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A new *Platessa* Lange-Bertalot species and a *Planoplatessa* Kulikovskiy *et al.* (Achnanthidiaceae, Bacillariophyta) species from two high altitude lakes in southwest China

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Abstract

A new monoraphid diatom species, *Platessa deqinensis sp. nov.*, and *Planoplatessa joursacensis* (Héribaud) Kulikovskiy *et al.* are reported from high-altitude lakes of the Hengduan Mountains region in southwestern China. Detailed morphological characteristics of both species are documented based on light microscopy (LM) and scanning electron microscopy (SEM). *Platessa deqinensis* is similar to *P. mugecuonesis*, *P. lanceolata*, *P. stewartii and P. bahlsii*, but it differs from these species in terms of its valve outline, size, stria density and SEM details. *Planoplatessa joursacensis*, is illustrated with LM and SEM. We discuss the morphology of this species and its reported broad distribution over space and time. Populations of *P. joursacensis* from Asia are compared with specimens from the type locality, Joursac, France. The discovery of these species enhances our understanding of monoraphid diatom diversity and the unique diatom flora in southwestern China.

Keywords

diatoms, morphology, new species, *Planoplatessa*, *Platessa*, scanning electron microscopy

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Introduction

Platessa Lange-Bertalot is a small genus based on *Platessa bavarica* Lange-Bertalot *et* G. Hofmann (in Krammer & Lange-Bertalot, 2004, p. 442). The main diagnostic features of this genus include: (1) small, elliptical and flat heterovalvate frustules; (2) raphe straight without terminal fissures; (3) striae mostly biseriate, sometimes uniseriate on raphe valve (Potapova, 2012; Spaulding & Edlund, 2008; You, *et al.* 2021). There are 24 species of *Platessa* listed in Algaebase (Guiry & Guiry, 2025) and two of them were described from China. A new species of *Platessa* was recently described from Sichuan Province (Zhang *et al.*, 2025). Potapova (2012), Liu *et al.* (2014),

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and You *et al.* (2021) discussed species placed within *Platessa* sharing similarities with other genera. From the perspective of biogeography, species of *Platessa* have been reported in North America (Enache *et al.*, 2014; Potapova, 2012), a rainforest in Amazonia (Tudesque *et al.*, 2016), India (Sherly *et al.*, 2022), and China (Liu *et al.*, 2014; You *et al.*, 2021; Zhang *et al.*, 2025).

Planoplatessa Kulikovskiy, Glushchenko *et* Kociolek in Kulikovskiy *et al.* (2022b) is based on *Planoplatessa joursacensis* (Héribaud) Kulikovskiy, Glushchenko *et* Kociolek, a species originally described as *Achnanthes joursacense* Héribaud (1903). This species possesses the characteristics of both *Planothidium* and *Platessa*, which has led to its classification remaining unstable for a long time (Kulikovskiy *et al.*, 2022b). It was transferred from *Achnanthes* to *Planothidium* as *Planothidium joursacense* (Héribaud) Lange-Bertalot 1999 due to the possession of a cavum, and later again transferred to *Platessa* as *Platessa joursacensis* (Héribaud) Chudaev 2015 (Chudaev *et al.*, 2015; Héribaud, 1903; Kulikovskiy *et al.*, 2022b; Spaulding & Edlund, 2008). Kulikovskiy *et al.* (2022b) re-described this species and provided additional morphological evidence to distinguish it from similar genera. Distinguishing features of this genus as compared to *Planothidium* and *Platessa* are that it has uniseriate striae (not a typical feature for *Planothidum*), a cavum is present in rapheless valves (not a typical feature for *Platessa*), and straight external distal raphe ends terminate on the valve face (Kulikovskiy *et al.*, 2022b). The type species of *Planoplatessa, P. joursacensis,* has been reported across time (Miocene to Recent) (Héribaud, 1903; Tanaka *et al.*, 2004; Tanaka & Nagumo, 2006; Titova *et al.*, 2021) and space (Western Europe, the European and Asian parts of Russia as well as Japan (see Kulikovskiy *et al.*, 2022b), other parts of Asia (Gupta & Das, 2020; Potapova, 2014), as well as Australasia (Harper *et al.*, 2012), North America (Bahls, 2009, 2021; Stoermer *et al.*, 1999) and South America (Vouilloud, 2003). Krammer and Lange-Bertalot (2004) has documented the Lectotype for this species.

