

Mastogloia wulffii, a new diatom (Bacillariophyceae) from the west coast of Sweden

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Abstract: While collecting epiphytic diatom samples from the west coast of Sweden, a small *Mastogloia* species has been observed and could not be matched with any of the described taxa. Based on both light and electron microscopes examination, this species has been described as new, *Mastogloia wulffii* sp. nov. and included in *Mastogloia* section Sulcatae. This species is very small with valve length not exceeding 16.3 µm. It is characterized by having a narrow, almost straight median depression on both sides of the sternum–raphe, no marginal ridge and with rounded areolae on valve mantle as well as having completely hyaline lateral sterna. A comparison with similar taxa is given. *M. wulffii* is a marine species growing in moderate numbers on the red alga *Polyides rotunda* which is widely distributed along the coast of Vrångö Island, Sweden.

Key words: Diatoms, Epiphytic, *Mastogloia*, New species, West coast of Sweden

INTRODUCTION

Mastogloia Thwaites ex W. Smith is a very diversified diatom genus with more than 410 taxa described from freshwater, brackish and marine habitats (NOVARINO 1989). This number has increased remarkably with the description of new species in recent years (e.g. LEE et al. 2014; LOBBAN & PENNESI 2014; Pennesi et al. 2011, 2012; 2013; AL-HANDAL & PENNESI 2015, 2016; PAVLOV et al. 2016; PENNESI et al. 2016). High diversity of *Mastogloia* is most likely attributed to its fast evolution (PADDOCK & KEMP 1990) which results in wide variation in valve outline and structure. The most striking feature of *Mastogloia* which separate it from all other naviculoid diatoms, is the presence of one to several hollow chambers on both sides of the internal face of valve margin, these chambers (sensu HUSTEDT 1933) are named partecta and form a structure that runs along the edge of valve margin called partectal ring. Partecta vary in shape, size, orientation and number in the different species and represent a modification of the valvocopula (HUSTEDT 1933, PADDOCK & KEMP 1990, ROUND et al., 1990; PENNESI et al. 2011). As with other diatom genera which are highly diversified, taxa (mostly marine) of *Mastogloia* were divided into 10 sections based on ecological and morphological features (HUSTEDT 1933). Another

section containing mostly freshwater taxa was added by SIMONSEN (1990). Morphological similarities between closely related taxa have led to misidentification such as the case of *M. smithii* THWAITES ex W. SMITH and *M. lacustris* Grunow which were largely confused with each other in the literature (LEE et al. 2014).

Partecta variation in *Mastogloia* is not the only character to separate species. HUSTEDT (1933) selected several features beside partecta to group *Mastogloia* into different sections, these include valve outline, stria density, depression on valve face, lateral sterna and others. It became a regular approach to assign a particular Husted's section to any described *Mastogloia* species.

Marine benthic diatoms in the west coast of Sweden have not been widely investigated and most works were made on the plankton diatoms, mainly as part of environmental monitoring programs (HÖGLANDER et al. 2013). *Mastogloia* does not seem to be widely distributed along the coasts of Sweden and only few species were reported. EDSBAGGE (1968) has recorded 8 species of *Mastogloia* from the Swedish west coast and none of them were found in large numbers. In the Älv Estuary, not far from the location of the present study, KUYLENSTIERNA (1991) has identified a single species of *Mastogloia* (*M. exigua* Lewis) in 75 samples collected over a period of 10 years. On the

eastern coast of Sweden (Baltic Sea), SNOEJS (1993) recorded 9 species which were mostly brackish water forms. Limited distribution of *Mastogloia* along coasts of Sweden is attributed to the ecological preference of its species which mostly prefer tropical to subtropical conditions.

In the present study, an epiphytic species of *Mastogloia* from the west coast of Sweden, in the Gothenburg archipelago, is described as new to science. *M. wulffii* sp. nov. belongs to Hustedt's section Sulcatae (HUSTEDT 1933), subgroup 2 (PENNESI et al. 2012). Morphological features and valve ultrastructure are described based on light and scanning electron microscopy. Comparison with other related taxa as well as ecological preference are provided.

