

## *Cyclotella hinziae* sp. nov. – a small *Cyclotella* (Bacillariophyceae) from subalpine lake Schliersee (Bavaria, Germany)

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**Abstract:** A small *Cyclotella* species (Thalassiosiraceae) from a subalpine lake Schliersee (Bavaria, Germany) is described. The species has characteristic valve morphology different from this of the other similar taxa. It differs from them especially with the presence of radially arranged ghost structures in the valve central part and with the presence and low number of transversal trabeculae inside the alveolus – maximally 6 in 1 µm. The valve morphology and ultrastructure of this taxon is described and its new name, *Cyclotella hinziae*, is proposed. Its valve morphology is compared and discussed with this of other similar taxa.

**Key words:** Lake Schliersee, Thalassiosiraceae, freshwater centric diatoms, valve morphology, valve ultrastructure

## INTRODUCTION

The genus *Cyclotella* (KÜTZING) BRÉBISSEON belongs among the most frequently quoted genus of the Family Stephanodiscaceae (ROUND et al. 1990), having about 300 till now described taxa, fossil as well as recent (see e.g. Index Nominum Algarum by P. Silva). Their recent representatives live mostly in freshwater phytoplankton or littoral and some of them are often accepted as important indicators of environmental conditions in limnology. They live solitary or they can create shorter or longer loose or more or less tight chains of cells, sometimes the cells are enclosed in mucous sheets (see e.g. ROUND et al. 1990; KRAMMER & LANGE–BERTALOT 1991; HOUK et al. 2010). The identification of the species with the large cells is usually relatively easy, however, in the species with small cells, usually with the valve diameter smaller than 5–7 µm, is the identification very hard, even in SEM. And just the representatives of this genus with cells of a smaller size often create their maximum of development in spring or autumn in many lakes or slowly running rivers. Among these most often cited taxa belong e.g. *Cyclotella comensis* GRUNOW in VAN HEURCK (e.g. HAUSMANN & LOTTER 2001; SCHEFFLER & MORABITO 2003; SCHEFFLER et al. 2005), *C. pseudocomensis* SCHEFFLER (SCHEFFLER 1994; SCHEFFLER et al. 2003), *C. ocellata* PANTOCSEK (PANTOCSEK 1901; KISS et al. 1999), *C. delicatula* HUSTEDT

(HUSTEDT 1952; KISS et al. 2007) and *C. costei* DRUART & STRAUB (DRUART & STRAUB 1988). During our investigations of the centric diatom communities in the lake Schliersee in the period 1997–2014 was observed a small *Cyclotella* taxon with distinctive valve morphology different from this of the other similar, till now described taxa. The valve morphology and ultrastructure of this taxon is described and its new name, *Cyclotella hinziae*, is proposed. Its valve morphology is compared and discussed with this of other similar taxa.

## MATERIALS AND METHODS

For the investigation were used Schliersee net plankton samples from 6 May 1997, 5 Nov 2001, 21 Aug 2006, 25 May 2010 and 31 Mar 2014. A core from Lake Schliersee May 2001 taken by R. Klee and J. Müller was also used for description.

Schliersee is a natural lake in Upper Bavaria in the Bavarian Alps. It is located next to the small town of Schliersee in the Miesbach district. The lake is of the glacial origin. Some morphometric and trophy-relevant data.

The raw material was washed in distilled water and cleaned using Hydrogen peroxide/potassium dichromate. For LM-observations the cleaned material was mounted in Naphrax and the LM investigations were carried out on an Olympus BX 51 microscope with UPlanApo 100×/1.35 Oil Iris objective equipped with a digital camera Olympus DP

Table 1. Morphometric and trophy-relevant data of the lake

Surface (km <sup>2</sup> )	Volume (10 <sup>6</sup> m <sup>3</sup> )	Altitude (m a.s.l.)	Depth <sub>max</sub> (m)	Depth <sub>mean</sub> (m)	P <sub>tot</sub> (µg.l <sup>-1</sup> )	Chl a (µg.l <sup>-1</sup> )
2.22	23.13	777	40.5	23.9	7–23	< 5

71. For SEM-investigations, material was dried on glass slides, mounted on aluminium stubs and coated with gold by Polaron coating unit E-5000. Hitachi S-3000N and FEI QUANTA 200F electron microscopes were used for SEM-investigations.

The terminology used is based on Anonymous (1975), Ross et al. 1979 and THERIOT & SERIEYSSOL (1994). Number of striae in 10 µm were determined following Genkal (1977), i.e. as the number of striae in 10µm of the valve circumference, not in 10µm of a transect (chord).