Recent research in China has identified the presence of 10 genera with 39 taxa of monoraphid diatoms. New diatom taxa have come from the following genera: *Achnanthes* (Chen *et al.*, 2024; You *et al.*, 2019b;), *Achnanthidium* (Ge *et al.*, 2022; Liu *et al.*, 2016, 2021b; You *et al.*, 2019a, 2021; Yu *et al.*, 2018, 2019, 2022), *Crenotia* (Liu *et al.*, 2020; Na *et al.*, 2024), *Cocconeis* (Zhou *et al.*, 2024), *Eucocconeis* (Li *et al.*, 2012; You *et al.*, 2021), *Kolbesia* (Yu *et al.*, 2019), *Nupela* (Liu *et al.*, 2023; Yu *et al.*, 2017), *Platessa* (Liu *et al.*, 2014; You *et al.*, 2021; Zhang *et al.*, 2025), *Planothidium* (Li *et al.*, 2024, 2025), and *Psammothidium* (Liu *et al.*, 2014). However, our understanding of the diversity of *Platessa* and *Planoplatessa* in China is still limited.

In this paper, a new *Platessa* species and a species of *Planoplatessa* Kulikovskiy, *et al.* (2022b) species are investigated from surface sediments of two alpine lakes in the Hengduan Mountains Region. The new species will be described and discussed mainly from the following aspects: 1) the features of the new species as well as *Planoplatessa joursacensis* are described based on the images from light (LM) and scanning electron microscopy (SEM); 2) morphological comparison between the new species and its similar species are presented; 3) a brief introduction to the ecological characteristics of these species in China is offered.

Material and methods

The Hengduan Mountains region (23–33°N, 97–103°E) is located in southwestern China. Its extensive range crosses the territories of western Sichuan Province, western Yunnan Province, and part of eastern Tibet (Hu *et al.*, 2013). The elevation range of this area is from less than 3,500 m a.s.l. to over 5,000 m a.s.l., with the average altitude of the main peaks being approximately 5,028 m a.s.l. (Wang *et al.*, 2004). The influence of the southwest monsoon, and its unique geologic history, together make this region one of the world's biodiversity hotspots (Ding *et al.*, 2020; Zhang *et al.*, 2009). Previous studies have described several diatom species in the region (Hu *et al.*, 2013; Liu *et al.*, 2021a; Luo *et al.*, 2018, 2019, 2021, 2022; Wu *et al.*, 2020; Zhang *et al.*, 2020, 2021), indicating that high altitude lakes located here are important sources of regional biodiversity.

In 2016, surface samples (0.5 cm) were collected in September and October at Lake Deqindong-4 and Lake Shudu, respectively. The samples were stored in the refrigerator at under 4 °C before laboratory treatment. In the laboratory, carbonates and organic matter were removed from samples using 10% HCl and 30% H_2O_2 to dissolve carbonates and oxidize organics according to the method of Battarbee (1986). After several rinses and settling for 24 hours in distilled water, permanent diatom mounts were made from the cleaned material using Naphrax®. The sample and slides were deposited in the Herbarium of the Institute for Ecological Research and Pollution Control of Plateau Lakes, Yunnan University, Kunming, P.R. China.

A raw diatomite sample from the material of Héribaud deposited in the Natural History Museum, London, labeled "Joursac" was shared with JPK. Slides were prepared by mixing distilled water with a small portion of the diatomite, air-drying the material onto coverslips and mounting the dried material onto slides with Hyrax. Observations were made at the University of Colorado with an Olympus BX-51 light microscope (with a 1.4NA 100× oil immersion objective and DIC optics). Images were taken using an Olympus DP 71 digital camera. Slides are deposited in the Kociolek Collection at COLO.

Morphological observations of the Chinese diatom samples were made and photographs were taken under light microscopy (LM) using a ZEISS Imager A2 (with a 1.4NA 100× oil immersion objective and DIC optics) research microscope with a ZEISS digital camera. At least 500 valves were identified and counted in each epilithic sample. Cleaned material for scanning electron microscopy (SEM) analysis was air-dried onto cover glasses, mounted onto stubs, and coated with 20 nm of Au for 4–5 min (EMSCOP SC 500 sputter coater). The resulting stubs were examined and photographed using a LEO 1530 SEM with an acceleration voltage of 5–10 kV and a 3–12 mm working distance. The image analysis and plate arrangement were processed with Adobe Photoshop (CS5) (V. 12.1, Adobe Systems, San Jose, C.A, USA). The description of the new species follows the terminology provided by Lange-Bertalot & Hofmann (2004), Kulikovskiy *et al.* (2022a, b) and You *et al.* (2021).