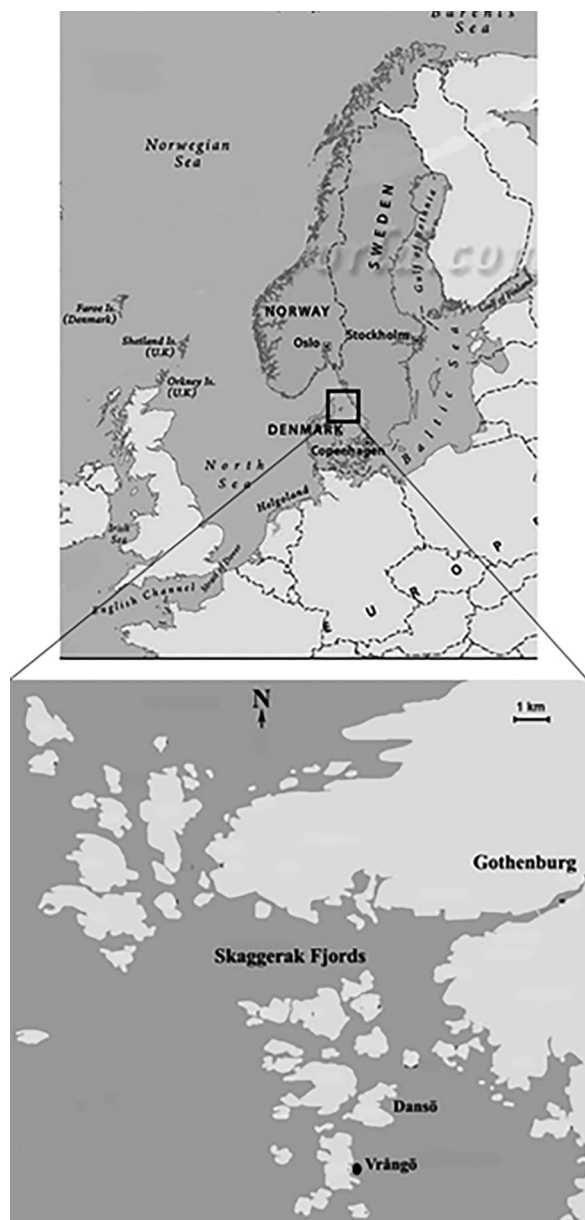


Fig. 1. Map showing sampling location in the west coast of Sweden.

MATERIAL AND METHODS

Samples were collected from Vrångö Island (57°34'N; 11°47' E) which is one of several little islands in the archipelago of the Kattegat strait opposite to the west coast of Sweden (Fig. 1). The Kattegat strait, together with the Skagerrak strait to the north form a connection between the Baltic Sea and the North Sea. Kattegat strait is 220 km long with a varying width ranging between 60 to 140 km. Brackish water flow from the Baltic Sea lowers salinity in the strait to 30 psu, but this value can vary depending on time of the year.

Samples of macrophytes were collected by hand from the eastern coast of Vrångö small island. Macrophytes growing in tidal pools along the intertidal zone and in open water were collected. *M. wulffii* was found only on the rhodophyte *Polyides rotunda* (HUDSON) GAILLON. In the laboratory, thalli of this macrophyte were shaken vigorously to detach diatoms. Suspension containing diatoms was washed with distilled water from which 20 milliliters were boiled with 35% hydrogen peroxide for 15 minutes. After cooling, the material was rinsed few times with deionized water. One milliliter of the cleaned material was left to dry on a coverslip in air temperature. Coverslips were left on a hot plate (150 °C) for few minutes to insure that diatom valves adhere to the surface and then inverted on a microscope slide containing small amount of Naphrax® (Brunel Microscopes Ltd., UK), which then heated until all air in the mountant is released to the outside. Light microscope (LM) examination and imaging was made under Zeiss Axioimager 2 microscope with differential interference contrast objectives (Department of Biological and Environmental Sciences, Gothenburg University, Sweden). For scanning electron microscopy (SEM), few drops of the cleaned diatom suspension were left to dry on a black plastic piece adhered to an aluminium stub. When dry, the sample was examined in Hitachi SU8010 SEM (Botanischer Museum, Berlin, Germany). Husted (1933), Paddock and Kemp (1990) and Round (1990) were consulted for the terminology of valve description.