## RESULTS

### *Cyclotella hinziae* HOUK, KÖNIG et KLEE sp. nov. (Figs 1–6, 19–37)

**Description:** Cells cylindrical, often in chains. Valves circular, 3.5–12 µm in diameter, frustules height mostly between 1.5 and 3.2 µm. The central area smooth, flat to slightly transversally undulate, often with shallow radial furrows or lines, sometimes with sparsely, ± radially arranged, circular to elongate pori not penetrating the cell wall. One central fultoportula, externally as a simple large rimmed porus, internally with a short central tube situated opposite to rimoportula, surrounded with (1)2(3) satellite pori. Valve marginal part with the radially arranged striae (alveoli) of nearly equal lengths, 17.5–23 striae in 10 µm. Alveoli inside with rings of concentrically arranged trabeculae, usually (2)3–6 trabeculae in an alveolus, externally these trabecular rings as smooth crossbars or partitions. Between trabeculae many irregularly arranged small pori penetrating the cell wall. The marginal fultoportulae situated on costae, (3)4–6 costae between them, 4–12 per valve, 2.4–3.7 mfp in 10 µm. Internally the short central tubes surrounded with two laterally arranged satellite pori, externally they are opened as simple large pori inside small smooth circular fields. A single rimoportula is situated on a costa in the marginal part, internally with a sessile labium, externally as a circular, sometimes radially elongated, simple small porus. Valve surface is without granules.

Initial valves of lenticular shape. Their central part sometimes slightly transversally undulate, sometimes externally with pori not penetrating the cell wall, often with a single central fultoportula.

**Holotype:** Slide Zu9/93, Lake Schliersee (Germany), plankton 31 March 2014, Diatom Collection of Friedrich Hustedt, Alfred-Wegener-Institut für Polar- und

Meeresforschung, Bremerhaven, Germany.

**Isotype:** Slide no. A337, Lake Schliersee (Germany), 31 March 2014, Diatom Slides Collection, Department of Botany, Charles University, Prague, Czech Republic.

**Type locality:** Lake Schliersee (Germany).

**Etymology:** This taxon is named in honor of Mrs Friedel Hinz, the assistant of long-standing in the Diatom Collection of Friedrich Hustedt, Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany.

It differs from the morphologically most similar species *C. delicatula* HUSTEDT with the presence of radially arranged ghost structures in the valve central part and with a lower number of trabeculae in 1 µm of the alveolus – maximally 6 in *C. hinziae*, more than 6 in *C. delicatula*. From morphologically similar *C. arctica* GENKAL & KHARITONOV it differs in the structure of the valve central part where *C. arctica* has much coarser, often radially arranged structures there, and in the marginal has alveoli of different lengths (see GENKAL & KHARITONOV 1996, p. 69; GENKAL & KHARITONOV 2005, p. 21).

### LM Observations (Figs 1–16)

In the slides the cells occur mostly solitary (Figs 1–16), in the live plankton samples cells in chains consisting of more than 10 cells were often found. Cells are shallow cylinders, with the pervalvar axis much shorter than the valve diameter. Valves were circular, with the diameter 6–12 µm. The central area takes 0.7 to 0.5 of the valve diameter, with an ill-defined stellate pattern consisting of radially arranged ghost striae (Figs 13–16) with one coarser punctum near the valve centre (Figs 6–13). The marginal zone is radially striated with 18–23 striae (alveolae in SEM) in 10 µm, striae of nearly equal lengths. The marginal fultoportulae hardly distinguishable in LM (e.g. Figs 9 and 14). Initial cells/valves have not been observed in LM.

### SEM Observations (Figs 17–42)

Cells cylindrical, often in chains. Valves circular, 3.5–12 µm in diameter, frustules height mostly between 1.5 and 3.2 µm. The central area is mostly smooth, often with shallow radial furrows or lines (Figs 21, 23, 38, 39), flat to slightly transversally undulate (Figs 21, 39). Sometimes the valve central part externally with sparsely, ± radially arranged, circular to elongate pori not penetrating the cell wall (Figs 20, 22, 24). One central fultoportula

