

New and interesting species of the genus *Gomphosinica* Kociolek, You et Wang (Bacillariophyta) from Xizang Autonomous Region, China

Hanxun Jv^{1,6}, Yutong JIANG¹, Xinyuan NA¹, John P. KOCIOLEK², Huan ZHU³, Guoxiang LIU³, Maxim KULIKOVSKIY⁴, Yanling LI⁵, Yawen FAN^{1,*} & Yan LIU^{1,*}

¹College of Life Science and Technology, Harbin Normal University, 150025 Harbin, China, *Corresponding authors e-mails: yawenf@163.com; yanliuhrb@hotmail.com

²Museum of Natural History and Department of Ecology and Evolutionary Biology, University of Colorado, 80309 Boulder, CO, USA

³Key Laboratory of Algal Biology, Institute of Hydrobiology, Chinese Academy of Sciences, 430072 Wuhan, China

⁴K.A. Timiryazev Institute of Plant Physiology RAS, IPP RAS, 35 Botanicheskaya St., 127276, Moscow, Russia

⁵Institute for Ecological Research and Pollution Control of Plateau Lakes, School of Ecology and Environment Science, Yunnan University, 650500 Kunming, China

⁶Instrumental analysis center of Northeast Agricultural University, 150038 Harbin, China

Abstract: During the investigation of freshwater biodiversity of Xizang Autonomous Region, diatom samples were collected from several habitats and two new species were discovered and are formally described herein, namely, *Gomphosinica stoermeri* Liu, Kociolek et Li sp. nov., and *Gomphosinica qii* Liu, Kociolek et Li sp. nov. Both of these new species have biserial striae, straight raphe ends, pseudosepta at both ends and a hooded stigma covering in the central area. *Gomphosinica stoermeri* can be separated from other similar species by its clavate outline, bluntly rounded headpole, rounded footpole, small and rounded central area formed by 2–4 short striae. *Gomphosinica qii* is relatively small, has small and more elliptical valves, small bluntly headpole and narrow footpole, round to rhombic central area formed by 2–6 short striae. Specimens which appear very similar to *Gomphosinica hedinii* were observed, but the outline and shape of central area do not match the original of *Gomphosinica hedinii*; herein we document these specimens and designate them as “*Gomphosinica* cf. *hedinii*”. *Gomphosinica linearis* was also observed, and we provide a more detailed description of it based on LM and SEM. Differences between the two newly described species and other known species of the genus are also discussed.

Keywords: gomphonemoid diatoms, *Gomphosinica*, new species, Xizang

INTRODUCTION

Kützing established the family Gomphonemataceae (KÜTZING 1844) based on genus *Gomphonema* Ehrenberg (EHRENBERG 1832), which is worldwide in its distribution in freshwaters. Members in this family have key characters such as being asymmetrical along the transapical axis in both valve and girdle view, apical pore fields (APF) at the footpole, a stigma positioned in the central area (though there can be taxa lacking a stigma or species with multiple stigmata), and septa and pseudosepta present at apices. The generic composition of the Gomphonemataceae is in flux, and has changed significantly based on both morphology and molecular data.

Based on its gomphonemoid symmetry, presence of stigmata and APF at the footpole, the genus *Didymosphenia* Schmidt (SCHMIDT 1899) was formerly included in the Gomphonemataceae (e.g. HUSTEDT 1930;

KRAMMER & LANGE–BERTALOT 1986; ROUND et al. 1990). Cladistic analysis of morphological data of the apical pore field-bearing genera showed *Didymosphenia* to be more closely to cymbelloid diatoms than to other gomphonemoid diatoms (KOCIOLEK & STOERMER 1988), a systematic position that has also been indicated with molecular data (e.g. KULIKOVSKIY et al. 2019). Another genus, *Gomphonella* Rabenhorst, was revived by JAHN et al. (2019), and this genus has typical gomphonemoid frustules, APF at footpole, and pseudosepta present at both apices, all suggesting similarity with other members of the gomphonemoid group, but molecular data were ambiguous in its systematic position, with some data showing this genus belonging to Cymbellaceae rather than the Gomphonemataceae, or support for its position within the Cymbellales was not strong (JAHN et al. 2019).

In the classification scheme of ROUND et al. (1990) the Gomphonemataceae Kützing included the genera

Gomphonema, *Didymosphenia*, *Gomphoneis* Cleve, *Reimeria* Kociolek et Stoermer and *Gomphopleura* Reichelt et Tempère. Cox (2015) amended the description of the Gomphonemataceae mostly based on the chloroplast and valve morphology, and nine genera were included within the family, including *Delicata* Krammer (*Delicatophycus* Wynne), *Encyonema* Kützing, *Encyonopsis* Krammer, *Placoneis* Merechkowsky, *Pseudencyonema* Krammer, *Reimeria* Kociolek et Stoermer, *Gomphoneis*, *Gomphonema*, *Gomphopleura*, although the former five genera possess cymbelloid symmetry and no APF. Recent studies based on molecular data yielded consistent results within this cymbelloid–gomphonemoid group. *Encyonema*, *Didymosphenia* and *Placoneis* were clustered together with *Cymbella* and *Cymbopleura* and, combined with the *Geissleria* and *Paraplaconeis*, formed the lineage of Cymbellaceae in KULIKOVSKIY et al. (2019). The newly-proposed genus *Gomphadelphina* Jahn et Abarca was established in 2023 (ABARCA et al. 2023), which was the 10th genus in this group. It is distinguished by biserial striae, one stigma with slit-like opening internally, and longitudinal lines were produced by axial plate and represent the “*Gomphoneis herculeana*” group of KOCIOLEK & STOERMER (1989). Recognition of this genus by ABARCA et al. (2023), however, renders the genus *Gomphonema* as non-monophyletic.

Gomphosinica was established by KOCIOLEK et al. (2015), with the genotype as *Gomphosinica geitleri* (Kociolek et Stoermer) Kociolek, You et Wang. This genus has gomphonemoid valves and an APF at the footpole, as well as septa and pseudosepta present at both ends. The conspicuous differences between this genus and *Gomphonema* and its allies include its biserial striae with small round areolae, and stigma openings covered by a hooded structure, a feature with many small and round openings internally. This genus was assigned to the Gomphonemataceae, but the areolae structure showed some similarity with *Gomphonella*, and other cymbelloid genera. Further research with both morphological and molecular data analyses is needed to clarify the position of this genus.

