A new species of Synedra Ehrenb. with comments on auxospore and initial cell morphology

David M. Williams and Ditmar Metzeltin

Abstract

A new species of Synedra from Uruguay is described. Comparison with other species from the genus Synedra sensu lato suspected to be either auxospores or initial cells are made. We describe the new species with reference to its auxospore and initial cell structure as well as its vegetative valves.

Key index words: auxospores, initial cells, new species, Synedra

Introduction

In one of the few freshwater diatom floras of Uruguay, Metzeltin & García-Rodriguez published a series of images from specimens they named Synedra reinboldii Van Heurck (Metzeltin & García-Rodriguez 2003 : 74–75, Lam. 14, Figs 1–9). In one of a series of revisionary papers on the genus Synedra Ehrenb. sensu lato, Reid & Round transferred Synedra reinboldii to a new, monotypic genus, Trichotoxon F.Reid & Round (Reid & Round 1987). They noted that further species are likely to be discovered and Trichotoxon will not remain monotypic (see comments in Reid & Round 1987 : 223). Trichotoxon reinboldii (Van Heurck) F.Reid & Round belongs to a marine genus that significantly differs in morphology from those species usually placed in Synedra (sensu Williams 1986, i.e. as typified by Synedra ulna (Nitzsch) Ehrenb.). The valve striation of T. reinboldii has large outer apertures occluded by cribra (Reid & Round 1987 : Figs 6–9) but when the valves are viewed from the inside the surface is composed of simple, plain 'holes' (Reid & Round 1987 : Figs 11, 13–16), suggesting that the basal siliceous layer is rather more complex than a simple flat surface penetrated by puncta of various kinds (see Williams & Round 1986). Trichotoxon also lacks pore fields, even a simple basic arrangement of pores at each pole (Reid & Round 1987 : 6–8, 9–11, 13–16). In contrast, the specimens illustrated by Metzeltin & García-Rodríguez (2003 : 74–75, Lam. 14, Figs 1–9) have a simple valve surface, with regularly placed striae and each pole has a typical ocellulimbus (Williams 1986). In any case, the overall structure of these specimens and the fact that they are freshwater, excludes T. reinboldii from consideration as to its identity. In short, Trichotoxon most closely resemble species of the genus Thalassionema Grunow ex Mereschk. and Thalassiothrix Cleve et Grunow (see Hasle 2001), where our specimens resemble species with a morphology similar to Synedra ulna. Comparison with other similar species leads us to conclude that the specimens in Metzeltin & García-Rodríguez (2003) are of a new species, related to those with morphology similar to Synedra ulna.

In addition, some of the specimens illustrated by Metzeltin & García-Rodríguez (2003, in particular Lám. 14, Figs 2, 3, 6–8) resemble auxospore or initial cells of species from the genus Synedra sensu lato (see, for example, Geitler 1939a : Abb. 5a and Abb. 6a and c); they are extremely long (c. 450 μm in Lám. 14, fig. 2, for example) and have some unusual features, such as the pore-field (ocellulimbus) in some specimens are situated more on the valve surface rather than the mantle (Lám. 14, fig. 7).

In this paper we present evidence from scanning electron microscopy (SEM) and document in detail the ultrastructure of this new species. We also offer some comments on previously accepted on October 5, 2004
described auxospore and initial cells from freshwater species previously considered to belong to the genus Synedra Ehrenb. (Williams 1986, Williams & Round 1986, Round et al. 1990). In addition, because of the complex evolution of the concept of the genus Synedra, we first offer a few comments on its nomenclature and the approach we have taken.