RESULTS

Polyides rotunda (Gigartinales, Rhodophyta) is a widely distributed macrophyte along the west coast of Sweden (KORNFELDT 1984) and to less extent on the east coast in the Baltic Sea (WALLENTINUS 1979). Besides *Mastogloia wulffii* sp. nov., a number of diatom species were found epiphytic on this alga but none was in high numbers. *Striatella unipunctata* Lyngbye, *Tabellaria fenestrata* (Lyngbye) Kützing, *Cocconeis scutellum* Ehrenberg, *Cocconeis stauroneiformis* (Smith & Rabenhorst) Okuno and small orbicular forms of *Fragillaria* Lyngbye were found in moderate numbers. Few other very small unidentified taxa were also observed.

Division Bacillariophyta

Class Bacillariophyceae Haekel

Order Mastogloiales D.G. Mann

Family Mastogloiaceae Mereschkowsky

Genus *Mastogloia* Thwaites ex W. Smith

***Mastogloia wulffii* Al-Handal et Pennesi sp. nov.**

Light microscopy (LM) (Figs 2–19): Valves elliptical to elliptical-lanceolate with rounded apices and shallow median depression. Apical axis varies from 12.5 to 16.5 μm , and the transapical axis from 6.5 to 8 μm (50 specimens measured). Transapical striae 14–17 in 10 μm . Raphe branches almost straight. Partectal ring protrudes towards middle of the valve on a siliceous flange. Partecta different in shape with larger size in the middle of the valve, partecta number 3–6 on each side.

Scanning electron microscopy (SEM) (Figs 20–31): Valves are elliptical to elliptical-lanceolate (Figs. 2–19 and 20, 23, 26, 31). External valve face: Raphe branches are almost straight (Figs 20, 31), ending centrally in slightly expanded pores (Figs 20, 21, 31) and distally in terminal fissures bent toward the same side (Figs 20, 22, 31). Hyaline zones are present on the apices (Figs 20, 22, 31). Valve face shows two distinct zones, one in a shallow narrow and almost straight median depression on both sides of the raphe–sternum not reaching the poles, and an outer zone up to the valve margin (Figs 20, 31). A quadrangular central area is transapically dilated into inner zone (Figs 20, 21, 30, 31). Valve ornamentation consists of transapical striae ranging from straight at the center to slightly radiate at poles (Figs 20, 28, 30, 31). Striation are monoseriate over most of the valve surface and mantle, becoming biseriate near the margins (Figs 28, 29, 31). Areolae are rounded in the outer zone and transapically elongated or quadrangular in the depression and one row of irregular areolae on both sides of the raphe–sternum (Figs 20–22, 31). All areolae are occluded by rota-like velum (Figs 20–22, 30, 31). Internal valve face: Raphe branches are straight and bordered by siliceous ribs, ending centrally in raised slightly expanded pores (Figs 23, 26, 27). Valve surface is characterized by thin hyaline lateral sternum on both sides of the axial area corresponding to the external valve depression; costa-like silicified interstriae are visible beyond the inner median zone (Figs 23–27). Partectal ring attached to the valve's margin by a very short siliceous flange (Figs 23). Partecta are unequal (1.3–2.4 μm in width) positioned centrally along each side of the partectal ring (Fig. 23), opening at poles through a lacuna (Fig. 25), septa are visible (Fig. 25, arrowhead). Large partecta (2–2.4 μm in width) are ornamented with tiny pores irregularly arranged in the middle convex margin (Figs 23–25) and open externally through apical partectal pores (Figs 28, 29). Partecta free margin, particularly in the middle, is irregular (Fig. 24).

