

VALVE MORPHOLOGY OF THE BENTHIC DIATOM  
*Fallacia marnieri* (Manguin) Witkowski  
(SELLAPHORACEAE – BACILLARIOPHYTA)

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ABSTRACT

The genus *Fallacia* Stickle & Mann includes naviculoid birraphid diatoms with H-like plastids, valves with uniseriate striae and covered by porous conopea, rounded areolae occluded by hymens, and depressed hyaline lyriform area characterizing the valvar surface. The species *Fallacia marnieri* was found in samples collected in King George Island, Antarctic Peninsula, on which an electron microscopy study and literature revision were carried out. From this investigation, we found that since *Fallacia marnieri* has the diagnostic structures of the genus, its recent inclusion in *Fallacia* is justified. The species was found on rocks of an intertidal region, and seems to be endemic in cold regions, as indicated in the literature.

*Key words:* diatom, *Fallacia marnieri*, Bacillariophyta, benthic, microphytobenthos, Antarctic.

RESUMO

**Morfologia da valva da diatomácea bêntica *Fallacia marnieri* (Manguin) Witkowski (Sellaphoraceae – Bacillariophyta)**

O gênero *Fallacia* Stickle & Mann inclui diatomáceas naviculóides birrafídeas contendo plastídeos em “H”, valvas com estrias geralmente unisseriadas cobertas externamente por conopea porosa, aréolas arredondadas ocluídas por hímenes e área hialina liriforme em canal. A espécie *Fallacia marnieri* foi encontrada em amostras coletadas na Ilha Rei George, Península Antártica, e estudos em microscopia eletrônica de varredura e revisão bibliográfica da mesma foram realizados. Com base nessa investigação, observamos que sua transferência para o gênero *Fallacia* foi justificada, uma vez que essa diatomácea apresenta estruturas diagnósticas de *Fallacia*. A espécie foi encontrada sobre rochas de região entremarés na Antártica, e parece ser endêmica de regiões frias, conforme mencionado na literatura.

*Palavras-chave:* diatomácea, *Fallacia marnieri*, Bacillariophyta, bêntica, Antártica.

INTRODUCTION

Many species with uncertain affinities have been assigned to the genus *Navicula* Bory, 1822, one of the largest among the diatoms, leading to considerable taxonomic problems. Indeed, the genus has become a catchall of species diversely

related. Even the nomenclatural type of this important genus has just recently been designated by Patrick (1959), after much confusion in the literature (Cox, 1979). Later, its circumscription was elegantly reviewed by Cox (1979), who also provided an amended description of the genus. After the development of electron microscopy

techniques for morphological studies of these naviculoid biraphid diatoms, many changes in the systematics of *Navicula* have been proposed. These include the creation of new genera, a necessary step to improve the circumscription of *Navicula* as well as to accommodate groups having closer affinities with each other and, at the same time, quite different from those having the diagnostic features of *Navicula sensu* Cox (1979). In some cases, the adequacy of this procedure has been a matter of controversy among diatomists (Kocielek, 1996, 1998; Round, 1996, 1997).

The genus *Fallacia* Stickle & Mann (in Round *et al.*, 1990) has resulted from one of the initiatives for improving the systematics of *Navicula*, which removed some taxa belonging to the Lyratae Cleve section to *Fallacia* (Round *et al.*, 1990; Witkowski, 1991, 1993). The genus was placed in the family Sellaphoraceae, which includes *Caponea*, *Rossia*, and *Sellaphora* (Round *et al.*, 1990). Its main characteristics are lanceolate to elliptic valves with flat surface, curving near the mantle margin, areolae occluded by hymenes and forming unisseriate striae, and the presence of a conopea covering the valvar surface partially or totally, including the hyaline lyriform area, which is sunken on the external surface. The raphe system is double, having a thickened raphe sternum. The internal central endings of the raphe are turned to the primary side of the valve, and the external ones are straight and expanded, with terminal fissures conspicuously bent or hook-like. The genus *Lyrella* N.I. Karajeva (Family Lyrellaceae) is closely related to *Fallacia* when observed under light microscopy but, under an electron microscope, it can be noted that the former genus lacks conopea, and its lyriform area is continuous in relation to the valvar surface.