**Nomenclature**

This paper is not intended as a contribution on the status of the genera Fragilaria Lyngb. and Synedra (and related genera) but a description of a new species with commentary on valves that appear to be either auxospores and/or initial cells. However, as the species is new to science it does need to be placed in a genus. We demonstrate below that our new species has features that characterise the genus Synedra as understood by Williams (1986), Williams & Round (1986) and Round et al. (1990), a taxonomic group equivalent to the subgenus Alterasynedra Lange-Bert. (in Krammer & Lange-Bertalot 1991: 143, validated in Lange-Bertalot 1993: 52, see also Compère 2001: 99 and Kusbert & Jahn 2003: 39). That is, a genus characterised by Synedra ulna (Nitzsch) Ehrenb. Although Williams (1986) typified Synedra with S. ulna and Lange-Bertalot typified the subgenus Alterasynedra with Synedra ungeriana (Grunow) D.M. Williams, both it and S. ulna have very similar morphologies and S. ungeriana was included in Synedra by Williams (1986). No one disputes the close relationship between S. ulna and S. ungeriana or that they should be included in the same group, whatever it might be called. Thus, Synedra sensu Williams and subgenus Alterasynedra are equivalent groups (but with different ranks). According to Lange-Bertalot & Compère (2001), the subgenus Alterasynedra is invalid and its correct name, as a subgenus, should be Ulnaria (Kütz.) Lange-Bert. & Compère, typified by Synedra ulna (Kütz.) Lange-Bert. & Compère, typified by Synedra ulna.

From a nomenclatural point of view, as has been pointed out on a number of occasions, strict adherence to the International Code of Botanical Nomenclature (ICBN) demands that any genus called Synedra should properly be typified by the marine species Synedra gaillonii (Bory) Ehrenb. (Williams 1986. For recent commentary, see Lange-Bertalot 1993: XII and XVII, Compère 2001 and Morales 2003). Synedra gaillonii is quite different from what is usually understood as a species of Synedra and consequently was transferred to the new genus Catacombas D.M. Williams & Round (Williams & Round 1986). Thus, Synedra has been typified with two quite different species, Synedra ulna and Synedra gaillonii. This does not mean that two species, both Synedra ulna and Synedra gaillonii, have been used to typify the same genus (cf. Morales 2003: 158). Rather, there are two different interpretations of the genus Synedra.

Compère (2001) attempted to solve the problem by proposing that Ulnaria Kütz. is the correct name for any genus of diatoms including the species Synedra ulna and the genus Synedra must be typified by Synedra gaillonii (S. baltica (baltica) Ehrenb.). While this suggestion does indeed adhere to the principles of typification as outlines in the ICBN, it does not take into account the practical aspect of 'common usage' and the principle of conservation, rules introduced to avoid name changes that may have a detrimental effect on nomenclature (ICBN, Art. 14.2 states: "Conservation aims at retention of those names which best serve stability of nomenclature"). It is more than possible that the use of the generic name Ulnaria will add further confusion, rather than clarify, an already complex nomenclatural situation (cf. Morales 2003). Hence we have chosen to use the generic name Synedra pending the outcome of a conservation proposal with the objective to preserve the use of the generic name Synedra as typified by S. ulna (Williams & Round In Prep.).

**Systematic description**

*Synedra tortuosa* D.M.Williams et Metzeltin, nov. sp.  
Figs 1–16

Valva linearis ad centrum tenuis sufflatus, parallelus ad marginem, ad apices gradatum, 120–450 \(\mu\)m longa, 5–8 \(\mu\)m lata, 10–12 \(\mu\)m lata ad centrum. Striae parallels uniseriatus 5–10 per 10 \(\mu\)m. Sternum centralis. Rimoportulae ad ocel lulimbus ad apices. Neque spinis neque interordinatus proprietas.

Type slide: BM 101108.

Type locality: Arroyo del Aigua, c. 54°45' W; 34°40' S, Department of Maldonado, leg. Met-
A new species of *Synedra*

