# Observations on *Tabularia sinensis* Yue Cao & al. (*Ulnariaceae, Bacillariophyceae*), a potentially invasive species in European rivers

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*Tabularia sinensis* Yue Cao & al. (2018) was recently described from Poyang Lake, Jiangxi Province, the largest freshwater lake in China. The lake, with an almost circumneutral pH (7.4) and low conductivity 92 µS/cm), is connected to the lower and middle stretched Yangtze River and heavily used for navigation. This large (valve length up to ± 170 µm) species has several distinct morphological features that were not described previously for any *Tabularia* species. *Synedra* subgenus *Tabularia* Kützing (1844: 57) was raised to genus rank as the genus *Tabularia* (Kützing) D.M.Williams & Round (1986). Three different groups were separated within *Tabularia*, one typified by *Tabularia barbatula* (Kützing) D.M.Williams & Round, another by *T. investiens* (W.Smith) D.M.Williams & Round and the third that included all taxa in the *Tabularia fasciculata* (C.Agardh) D.M.Williams & Round complex. Cao & al. (2018), having unidentified specimens of a possible *Tabularia* species, undertook a cladistic analysis of 16 morphological characters to establish which of the three groups *T. sinensis* belonged. *Tabularia*, as presently constituted, is clearly paraphyletic and in need of revision. The analysis showed that *T. sinensis* could be considered a species of *Tabularia*, which may, of course, change when monophyletic taxa within *Tabularia* are delineated.

*Tabularia sinensis* possesses very short striae (13–15 in 10 µm) composed of up to 7 (at the apices) transapically elongated, slit-like areolae covered each by a singular simple closing plate (see Cao & al. 2018, figs 23, 25). This high number of areolae is only observed at the apices as on the rest of the valve, only one to occasionally two areolae are found in each stria. This stria structure differs markedly from all other *Tabularia* species so far described (see for instance Williams & Round 1986, Snoeijs & Kuylenstierna 1991, Harper & al. 2009). Two short but robust spines are located on the valve apices, overhanging the quite large sunken ocellulimbus.

Despite the typical valve outline of this species in light microscopy and its large valve dimensions, records of *T. sinensis* in literature are scarce. Based on scarce published images in the literature, the species has been reported from several freshwater Japanese localities, although always identified under a different name. Gotoh (1986) previous observed the species in the Kumano-gawa river estuary (Kii Peninsula in central Japan) in 1986 but identified and illustrated it as *Synedra fasciculata* (C.Agardh) Kützing. Ohtsuka (2002: fig. 270) illustrates a single valve from the Hii river, Honshu, Japan, but named it *Tabularia tabulata* (C.Agardh) Snoeijs. Ohtsuka & al. (2007: fig. 30) reported the species as *Catacombas obtusa* (Pantoczek) Snoeijs from another Japanese river (Ishite stream) illustrating a single valve showing the same valve outline (shape of the apices, short striae) as *T. sinensis*, indicating that the Japanese population should be identified as *T. sinensis*. Apart from these Japanese localities and the type locality in China, the species seemed to be restricted to eastern Asia.

In 2018 and 2021, large populations of a long araphid taxon identified as an unknown *Tabularia* species were observed in several localities in Belgium and France. Detailed scanning electron microscopy observations showed the presence of very short striae composed of up to 2 slit-like areolae in most part of the valve, a large ocellulimbus and two overhanging spines. The valvocopulae was broad and lacking any poroids, a feature indicated in the cladistic analysis of Cao & al. (2018) as being solely present in *T. sinensis*. Apart from a slightly larger ocellulimbus and possible slightly broader virgae between the mantle striae, there are hardly any morphological differences observed between the European population and the valves in illustrated Cao et al. (2018: figs 1–21) prompting the hypothesis that the European valves should be identified as *T. sinensis*.

A first population was observed in 2018 in the Seine River near Le Havre (Seine-Maritime, France). The valves were somewhat shorter (<100 µm) than the Chinese type population, but the typical stria structure and valve outline confirmed the conspecificity. Three years later, a large population of much longer specimens (160–200 µm) of this species was observed in the Flemisch Zeekanaal Brussel-Schelde, a connecting canal between the Scheldt River and Brussels (Belgium), initially identified as *Tabularia tabulata* (Van de Vijver, pers. obs.) (Figs 1–13). In both European localities, the species was not observed before these dates but later surveys in the framework of water quality monitoring programs revealed multiple observations, indicating that the species is spreading in western Europe (Quiniou, pers. obs.). The Seine and Flemish locality present comparable ecological data with pH value ranging from 7.1–9.3 and conductivity levels ranging from 600–870 µS/cm.

The seemingly sudden appearance of this putatively Asian diatom in European waters raises some concern. In the recent past, several non-European established large populations in Europe. Coste & Ector (2000) described the presence of more than 10 ‘exotic’ diatom taxa that had appeared and were spreading in European rivers such as *Reimeria uniseriata* Sala, Guerrero & Ferrario. More recently, the spread of *Achnanthidium delmontii* Pérès, Le Cohu & Barthès in Central European rivers was documented by Buczkó & al. (2022) and more recently by Falasco & al. (2023). Some of these species seemingly arrived in Europe either by plant litter from botanical gardens (such as *Diadesmis confervacea* Kützing), or by the introduction of exotic aquatic animals such as tropical freshwater turtles [in the case of *Encyonema triangulum* (Ehrenberg) Kützing] or via the ballast water in ships (Cheniti & al. 2018). Most likely, the accidental introduction of *Tabularia sinensis* in European rivers is the result of exchange of ballast near European larger ports such as Le Havre (France) or Antwerp (Belgium). Both ports are connected by rivers and canals with inland European waters, and it is highly likely that extensive boat traffic on these rivers and canals is spreading the species further inland. It is unclear what the effect of this new introduction in European will have on the native diatom flora in these rivers, but it is already clear that that *Tabularia sinensis* is becoming dominant in the localities where it was first observed.