In this report, we studied the Antarctic diatom *Fallacia marnieri* (Manguin) Witkowski, 2000 under a scanning electron microscope in order to verify the existence of typical features of *Fallacia*, as advocated by Witkowski *et al.* (2000) based on light microscope examination.

## MATERIAL AND METHODS

Samples containing the studied material were collected in November-December 1994 in Admiralty

Bay (62°05'S and 58°35'W), facing the Brazilian Antarctic Station "Comandante Ferraz", during the XIII Brazilian Antarctic Program (PROANTAR XIII). The material was obtained from intertidal and sublittoral zones through autonomous diving (SCUBA) and removed by using a fine-bristled brush. For cleaning the frustules, the technique of Hasle & Fryxell (1970) was used, with Naphrax as the mounting medium for permanent slides. Analyses of valves by light microscopy (LM) were made by using an Olympus BX40 photomicroscope. A Phillips XL30 scanning electron microscope at an acceleration voltage of 10-20 kV was used for examinations in electron microscopy (SEM). As the species was rare among the samples, aliquots of cleaned material were dropped on several microscope slides, left to evaporate and, soon after, examined under light microscopy. The valves found of *F. marnieri* were then transferred to aluminium stubs by using a delicate acupuncture needle and gently placing each valve on a carbon tape.

## OBSERVATIONS

### Description of the species

*Fallacia marnieri* (Manguin) Witkowski, 2000

Basionym: *Navicula marnieri* Manguin, 1957, Revue Algologique, n° 3, Nov. 1957, p. 127, Figs. 35a and 35b, as *N. marnieri*.

Synonyms: *Navicula diploneiformis* Hustedt, 1958; *Navicula marnieri* Manguin, 1960; *Diploneis reichardtii* var. *tschuktschorum* (Cleve) Heiden (Cardinal *et al.*, 1984, their Figs. 50, 51, 53).

Literature: Cleve (1883):472, Pl. 37, Fig. 48; Manguin (1957):127-128, Pl. 5, Figs. 35a-b; Hustedt (1927-66):367-369, Fig. 1458a-b; Hustedt (1958):147, Pl. 9, Fig. 100; Manguin (1960):314, Pl. 15, Fig. 180; Cardinal *et al.* (1984):377, Figs. 50-51, 53; Witkowski *et al.* (2000):207, Pl. 71, Figs. 1-3.

The valves are elliptic with flat valvar surface, curving near the margin (Figs. 2-4, 9). Dimensions are 16.4 µm to 26.2 µm of apical axis, 7.9 µm to 10.6 µm of transapical axis and 7-10 striae in 10 µm (15 valves measured). Striae are parallel only at the center, gradually becoming radiate towards the apices, and sharply spaced with respect to each other (Figs. 3, 7), also illustrated in Manguin's