(**cfp**), externally as a simple large rimmed porus (e.g. Figs 20–24), internally with a short central tube situated opposite to rimoportula (**rp**), surrounded with (1)2(3) satellite pori (e.g. Figs 27, 30, 32). Valve marginal part consists of the radially arranged alveoli of nearly equal lengths, 17.5–23 alveoli in 10 µm. Alveoli inside with rings of concentrically arranged trabeculae (Fig. 28, 32), usually (2)3–6 trabeculae in an alveolus (maximally 6 trabeculae in 1 µm), externally these trabecular rings as smooth crossbars or partitions (Figs 25, 26). Between these trabeculae many irregularly arranged small pori penetrating the cell wall (Figs 28, 32). The marginal fuloportulae (**mfp**) are situated on costae (e.g. Fig. 33), (3)4–6 costae between them, 4–12 per valve, 2.4–3.7 mfp/10 µm. Internally the short central tubes are surrounded with two laterally arranged satellite pori (Fig. 33), externally they are opened as simple large pori inside small smooth circular fields (Fig. 23). A single rimoportula is situated on a costa in the marginal part, internally with a sessile labium (Figs 27, 30, 32, 33), externally as a circular, sometimes radially elongated, simple small porus (Figs 20–22). Granules on the valve surface have never been observed.

Initial valves of hemispherical to rather lenticular shape were also observed (Figs 34–37). Their central part sometimes slightly transversally undulate, sometimes externally with pori not penetrated the cell wall (Fig. 34), often with a single central fuloportula (Fig. 35).

## DISCUSSION

Several small freshwater *Cyclotella* taxa have been described until now. In their natural populations can be observed cells with the valve diameter smaller than 5 µm. Among these taxa belong particularly *Cyclotella ocellata* PANTOCSEK, *C. cretica* JOHN et ECONOMOU-AMILLI, *C. tripartita* HÅKANSSON, *C. comensis* GRUNOW in VAN HEURCK, *C. pseudocomensis* SCHEFFLER, *C. delicatula* HUSTEDT, *C. wuethrichiana* DRUART et STRAUB, *C. costei* DRUART et STRAUB and *C. arctica* GENKAL et KHARITONOV. However, it seems that there are still small *Cyclotella* taxa which were not described yet, probably just due to their small size. Morphologically the most similar species to *C. hinziae* described here is *C. delicatula* HUSTEDT, mainly due to the location of internal projections of marginal fuloportulae on not depressed costae. However, it differs from *C. delicatula* with the presence of radially arranged ghost structures in the valve central part and with a lower number of trabeculae in 1 µm of the alveolus – maximally 6 in *C. hinziae* sp. nov., more than 6 in *C. delicatula*. Another morphologically similar small taxon with internal projections of marginal fuloportulae on not depressed costae is *C. arctica* GENKAL et KHARITONOV. These two species, *C. hinziae* sp. nov. and *C. arctica*,

mutually differ in the structure of the valve central part where *C. arctica* has much coarser, often radially arranged structures there and its marginal part consists of long alveoli of different lengths often running deep to valve center (see GENKAL & KHARITONOV 1996, p. 69; GENKAL & KHARITONOV 2005, p. 21). Also the striation density of *C. arctica*, 24–32 in 10 µm (GENKAL & KHARITONOV 1996, p. 69; GENKAL & KHARITONOV 2005, p. 21), differs from *C. hinziae* with 17.5–23 striae in 10 µm. Other small similar *Cyclotella* taxa as *C. comensis* GRUNOW in VAN HEURCK, *C. pseudocomensis* SCHEFFLER, *C. wuethrichiana* DRUART et STRAUB and *C. costei* DRUART et STRAUB have their internal projections of the marginal fuloportulae situated on depressed costae, and also their structures in the valve central part are of another type (e.g. SCHEFFLER 1994; SCHEFFLER et al. 2005; HOUK et al. 2010).