Until now, a total of 13 *Gomphosinica* taxa have been discovered, most of them endemic to their type locality in either China or USA (KOCIOLEK et al. 2015; CHENG et al. 2018; YANG et al. 2019). An exception is *Gomphosinica hedinii* (Hustedt) Kociolek, You et Wang, which has relatively wide distribution (ZHU & CHEN 2000; KOCIOLEK et al. 2015; YANG et al. 2019). In China, species seem to prefer high elevation, epiphytic and alkaline habitats (KOCIOLEK et al. 2015; CHENG et al. 2018; YANG et al. 2019). It is a genus that seems to be indicative of pristine conditions (KOCIOLEK et al. 2015).

Diatoms of Xizang were illustrated by ZHU & CHEN (2000) and more than 900 taxa were recorded, but new species from the region continue to be discovered (LIU Q. et al. 2019, 2020; LIU Y. et al. 2022). These new discoveries have shown that the biodiversity of diatoms in Xizang still requires additional exploration. During the second Xizang Plateau Scientific Expedition, *Gomphosinica* species were relatively common in several samples. In the current report, we describe two new species of *Gomphosinica*, based on their valve morphology, made with light microscopy (LM) and scanning electron microscopy (SEM). Differences between the new species described herein and other known species are documented.

MATERIALS AND METHODS

Samples were collected from Xizang, during the biodiversity investigation from 2014 to 2023. Samples containing the new species were collected from Baingoin, Xainza, and Nyima counties. The habitats sampled included a variety of lentic and lotic environments. The sampling information is provided in Table 1. Terminology descriptions followed the KOCIOLEK et al. 2015.

Benthic and epiphytic samples were fixed with 4% formaldehyde in the field, then cleaned at Key laboratory of Biodiversity of Aquatic Organisms, following the method described in GE et al. (2022). Cleaned materials were preserved in distilled water in glass bottles (10 ml). Naphrax was used to make permanent slides for LM with a Zeiss Imager A2 microscope equipped with a digital camera (AxioCam MRc 5) and observed with DIC (differential interference contrast)

Table 1. The collection data of samples from Tibet. All samples were collected by Zhu H. et al.

Sample/ Slide	Locality	Coordinates	Habitat	Altitude (m)	Coll. date
THXZ2022031#(b)	Tibet Autonomous Region, Nagqu City, Baingoin County	31°19'09.48" N, 89°25'39.00" E	benthos, periphyton	4826	04/30/22
THXZ2023032#	Tibet Autonomous Region, Nagqu City, Baingoin County	31°19'09.84" N, 89°25'39.00" E	benthos, periphyton	4827	04/30/23
THXZ2014THE67	Tibet Autonomous Region, Nagqu City, Xainza County, Spring stream	30°55'49.55" N, 88°42'35.35" E	benthos, periphyton	4650	09/04/14
THXZ2014THE72	Tibet Autonomous Region, Nagqu City, Xainza County, Qiaguicuo Lake	31°49'57.04" N, 88°16'01.23" E	periphyton	4650	09/05/14
THXZ2014THE87	Tibet Autonomous Region, Nagqu City, Nyima County, Dangqiongcuo Lake	31°02'43.23" N, 89°05'37.47" E	benthos	4475	09/07/14

optics (Zeiss, Jena, Germany at Harbin Normal University). Cleaned material was air-dried and coated with gold–palladium for 1 minute. SEM observations were made with a Hitachi S-4800 field emission SEM (Hitachi, Tokyo, Japan at Harbin Normal University) at an operating voltage of 15 kV. Diatom images were compiled with Photoshop 7.0. Cleaned material and permanent slides are archived at the Key Laboratory of Biodiversity of Aquatic Organisms, Harbin Normal University.

RESULTS

Gomphosinica stoermeri Yan Liu, Kocielek et Yanling Li sp. nov. (Figs 1–26)