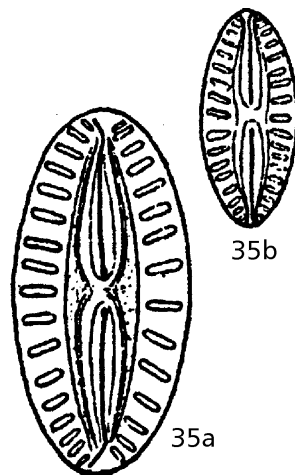
original drawings (Fig. 1). The areolae are round, occluded by hymenes (Figs. 7, 8). Raphe system is straight. On the outer side, the central endings are slightly expanded (Fig. 9), and the terminal ones are hook-like (Fig. 10), deflected to the same side. Internally, both the central and terminal endings are straight (Figs. 5-7), and the latter are slightly raised in relation to the valve face (Fig. 6). A well-developed conopea seems to reach the valvar margin (Figs. 11-12). Under SEM, the valvar surface is covered by the siliceous membrane of the conopea, masking other structures like striae and areolae, the lyriform area, and a portion of the raphe system (Figs. 9, 12). On the other hand, under LM one can observe these structures, but not the conopea (Figs. 2-4). Viewed internally, the areolae and the raphe system are evident (Fig. 7). The lyriform area is narrow, showing a constriction in the central region of the valve (Figs. 3-5). Besides, it is sunk within the external surface to form a canal-like structure, which is seen as a projection on the internal side (Fig. 5). The best picture we got to elucidate the canal structure shows a fractured valve making visible a small opening (Fig. 8). Between the lyriform area and the raphe sternum there is a smooth siliceous layer (Fig. 5), i.e., lacking areolae though they are common in another species within the genus (Round *et al.*,

1990; Witkowski, 1991, 1993). All the valves we observed had 1-3 perforations, similar to areolae in that region (Figs. 3, 5-7).