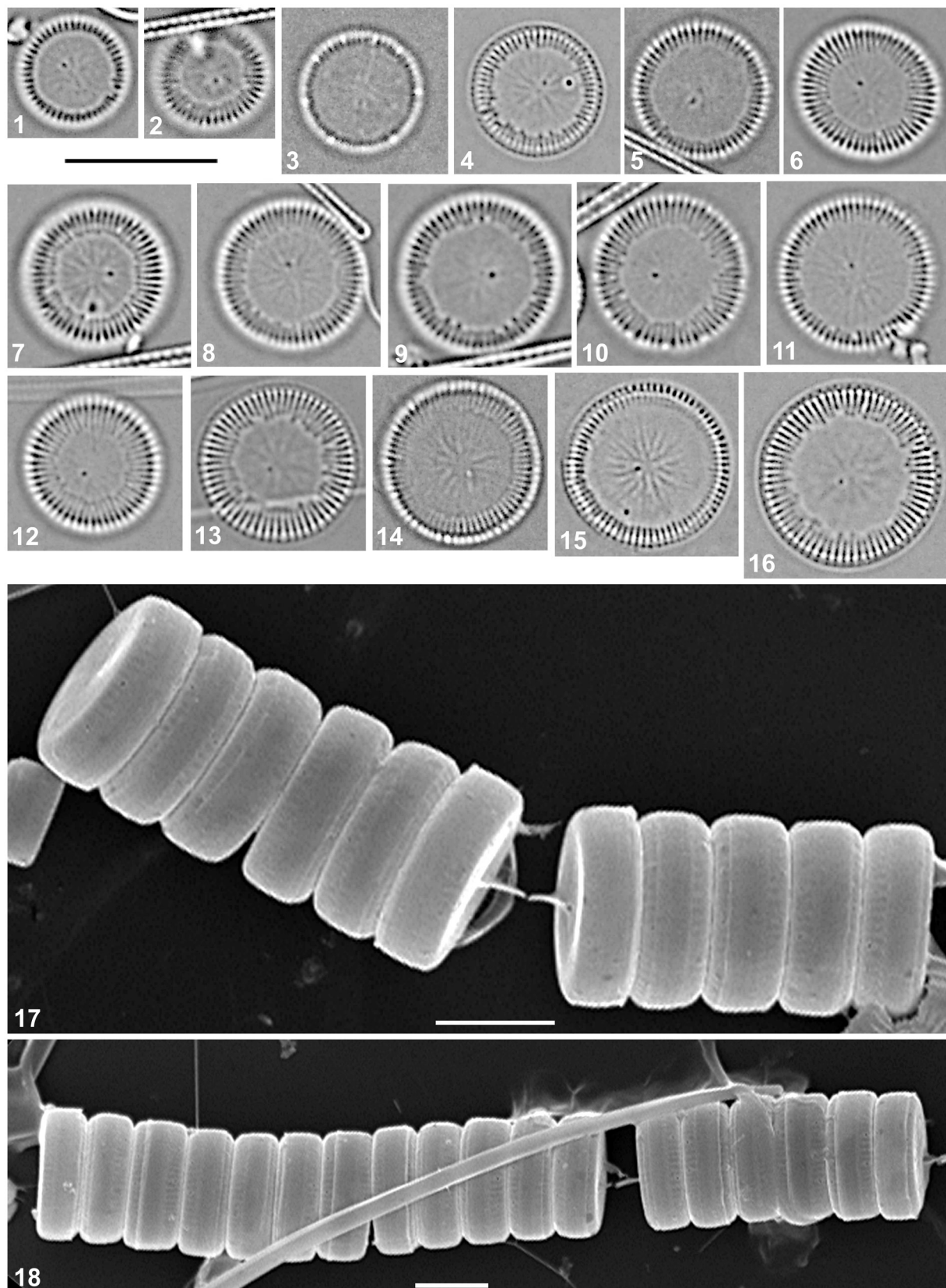
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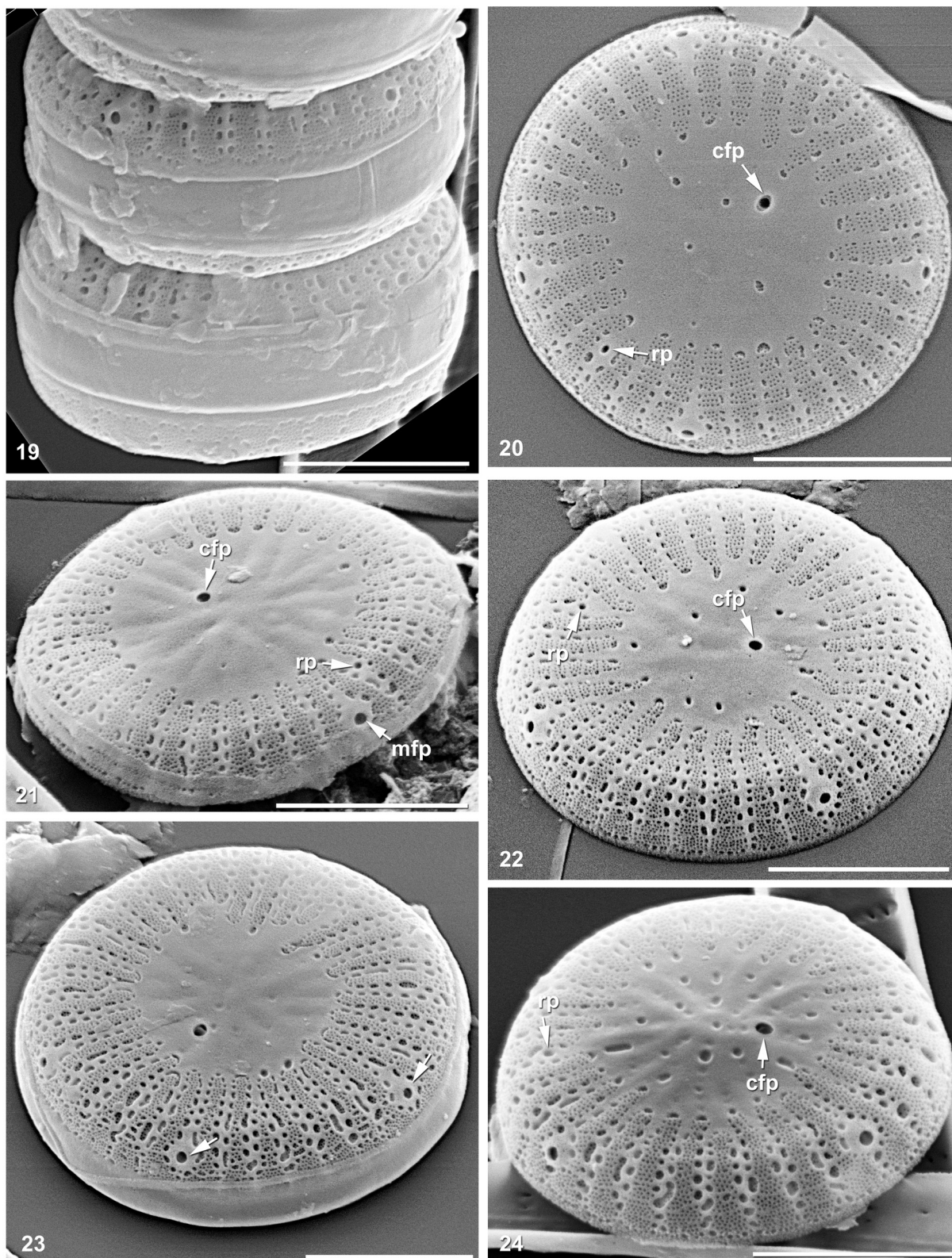
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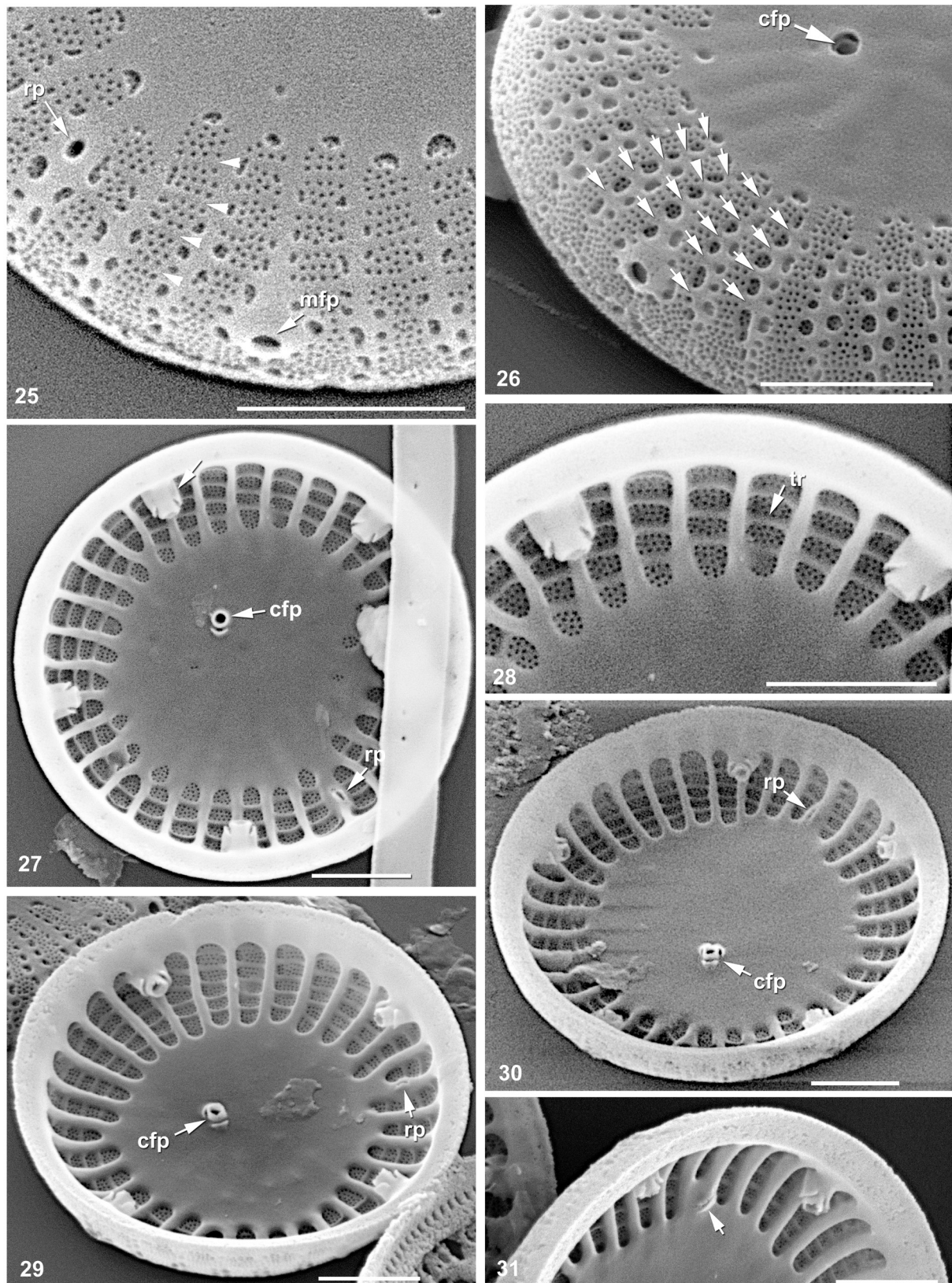
Figs 1–18. *Cyclotella hinziae* sp. nov.: (1–16) LM, holotype, slide Zu9/93, valve views, Diatom Collection of Friedrich Hustedt, Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany, Lake Schliersee (Bavaria, Germany), plankton 31 March 2014, (3, 10, 11, 13–16) valves with a ghost stellate pattern in the central part; (17, 18) SEM, girdle views of short chains of living cells, Lake Schliersee (Bavaria, Germany), plankton 6 May 1997. Scale bar 10  $\mu\text{m}$  (1–16), 5  $\mu\text{m}$  (17, 18).