Holotype: Slide number B 40 0042019 deposited in the Botanischer Garten und Botanischer Museum (BGBM), Berlin, Germany. The species was found as an epiphyte on the thallus of *Polyides rotunda*. Figures 14 and 15 represent the holotype (two views of the same valve).

Type locality: Intertidal zone, eastern side of Vrångö

Island, west coast of Gothenburg, Sweden (57°34'N; 11°47'E).

Etymology: The epithet is named in honor of our friend and colleague Professor Angela Wulff who has largely contributed to the ecology of diatoms, particularly in polar regions.

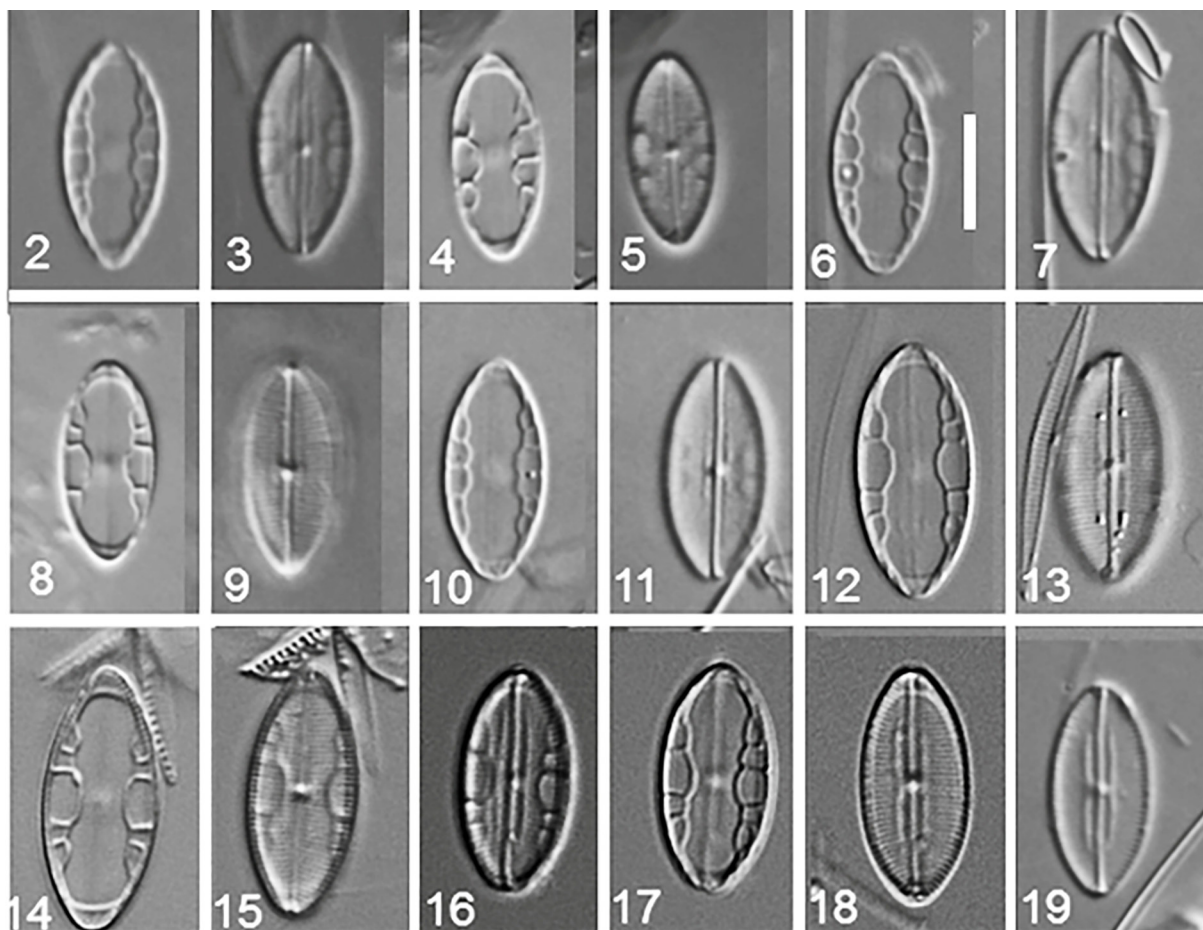
DISCUSSION

Mastogloia wulffii sp. nov. described in this work belongs to HUSTEDT's section Sulcatae (HUSTEDT 1933) based on the presence of a depression on valve face. Recently, PENNESI et al. (2011, 2012) revised the genus *Mastogloia* and divided section Sulcatae into two different subgroups. The first one composed of taxa with siliceous features such as conopea and pseudo-conopea on external valve face (subgroup 1, PENNESI et al. 2011), whereas the second subgroup included taxa without these siliceous outgrowths on the valve depression (subgroup 2, PENNESI et al. 2012). It is obvious that *M. wulffii* belongs to the Sulcatae subgroup 2 for the features mentioned above.

Mastogloia wulffii sp. nov. exhibits some affinities with two other similar *Mastogloia* species, *M. exilis* Hustedt and *M. sergiana* Pennesi et Poulin. *M. exilis* shares similar internal valve face ornamentation, type of partecta and valve outline but differs by its external valve shape. *Mastogloia wulffii* has narrow, almost straight median depression on both sides of the sternum–raphe while in *M. exilis* the depressions are semi-elliptical and larger (PENNESI et al. 2012). In addition, *M. exilis* shows well-defined marginal ridge runs almost up to the apices and slit-like areolae in the mantle, whereas in *M. wulffii* there is no marginal ridge and has rounded areolae in the mantle (Fig. 20, 21, 23).