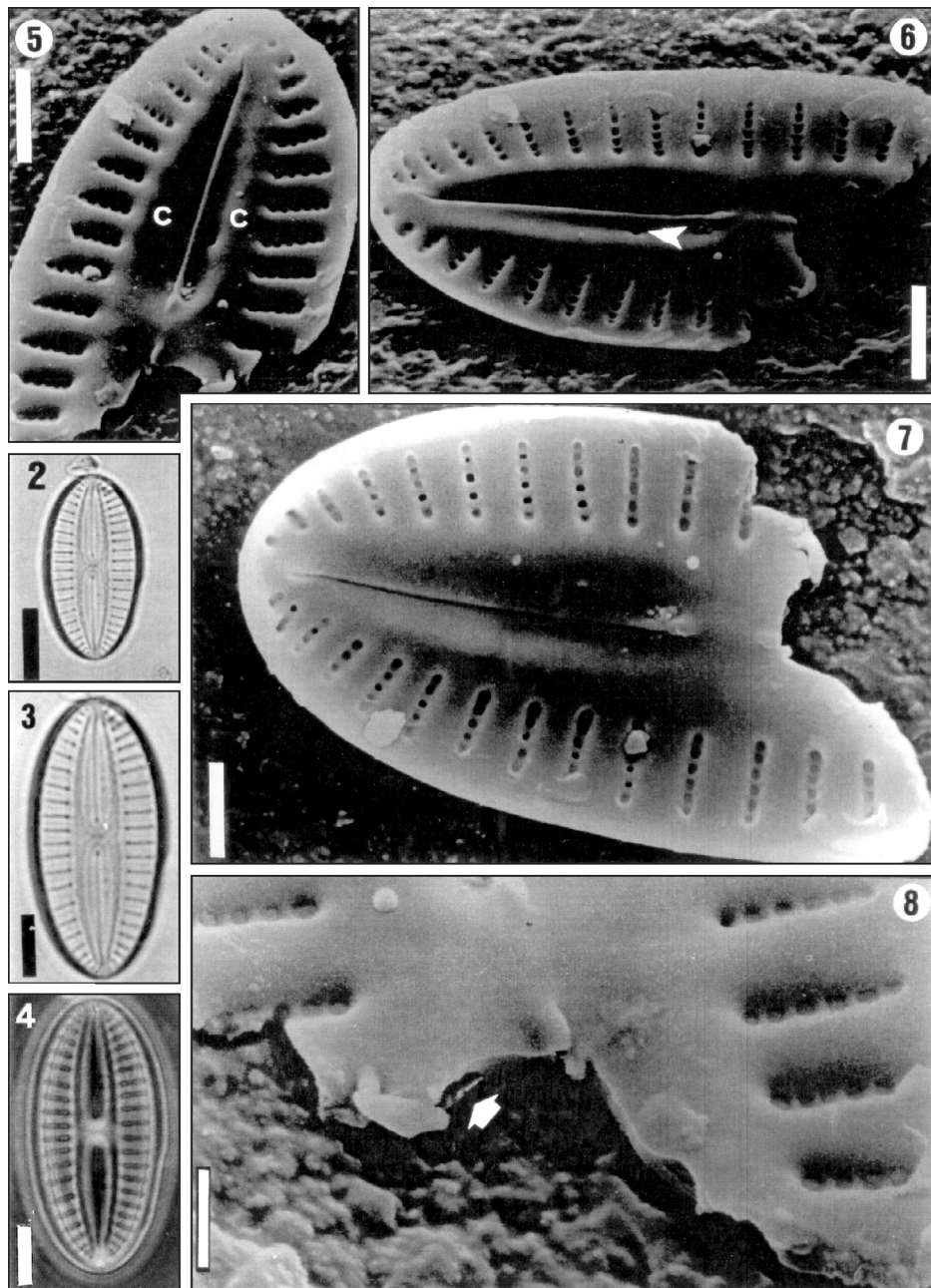
#### Nomenclature

Manguin (1957) originally described the species *Navicula marnieri*, dedicated to the botanist M. J. Marnier-Lapostolle, found in Antarctica. Almost at the same time, Hustedt (1958) described the same species under the name *Navicula diploneiformis* Hustedt, also found in Antarctica, in the intestine of *Salpa fusiformis*. Not much later, Hustedt (1927-66) claimed that his work of 1958 appeared soon after that of Manguin due to press problems, but accepted the precedence of Manguin, including that species as a later synonym of *N. marnieri*. Surprisingly, Manguin (1960) redescribed the same species three years later, in a more detailed way than the first description by Manguin (1957).

