



FIRST REPORT OF THE DIATOM GENUS *PLAYAENSIS* (BACILLARIOPHYCEAE, BACILLARIOPHYTA) IN SOUTH AMERICA: VALVE MORPHOLOGY, COLONY FORMATION AND BIOGEOGRAPHY OF THE GENUS

PRIMER REPORTE DEL GÉNERO *PLAYAENSIS* (BACILLARIOPHYCEAE, BACILLARIOPHYTA) EN AMÉRICA DEL SUR: MORFOLOGÍA DE LA VALVA, FORMACIÓN DE COLONIA Y BIOGEOGRAFÍA DEL GÉNERO

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RESUMEN

Introducción y objetivos: *Navicula toba*, descrita originalmente en 1994 para el norte de Argentina, presenta todas las características diagnósticas atribuidas al género *Playaensis*: forma lineal, ligeramente panduriforme debido a valvas onduladas, con una costilla longitudinal prominente bordeando el rafe y espinas marginales. Esta especie habita en humedales del norte de Argentina. Una población de especímenes que formaban colonias cortas en forma de cinta, se registró en la laguna temporaria Valerio, en la Meseta de Somuncurá, Patagonia, Argentina. Las comparaciones indicaron que *P. circumfimbria* (la especie tipo del género), *Navicula toba* y los especímenes de Somuncurá representan la misma entidad taxonómica.

M&M: Los especímenes recolectados en la Meseta de Somuncurá se analizaron mediante microscopía óptica y electrónica de barrido.

Resultados: Según el principio de prioridad, proponemos la combinación *Playaensis toba*, estableciendo a *P. circumfimbria* como sinónimo heterotípico. Dado que el holotipo de *N. toba* fue extraviado, reconocemos el dibujo original como lectotipo y designamos el material de Somuncurá como epítipo, para garantizar la estabilidad nomenclatural y proporcionar una referencia morfológica inequívoca. Adicionalmente, consideramos que *Craticula citrus* y *C. citroides*, transferidas a *Playaensis*, carecen de varios rasgos diagnósticos del género; por ello, recomendamos mantener sus nombres anteriores.

Conclusiones: La distribución geográfica de *Playaensis* (*sensu stricto*) permanece restringida a humedales temporarios o efímeros en América del Norte y del Sur.

PALABRAS CLAVE

Argentina, biogeografía, diatomeas, Meseta de Somuncurá.

SUMMARY

Background and aims: Described in 1994 in Northern Argentina, *Navicula toba*, exhibits all diagnostic features attributed to the genus *Playaensis*: linear, slightly panduriform due to undulate valves with a prominent longitudinal rib bordering the raphe and marginal spines. This species occurs in temporary wetlands in northern Argentina. A population of specimens forming short, ribbon-like colonies was found in the temporary Valerio Lake, on the Somuncurá Plateau, Patagonia, Argentina. Comparisons indicated that *P. circumfimbria* (the generic type), *Navicula toba* and Somuncurá specimens represent the same taxonomic entity.

M&M: Specimens collected at the Somuncurá Plateau were analysed with LM and SEM.

Results: Based on the priority principle, we propose the combination *Playaensis toba*, establishing *P. circumfimbria* as a heterotypic synonym. Since the holotype of *N. toba* is currently missing, we recognize the original drawing as lectotype and designate the Somuncurá material as epitype to ensure nomenclatural stability and provide an unambiguous morphological reference. Additionally, we consider that *Craticula citrus* and *C. citroides* transferred to *Playaensis*, lack several diagnostic features of the genus, so we recommend maintaining their previous names.

Conclusions: The geographic distribution of *Playaensis* (*sensu stricto*) remains restricted to temporary to ephemeral wetlands throughout North and South America.

KEY WORDS

Argentina, biogeography, diatoms, Somuncurá Plateau.

INTRODUCTION

Playaensis Spaulding & Kociolek 2002 is a relatively recently described genus reported from small, shallow, ephemeral closed-basin lakes (playas) of New Mexico, USA (Spaulding *et al.*, 2002). The two species originally assigned to the genus, *P. circumfimbria* Spaulding & Kociolek 2002 and *P. furtiva* Spaulding & Kociolek 2002 (in Spaulding *et al.*, 2002) were assumed to be restricted to alkaline, slightly saline playa-lakes of this region. However, *P. circumfimbria* was later recorded from Piute Reservoir, Oregon (Kociolek *et al.*, 2014), a shallow, low-alkaline reservoir of low conductivity (1.7 m maximum depth, pH 7.7; conductivity 152 μ mhos/cm; Hubler & Merrick, 2010).