**Figs 1–7.** SEM images of *Synedra tortuosa*, sp. nov., from type material, Arroyo del Aigua, c. 54° 45' W; 34° 40' S, Department of Maldonado, leg. Metzeltin & Garcia-Rodriguez, Nov. 2002, all bars = 2 µm except Fig. 7 = 90 µm. **Figs 1, 4.** Internal views of both poles, showing rimoportula (arrowed in Fig. 1), ocellulimbus and striae structure. **Figs 2, 7.** External views of both poles, showing rimoportula (arrowed in Fig. 2), ocellulimbus and striae structure. **Fig. 3.** External view of whole valve. **Figs 5, 6.** Showing external and internal views, respectively, of the centre of the valve for its structure.
Figs 8–16. SEM images of *Synedra tortuosa*, sp. nov., from type material, Arroyo del Aigua, c. 54° 45’ W; 34° 40’ S, Department of Maldonado, leg. Metzeltin & Garcia-Rodriguez, Nov. 2002. Some of these specimens are most likely of initial cells. **Fig. 8.** External view of pole, showing rimoportula (arrow) and ocellulimbus, bar = 2 µm. **Fig. 9.** External view of valve centre, with slight inflation and absence of striae, bar = 2 µm. **Fig. 10.** Frustule with two dissimilar valves, the left-hand valve possi-
Valves linear, with parallel margins, tapering towards the poles; valves with a faint central inflation (Figs 3, 5, 13, 14). In larger specimens, valves curve dramatically (Metzeltin & Garcia-Rodriguez 2003: Lam. 14, Figs 2, 3), less so in smaller specimens (Fig. 3; Metzeltin & Garcia-Rodriguez 2003: 74-75, Lam. 14, Figs 1, 4, 5); length 120–450 μm, breadth, 5–8 μm, increasing to 10–12 μm at its centre (Metzeltin & Garcia-Rodriguez 2003: Lam. 14, Figs 6–8). Valves linear, with parallel margins, tapering towards the poles; valves with a faint central inflation (Figs 3, 5, 13, 14). In larger specimens, valves curve dramatically (Metzeltin & Garcia-Rodriguez 2003: Lam. 14, Figs 2, 3), less so in smaller specimens (Fig. 3; Metzeltin & Garcia-Rodriguez 2003: 74-75, Lam. 14, Figs 1, 4, 5); length 120–450 μm, breadth, 5–8 μm, increasing to 10–12 μm at its centre (Metzeltin & Garcia-Rodriguez 2003: Lam. 14, Figs 6–8).

Striae parallel to each other (Figs 1, 2, 4, 5, 13) in uniseriate rows, approximately 5–10 in 10 μm; no more than 8 puncta in each row at the poles, more than 15 at the centre (Figs 1, 2, 4–6, 7, 13, 14). Sternum central, a narrow line extending pole to pole, interconnecting striae at either side (Figs 1, 2, 5, 6), inflated at valve centre (Figs 5, 14 Metzeltin & García-Rodríguez 2003: Lam. 14, Figs 6, 8). Rimoportulae (Figs 1, 2 arrows, 4, 7, 8 arrow, 16) and complex pore field (ocellulum) at each pole (Figs 1, 2, 4, 7, 8, 10, 16). Rimoportulae orientated at an angle of roughly 30° relative to the striae (Figs 1, 2, 4, 7, 8, 16); ocellulum with regular rows of puncta, extending from the edge of the valve margin to the edge of the valve surface (Figs 10, 16). No evidence of spines or other interconnecting mechanism. Initial cells with striae scattered on surface, irregular, often not parallel (Figs 11–16; Metzeltin & García-Rodríguez 2003: Lam. 14, Figs 7, 8); ocellulum smaller than in vegetative valves, less well developed, situated further on valve polar margin (Figs 10, 16; Metzeltin & García-Rodríguez 2003: Lam. 14, Fig. 7). Girdle composed of three to four bands (Figs 11, 14, 15, 16); each band simple, with few central pores (Figs 14, 15, arrows, 16); valvocopula a closed band (Fig. 16), with pars interior rim complete and attaching to valve inner surface. Initial cell bands more delicate, thin almost transparent, folding over the valve surface (Figs 14–16).

Discussion

As noted above, morphological differences between species in the genus Synedra (sensu Williams 1986) and those in Trichotoxon are profound, including perhaps every feature of valve morphology, such as pore-fields (ocellulimbus), valve surface structure (internal and external aspects) and outer surface morphology. In addition, they differ in ecology, with Synedra being freshwater, Trichotoxon marine. Our specimens bear all the characteristics of Synedra, including a closed valvocopula. In a survey of species described in the genus Synedra (Williams unpublished), only a few previously described species are similar enough to warrant comparison to our specimens. However, many of these species lack detailed LM or SEM documentation. As such, we have described our specimens as belonging to a new species. However, as some of the specimens resemble auxospore/initial cells we have examined more carefully previous reports and present our findings below.