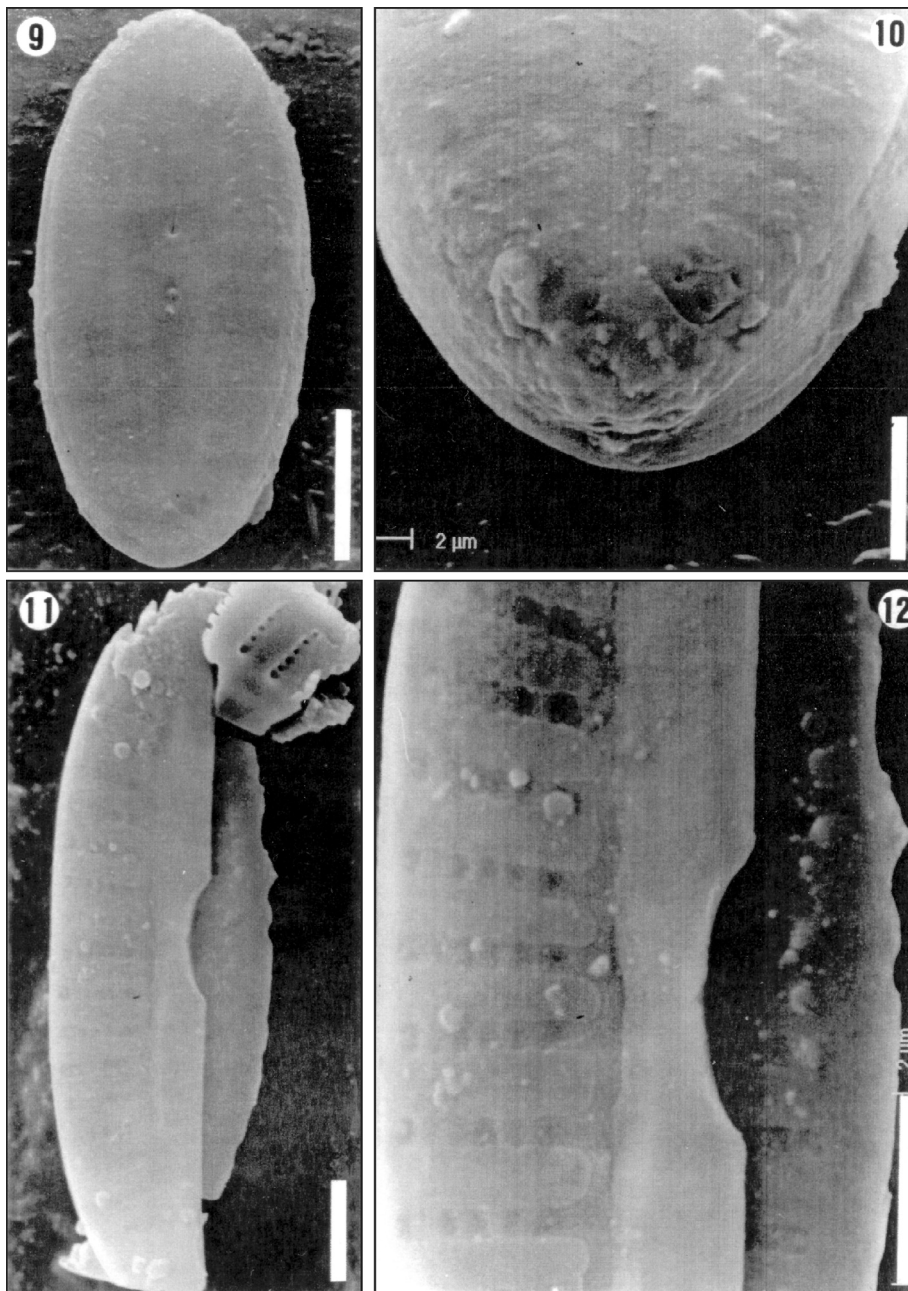
The reasons for this procedure are unclear, as the publication of 1957 is valid according to ICBN. Van Landingham (1975) also considered all these names synonyms of *N. marnieri*, correcting the specific epithet for “*marnieri*”. Cardinal *et al.* (1984) illustrated in their Figs. 50, 51, and 53 three valves which they named *Diploneis reichardtii* var. *tshuktschorum* (Cleve) Heiden in Heiden *et* Kolbe.



**Fig. 1** — *Fallacia marnieri*. Original drawings of Manguin (1957).



**Figs. 2-8** — *Fallacia marnieri*, Elephant Island, Antarctic Peninsula. **Figs. 2-4** — LM, cleaned valves. **Figs. 5-8** — SEM, internal views. **Fig. 2** — Scale bar = 10  $\mu\text{m}$ . **Figs. 3-4** — Note lyriform area and two perforations in each of the hyaline areas between the raphe and the lyriform area. Scale bar = 5  $\mu\text{m}$ . **Figs. 5-6** — Valve tilt 30° in different positions, showing the raphe branch ending in incipient helictoglossa. Lyriform area is well marked, projecting from the siliceous layer to form the canal (C). Note thickened ribs separating striae. Scale bar = 2.5  $\mu\text{m}$ . **Fig. 7** — General view of valve, elucidating striae pattern and number of areolae per striae. Scale bar = 2  $\mu\text{m}$ . **Fig. 8** — Broken valve, tilt 30°. The canal of lyriform area is showed (arrow). Scale bar = 1  $\mu\text{m}$ .



**Figs. 9-12** — *Fallacia marnieri*, Elephant Island, Antarctic Peninsula. SEM, external views. **Fig. 9** — General view of frustule. Conopea covers the valvar surface, hiding other ornamentations. The lyriform area is just discernible (arrows). Scale bar = 5  $\mu\text{m}$ . **Fig. 10** — Detail of apex, showing distal ending of the raphe, hook-like. Scale bar = 2  $\mu\text{m}$ . **Fig. 11** — Broken valve across the apical axis. Scale bar = 2.5  $\mu\text{m}$ . **Fig. 12** — Same valve enlarged to show the delicate conopea recovering areolae. Scale bar = 2  $\mu\text{m}$ .