Mastogloia wulffii may also be compared to *M. sergiana* (PENNESI et al. 2012) which share similar valve outline, type of partecta, type of areolae on the external valve face and similar costa-like silicified interstriae in the internal valve face. However, *M. sergiana* has a thin, well-defined marginal ridge runs up to the apices and a longitudinal rib visible in the depression close to the first row of areolae while in *M. wulffii* these features are lacking (Fig. 20). Also in *M. wulffii* the median depression is narrow and almost straight while in *M. sergiana* it is semi-elliptical (PENNESI et al. 2012). Furthermore, this new species shows rounded apices and almost straight raphe branches, whereas in *M. sergiana* apices are rostrate and sinuses. Internally, the lateral sterna are thin and interrupted by short striae in *M. sergiana* while in *M. wulffii* the lateral sterna are completely hyaline (Figs 24, 25, 31). This new species shows partecta with slightly irregular free margin (Fig. 23), a feature that has not been observed in taxa belonging to the section Sulcatae (HUSTEDT 1933; PENNESI et al. 2011, 2012).

Ecology



Figs 2–19. Light micrographs of *Mastogloia wulffii* sp. nov. at different foci showing variable valve size. Scale bars 10 µm.

M. wulffii is a marine species found as an epiphyte on the rhodophyte *Polydora rotunda* in the archipelago of the west coast of Gothenburg, Sweden. It occurred in moderate numbers and has not been observed on other macrophytes collected from the same region. It has been previously shown that some diatom species prefer a particular host which narrow their ecological preference (Al-Handal & Wulff 2008). Salinity in the region varies between 25 to 30 psu.