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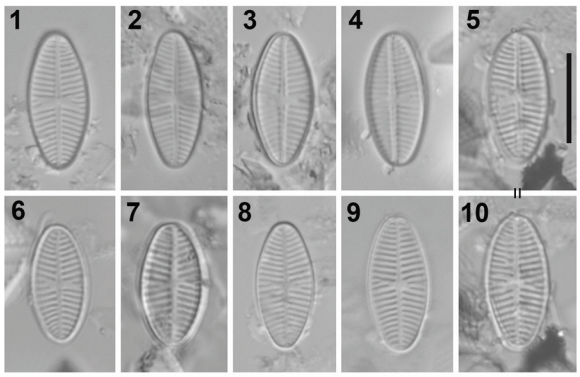
Results

***Platessa deqinensis* Y.-L. Li *sp. nov*. (Figures 1–18)**
Description
LM (Figures 1–10): Valve lanceolate-elliptical with bluntly rounded apices. Length 13.0–15.4 µm, width 6.1–7.1 µm. Striae slightly radiate towards the poles, density 16–18 in 10 µm. On the raphe valves, raphe straight and filiform, expanded slightly towards the central ends. Central area a transverse rectangle, formed by one or two shortened striae. On the rapheless valves, central area small and often asymmetric, axial area linear and striae arrangement is similar to the raphe valve.
SEM (Figures 11–18): On the raphe valves (Figures 11–13): Externally, straight raphe with proximal raphe endings straight and slightly dilated; distal raphe ends slightly expanded into drop-like pores and bent in opposite directions, not protracted to the mantle (Figures 11–12). One row of slit-like areolae on the mantle (Figure 11). Striae biseriate and composed of small and rounded areolae. Central area formed by shortened striae and takes the shape of a transverse rectangle (Figures 11–13). Internally, raphe with proximal raphe ends deflected in opposite directions. Each of the distal raphe ends with a small helictoglossa (Figure 13). On the rapheless valves (Figures14–18): Externally, valve show the short and wide spine-like projections on the margin (Figures 14–15, and 16). Internally, areolae rounded and occluded with fine hymenate structures (Figures 17–18).

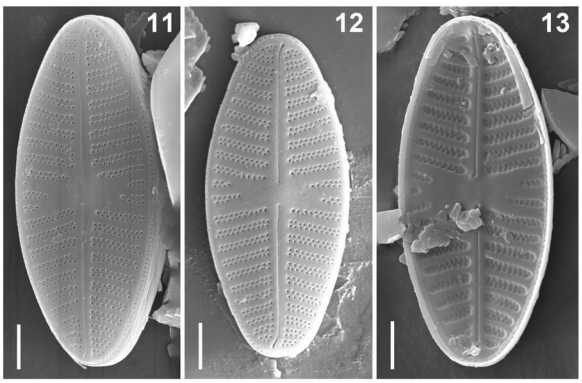
Holotype: PYU! Slide no. DQD2016090904 deposited in Yunnan University, Kunming, China. Holotype specimen illustrated in Figure 1.
Isotype: HANU! Slide no. YUNGL20160994 deposited in Harbin Normal University, Harbin, China.
Type locality: Lake DQD-4, Deqin County, Diqing Tibetan Autonomous Prefecture, Yunnan Province, China, elevation 4749 m a.s.l., 28.50017°N, 98.98490°E, sample collected by Prof. Yan-Ling Li, 9th September 2016.
Habitat: Benthic.

Etymology: The specific epithet '*deqinensis*' refers to the locality from which the new species was collected.
Ecology: *Platessa deqinensis sp. nov.* has been observed on surface sediment samples from Lake Deqindong-4, a habitat with moderate DO (6.28 $mg \cdot L^{-1}$), weakly alkaline (pH 8.2) and low conductivity (125 $\mu S \cdot cm^{-1}$). This species (relative abundance < 1%) was mainly associated with *Achnanthidium minutissimum* (Kützing) Czarnecki 1994 (58.5%), *Nitzschia palea* (Kützing) W.Smith 1856 (25.4%), *Cyclotella ocellata* Pantocsek 1901 (6.2%) *Amphora libyca* Ehrenberg 1841 (3.9%), *Neidium* sp (1.7%), *Encyonema minutum* (Hilse) D.G.Mann 1990 (1.4%), *Encyonema silesiacum* (Bleisch) D.G.Mann 1990 (1.1%).
Distribution: The species has been found so far only in the type locality.