After analyzing those figures, we concluded that the valves actually belong to *Fallacia marnieri*. Recently, Witkowski *et al.* (2000) transferred *N. marnieri* to *Fallacia marnieri* based on light microscopy observations. Finally, an important note must be made here. Cleve (1883) described the species *Navicula tschuktschorum* which is very similar to *F. marnieri*. Conversely, after examining the description and figure given by Cleve, we suspect the species actually is the same as *F. marnieri*. Its dimensions are 10 µm apical axis, 6.5 µm transapical axis, and 13 striae in 10 µm (Cleve, 1883). If this assumption is true, *N. tschuktschorum* has priority over *F. marnieri*, and this specific name is a later synonym of *N. tschuktschorum*.

### DISCUSSION

Hustedt and Manguin had already noticed that *F. marnieri* presented characteristics (like hyaline area and type of areolae) that allowed for its placement in the Lyratae section. Indeed, they also pointed out other features that drew *F. marnieri* closer to *Diploneis* “par les branchés du raphé placées dans un sillon semblables aux cornes si caractéristiques des représentants de ce genre” (Manguin, 1960). These are structures that distinguish “*N. marnieri*” from another taxa of *Navicula*. The investigations carried out in the present work indicated the presence of diagnostic characters of *Fallacia*, like areolae with hymenes and well-developed conopea, allowing us to confirm the allocation of *N. marnieri* in *Fallacia*, as proposed by Witkowski *et al.* (2000) based on light microscope observations.

The dimensions found in our material are similar or larger than those found in previous publications: 15-19 µm apical axis, 6.5-8 µm transapical axis, and 7-9 striae in 10 µm in Manguin (1957, 1960); 14 µm apical axis and 6.5 µm transapical axis in Hustedt (1958 corrected in Simonsen, 1987); 14-19 µm apical axis, 6.5 µm transapical axis, and 7-8 striae in 10 µm in Hustedt (1927-66); 11-24 µm apical axis, 6-11 µm transapical axis, and 9-12 striae in 10 µm in Cardinal *et al.* (1984); and 11-24 µm apical axis, 6-11 µm transapical axis and 7-12 striae in 10 µm in Witkowski *et al.* (2000).

*F. marnieri* is similar to *F. florinae* (Moeller) Witkowski (= *Navicula florinae*), but the latter has

a larger number of striae in the valvar surface, the hyaline area is more expanded and lacks constriction, and the conopea has expansions similar to fingers, not reaching the valvar margin (Witkowski, 1993). In *F. marnieri*, the conopea is regular and well developed, recovering the entire valvar surface. Additionally, *F. marnieri* has a smooth siliceous layer between the lyriform area and the raphe sternum, which is absent in *F. florinae* and many other related species (Hustedt, 1927-66, within Section Lyratae; Round *et al.*, 1990; Witkowski, 1991, 1993).

According to Hustedt (1927-66), this diatom is a marine species endemic in Antarctica. Hustedt (1958) found it there in the intestine of *Salpa fusiformis*. Manguin (1960) collected *N. marnieri* in depths of from 20 to 50 meters. We found the species on intertidal rocks of King George Island, Admiralty Bay, facing the Brazilian Antarctic Station. Other authors have found their specimens in cold northern seas, like the Baltic, and off the Quebec coasts (Cardinal *et al.*, 1984) and the Baltic Sea (Witkowski *et al.*, 2000). Other species of *Fallacia* have occurred in sandy or muddy sediments, a common habitat of the genus (Hustedt, 1955; Round *et al.*, 1990; Witkowski, 1991, 1993), including the mangrove areas of Southern Brazil (Fernandes *et al.*, 1990; Felício-Fernandes & Souza-Mosimann, 1994; Felício-Fernandes, 1996).

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