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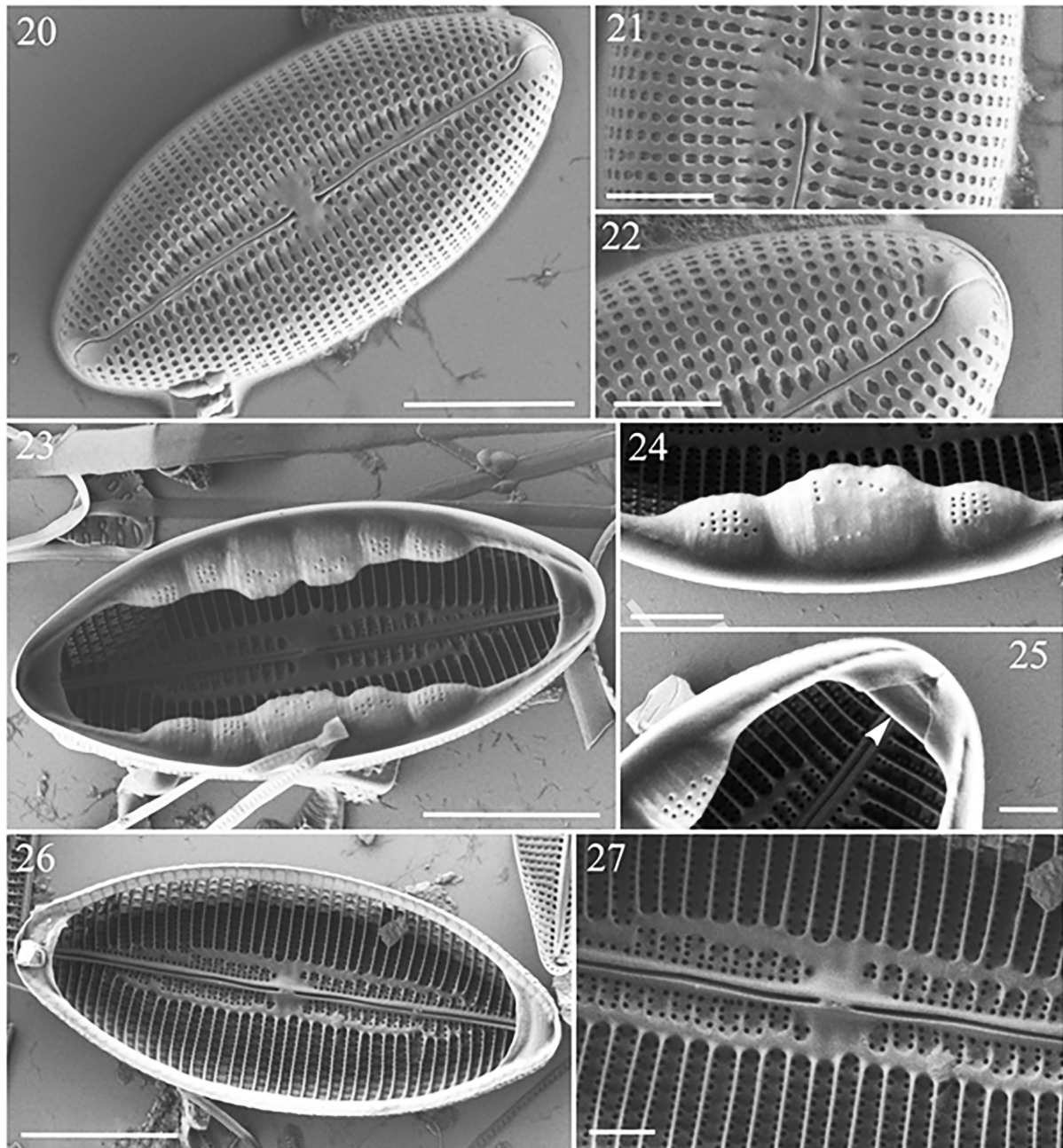
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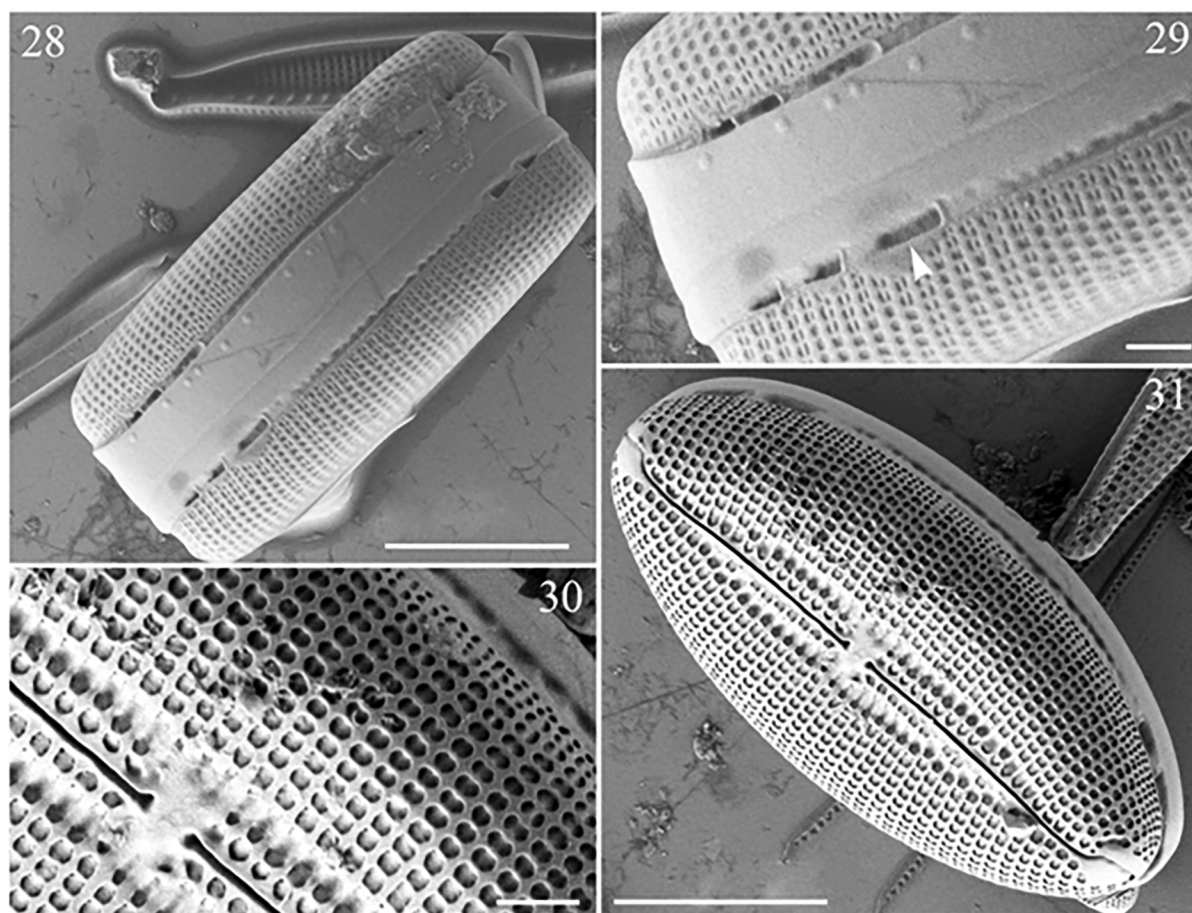
Figs 20–27. *Mastogloia wulffii* sp. nov., SEM images: (20) External valve view showing shallow median depression and raphe branches; (21) External view of central area and raphe endings; (22) External view of apex showing the bent terminal raphe fissure; (23) Internal valve view showing the partectal ring; (24) Partecta with tiny pores; (25) Apex with lacuna and septum (arrowhead); (26) Internal valve view showing hyaline lateral sterna; (27) Details of the internal central nodule with raised simple pores and interstriae. Scale bars 5 μ m (20, 23, 26), 2 μ m (21, 22, 24), 1 μ m (25, 27).

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Figs 28–31. *Mastogloia wulffii* sp. nov., SEM images: (28) Girdle view with partectal pores on the valvocopula; (29) Details on the apex showing partecta pores (arrowhead); (30) External view of areolae; (31) External view of a tilted valve showing median depression. Scale bars 5 μ m (28, 31), 1 μ m (29, 30).

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