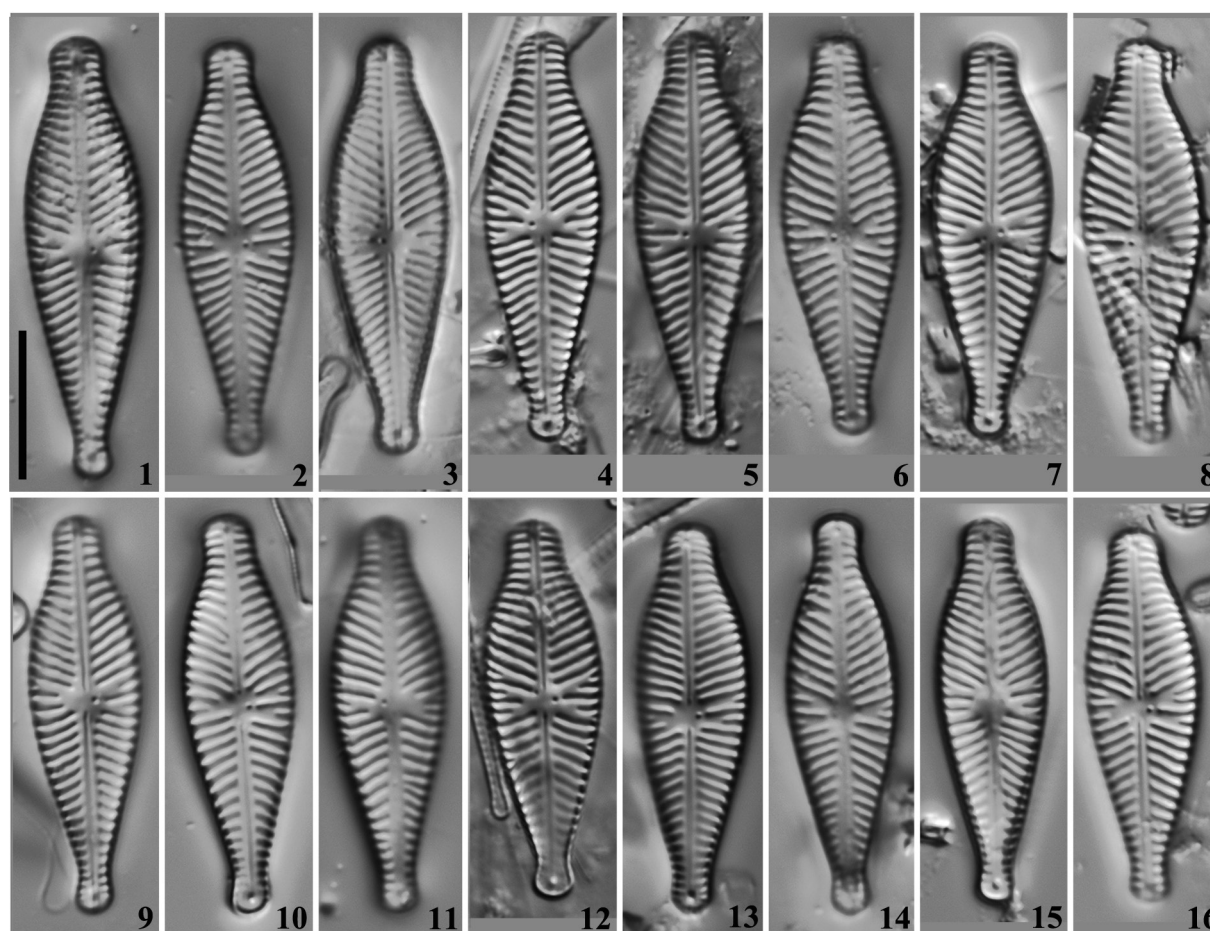
Description

LM (Figs 1–16): Valves heteropolar, clavate-shaped, distinctly asymmetrical along the transapical axis. Head-pole slightly protracted, forming a small capitate, rounded end. Footpole narrow, capitate and rounded. Valve length 20.0–30.0 µm, width 6.5–8.5 µm. Axial area linear and narrow. Striae in the center shorter, forming a round to rhombic central area, one stigma present in the central area. Striae strongly radiate at valve center, and becoming nearly parallel at the apices, 11–13 in 10 µm. **SEM (Figs 17–26):** Externally, raphe straight, proximal raphe ends straight, slightly enlarged (Fig. 19). At head-

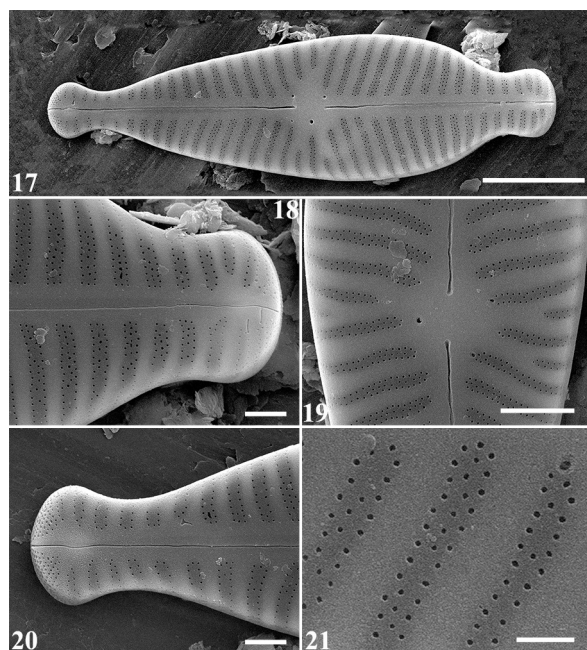
pole, distal raphe ends straight or slightly curved (Fig. 18), extending onto the mantle. At footpole, distal raphe end straight, bisecting the APF. APF is composed by very small round porelli which are similar in morphology to the valve areolae (Fig. 20). Striae are composed of 2–3 rows of areolae (Fig. 21), extending from the valve face onto the mantle. Areolae with round openings. One stigma present in the central area, slightly larger than the valve areolae, with round opening (Fig. 19). Internally, proximal raphe ends small, hooked-shaped, curved towards the stigma side of the valve (Figs 22–24). Helictoglossa slightly offset from the raphe. Areolae unoccluded, with small and round openings, interstriae well developed, thickened between striae (Fig. 26). Stigma opening is typically sieve shaped, covered by a hooded structure with small and round pores (Fig. 24). Porelli located between thickened ribs at the footpole (Fig. 25). Pseudosepta present at both apices (Figs 22, 23, 25).

Holotype: HANU! Individual in slide THXZ2014THE72, in collection of Aquatic Biodiversity Laboratory of College of Life Science and Technology, Harbin Normal University, Harbin, China. Holotype specimen illustrated in Fig. 2.

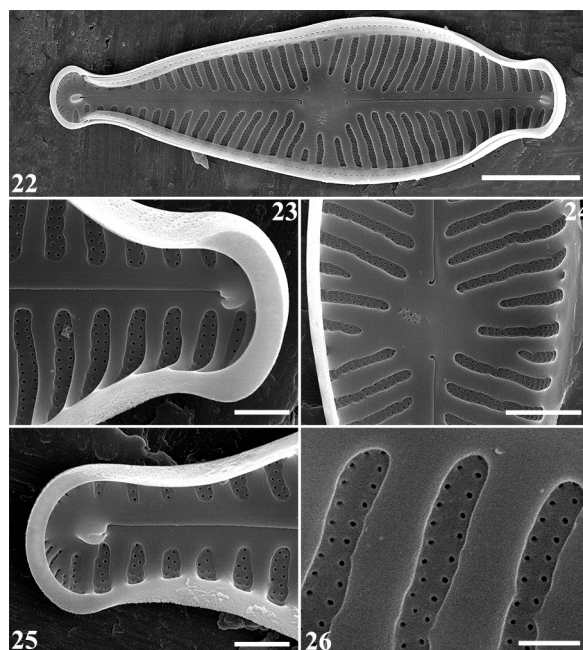
Isotype: Material no. THE72, slide no. THE72s. Cleaned material housed in the Key laboratory of Algal Biology, Institute of Hydrobiology, Chinese Academy of Science,



Figs 1–16. *Gomphosinica stoermeri* sp. nov., LM. Scale bar 10 µm.



Figs 17–21. *Gomphosinica stoermeri* sp. nov., SEM, external view: (17) external view of the whole valve; (18) headpole of valve, showing the distal raphe end; (19) central area of the valve, showing the proximal raphe ends and stigma; (20) footpole of valve, showing the distal raphe end bisect the APF; (21) magnification of striae, striae composed by 2–3 rows of areolae. Scale bars 5 μ m (17), 2 μ m (19), 1 μ m (18, 20) and 500 nm (21).