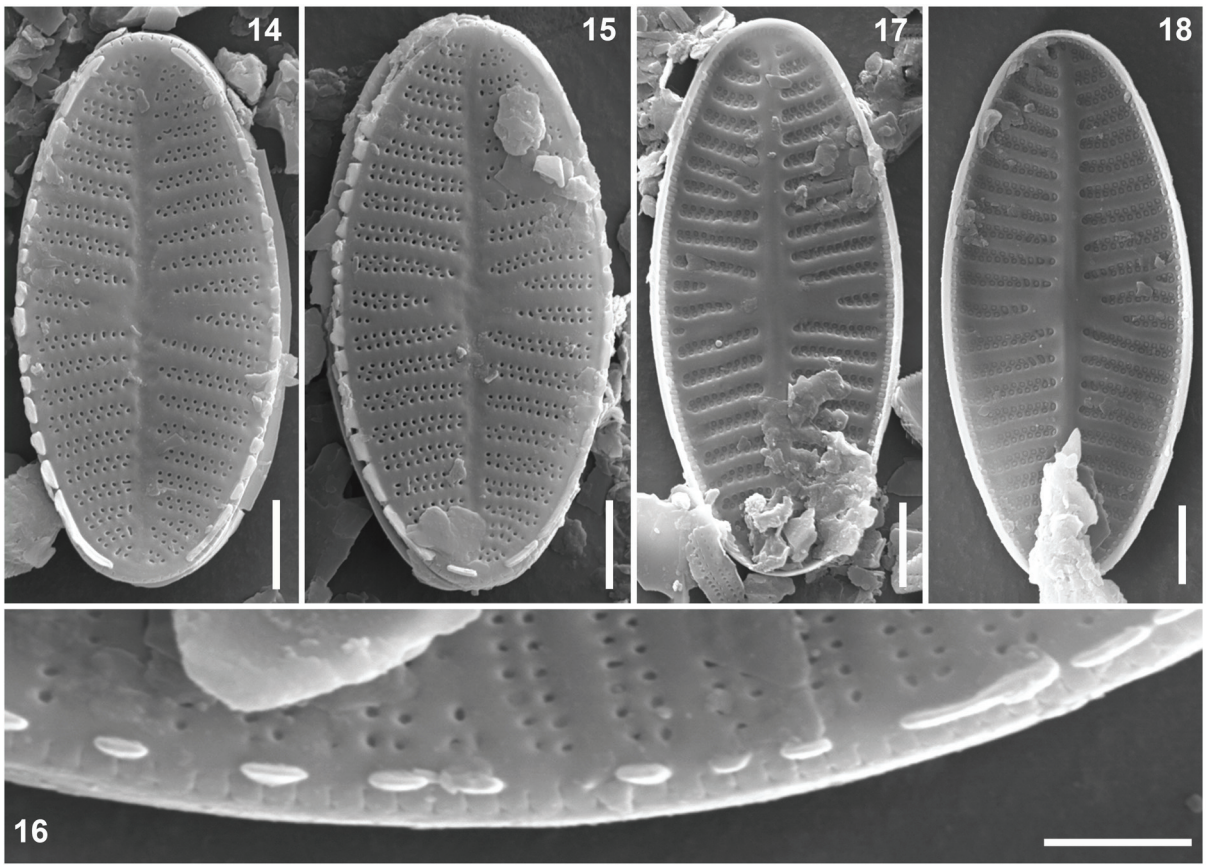
***Planoplatessa joursacensis* (Héribaud) Kulikovskiy *et al*. (Figures 19–34)**
Description
LM (Figures 19–28): Valves broadly elliptic with blunt-rounded ends, asymmetrical about the transapical axis. Length 10.5–16.4 µm, width 5.6–8.3 µm. On the raphe valves, raphe straight and filiform, proximal raphe endings slightly dilated. Central area small and round. Axial area moderately narrow, almost linear. Striae slightly radiate towards the poles, density 17–19 in 10 µm. On the rapheless valves, axial area slightly wide lanceolate. The structure horseshoe-shaped is visible. The specimens from the type locality in France differ, however, in having a much broader axial area at the valve center, and coarser striae density (15–17 in 10 µm).
SEM (Figures 29–34): On the raphe valves (Figures 29–30): Externally, raphe straight and filiform, proximal raphe endings slightly dilated. Distal raphe ends slightly curved in opposite directions (Figure 29). Striae uniseriate. Areolae mostly with slit-like shaped, few rounded shaped (Figures 19–30, arrows A and B). Internally, raphe with proximal raphe ends deflected in opposite directions (Figure 30, arrows C). Each of the distal raphe ends with a small helictoglossa and curved in opposite direction (Figure