Studies on the auxospores of species belonging to Synedra sensu lato are limited (but see comments in Schmid 1997). An early study can be found in Karsten (1897), who illustrated with several pictures specimens he called Synedra (Tabularia) affinis Kütz. Karsten's pictures show a number of irregularly shaped auxospores and, possibly, initial cells (Karsten 1897: Figs 1–21). Karsten also noted that the auxospores were rather longer than one expects from vegetative valves, giving dimensions as between 360 μm to 572 μm in length. A much later study, published probably a late initial cell (with ocellulum on both the valve margin and face), the right-hand side valve a vegetative valve (with ocellulum on the margin and regular striae patterns), bar = 2 μm. Fig. 11. Centre of frustule in Fig. 10, showing the contrast in valve stria tion between the two different valves; also showing two rather plain and thin girdle bands, bar = 2 μm. Fig. 12. External view of valve face centre for initial cell, with raised ridges of striae, bar = 2 μm. Fig. 13. External view of valve face of initial cell, with exposed striae as open puncta, bar = 2 μm. Fig. 14. External view of valve centre for initial cell, with central inflation, few pores, large sternum and two thin, porate bands (arrows), bar = 5 μm. Fig. 15. Detail of two girdle bands from initial cell (arrows), bar = 2 μm. Fig. 16. Detail of pole for girdle, with two open bands; the break (at arrow) is a preparation artefact, not the opening of the band. bar = 2 μm.
by Geitler (1939a, b), includes a few illustrations of auxospore valves of Synedra ulna (Geitler 1939a : Abb. 5a and Abb. 6a and c). Geitler illustrated one frustule of 300 μm in length with the suggestion of a central inflation (Geitler 1939a, Abb. 5a) and another auxospore of 250 μm long that curves throughout its length (Geitler 1939a, Abb. 6a). He also included some details of the ‘valve’ structure showing them with irregular, slightly undulating outlines (Geitler 1939a, Abb. 6a). Later, Geitler (1958 : 436, Abb. 13) published an illustration of an auxospore (initial cell?) of Synedra amphi cephalta Kütz. (=Fragilaria am phi cephalta (Kütz.) Lange-Bert.; for further details of this taxon including illustrations of type specimens see Lange-Bertalot 1980 : 747 ; Kramer & Lange-Bertalot 1991 : 448, Taf. 109, Fig. 20, Lange-Bertalot 1993 : 44 and Kramer & Lange-Bertalot 2000 : 581).

Overall, it appears that auxospore/initial cells from species in Synedra sensu lato are usually rather large (in excess of 250 μm), are often curved along their entire length, have a rather irregular basal siliceous layer and the valve outline is sometimes interrupted by undulations or a central inflation to the valve. Using these criteria it is possible to examine named taxa that may be worth investigating for their status as auxospore/initial cells rather than species in their own right, or the ‘normal’ vegetative valves (Table 1). Many of these species have never been properly examined since their original description. Below we deal with only those that have sufficient data to be of direct relevance in the interpretation of our specimens.

Synedra montana Krasske was first described by Krasske in 1932 (Hustedt 1932 : 204, Fig. 694, Krasske 1932 : 99, Pl. 2, fig. 2*). A full description appeared in Hustedt (1932 : 204, reproduced in Lange-Bertalot et al. 1996 : 184 ; an English translation from Hustedt 1932 appears in Jensen 1985 : 190), which includes some locality details: "In Sturzbächlen der Alpen, vorläufig nur von einem Standort bekannt... In Mooresen in einem Sturzbach oberhalb Kaprun, Hohe Tauern, Tirol (Krasske)!" (Krasske noted only the Hohe Tauern locality; Krasske 1932 : 99). The illustrations in Hustedt are of long (120 μm) specimens,
A new species of *Synedra* is slightly inflated at their centre. One specimen (Hustedt 1932, fig. 694, left) appears to be in girdle view and lacks a central constriction, whereas the second specimen (Hustedt 1932, fig. 694, right, probably the same as Krasske's single illustration, Krasske 1932: Pl. 2, fig. 2, reproduced in Lange-Bertalot et al. 1996: 184) is in valve view and has a distinct central constriction. In both of Hustedt's illustrations the valves are slightly curved in the same direction, although this is not particularly pronounced in valve view. The length of the valves and their curvature is suggestive of initial cells, rather than the more usual linear vegetative valves.