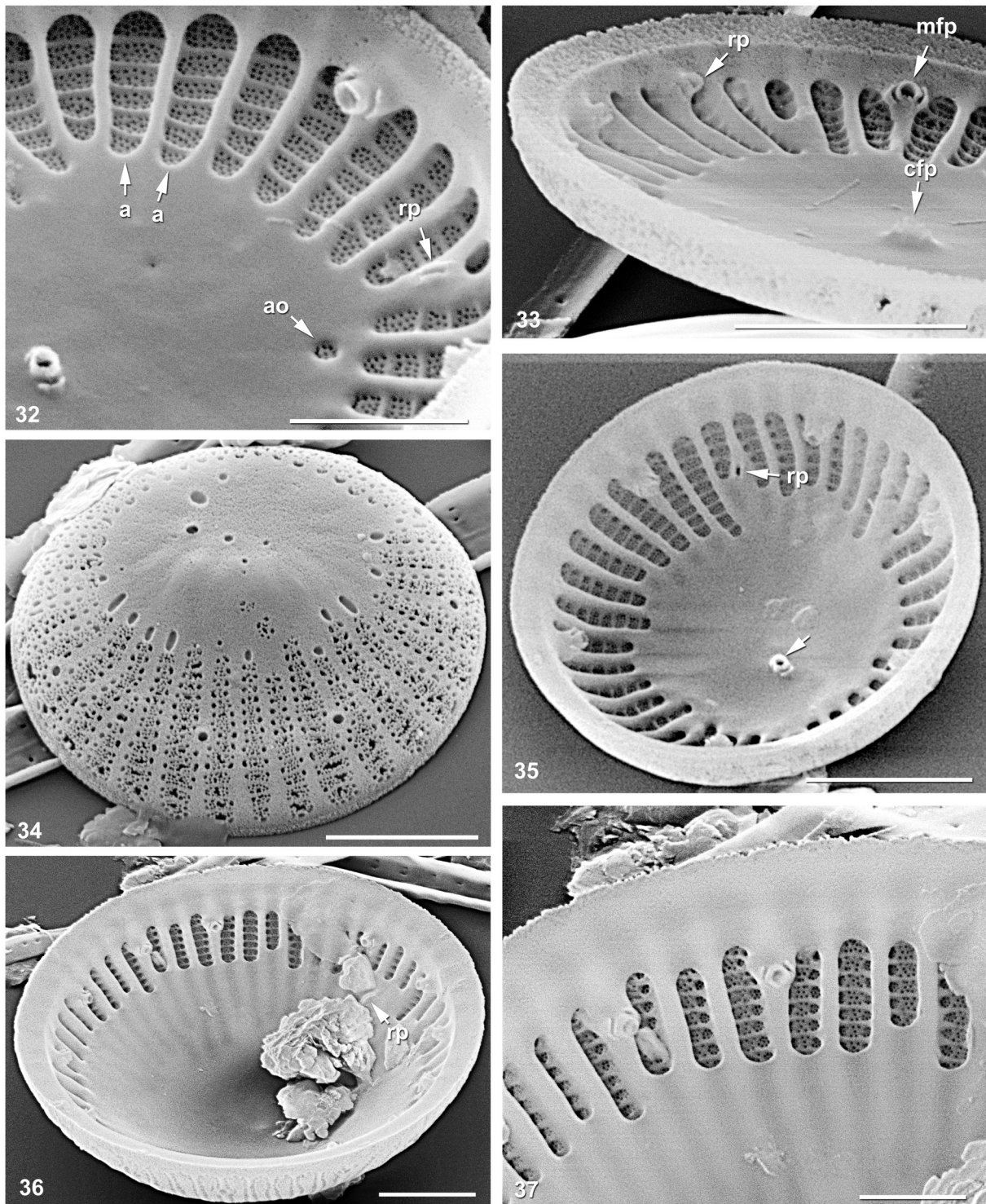
Figs 19–24. *Cyclotella hinziae* sp. nov. SEM, type material, Lake Schliersee (Bavaria, Germany), plankton 31 March 2014: (19–24) external views; (19) girdle view of a short tilted chain of cells; (20–24) valve exterior of valves; (20–22, 24) note central and marginal valve part with central fultoportula (cfp) and a rimoportula (rp) situated opposite; (23) note outer openings of marginal fultoportulae (arrows) as simple large pori inside small smooth circular fields; (20, 22, 24) note poria in the valve central part. Scale bar 2 μm.