Maidana & Herbst (1994) described *Navicula toba* Maidana & Herbst from an ephemeral pond of Avia Terai, Chaco, Argentina, which resembles *P. circumfimbria* in its triundulate valves and unique striae organization. Bahls (2013, 2019) recorded *P. circumfimbria* from Montana and Oregon and noted its presence in an artificial pond in Mexico (Bahls, 2013). Reichardt (2018) transferred to *Playaensis* two small taxa, *Craticula citrus* (Krasske) Reichardt 1997 and *Craticula citroides* Lange-Bertalot *et al.* 2003, known mostly from Europe (e.g. Hustedt, 1961, 1966) though the former was also recorded from Luzon, Philippines (Hustedt, 1966). Those two taxa lack several of the morphological features considered diagnostic for the genus (raphe bordered by prominent lunate longitudinal rib and panduriform valves). More recently, we recorded diatom specimens with panduriform shape and apiculate valve ends resembling *Navicula toba* and *Playaensis circumfimbria* in temporary volcanic lakes of the arid highlands of the Somuncurá Plateau, Patagonia, Argentina.

In ephemeral ecosystems, such as *playa* lakes, the floristic diatom similarity among widely differing environments (e.g., salinity) is considered more linked to the inconsistency of the environment within these habitats, which drives assemblages with broad tolerance (Busch & Kubly, 1980). Therefore, it would be expected that there will be more records of *Playaensis* in this type of ephemeral ecosystem in at least Northern and Central America. However, these ephemeral-like habitats are frequently referred to by various names,

lacking a standardized nomenclature —such as ephemeral ponds, intermittent rivers, ephemeral wetlands, vernal pools, and riverine pools (Novais & Morais, 2024; Taurozzi *et al.*, 2024)— which complicates the detection of characteristic species assemblages. Additionally, the diatom diversity in the region of Central and South America appears to be low due to the clustering of taxa into species complexes and their forced classification into already described taxa (Mora *et al.*, 2017; Simonato, 2025). These factors, added to the small size of specimens of the genus *Playaensis* possibly lead to an underestimation of the distribution of this genus in Central and South America.

The aims of this study are: 1) to analyze the morphological features of specimens of Somuncurá, 2) to discuss taxonomic and nomenclatural aspects related to *Playaensis*, and 3) to elucidate ecological and biogeographical circumscription of the genus.

MATERIALS AND METHODS

Specimens belonging to the genus *Playaensis*, collected at the Somuncurá Plateau were analysed with light microscopy (LM) and scanning electron microscopy (SEM). These materials were compared with *Playaensis circumfimbria*, *P. citrus*, *P. citroides*, and *Navicula toba*.

Somuncurá Plateau Protected Natural Area is located in the northern region of the Patagonian Plateau, and it holds this category, mainly due to its high biodiversity and many endemic forms (Ceí, 1969; Muzón *et al.*, 2005). In the Somuncurá Plateau the zone associated with basaltic lava flows extends over a distance of 15 to 20 km, surrounding older volcanic constructions (Remesal *et al.*, 2019). Summer temperatures usually are within the range of 20.8–23.6 °C but high outliers to 41.5 °C also occur, and winter temperatures range between 6–7.1 °C, but can drop to -19.5 °C (PMANPMS, 2008).

Valerio Lake (Laguna Valerio) is located in northern Somuncurá Plateau, and it is a temporary, shallow lake of some 200–300 m in diameter. The lake had about 1 m maximum depth at the time of sampling, although the depth can be variable, as it is a lake dependent on precipitation. The rainfall regime of Valerio is around 208 mm per year (Fick & Hijmans, 2017) and in summer months, or the whole year, the lake may become completely dry (Fig.

1). The lake is destitute of any vascular aquatics, charophytes being the main macrophytes (Labaut & Coesel, 2023), with also *Riella* sp. (Marchantiopsida) being present.

Phytobenthos was collected on 20 November 2022 (austral spring) from the margin zone of the lake between 5 and 30 cm below the surface. General characteristics of the benthos were mentioned in Labaut & Coesel (2023), which included predominance of *Oedogonium* sp., pennate diatoms and cosmopolitan and endemic desmid species such as *Cosmarium valerioëense* Coesel & Labaut.

Conductivity and pH were measured in situ with an OAKTON PCS Testr 35 multiparameter probe. Samples were collected by scraping off submerged stones with a toothbrush. All samples were fixed with formaldehyde to a final concentration of 4 % and observed with a Zeiss Axio Imager.2M at 1000x magnification and Axiom 105 camera. Samples were

cleaned by the process recommended by Renberg (1990). For LM, cleaned material was dried onto coverslips and processed into permanent slides with Naphrax. For SEM, clean subsamples were dried onto aluminum stubs, sputter coated with 9 nm of gold, and viewed with a Zeiss Evo 15 scanning electron microscope at an operating voltage of 5.0 kV and working distance of 11.4 mm.

Nomenclatural proposals were done following the criteria of the Madrid Code (Turland *et al.*, 2025).

RESULTS

In Valerio Lake, the action of the wind, together with the fine sediments of the lake, produced very turbid water. Maximum depth of the lake was about 1 m, conductivity was 215 $\mu\text{S}/\text{cm}$ and pH was 7.4.