Figs 22–26. *Gomphosinica stoermeri* sp. nov., SEM, internal view: (22) internal view of the whole valve; (23) headpole of valve, showing the pseudosepta and helictoglossa; (24) central area of the valve, showing the hooded stigma opening; (25) footpole of valve; (26) magnification of striae, showing the interstriae and unoccluded areolae openings. Scale bars 5 μ m (22), 2 μ m (24), 1 μ m (23, 25) and 500 nm (26).

Wuhan, China.

Type locality: Qiagui Lake, Shenzha county, Xizang, China.

Etymology: Named for the excellent American diatomist Dr. Eugene F. Stoermer.

Ecology: Samples in which this new taxon was identified were collected from periphyton habitats; the species that co-occurred with this new species included *Fragilaria tenera* (Smith) Lange–Bertalot, *Aneumastus minor* (Hustedt) Lange–Bertalot, *Mastogloia elliptica* var. *dansei* (Thwaites) Cleve, *Mastogloia smithii* var. *amphicephala* Grunow, *Encyonema lacustre* (Agardh) Pantocsek and others. This species was also observed in samples THXZ2022031#b, THXZ2023032#, THXZ2014THE67, THXZ2014THE87, in habitats of benthic and periphyton in lakes or rivers, at altitudes between 4475 and 4826 m above sea level.

***Gomphosinica qii* Yan Liu, Kociolek et Yanling Li sp. nov. (Figs 27–51)**

Description

LM (Figs 27–41): Valve heteropolar, small and nearly elliptical shaped, asymmetrical about the transapical axis. Headpole slightly protracted, with nearly bluntly round end. Footpole narrow with rounded end. Length 14.0–21.0 μ m, width 7.0–9.5 μ m. Axial area linear and narrow. Central area round to rhombic, one stigma present. Striae radiate in the center, becoming parallel near the apices, 10–12 in 10 μ m.

SEM (Figs 42–51): Externally, raphe straight, proximal raphe ends straight and slightly expanded to form a

small, round central pore (Fig. 44). At headpole, distal raphe end straight, extending onto the mantle (Fig. 43). At footpole, distal raphe end straight, bisecting the APF. APF composed of small, round porelli undifferentiated and not physically separated from the valve areolae (Fig. 45). Striae composed of two or three rows of areolae, with small and round openings (Fig. 46). Internally, proximal raphe ends curved to the stigma side of the valve (Fig. 47). Helictoglossae large, slightly offset from the raphe branches. Areolae unoccluded with small and round openings. Interstriae well developed, thickened between striae (Fig. 51). Stigma opening covered by hooded structure that has small pores (Fig. 49). Pseudosepta present at both apices (Figs 47, 48, 50).

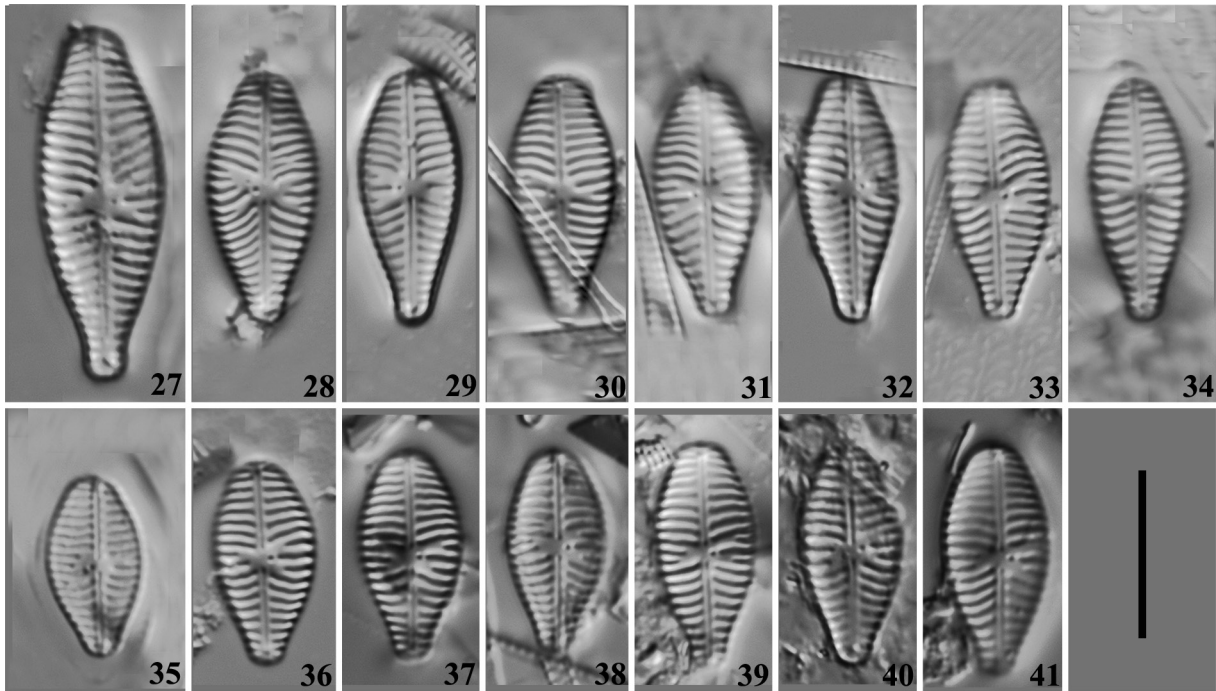
Holotype: HANU! Individual in slide THXZ2014THE72, in collection of Aquatic Biodiversity Laboratory of College of Life Science and Technology, Harbin Normal University, Harbin, China. Here illustrated as Fig. 29.

Isotype: Material no. THE72, slide no. THE72s. Cleaned material housed in the Key laboratory of Algal Biology, Institute of Hydrobiology, Chinese Academy of Science, Wuhan, China.