When Lange-Bertalot revised the genus *Fragilaria* he transferred Krasske's *S. montana* to the genus *Fragilaria* noting that "Überprüfung des Typenmaterials : wahrscheinlich Sporangialstadien von *Fragilara capucina* s.l. (Lange-Bertalot 1980: 747; "Examination of type material : probably Sporangial stages of *Fragilara capucina* s.l."") (our translation). With the publication of the third volume of the *Süsswasserflora von Mitteleuropa*, two light micrographs of *Fragilaria montana* (Krasske) Lange-Bert. were included (Krammer & Lange-Bertalot 1991: Taf. 116, Figs 6, 7 and Krammer & Lange-Bertalot 2000: Taf. 116, Figs 6, 7, reproduced in Lange-Bertalot et al. 1996: Taf. 2, Figs 23, 24). Both of the illustrations are of specimens taken from type material, where the valve structure appears somewhat less organised than one might expect from vegetative valves, the central constriction is evident (Krammer & Lange-Bertalot 1991: 462–3, Taf. 116, Figs 6, 7) and the valves appear of exceptional length (although no size ranges are given). Again, the features evident in these micrographs point to initial cells rather than vegetative valves. Indeed, Krammer & Lange-Bertalot wrote: "Das Typenmaterial enthält nicht nur die exemplarisch abgebildeten, in der Mitte zweiwelligen, relativ linear gestalteten Exemplar, sondern auch wesentlich stärker 'verformte', in der Mitte nur einfach aufgetriebene Schalen. Erstlingszellen von *F. pulchella* können analog dazu ähnliche Gestalt annnehmen" (Krammer & Lange-Bertalot 1991: 131; "The type material does not only contain the examples illustrated, which are relatively linear and have a double-curve at the centre, but also contains valves substantially more 'deformed', but with the valve centre having only a simple expansion. Initial cells of *F. pulchella* are similar in shape." (our translation; it is possible the reference to *F. pulchella* is from Karsten's early work)). Further, in their study of Georg Krasske's type material, Lange-Bertalot et al. (1996) added the following comment to the account of *Synedra montana*: "Es ist jedoch ziemlich sicher, daß diese durch ihren Umriff auffallenden Exemplare Erstlingszellen einer vorläufig nicht sicher bestimmmbaren Art aus der Gattung *Fragilaria* (Subgenus : *Alterasynedra*) repräsentieren" (Lange-Bertalot et al. 1996: 184; "It is, however, rather certain that these remarkable initial cells are of a kind provisionally, but not certainly, assignable to *Fragilaria* (Subgenus : *Alterasynedra*)" (our translation)). In summary, it seems clear that most commentary on *Synedra* (*Fragilaria*) *montana* suggests that they are initial cells rather than vegetative valves.

Subsequent to Krasske's discovery, Cleve-Euler, in her comprehensive but confusing *Die Diatomeen von Schweden und Finnland* (Cleve-Euler 1953), added some complexity to the identity of *Synedra montana*. While she described *S. montana*, taking her description mainly from that of Hustedt and Krasske, she added "Schalen bisweilen gebogen (f. curvata mh.) (Fig. 389)" (Cleve-Euler 1953: 68). Inspection of her illustrations (Cleve-Euler 1953: Fig. 389) reveals crude reproductions of Hustedt's two figures of *S. montana* ("Nach Hustedt...", Cleve-Euler 1953: 154). It is difficult to understand which of these Cleve-Euler meant to indicate as an example of *S. montana* var. *curvata* A.Cleve, if any at all. Nevertheless, on the same page as the illustrations of *S. montana* are four specimens, included as figures 388Ba–c and 388C, all resembling valves that might also be considered initial cells of some species of *Synedra*. Figure 388Ba and b were identified as specimens of *Synedra arcuata* (Ostrup) A.Cleve, based on *S. ulna* var. *longissima* f. *arcuata* Ostrup (Ostrup 1918: 58, Pl. 5, Fig. 77). Cleve-Euler's figure 388Ba is a reproduction of Ostrup's original but figure 388Bb is of Cleve-Euler's own specimens from "Finn. Lappl. Kemijärvi", derived from an earlier report in which Cleve-Euler made the combination *Synedra ulna* f. *arcuata* (Ostrup) A.Cleve, but which had no illustrations (Cleve-Euler 1934: 16). It is
not clear from Østrup's account where the original specimens of *S. ulna* var. *longissima* f. *arcuata* came from but examination of Østrup's collections in Copenhagen (DMW, 2000) yielded one slide that is indicated as holotype: C Østr. 6536, labelled "I 204.1.KB". While few appropriate specimens were noted in Østrup's material, some did curve dramatically at each pole and the valve structure appeared rather disorganised, as one might expect from initial cells. The valves examined were up to 250 μm in length, but have been reported as much as 320 μm long (Cleve-Euler 1953: 68). In addition to *Synedra arcuata*, Cleve-Euler also described the new variety *Synedra arcuata var. subrecta* A.Cleve, illustrated as figure 388Bc, from "Boh Kristineberg [Sweden]". These specimens have not been available for examination but the illustration provided in Cleve-Euler is very similar to that of *S. montana* except the valve lacks the central constriction. It should be noted here that if Cleve-Euler's *Synedra arcuata* is found to be a valid taxon it will require a new name, as *S. arcuata* has been used twice before: *Synedra arcuata* Nageli ex Kütz. (1849: 890, possibly a species of *Eunotia* Ehrenb.) and *Synedra arcuata* Wigand (1860: 44, Pl. 7, Fig. 15 = *S. wigandii* Rabenh.).