This contribution is intended to highlight the existence of this alien species in European rivers, alerting environmental agencies of a new possibly invasive species in our native European floras.

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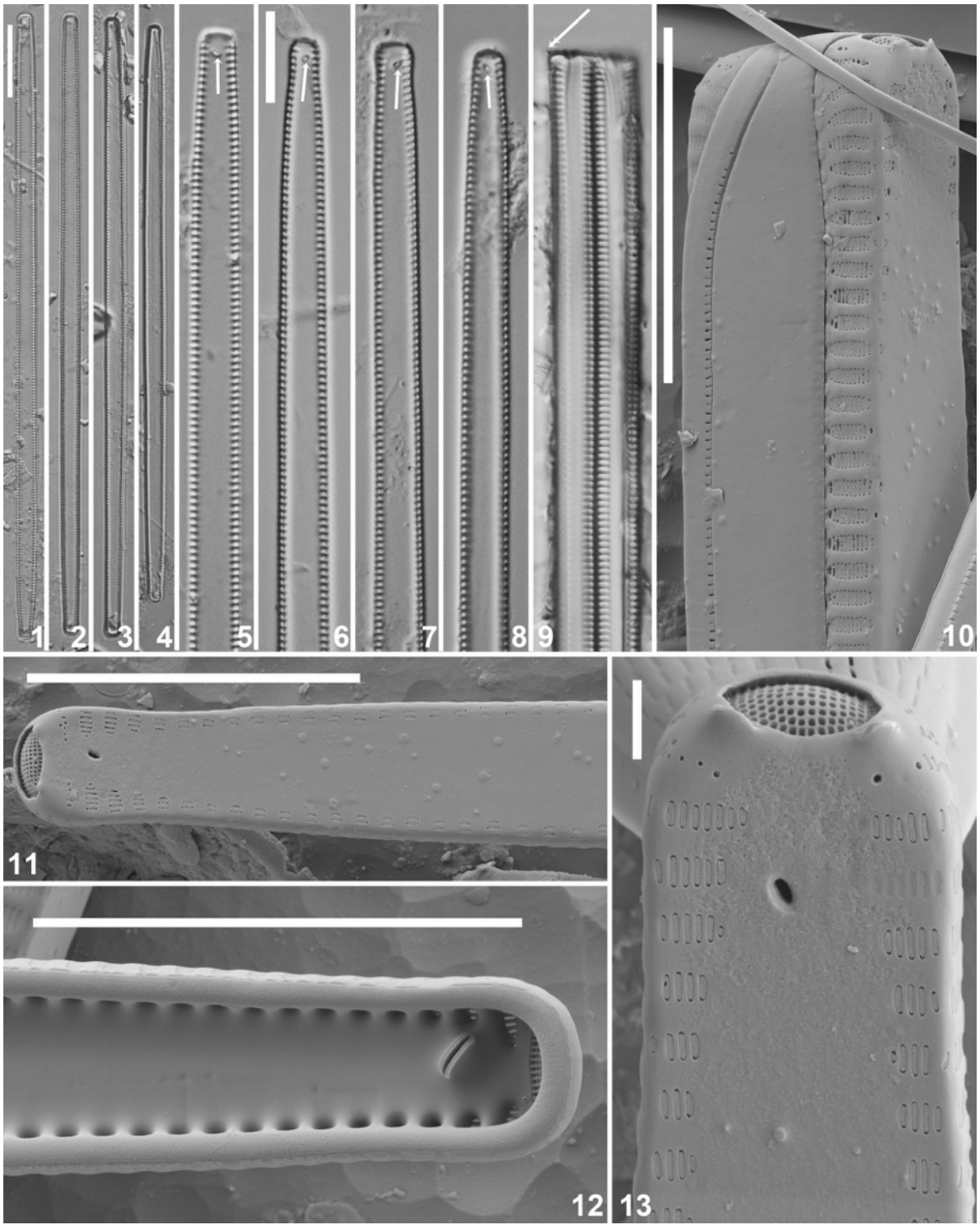


**Figs 1–13.** *Tabularia sinensis* Yue Cao & al. LM and SEM pictures taken from the Flemish Zeekanaal Brussel-Schelde (coll. date 18.vi.2021, leg. VMM). **Figs 1-4.** Four entire valves at lower magnification. **Figs 5–8.** LM views of four apices showing the short striae, truncated apices and the presence of the rimoportulae (arrows). **Fig. 10.** SEM girdle view showing the broad valvocopula, the apical spines and the large sunken ocellulimbus. **Fig. 11.** SEM external detail of a valve apex with the rimoportula the decreasing size of the striae and the sunken ocellulimbus. **Fig. 12.** SEM internal view of the apex with the oblique, large rimoportula, and the very large axial area. **Fig. 13.** SEM external detail of a valve apex with the rimoportula the decreasing size of the striae and the sunken ocellulimbus. Scale bar = 20 µm (Figs 1–4, 10 µm (Figs 5–13)