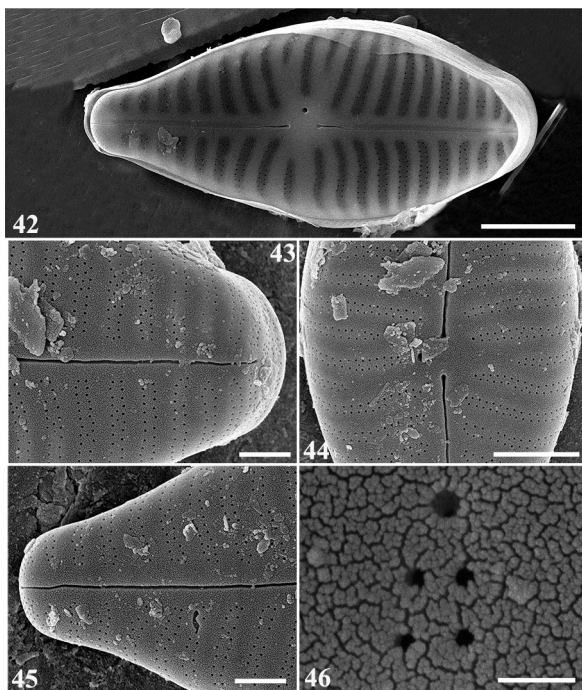
Type locality: Qiagui Lake, Shenzha county, Xizang, China.

Etymology: Named for excellent Chinese diatomist Prof. Yuzao Qi.

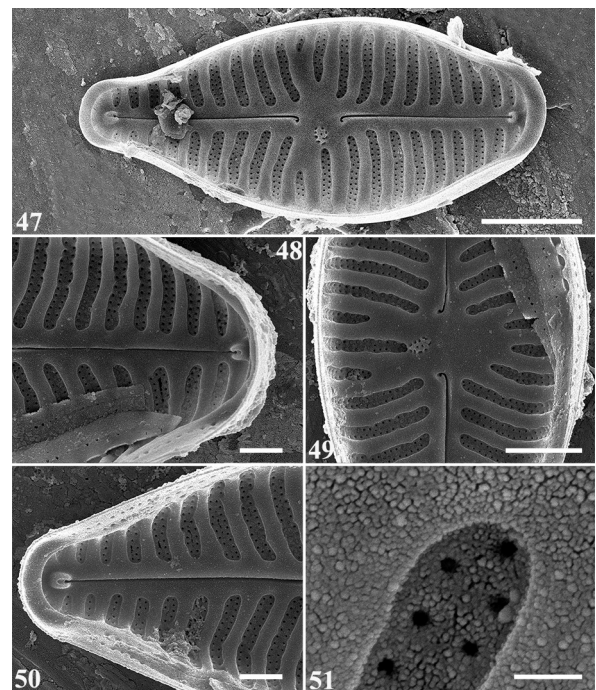
Ecology: This species was also observed in samples THXZ-2014THE67, THXZ2014THE87, in habitats of benthic and periphyton in lakes or streams, at altitudes 4475–4650 masl.



Figs 27–41. *Gomphosinica qii* sp. nov., LM. Scale bar 10 µm.



Figs 42–46. *Gomphosinica qii* sp. nov., SEM, external view: (42) external view of the whole valve; (43) headpole of valve, showing the distal raphe end; (44) central area of the valve, showing the proximal raphe ends; (45) footpole of valve, showing the distal raphe end bisect the APF; (46) magnification of striae, showing unoccluded areolae. Scale bars 3 µm (42), 2 µm (44), 1 µm (43, 45) and 200 nm (46).



Figs 47–51. *Gomphosinica qii* sp. nov., SEM, internal view: (47) internal view of the whole valve; (48) headpole of valve, showing helictoglossa; (49) central area of the valve, showing the hooded stigma and proximal raphe ends; (50) footpole of valve, showing pseudosepta; (51) magnification of unoccluded areolae between interstriae. Scale bars 3 µm (47), 2 µm (49), 1 µm (48, 50) and 200 nm (51).

Gomphosinica* cf. *hedinii* (Figs 52–77)*Description**

LM (Figs 52–67): Valves heteropolar, clavate-shaped. Headpole slightly protracted, capitate, apex bluntly rounded. Footpole protracted with rounded end. Valve length 24.5–37.5 μm , width 7.5–10.5 μm . Axial area linear and narrow, central area round to rhombic, with one stigma present. Striae strongly radiate at the center, becoming parallel near the apices, 8–10 in 10 μm .

SEM (Figs 68–77): Externally, raphe straight, proximal raphe ends straight, slightly enlarged (Fig. 70). At headpole distal raphe end straight, extending onto the mantle (Fig. 69). At footpole, distal raphe end bisects the APF (Fig. 71). Stigma opening round, larger than areolae (Fig. 70). Striae mostly biseriate, occasionally triseriate, extending onto the mantle. Areolar openings are small and round (Fig. 72). Apical pore field is mostly located on the mantle, separated from the valve striae by a large hyaline area. Porelli small and round, similar to valve areolae, arranged densely (Fig. 71). Internally, proximal raphe ends small, hook-shaped, curved to the stigma side of the valve (Fig. 73). Helictoglossae large and slightly offset from the raphe. Areolae unoccluded, with small and round openings. Interstriae well developed, thickened between striae (Fig. 77). Stigma opening hooded, covered by small and round openings (Fig. 75). Porelli at APF separated by radiate ribs (Fig. 76). Pseudosepta present at both ends (Figs 73, 74, 76).
Ecology: This taxon was observed from several loca-

tions in Xizang, such as rivers and lakes, at altitudes between 3610 and 4834 m above sea level, all samples were collected from benthic or periphyton habitats.

Remarks: The outline of our specimen is very similar to *Gomphosinica hedinii* as illustrated by HUSTEDT (1922; SIMONSEN 1987) and was found in similar habitats of reported *G. hedinii* (HUSTEDT 1922). But the size of our specimens are larger, with coarser striae density, the width of headpole looks slightly wider than the original description (length 23–26 μm , width 6–7 μm , striae number 15–17/10 μm in HUSTEDT 1922) and the specimen from Xinjiang (length 22–30 μm , width 6.0–6.5 μm , striae number 12–15/10 μm in KOCIOLEK et al. 2015).