Figures 1–10. *Platessa deqinensis sp. nov.*, LM, DIC. Valve views, showing size range and variability of the holotype population. **(1–5)** Raphe valves. Figure 1 is the holotype. **(6–10)** Rapheless valves. Scale bar 10 µm.



Figures 11–13. *Platessa deqinensis sp. nov.*, SEM, raphe valve views. **(11–12)** External view of the raphe valves. **(13)** Internal view of the raphe valve. Scale bars 2 µm.



Figures 14–18. *Platessa deqinensis sp. nov.*, SEM, rapheless views. **(14–15)** External view of the raphe valves. **(16)** Detail of valve showing the short and wide spine-like projections on the margin. **(17–18)** Internal view of the rapheless valves. Scale bars 2 µm (14–15, 17–18) and 1 µm (16).

30, arrows D). On the rapheless valves (Figures 31–34): Externally, the central area with irregularly arranged fine dots (Figures 31–32, white arrows). Internally, axial area slightly wide lanceolate, the structure cavum at central area is visible (Figure 33, arrow E).

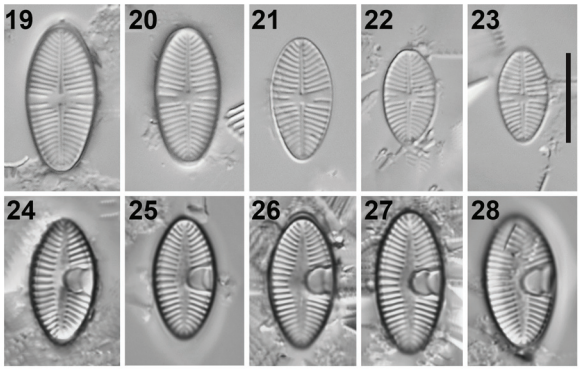
Ecology: *Planoplatessa joursacensis* has been observed on surface sediment samples from Shangri-La City, Diqing Tibetan Autonomous Prefecture, elevation 3700 m a.s.l., 27.90959° N, 99.94562° E, Lake Shudu, a habitat with P-limitation (TN 1.52 $mg \cdot L^{-1}$, TP 0.04 $mg \cdot L^{-1}$) and weakly alkaline (pH 7.8). This species (relative abundance < 1%) was mainly associated with *Staurosira venter* (Ehrenberg) Cleve *et* J.D.Möller 1879 (48.5%), *Staurosira construens* Ehrenberg 1843 (23.9%), *Staurosirella pinnata* (Ehrenberg) D.M.Williams *et* Round 1988 (10.5%), *Pseudostaurosira brevistriata* (Grunow) D.M.Williams *et* Round 1988 (2.8%), *Achnanthidium minutissimum* (Kützing) Czarnecki 1994 (1.9%), *Asterionella formosa* Hassall 1850 (1.2%).

***Achnanthes joursacense* Héribaud 1903 (Figures 35–44)**
Description
Light microscope observations of specimens of *P. joursacensis* from the Joursac locality studied by Héribaud are presented in figures 35–44. Raphe valves (Figures 35–39) have radiate striae, 15–17 / 10 µm. Individual areolae are not evident. The raphe is straight, narrowing from the slightly dilated proximal raphe ends to the distal ends. The axial area is straight and narrow. The central area is narrow and irregular in shape, expanded to one or both sides of the valve. On the rapheless valves (Figures 40–44), there is a prominent cavum. The striae are radiate, 15–17 / 10µm. The axial area is wide and asymmetrical, expanded towards one side of the valve more than the other (arrow in Figure 40).