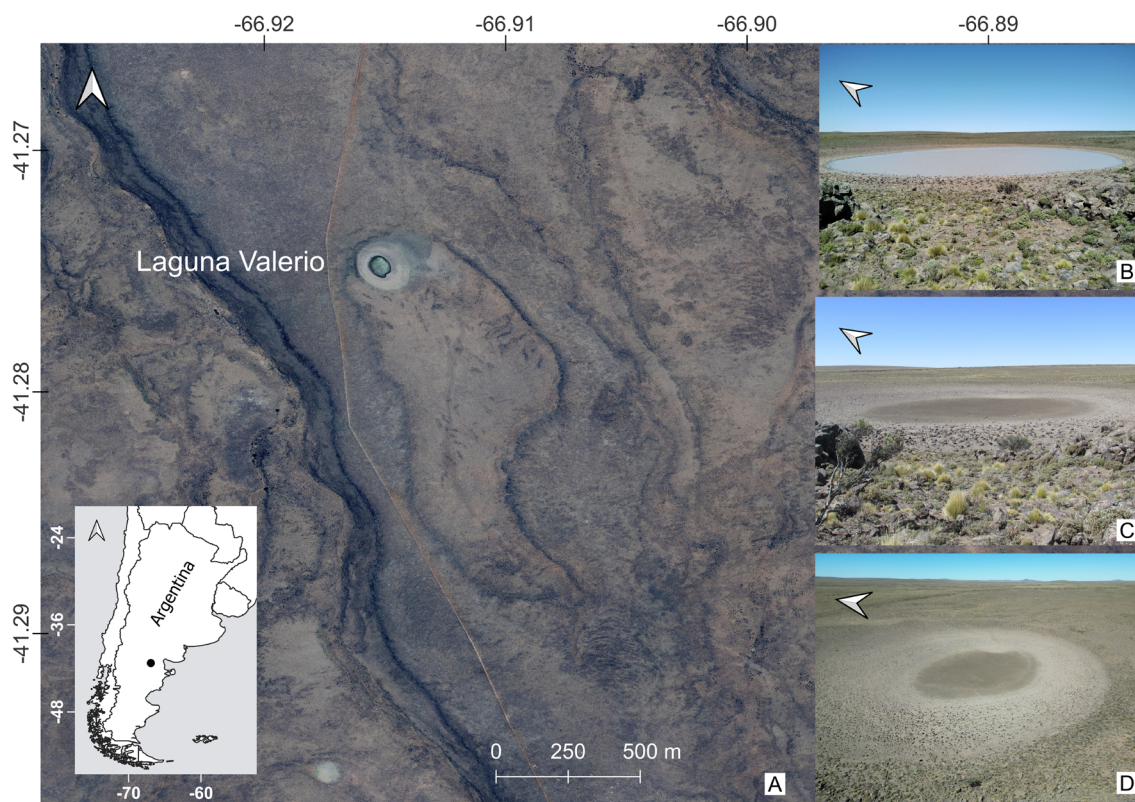


Fig. 1. Laguna Valerio within the Somuncurá Plateau as viewed from the QGIS Geographic Information System (left panel). The right panel features images of the lake taken in November 2022 (above) and March 2024 (center and bottom).

Specimens of Valerio Lake, Somuncurá, Patagonia, Argentina

Description: Living frustules linked side by side along the margins, forming short ribbon-like colonies. Colonies comprised 2-6 frustules (Fig. 2A). Cells not connected along their lengths, but rather at the gibbous portions of the undulate valve margins towards the poles and at the center. Chloroplast single H-shaped, with elongated lobes on either side of the frustule linked by a bridge in the center of the valve.

Light microscope observations of cleaned material (Fig. 2B): Valve margin undulate, slightly panduriform, with the central margin slightly gibbous. Valve apices broadly apiculate. Length: 32.6 to 44.0 μm ; Breadth: 6.3-9.9 μm . Raphe lateral, within a straight, lanceolate axial area. Proximal raphe ends straight; distal raphe ends not evident. Central area small, orbicular. Striae are radiate around the valve center, becoming convergent towards the poles. Striae more coarsely spaced and evident around the central area, parallel to radiate in orientation. Terminal nodules distinct.

Scanning Electron Microscopy (Fig. 3): Externally: valve covered with small, circular, siliceous nodules, more densely packed around the margins than across the center. Nodules on the valve face and mantle. Along the margin thick, rounded to bluntly conical spines regularly distributed, more densely arranged at the apices (ca. 6-16/10 μm). Raphe bordered by a thin silica rim. Proximal raphe ends slightly curved. Areolae with small, round openings. Distal raphe ends curved towards one side; not extending onto the mantle. Internally (Fig. 4): central nodule small.

More rectangular than seen with LM where it looks orbicular. Proximal raphe ends small and weakly deflected to one side of the valve. Areolae of the curved striae occluded by volae. Raphe bordered by an elevated rib. Terminal raphe ends with distinct helictoglossae, positioned away from the valve terminus.