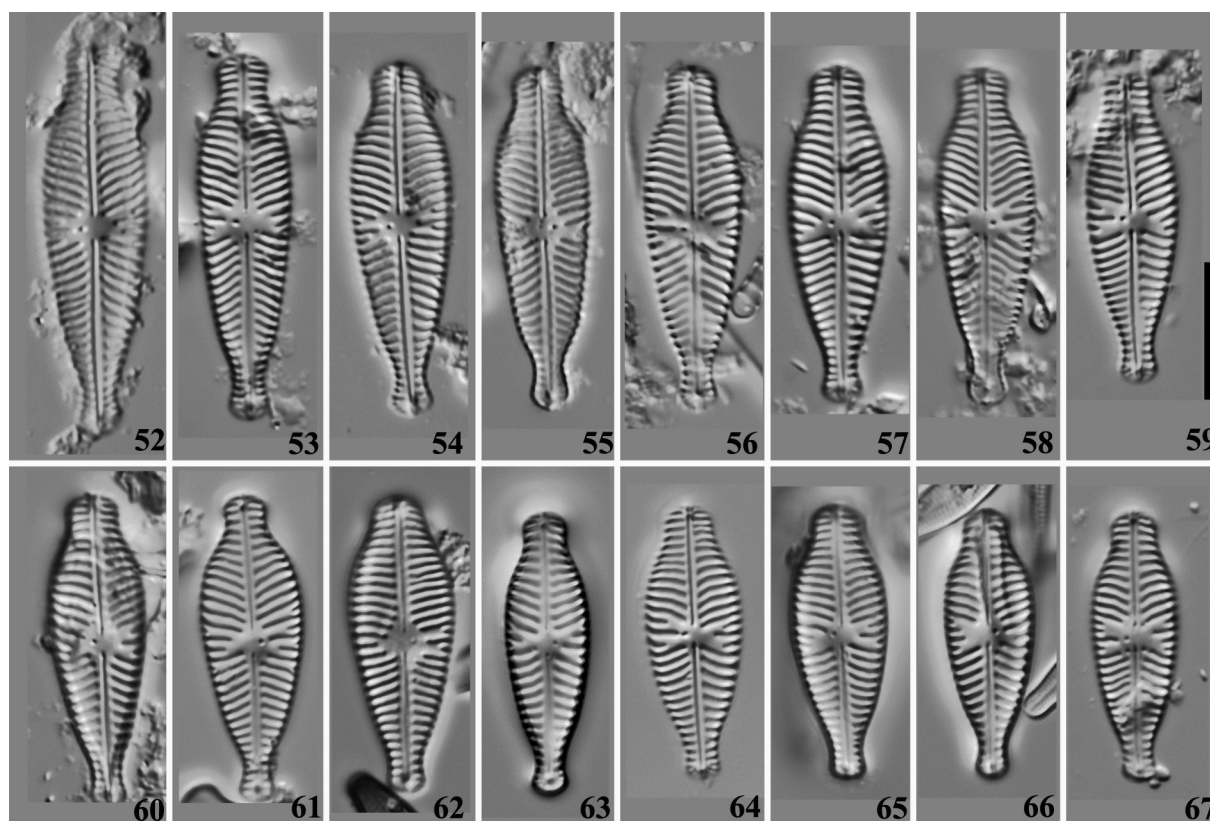
***Gomphosinica linearis* (Shi et Chen) Kociolek, You et Wang (Figs 78–94)**

Basionym: *Gomphonema hedinii* var. *lineare* Shi et Chen (SHI 1984)

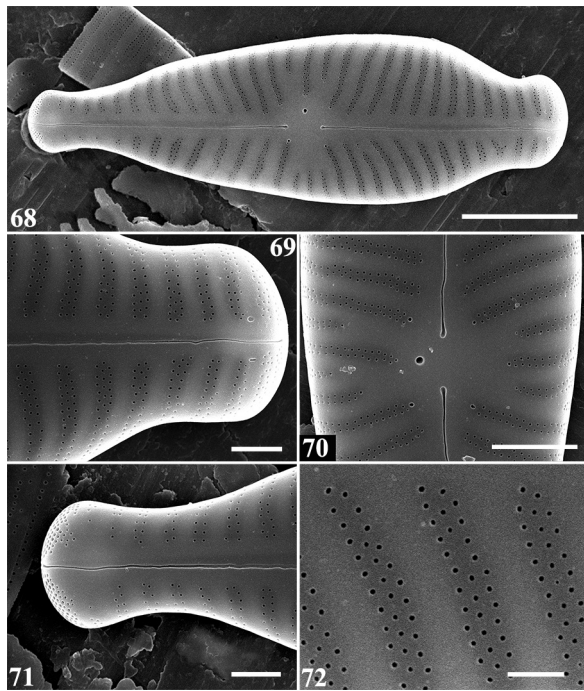
Description

LM (Figs 78–84): Valves heteropolar, clavate-shaped, headpole protracted forming a wide, capitate apex with bluntly rounded end; footpole narrow, capitate. Length 26.2–27.5 μm , width 5.3–6.5 μm . Axial area very narrow and linear. Central area nearly rectangular, one stigma present. Striae strongly radiate in the middle, and become convergent towards the ends, 12–14/10 μm .

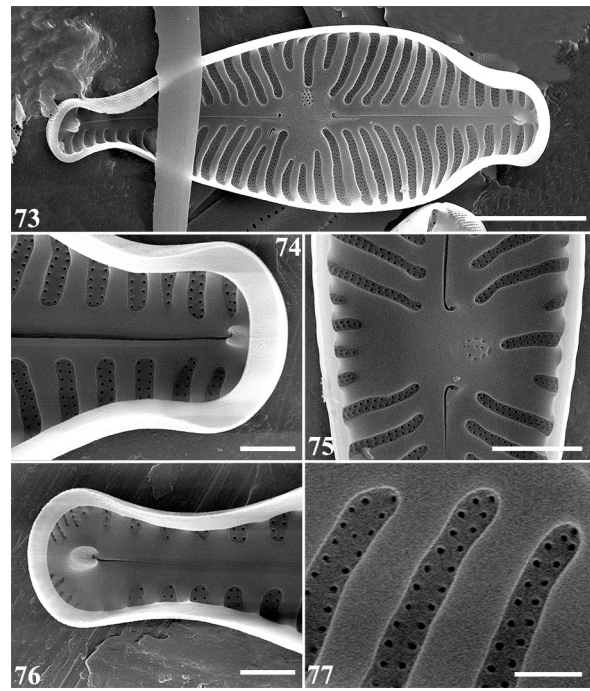
SEM (Figs 85–94): Externally, raphe straight, proximal raphe ends straight. Distal raphe ends straight, extending onto the mantle at the apices (Fig. 85). Distal raphe



Figs 52–67. *Gomphosinica* cf. *hedinii*, LM. Scale bar 10 μm .