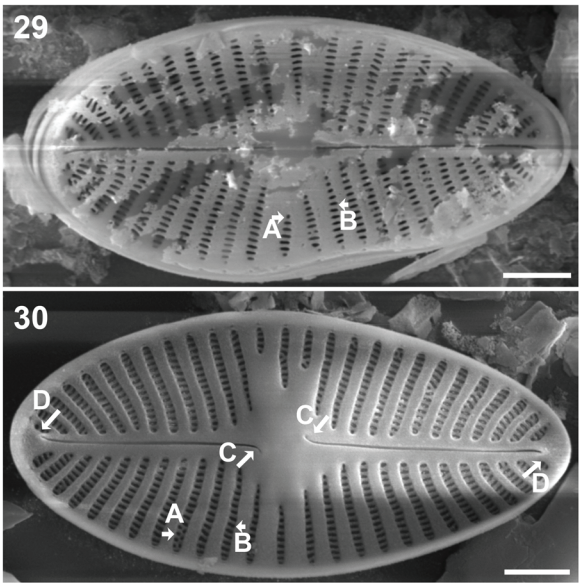
Discussion

Platessa deqinensis sp. nov. is suited to be placed in *Platessa* due to it having an elliptical to rhomboid-lanceolate valve, distal raphe ends that do not extend to the mantle, and biseriate striae on both raphe and rapheless valve. This species also shares features with other *Platessa* species, such as: *P. mugecuonesis* (2021, pp. 264–267), *P. lanceolata* (2021, pp. 267–269), *P. stewartii* (2012, pp. 38–39) and *P. bahlsii* (2012, pp. 38–40) (Table 1). With respect to valve outline and size, *P. deqinensis* closely resembles *P. mugecuonesis*, but they can be easily separated from one another by three distinct features. Firstly, stria density in *P. deqinensis* is 16–18 / 10 µm which is higher than seen

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Figures 19–28. *Planoplatessa joursacense.* LM, DIC. Valve views. **(19–23)** Raphe valves. **(24–28)** Rapheless valves. Scale bar 10 µm.



Figures 29–30. *Planoplatessa joursacense.* SEM, raphe valve views. **(29)** External view of the raphe valve. Arrows A and B show the round and slit-like shape of the areolae, respectively. **(30)** Internal view of the raphe valve. Arrows A and B same as mentioned previously. Arrows C show the deflected in proximal raphe endings; Arrows D show the helictoglossa. Scale bars 2 µm.

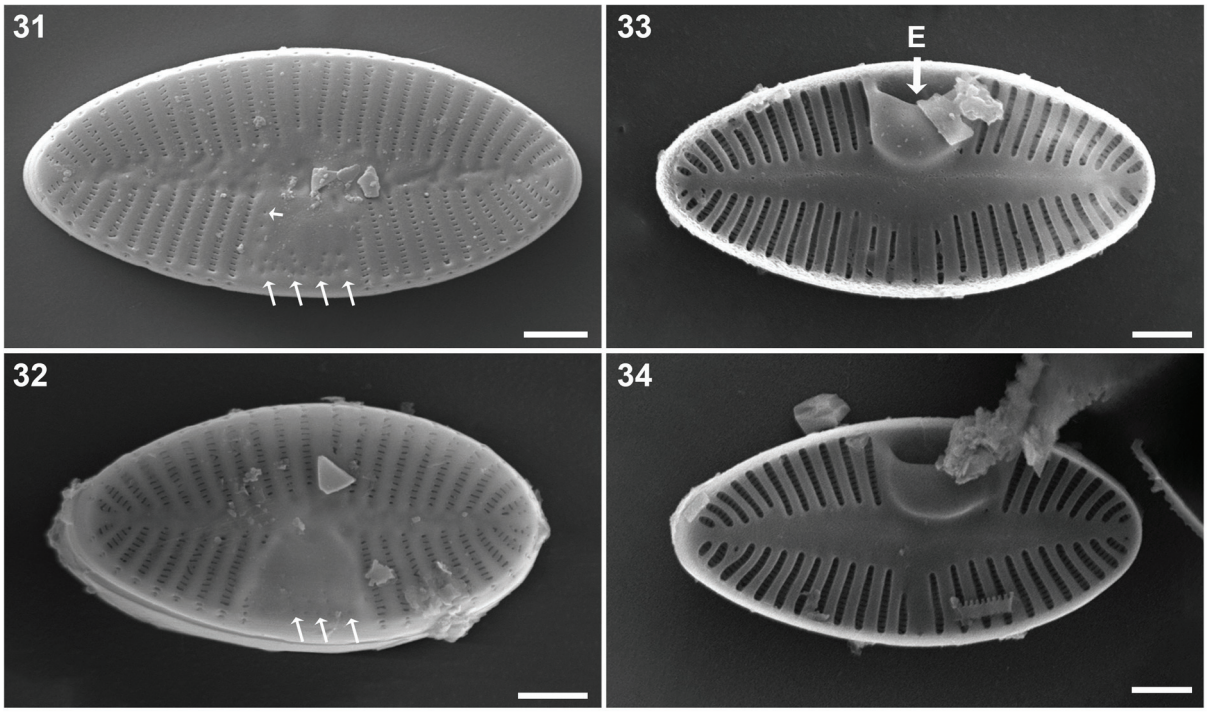
in *P. mugecuonesis* (13–16/10 µm). Secondly, the shape of the central area on the raphe valve differs between the two species; in *P. deqinensis* the central area is a transverse rectangle, but in *P. mugecuonesis* the central area is small and irregular in shape. Thirdly, the new species has special spine-like projections around the rapheless valve margin as seen with scanning electron microscopy (see Figures 14–16). These features help to distinguish *P. deqinensis* from not only *P. mugecuonesis* but the other similar species as well. The new species can be easily distinguished from other similar species by the outline of valve, valve size, stria density as well as the rows of areolae per stria (Table 1).