The specimens from Valerio Lake share with *Playaensis circumfimbria* Spaulding & Kociolek the following characters: triundulate, slightly panduriform valves with apiculate apices; a raphe bordered by an elevated longitudinal rib; marginal siliceous spines; areolae occluded by volae; and helictoglossae positioned away from the valve terminus. These features constitute the diagnostic characters of the genus *Playaensis* as defined by Spaulding *et al.* (2002). Minor differences between the Somuncurá population and the type material of *P. circumfimbria* from New Mexico were noted: slightly more lineolate areolae in the central area, slightly curved (rather than straight) proximal raphe ends, more conical (rather than flange-like) spine morphology, and distal raphe ends that terminate well before the apex without extending onto the mantle.

The two populations also differ slightly in size (Somuncurá population: length 32.6-44.0 μm , breadth 6.3-9.9 μm ; *P. circumfimbria sensu* Spaulding *et al.* 2002: length 28-37 μm , breadth 6.0-8.5 μm). Independent of the Somuncurá material, a re-examination of *Navicula toba* Maidana & Herbst (1994) reveals that this species shares all diagnostic characters of the genus *Playaensis*: triundulate valves

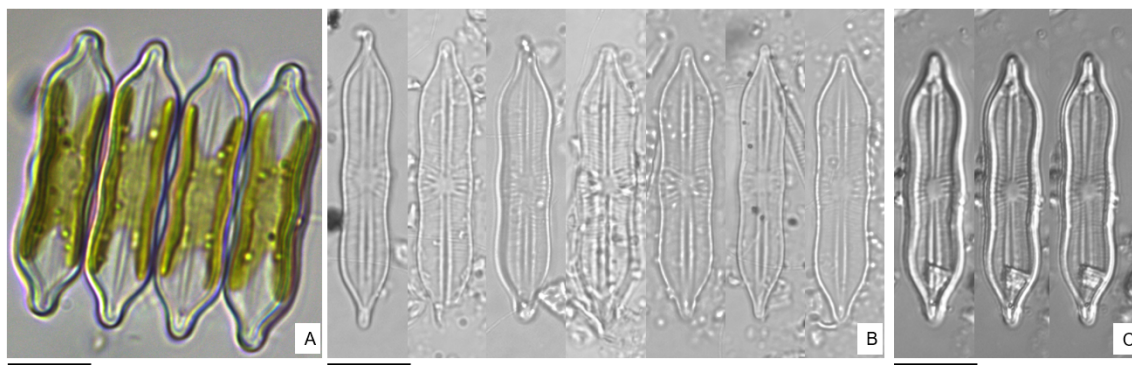


Fig. 2. *Playaensis toba* (light microscopy) of Somuncurá. **A:** Living specimens showing shape of colony and H-shaped plastid. **B:** Size diminution series of oxidized specimens. **C:** Phase contrast microscopy pictures of the same specimen at different focus levels. Scale bars= A-C: 10 μm .

with apiculate apices, marginal spines visible in SEM (Maidana & Herbst, 1994: Fig. 5D), and dimensions (length 29–36 μm , breadth 8–9 μm) fully consistent with the genus. The original description further notes that striae are radiate at the center and parallel towards the poles, with irregularly abbreviated central striae —

a pattern identical to that observed in *P. circumfimbria* and in the Somuncurá material. Differences in the extension and shape of the external distal raphe ends (terminating well before the apex and not extending onto the mantle in the Argentinian population) and the development of short filaments (not recorded for