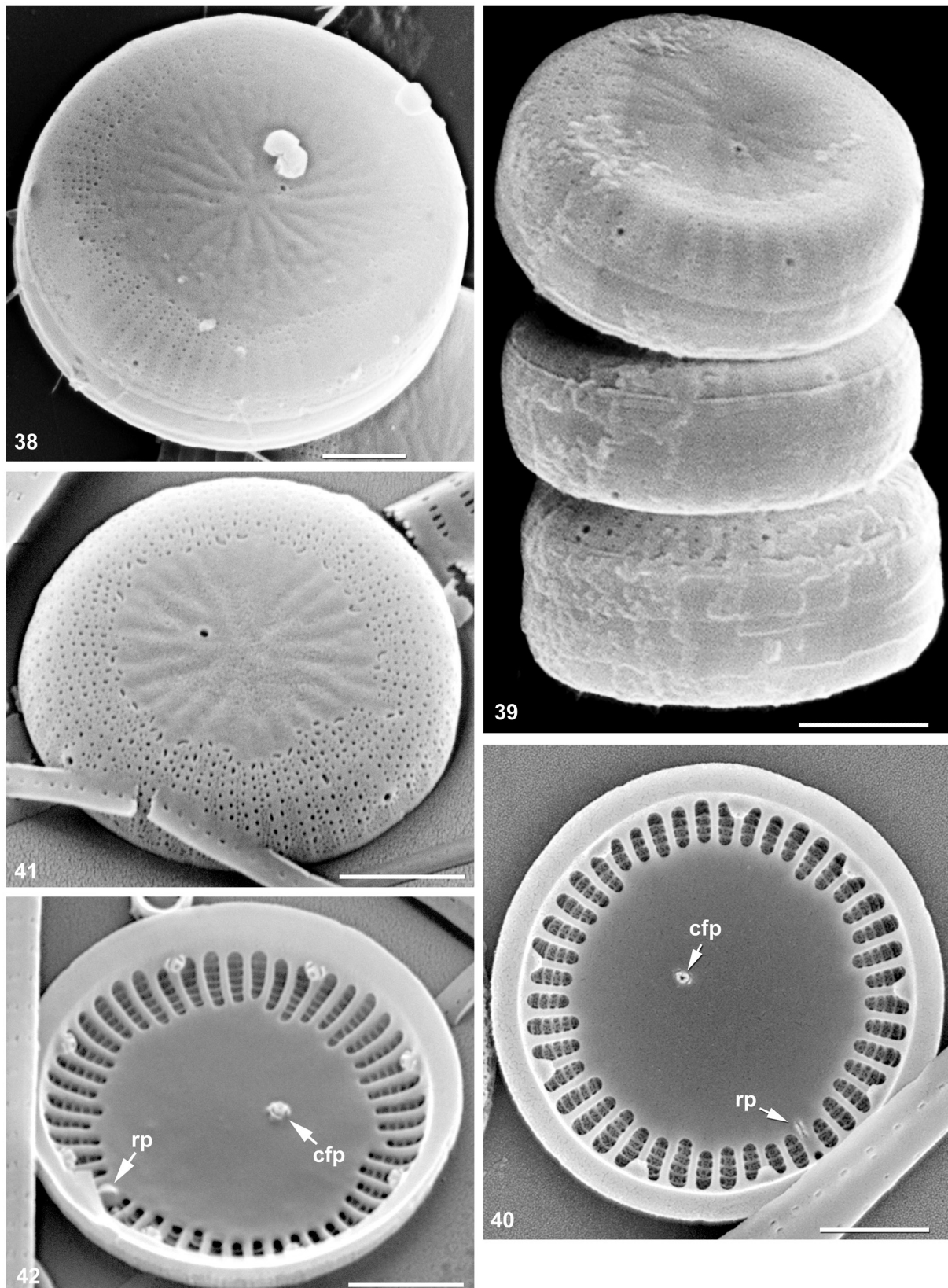
Figs 25–31. *Cyclotella hinziae* sp. nov. SEM, type material, Lake Schliersee (Bavaria, Germany), plankton 31 March 2014: (25, 26) details of the valve margin exterior, note the external bridges between the striae (arrows) internally corresponding to trabeculi, (26) note depressed external tube of central fultoportula (cfp); (27–31) valve interior views, (27) note long internal central tube of marginal fultoportula (arrow) with 2 long satellite pore covers oriented laterally, internal opening of central fultoportula (cfp) with a single satellite pore and sessile labium of rimoportula (rp) situated opposite on a rib, (28) detail from Fig. 27, note circumferentially oriented trabeculae (tr) in the valve marginal part with small irregularly arranged pori between them, (29) note the internal opening of central fultoportula (cfp) with 2 satellite pori, (30) note the internal opening of central fultoportula (cfp) with 3 satellite pori, (31) note the internal sessile labium of rimoportula situated near the central part. Scale bar 1  $\mu$ m.