Planoplatessa joursacensis has uniseriate striae, a visible cavum internally and a horseshoe-shaped area externally on the rapheless valve, as well as external distal raphe ends that do not extend onto the valve mantle. Together, these features are diagnostic for *Planoplatessa*. Specimens from China resemble specimens of *P. joursacensis* from Mongolia (Kulikovskiy *et al.*, 2022b) in valve size, stria density, and the structure of cavum and horseshoe-shaped. However, there are some details of features can separate the two populations in light (LM) and scanning electron microscopy (SEM). Observations with LM reveal that the specimens from southwest China have broad and heteropolar elliptic valves which differ from the valves of the Mongolian specimens of *P. joursacensis* (they are broadly elliptic) (Kulikovskiy *et al.*, 2022b). A careful comparison of the two populations with SEM reveals that the areolae in the specimens from southwest China are mostly slit-like but can also be round, while the shape of the areolae in *P. joursacensis* specimens from Mongolia are only slit-like. The rapheless valves of the specimens from southwest China have irregularly arranged fine dots in the central area, which are not visible in *P. joursacensis* specimens from Mongolia.

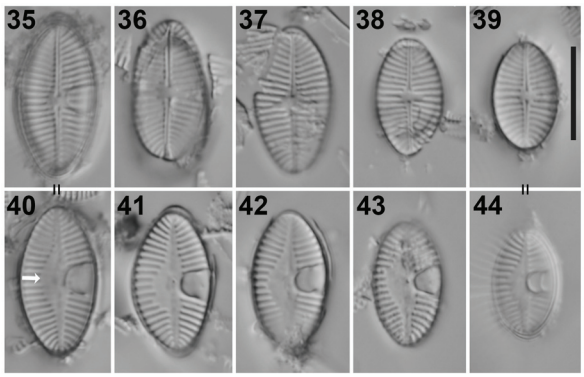
Specimens of *Achnanthes joursacense* Héribaud 1903 from the type locality differ from those from Mongolia (Kulikovskiy *et al.*, 2022b) and those presented herein from China. The difference between the specimens from Asia and specimens of *A. joursacense* from the type locality is obvious, especially on the rapheless valves. The expanded axial area of *A. joursacense* differs from China and Mongolian specimens (narrowly lanceolate). In terms of the stria density, specimens of *A. joursacense* from the type locality have a lower stria density (15–17 / 10 µm) than the specimens from China and Mongolian (17–19 / 10 µm). This is despite the fact that Héribaud (1903, Plate XI, Figures 26, 27) drew the rapheless valve to be without the expanded central area. Further research may require the specimens from Mongolia and China, which are similar to one another in this regard, be described as a new species. The differences between Héribaud's original illustrations and the specimens from the type locality reminds us that caution should be used when consulting illustrations made in the 18th and 19th century.

Besides, in view of the valve outline, size, and stria density, *P. joursacensis* is similar to *Platessa hustedtii* (Krasske) Lange-Bertalot (in Krammer & Lange-Bertalot 2004, p. 445), but the latter has biseriate striae and lacks the horseshoe-shaped structure. Given the reported distribution of *P. joursacensis*, extensive both temporally and geographically, and the morphological differences between the populations from Mongolia and southwest China, as well as specimens from the type locality, a worldwide revision of this species complex seems timely.