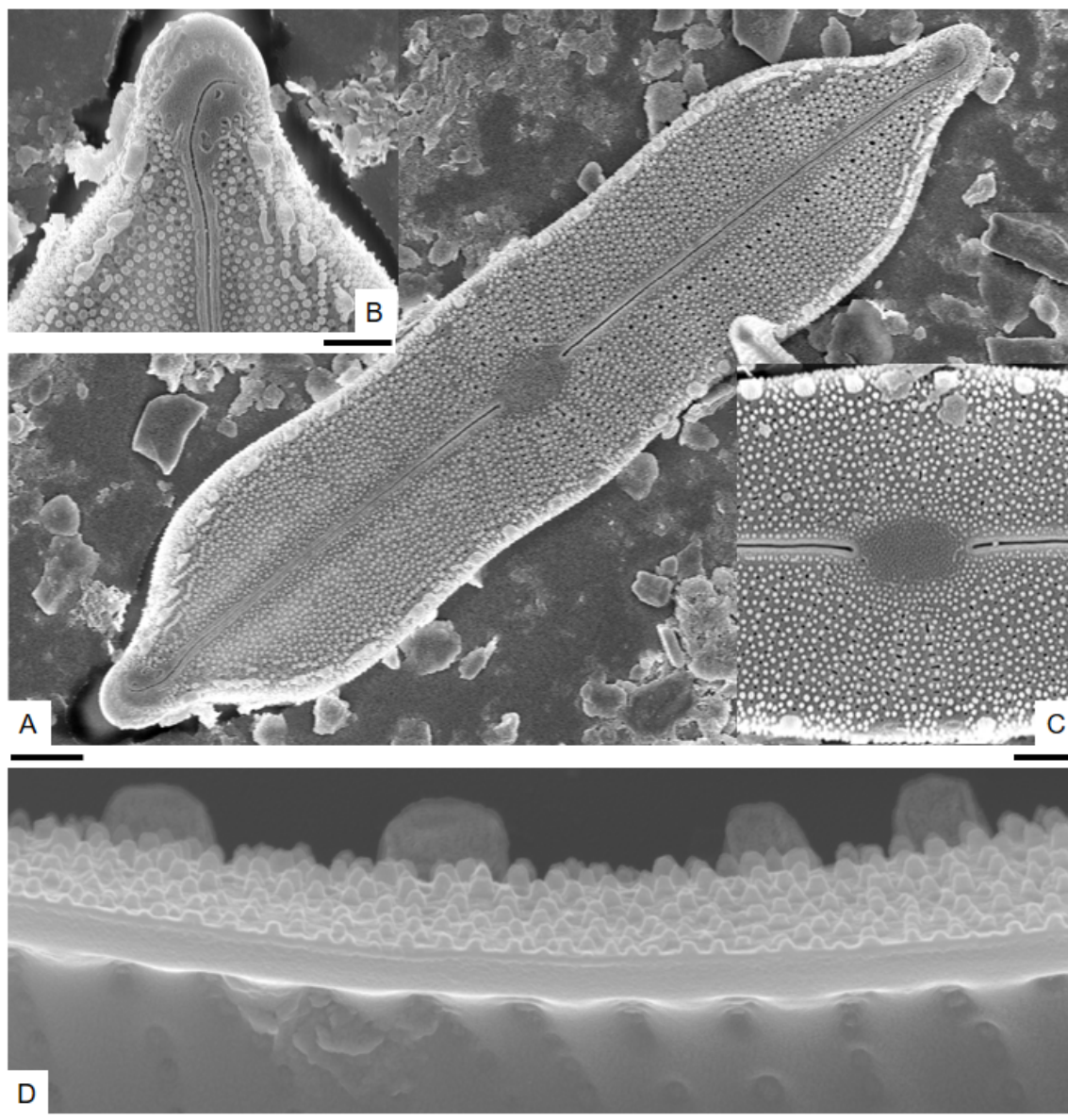


Fig. 3. External valve views of *Playaensis toba* of Somuncurá (scanning electron microscopy). **A:** General valve view. **B:** Detail of the valve apex showing terminal raphe end slightly curved. **C:** Detail of the valve center showing proximal raphe ends slightly curved and elliptic central area. **D:** Detail of the valve mantle showing the small siliceous nodules densely arranged. Scale bars= A: 2 μm ; B–C: 1 μm ; D: 300 nm.