Figs 32–37. *Cyclotella hinziae* sp. nov. SEM, Type material, Lake Schliersee (Bavaria, Germany), plankton 31 March 2014: (32, 33) valve interior views, (32) detail of a valve marginal part; note internal alveolar openings (a), one small extra alveolar opening (ao) and an internal sessile labium of rimoportula (rp) situated in the middle of a costa, (33) detail of a valve marginal part with an internal projection of marginal fultoportula (mfp) with two satellite pori oriented laterally (circumferentially), central fultoportula (cfp) and internal sessile labium of rimoportula (rp) situated near the valve edge; (34–37) initial valves, (34) external view of a valve; note partially transversally undulate central part; (35–37) valve interiors, (35) note internal sessile labium of rimoportula (rp) and an internal projection of central fultoportula (arrow), (36) note internal sessile labium of rimoportula (rp) located below the internal openings of alveoli, (37) detail from Fig. 36, note transversal trabeculi inside alveoli. Scale bar 1 µm (32, 37), 2 µm (33–36).





Figs 38–42. *Cyclotella hinziae* sp. nov., SEM: (38) Lake Schliersee (Bavaria, Germany), plankton 6 May 1997; (39) Lake Schliersee (Bavaria, Germany), plankton 5 Nov 2001; (40) Lake Schliersee (Bavaria, Germany), plankton 21 Aug 2006; (41, 42) Lake Schliersee (Bavaria, Germany), plankton 25 May 2010; (38, 39, 41) exterior of tilted valves, note finely radially warped valve central parts; (40, 42) valve internal views; note internal projections of central fultoportulae (cfp), internal sessile labia of rimoportulae (rp) and concentric transversal rings of trabeculae inside alveoli. Scale bar 2  $\mu$ m.



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