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Valve morphology of three species of *Neidiomorpha* (Bacillariophyceae) from Zoigê Wetland, China, including description of *Neidiomorpha sichuaniana* nov. sp.

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Abstract

A new diatom species, *Neidiomorpha sichuaniana* sp. nov., is described from Zoigê Wetland, China. The morphology of *N. sichuaniana* is documented by light and scanning electron microscope and discussed in detail, including a comparison with the two other species in the genus *Neidiomorpha* also found in Zoigê. *Neidiomorpha sichuaniana* has a smaller central area and smaller central constriction than *N. binodiformis* and less apiculate ends than *N. binodis*. We comment on the systematic position of *Neidiomorpha* based on the morphology of these three species.

Key words: China, Sichuan Province, *Neidiomorpha*, *Neidium*, new species, scanning electron microscopy

Introduction

The diatom genus *Neidiomorpha* Lange-Bertalot H. & Cantonati M. in Cantonati *et al.* (2010: 196) was described for species formerly placed in the genus *Neidium* Pfitzer (1871: 39). *Neidiomorpha* originally contained two species, *N. binodiformis* (K. Krammer in Krammer & Lange-Bertalot) M. Cantonati, H. Lange-Bertalot & N. Angeli (2010: 200) and *N. binodis* (Ehrenberg) M. Cantonati, H. Lange-Bertalot & N. Angeli (2010: 200), which are distinguished from *Neidium* by having longitudinal depressions or "caves" on either side of the axial area running the whole length of the valves. These species are also found in mostly alkaline habitats (Cantonati *et al.* 2010), which is different from many, but not all, *Neidium* species (e.g. Reimer 1959). The diagnosis of *Neidium*, as typified by *N. affine* (Ehrenberg) Pfitzer (1871: 39), was recently emended by Hamilton and Jahn (2005) to only include species with a suite of features such as longitudinal canals, renilimbi, lacinia and external proximal raphe ends recurved in opposite directions. Kavulic and Kociolek (2014) generated a cladistics analysis that included the two *Neidiomorpha* species, 'typical' *Neidium* species, as well as several *Neidium* species with suites of features that are necessary but not sufficient for inclusion in *Neidium*, such as *N. temperei* Reimer (1959: 33), *N. holstii* (Cleve) Krammer in Krammer & Lange-Bertalot (1985: 106) and *N. dubium* (Ehrenberg) Cleve (1894: 70). Kavulic and Kociolek (2014) suggested that *Neidiomorpha* is non-monophyletic, and that based on the emended diagnosis for *Neidium*, there are species that fit in neither genus as presently circumscribed. Relationships of those species suggest they may each need to be accommodated into new, separate genera, for all of them to be monophyletic.

Zoigê Wetland is located in the eastern edge of the Qinghai-Tibet Plateau, including Maqu County, Hongyuan County and Aba County (Zhou *et al.* 2002). It is one of the three Tibetan Plateau grass wetlands, which is a typical area of alpine ecosystems and cold peat wetland ecosystem (Chen *et al.* 2010). This area, with an elevation of over 3400–4000m, is a complete physiographic region, and possesses unique geological landform, hydrology, climate, flora and fauna (Mu1982). The average annual rainfall of this area is 650mm and an average temperature is about 1.7°C (Chen *et al.* 2010).

We encountered populations of the two known species of *Neidiomorpha* from the Zoigê Wetlands, as well as a species apparently new to science. In this paper we present LM and SEM observations on Chinese specimens of these *Neidiomorpha* taxa and discuss relationships within the genus.

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In the SEM, externally the striae are composed of individual, circular to irregularly-shaped areolae, with 1–5 larger apertures near the sterum which become abruptly and distinctly smaller towards and onto the valve mantle (Fig. 29). The striae on the mantle are comprised of a single, elongated areola (Figs 29, 30). The axial area is narrow and expanded laterally to form a small, elliptical to irregular central area (Figs 29, 31). The raphe is simple and filiform (Fig. 29). The distal raphe ends are deflected onto the mantle (Figs 29, 30). The central fissures are small, slightly dilated simple central pores (Fig. 30). Voigt faults are visible on the secondary side of the valve (Fig. 29).

Internally, the areolae commonly number between 1–4 per stria, close to the sternum, larger and with hymenes (Figs 32, 33). The longitudinal cave is shallow and visible in the mantle (Figs 32, 33). The raphe system has a straight raphe slit lying in the sternum with distinct, distal helictoglossae and a central thickened area of silica which appears similar to the helictoglossae (Figs 32, 33).

Discussion

Chinese specimens of both *N. binodis* and *N. binodiformis* fit the descriptions based on European (Germain 1981; Krammer & Lange-Bertalot 1986; Cantonati et al. 2010) and North American (Patrick & Reimer 1966) specimens. The *Neidiomorpha binodis* specimens from the Zoigê Wetlands are on the small end of the size range, but in general fit the description of the species. *Neidiomorpha sichuaniana* resembles *N. binodeformis* more than *N. binodis* in valve outline, lacking the more attenuated ends of the latter. *Neidiomorpha sichuaniana* has striae that are more punctate and appear undulate, more similar to those of *N. binodis* than the finer striae of *N. binodeformis*. Kavulic and Kociolek (2014: Figure 15) showed that *Neidiomorpha* is non-monophyletic, with *N. binodis* sharing a more recent common ancestor with other *Neidium* taxa, rather than *Neidiomorpha binodiformis*. *N. binodis* and species of *Neidium* share the synapomorphy of internal hymenate occlusions over the areolae, a feature apparently missing in *N. binodiformis*, the generitype of *Neidiomorpha*. Kavulic and Kociolek did not cite Krammer and Lange-Bertalot (1985: pl. 43, fig. 4), which shows *N. binodiformis* with internally positioned hymenes. Even so, the relationships *N. binodiformis* to *N. binodis*, remains uncertain.

It is noted here that *N. sichuaniana* has hymenate occlusions but lacks many of the features that would argue for its inclusion within *Neidium*, especially as Hamilton and Jahn (2005) have recently offered a narrow circumscription in their amended diagnosis of the genus. Further work is needed to determine if *Neidiomorpha* is indeed monophyletic.

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