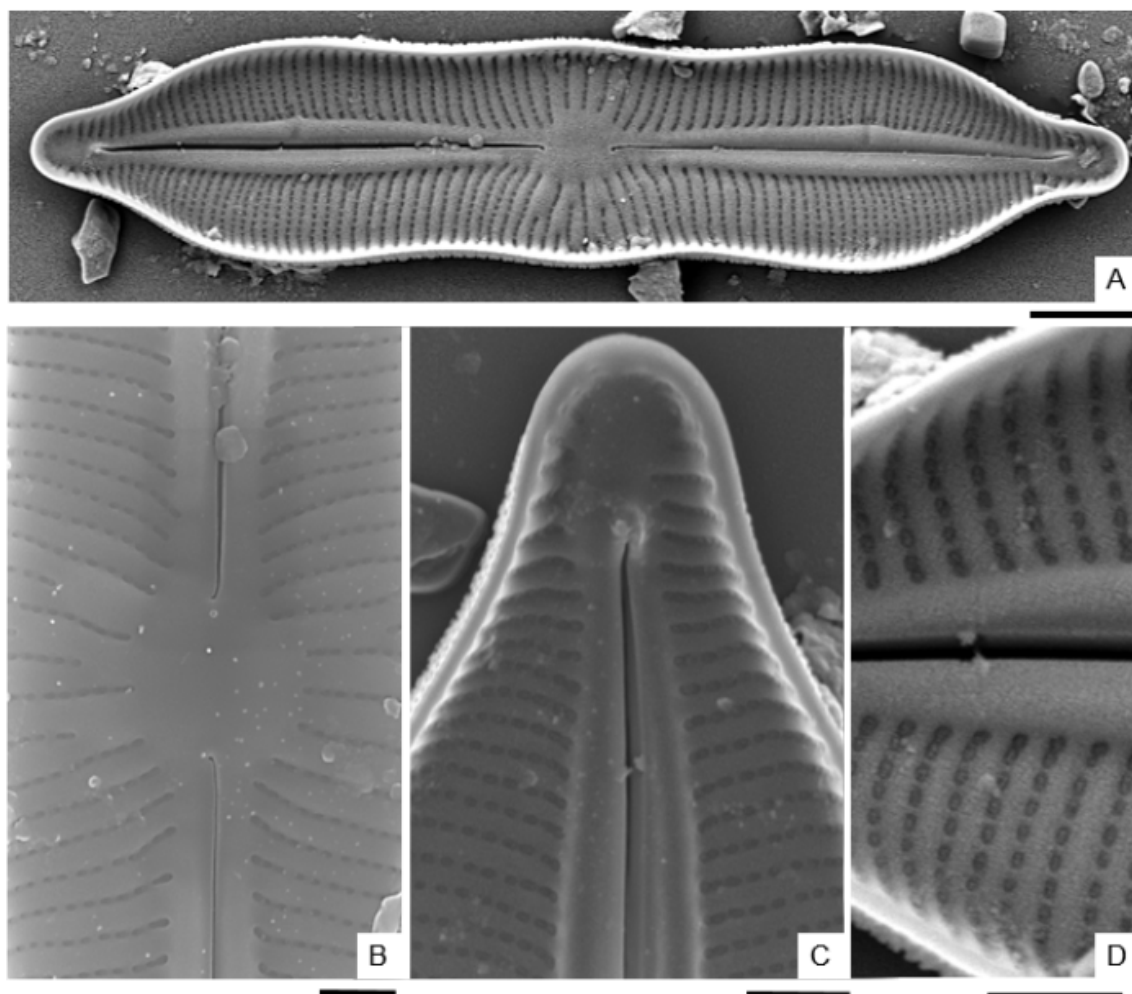


Fig. 4. Internal valve views of *Playaensis toba* of Somuncurá (scanning electron microscopy). **A:** General valve view. **B:** Detail of the valve center showing proximal raphe ends and striae distribution at the central area. **C:** Detail of the valve apex showing terminal raphe endings and helictoglossa. **D:** Detail of the striae showing the areolae with volae occlusions. Scale bars= A: 3 µm; B-D: 1 µm.

P. circumfimbria previously) were also noted. There are also differences in the degree of silicification (more nodules across the valve in the Argentinian population of Somuncurá) and shape of the spine-like ridges (more conical versus elongated flanges in the Argentinian population).

Comparison of all available morphological data (Table 1) indicates that *N. toba*, *P. circumfimbria*, and the Somuncurá specimens represent a single taxonomic entity, despite the slight morphological differences between them, attributable to intraspecific phenotypic variations. Because Maidana and Herbst's

species has nomenclatural priority, the correct name for this species should be: *Playaensis toba* (Maidana & Herbst) Sala, Kociolek & Labaut, *comb. nov.* and *Playaensis circumfimbria* Spaulding & Kociolek 2002 is a heterotypic synonym.

We therefore propose the following new combination:

Playaensis toba* (Maidana & Herbst) Sala, Kociolek & Labaut *nov. comb.

Basionym. *Navicula toba* Maidana & Herbst 1994: 35, Fig. 3D

Synonym. *Playaensis circumfimbria* Spaulding & Kociolek in Spaulding *et al.* 2002: 136, Figs 1-5, 11-18

Lectotype (designated here). Fig. 3D (Maidana & Herbst, 1994)

Epitype (designated here). Fig. 2C, in LPC 17737, Herbario del Museo de La Plata, Universidad Nacional de La Plata. Valerio Lake (Laguna Valerio) (41° 16' 29.72" S; 66° 54' 54.07" W), Meseta de Somuncurá, Patagonia, Argentina

Original description (Maidana & Herbst, 1994: 35).

Valvis triundulatis, apicibus apiculatis. Striis transversis punctatis centralibus radiantibus et curvatis, ad polos parallelis. Striis centralibus irregulariter abbreviatis. 29-36 μm longis et 8-9 μm latis, striis transversis 19-24 in 10 μm ad centrum et 22-24 in 10 μm ad polos, 40 areolae in 10 μm .

Observations. Maidana & Herbst mention that they observed with SEM a valve with marginal spines irregularly arranged on the interestriae (Maidana