Cleve-Euler's figure 388C (Cleve-Euler 1953) refers to a new variety *S. filiformis var. curvipes* A.Cleve, although she probably considered it worthy of species status; following the new name, she added "(n.sp.?)", repeating the query designation in the figure legend (Cleve-Euler 1953: 154). Again, no specimens have been available for examination but the illustration provided also resembles *S. arcuata*, a fact noted by Cleve-Euler (1953: 69).

Further, we note some records of *Synedra (Fragilaria) montana* that provide additional and relevant information as to its auxospore/initial cell status. First, Mpawenayo (1985, 1996) reported *Fragilaria cf. montana* from the Rusizi, Tanganyika (Mpawenayo 1985: 154, Pl. 1, Figs 5,6, 1996: 142). Mpawenayo included two drawings (Mpawenayo 1985: 154, Pl. 1, Figs 5,6; 1996: 191, Figs 324–5) and two light micrographs (Mpawenayo 1996: 235, Figs 4–6). It is clear from both of these illustrations that the specimens depicted are auxospores or, more likely, initial cells. Foged provides an illustration of *Synedra montana* from Alaska (Foged 1981: Pl. V, Fig. 11), which also gives the appearance of an initial cell: rather ill-defined outline, central inflation, and curved, at least towards the poles (although the specimen was apparently only 88 μm in length).

Finally, we note one more species, *Synedra manguinii* J.-E.Pierre from the Ile de la Possession (Pierre 1977; this species is not recorded in a more recent diatom flora, Van de Vijver et al. 2002). Pierre's species is invalidly published as no Latin description was included in the protologue but the two illustrations are of a single valve with a vaguely undulating outline and a central inflation but with reasonably uniform striae and not particularly long, at 90 μm (Pierre 1977: Figs 4, 5).

What general conclusions may be drawn from these observations, and what relevance do they have for the species we describe above? If the assumption that many of the specimens illustrated are auxospore/initial cells of *Synedra sensu lato* then they can be characters of valves being long, often curved, have a rather irregular basal siliceous layer and the valve outline is sometimes interrupted by undulations or a central inflation to the valve. These characteristics apply to most of the specimens illustrated in Metzeltin & García-Rodriguez (2003: 74–75, Lám. 14, Figs 1–9). Nevertheless, further examination of more specimens indicates that many of the valves have the more regular features of vegetative valves and that the sample examined from Uruguay contains a range of specimens from the life-cycle of this new species.

Further work on this genus will need to take into account the possible structures of the auxospores and initial cells and full descriptions should attempt to include such details. It seems clear, if we are correct in our judgements, that some already described species may be simply just part of the early life-cycle and that differentiation of species-specific characters occurs once the vegetative stage is reached. Such conclusions may have implications for the future identification of similar species, inasmuch as the vegetative valves provide the crucial information for differentiating species.
Acknowledgements

We would like to thank Geraldine Reid for assistance with the Latin and David Mann for nomenclatural advice.

References