Figs 68–72. *Gomphosinica* cf. *hedinii*, SEM, external view: (68) External view of the whole valve; (69) headpole of valve, showing the distal raphe end; (70) central area of the valve, showing the proximal raphe ends and stigma; (71) footpole of valve, showing distal raphe end bisect the APF; (72) magnification of striae, striae composed by 2–3 rows of areolae. Scale bars 5 μ m (68), 2 μ m (70), 1 μ m (69, 71) and 500 nm (72).



Figs 73–77. *Gomphosinica* cf. *hedinii*, SEM, internal view: (73) internal view of the whole valve; (74) headpole of valve, showing pseudosepta; (75) central area of the valve, showing the hooded stigma; (76) footpole of valve, showing the pseudosepta and helictoglossa; (77) magnification of striae, showing the interstriae and unoccluded areolae. Scale bars 5 μ m (73), 2 μ m (75), 1 μ m (74, 76) and 500 nm (77).

ends bisect the APF at the footpole, porelli small and round in APF, morphologically similar to, but physically separated from, the areolae of the striae (Fig. 88). Striae biseriate, rarely triseriate, areolae openings small and round (Fig. 89). Stigma opening small and round (Fig. 87). Internally, proximal raphe ends curved to the stigma side of the valve (Fig. 90). Helictoglossae large, slightly offset from the raphe. Areolae unoccluded with small and round openings. Interstriae well developed, thickened between striae (Fig. 94). Stigma opening with hooded structure covered by small pores (Fig. 92). Pseudosepta present at both apices (Figs 90, 91, 93).

Type locality: Xizang (Tibet), Gongbo'gyamda–Xian Regil, in amno in Niyang Rivub, temperature aquae 12.5 °C, pH 5.6, altitude 4300 m, 1974–07–06, Chen Jia–You, TB74004 (typus, HBI).

Neotype: HANU! Individual in slide THXZ2022031#b, in the collection of Aquatic Biodiversity Laboratory of College of Life Science and Technology, Harbin Normal University, Harbin, China. Here illustrated as Fig. 80. Sample was collected from Baingoin County, Nagqu city, Xizang, by Zhu H. et al. in 2022, in benthos and periphyton habitats, with altitude 4826 m above sea level.

Remarks: *Gomphosinica linearis* is species endemic to Xizang, China. It was originally described as a variety of *Gomphonema hedinii* (SHI 1984), differentiated from the nominate variety by having more slender valves,

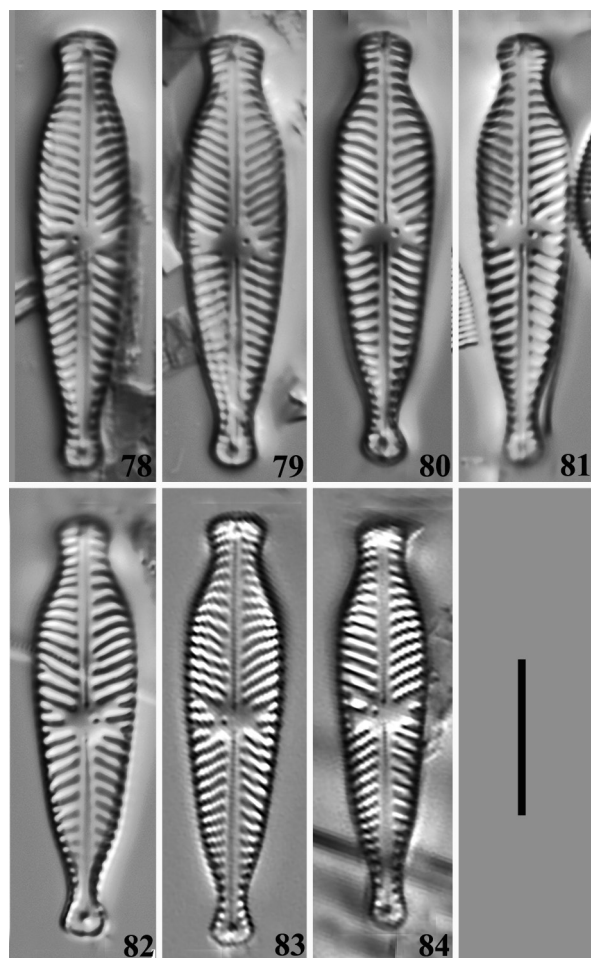
the two margins almost straight, forming a shoulder near the headpole, and forming a narrow angle towards the footpole. It was transferred to *Gomphosinica* and elevated to the species level by KOCIOLEK et al. (2015). The original material of the type has been lost, and we here designate a neotype for this taxon.

We found this species from Xizang, Bange county, has similar climate, habitat and altitude to the type locality. Our specimens match *G. linearis* based on the outline, size and striae pattern.

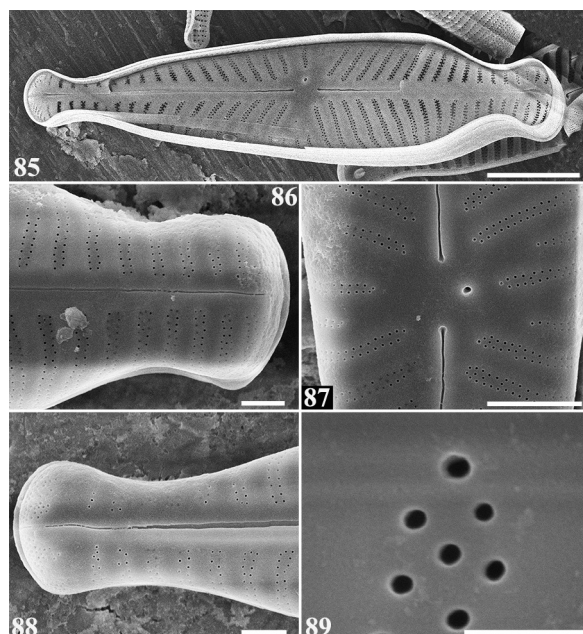
DISCUSSION

The genus *Gomphosinica* was established by KOCIOLEK et al. in 2015 based on the exploration of species from China and USA, new to science as well as those separated from the genus *Gomphonema* Cleve.