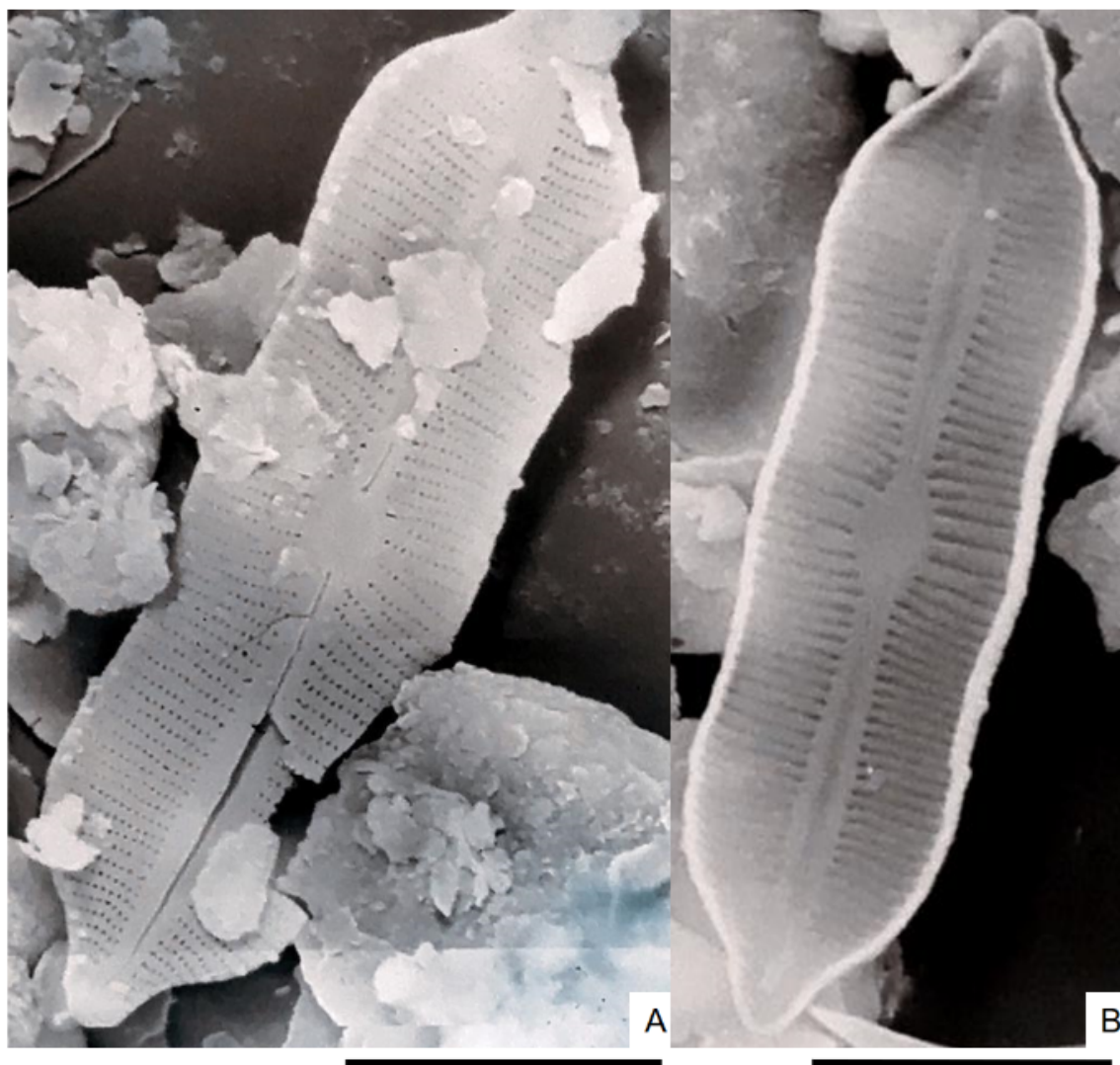


Fig. 5. *Playaensis toba* of Chaco (scanning electron microscopy). **A:** External valve view, **B:** Internal valve view. Photos courtesy of Nora I. Maidana. Scale bars= A-B: 10 μm .

& Herbst 1994: Fig. 5D). The general valve outline resembles *Navicula bicontracta* Østrup (Hustedt, 1930: 307, Fig. 549) but in this species the striae have regular and radial arrangement all along the valve and dimensions and striae density is lower (20-26 μm length; 7-8 μm wide; 14-16 striae in 10 μm).

Comments. The holotype and type material of *Navicula toba* (NIM-Ch002 and BAFC 1469, respectively) are missing (N. Maidana pers. comm.) but Dr. Maidana provided two SEM photos (Fig. 5). Although there are small differences in morphometric data (Table 1) and the specimens are eroded, there are some characters that differentiate them from *P. circumfimbria* populations of New Mexico (e. g. proximal external raphe ends slightly curved). However, we consider these differences as morphological variations of the same species.

Besides, due to iconotype cited is a drawing (Fig. 3D, Maidana & Herbst 1994), and other images of the species consist of a single light micrograph of insufficiently preserved material and does not permit evaluation of some of the ultrastructural characters of the genus *Playaensis* (e.g. raphe linear and thread-like, valves are ornamented, with conspicuous spherical nodules and fin-like spines and helictoglossae distinct). Under these circumstances, it is suitable to designate an epitype from the Somuncurá samples until samples NIM-Ch002 and BAFC 1469, if ever recovered. The aim is to clarify the application of the name *Playaensis toba* and to provide an unambiguous morphological reference based on well-preserved, ultrastructurally documented material.