From a morphological perspective, *Platessa* is a diverse genus. Some monoraphid species that were previously classified under this genus have been reclassified, as their character combinations were described and evaluated. For example, *P. elegans* Kulikovskiy *et* Lange-Bertalot (2015, p. 66) was placed in *Platebaikalia* (Kulikovskiy *et al.*, 2020) due to it having multiseriate striae on the raphe valves with biseriate striae on the



Figures 31–34. *Planoplatessa joursacense.* SEM, rapheless views. **(31–32)** External view of the rapheless valves. White arrows show the central area with irregularly arranged fine dots. **(33–34)** Internal view of the rapheless valves. Arrow E shows the cavum. Scale bars 2 µm.



Figures 35–44. *Achnanthes joursacense* Héribaud 1903. Slide1 (The specimens were provided by Prof. Kociolek, J.P.). LM, DIC. Valve views. **(35–39)** Raphe valves. **(40–44)** Rapheless valves. White arrow in Fig 40 shows the axial area expanded in central area. Scale bar 10 µm.

rapheless valves; *P. joursacensis* (Héribaud) Chudaev (2015, p. 112) with a cavum, uniseriate striae and the distal raphe that do not extend onto the mantle was placed in *Planoplatessa* (Kulikovskiy *et al.*, 2022b); *P. rhombicolanceolata* Kulikovskiy *et* Lange-Bertalot (2015, p. 67) and *P. baicalensis* Kulikovskiy *et* Lange-Bertalot (2015, p. 64) was placed in *Platesiberia* (Kulikovskiy *et al.*, 2022a) due to it having biseriate striae on the raphe valves with uniseriate striae on the rapheless; *P. arborea* Radhakrishnan, Sherly *et* B. Karthick (2022, p. 152) was re-described as *Indoplatessa arborea* (Radhakrishnan, Sherly *et* Karthick) Tseplik, Radhakrishnan, Karthick *et* Kulikovskiy (2025, p. 165) due to the presence of uniseriate striae on both valves, central raphe endings located in a rounded depression externally and distinctly hooked internally, and areolae with internally thickened interstriae. With regard to *Platessa deqinensis sp. nov.*, this species has short and wide spine-like projections on the margin of rapheless valve, differentiating it from other *Platessa* species. This characteristic may support recognition of a new grouping, however few species are currently known to possess it. Careful consideration is needed to determine if the spine-like projections surrounding the margin can constitute a new, independent taxonomic unit. Further verification using molecular data may be necessary.

In terms of ecological habitats, newly reported species of monoraphid diatoms have been predominantly found in alpine regions (e.g. Liu *et al.*, 2016; You *et al.*, 2021; Yu *et al.*, 2018, 2019; Zhang *et al.*, 2025), though a few have been documented in coastal environments (Li *et al.*, 2024) or amongst moss (Sherly *et al.*, 2022). The alpine lakes are mainly situated in nature reserves, isolated from human disturbance and containing relatively pristine water bodies. These habitats have been considered ideal environments for the emergence and evolution of monoraphid diatoms (You *et al.*, 2021). Subsequent studies on biodiversity discovery and the evolution of diatom species might be focused on mountainous areas and other nature reserves.

Acknowledgments

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Table 1. Morphological characteristics comparison between *Platessa deqinensis sp. nov.* and its similar species.

	P. deqinensis sp. nov.	***P. mugecuonesis***	***P. lanceolata***	***P. stewartii***	***P. bahlsii***
Reference	This study	You *et al.*, 2021	You *et al.*, 2021	Potapova, 2012	Potapova, 2012
Valve outline	Lanceolate-elliptical	Lanceolate-elliptical	Rhomboid-lanceolate	Elliptical	Elliptical
Valve length, µm	13.0–15.4	12.0–19.0	10.5–16.5	11–16	3.6–11.0
Valve width, µm	6.1–7.1	6.0–8.0	4.5–6.0	5.7–7.0	2.9–4.2
Striae in 10 µm	16–18	13–16	15–19	14–18	12–15
Central area	Transverse rectangle (raphe vale); Small and asymmetrical (rapheless valve)	Small and asymmetrical (raphe and rapheless valve)	Transverse rectangle (raphe vale); rhomboid (rapheless valve)	Small and asymmetrical	Small
rows of areolae per stria	Two	Two	Two	Two	Four

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