In KOCIOLEK et al. (2015), three taxa from genus *Gomphonema* were also moved to *Gomphosinica*. Both *Gomphonema* and *Gomphosinica* shared clavate valves, APF at footpole, pseudosepta present at both ends and one stigma present at central area. These species differed from species in *Gomphonema* by having the internal opening of the stigma possess a hooded structure with many small pores, as well as the course of the distal raphe endings, and structure and position of the porelli that compose the APF. LEVKOV et al. (2016) illustrated several patterns of internal opening of the stigma (LEVKOV



Figs 78–84. *Gomphosinca linearis* (Shi et Chen) Kociolek, You et Wang, LM. Scale bar 10 μm .



Figs 85–89. *Gomphosinca linearis* (Shi et Chen) Kociolek, You et Wang, SEM, external view: (85) external view of the whole valve; (86) headpole of valve, showing the distal raphe end; (87) central area of the valve, showing the proximal raphe ends and stigma; (88) footpole of valve, showing the distal raphe end bisect the APF; (89) magnification of areolae. Scale bars 5 μm (85), 2 μm (87), 1 μm (86, 88) and 300 nm (89).

et al. 2016, plate E, p. 15), which showed the diversity of the internal openings in *Gomphonema*, but none showed the same structure of *Gomphosinca*.

Based on the morphological features, *Gomphonella* Rabenhorst (JAHN et al. 2019; TUJI 2020) was also similar to *Gomphosinca*, especially for the straight distal raphe endings and undifferentiated porelli with valve areolae. The comparison of gomphonemoid genera made by JAHN et al. (2019, table 2, p. 243) showed the biggest difference between *Gomphonella* and *Gomphosinca* is the former genus lacks stigmata in central area. According to TUJI (2020), *Gomphosinca* may be a synonym of the genus *Gomphonella*, though no evidence was offered to support this conclusion. The taxonomical value of the stigma still needs to be investigated in this group, and molecular data is still required to analyze the relationship between these genera.

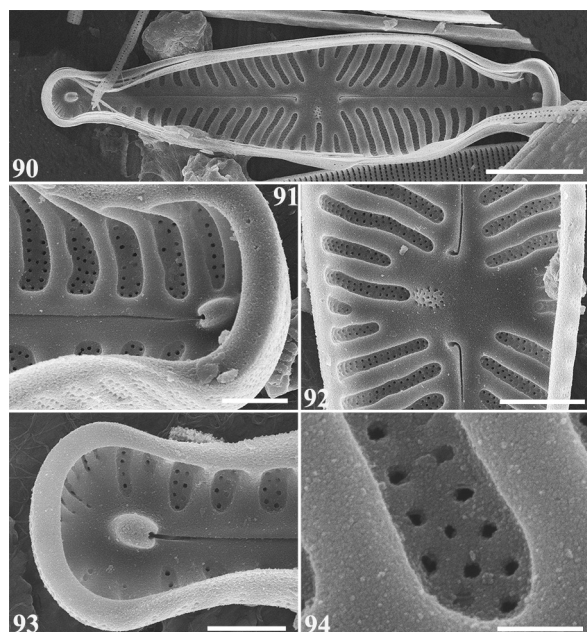
In the current report, two new species were observed from Xizang, based on the clavate-shape of the frustules, bi-triseriate striae, straight proximal and distal raphe ends, and all four of the taxa considered herein belong to the genus *Gomphosinca*. Comparisons between our new species and the other previously-described species in this genus are presented in Table S1.

Nine of 13 taxa in *Gomphosinca* have capitate ends. Of these, *G. stoermeri* is distinguished by its outline, having more elliptical valves. *G. stoermeri* has narrow, small capitate headpoles, most closely resembling *G. lacustris*, which has a small capitate headpole, but its valve is narrower and has a “shoulder” between central and headpole (KOCIOLEK et al. 2015).

G. qii has small, elliptical valves, with a slightly protracted, bluntly rounded headpole. The most similar species is *G. robusta*, which has a bluntly rounded headpole, but it is barely protracted, and the valves of *G. robusta* are narrower and have denser striae (KOCIOLEK et al. 2015).

Specimens we designated as *G. cf. hedinii* have an outline similar to *G. hedinii*, but populations we investigated are less slender and smaller than the type material (HUSTEDT 1922). Further research is needed to make a decision about whether the specimens we have denoted as “*G. cf. hedinii*” are indeed a separate taxon.

Specimens were observed from our samples which were collected from Baingoin county, Nagqu city, based on the outline, valve size, striae pattern, appear to be those of *G. linearis*. *G. linearis* was originally found from Niyang river, Gongbo’gyamda–Xian Region in Xizang, and named *Gomphonema hedinii* var. *lineare* Shi et Chen in SHI (2004). KOCIOLEK et al. (2015) transferred this taxon to the genus *Gomphosinca*, and recognized it at the level of species, making the new combination and new status as *Gomphosinca linearis*. However, a detailed description of this species with LM and SEM



Figs 90–94. *Gomphosinca linearis* (Shi et Chen) Kociolek, You et Wang, SEM, internal view: (90) internal view of the whole valve; (91) headpole of valve, showing the pseudosepta; (92) central area of the valve, showing the proximal raphe ends and hooded stigma; (93) footpole of valve, showing pseudosepta and helictoglossa; (94) magnification of stria, showing unoccluded areolae. Scale bars 5 µm (90), 2 µm (92), 1 µm (91, 93) and 300 nm (94).

features was still lacking. SHI (2004) provided only one line-drawing picture to illustrate the new taxon, and the material on which the new taxa were described has been lost. Herein, LM and SEM observations were made for several *Gomphosinca* species, including the detailed description provided for *G. linearis*. And we designate a neotype herein to represent the type of this taxon.

Asia has very high biodiversity of genus *Gomphosinca*, with eight of the 13 known taxa being recorded from this continent (KOCIOLEK et al. 2015; YANG et al. 2019; CHENG et al. 2020), and the disjunct distribution for the genus between Asia and North America was discussed by KOCIOLEK et al. (2015). In Xizang, six species of *Gomphosinca* were recently described. Although ZHU & CHEN (2000) recorded more than 900 taxa from all of Xizang, more and more new species have been published from this area recently (KOCIOLEK et al. 2020; LIU Y. et al. 2024; NA et al. 2024). Our discovery of additional species here demonstrates that more interesting species are still waiting to be found in this biodiversity hotspot area.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Comparison of valve features between *Gomphosinica* sp. and other species of the genus *Gomphosinica*.

This material is available as part of the online article (<http://fottea.czechphycology.cz/contents>)