DISCUSSION

Ephemeral or temporary aquatic ecosystems represent a harsh and rigorous environment for diatoms, e.g., hydric stress, solar exposition and desiccation (Novais & Morais, 2024), in which the community traits are the result of a long evolutionary process towards adaptation (Elias *et al.*, 2015). Habitats with fluctuating environmental conditions, such as periodic drying are also favourable to result in different morphologies of valves (Andrejić *et al.*, 2018).

We consider that the slight ultrastructural morphological differences between *Playaensis toba* from Somuncurá (Argentina) and from New Mexico (USA) can be related to phenotypic plasticity. For example, the differences in the degree of silicification could be the result of differences in the amounts of available silica in the surrounding environment. Concentrations of silica in Payton Lake, New Mexico site, was 16 mg/L which the authors considered as excess of normal cell requirements, and explains the elaborate ornamentation of this population. Neither Maidana & Herbst (1994), nor the present study recorded silica levels in water that could allow comparisons to explain the differences in silicification of the valves between populations.

To date, besides *Playaensis toba* comb. nov. and *Playaensis furtiva*, there are two other accepted *Playaensis* species, namely the small taxa *Playaensis citrus* (Krasske) Reichardt, and *Playaensis citroides* (Lange-Bertalot, Cavacini, Tagliaventi & Alfinito) Reichardt. In 2018 Reichardt transferred them from the genus *Craticula* - *C. citrus* (Krasske) Reichardt and *C.*

Table 1. Measurements of the *Playaensis* species. * Measures from Bahls, L. (2013), In *Diatoms of North America*. Retrieved October 24, 2025, from https://diatoms.org/species/49486/playaensis_circumfimbria

Taxon	Reference	Length (μm)	Breadth (μm)	Striae/ 10 μm	Areolae	Marginal spines/10 μm
<i>Playaensis circumfimbria</i>	Spaulding <i>et al.</i> (2002)	32-37	7-8.5	22-24	(30-45/10 μm)* or 10-11 per striae	20-24
Specimens of Somuncurá	This study	33-44	6.3-9.9	30-36	32-44 /10 μm or 3-11 per striae	6-14
<i>P. furtiva</i>	Spaulding <i>et al.</i> (2002)	28-32	6.0-7.0	18-20	3-9 per striae	ND
<i>Navicula toba</i>	Maidana & Herbst 1994	29-36	8.0-9.0	19-24	40/10 μm 8-14 per striae	ND

citroides Lange-Bertalot *et al.* 2003. These taxa are known mostly from Europe (e.g. Hustedt, 1961, 1966) though the former was also recorded from Luzon, Philippines (Hustedt, 1966). However, these taxa lack the panduriform valve outline, with central margin slightly gibbous (triundulate outline), the prominent longitudinal narrowly lunate rib bordering the raphe, and central area broad and circular that characterize the genus as circumscribed by Spaulding *et al.* (2002). Including these two species into *Playaensis* would require a significant emendation of the generic concept; however, such a modification lacks support from the morphological data currently available. Pending a formal revision of the genus, we consider to retain these taxa under their previous names before the combinations made by Reichardt (2018).

Playaensis resembles the monotypic genus *Kulikovskiyia* S. Roy *et al.* (Roy *et al.* 2020), a genus heretofore found only in Asia, in terms of valve outline and apex, but differs significantly in the chloroplast structure (*Playaensis* has a single chloroplast, *Kulikovskiyia* has two chloroplasts) and in the organization of the valve. *Kulikovskiyia*, for example, has numerous external longitudinal lines of silica running the length of the valves. The valve margin has long, conical spines. Internally the valves of *Kulikovskiyia* have axial plates that overlay portions of the striae (Roy *et al.*, 2020). Some of the most important similarities between these genera are the well-developed slats of silica (at least in *P. furtiva*), presence of marginal spines, external siliceous nodules, and their presence in shallow environments (i.e., ephemeral habitats) (Roy *et al.*, 2020). Also, *P. toba*, *P. furtiva* and *Kulikovskiyia triundulata* are rare to extremely rare in samples (Spaulding *et al.*, 2002; Roy *et al.*, 2020; present study). Probably, both genera are the so-called small generalists of disturbed habitats (Novais & Morais, 2024).

Present results broaden the distribution of the genus *Playaensis*, previously considered as endemic to North America (Kociolek, 2018), including North and South America. However, a landscape of playa lakes across the new world, from South America, Central America and to North America, provides a possible set of suitable habitats for the distribution of the two species of the genus. It is anticipated that further records of *Playaensis*

will emerge as ephemeral wetlands across the Americas are more extensively documented. How much they are in contact with one another, whether there is gene flow, and what differences might have accrued over a time scale that is not reflected in morphological (but in molecular) differences would all be interesting future questions for continued research on this enigmatic genus.

AUTHOR CONTRIBUTIONS

All authors have equally carried out the collection of data, its interpretation and the writing of the manuscript.

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