplankton density. According to Pérez & Odebrecht (2005), *S. potamos* was also mainly observed in August in the Mirim Lagoon (> 20 ind mL^{-1}).

The concentration of cells of *S. potamos* did not show any correlation with silicate concentration or temperature (Figs 10, 11). On the other hand, it showed a significant negative correlation

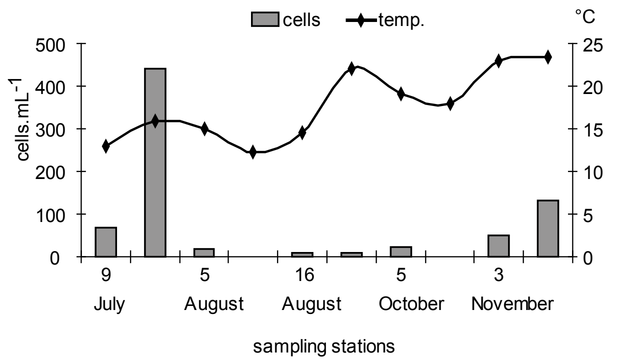

Figure 11. Spatial and temporal variations of water temperature and the density of *S. potamos* during 1988.

with salinity (r= -0,690; p= 0,05) (Fig. 12). In consequence, the population of *S. potamos* appears to be controlled by the salinity in the Patos Lagoon. The influence of salinity on the growth of this species was studied in culture experiments. The cells grew at salinity of 2—24‰, but when they were inoculated into a medium devoid of the major seawater salts, unexpectedly they failed to grow (Paasche 1975).

S. potamos usually appears together with *S. subsalsum* in the River Wümme (Germany), according to Hasle & Evensen (1976). In the Patos Lagoon, the species was also found with *S. subsalsum* (July, station 9; August, stations 9 and 16; and October, station 11) and .frenquently with *Aulacoseira ambigua* e *A. granulata* (Ehrenberg) Simonsen (Fig. 13).

It is interesting to observe that *S. potamos* has not been found in high density in Patos lagoon, which is impacted by organic matter and eutrophication, although it is considered a pollution-tolerant species. We suppose that the main factors influencing the development of the populations are probably light and/or competition. The Patos Lagoon has low transparency (< 0,50 m), and *S. potamos* has high light demand, as demonstrated by Kiss et al. (1994) in their investigation of the diurnal pattern

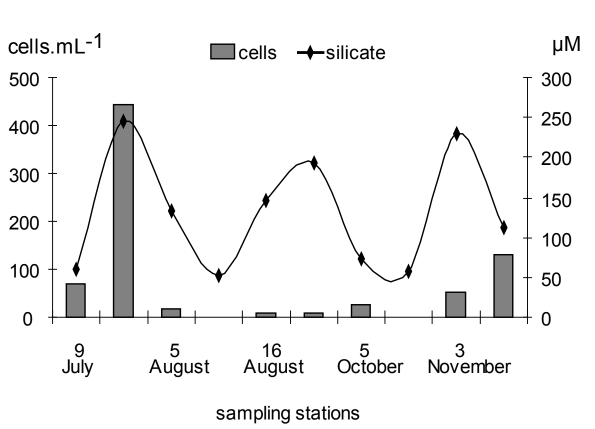

Figure 10. Spatial and temporal variations of silicate and the density of *S. potamos* during 1988.

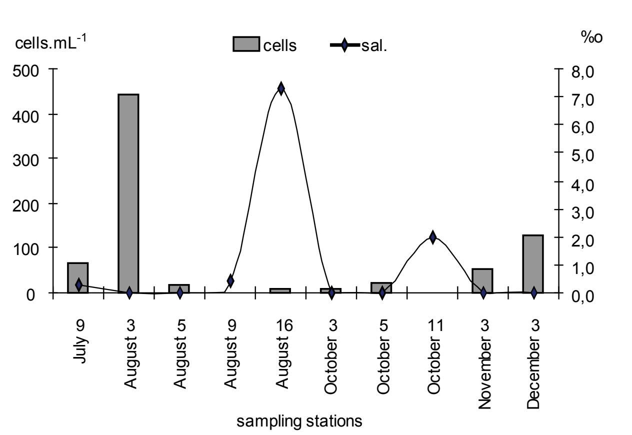

Figure 12. Spatial and temporal variations of salinity and the density of *S. potamos* during 1988.

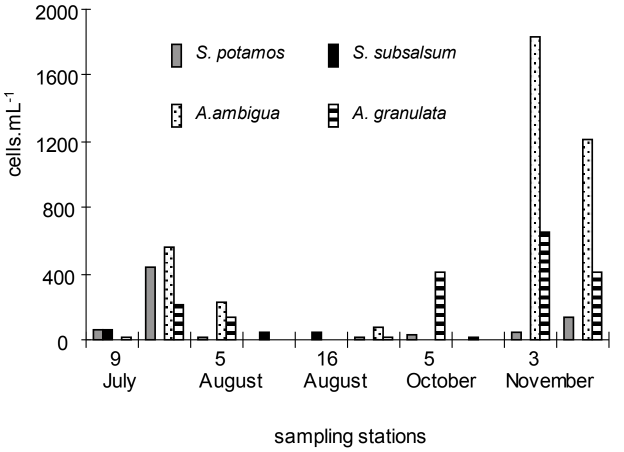

Figure 13. Spatial and temporal variations of the density of *S. potamos, S. subsalsum, A. ambigua and A. granulata* in the Patos lagoon during 1988.

of this species in the Danube River. Competition with other chain-forming centric diatoms, particularly *Aulacoseira granulata* and *A. ambigua*, also may be possible, because these species are abundant in the phytoplankton of the Patos lagoon.

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