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REGULAR PAPER

Microscopic observations of *Aulacoseira sphaerica* (Bacillariophyta)

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Background and aims – *Aulacoseira sphaerica* (Hérib.) Simonsen is described from samples of a boring made in a Late Pliocene freshwater maar sediments in Nogaret (Escandorgue volcanic massif, France). This species is described and compared with works of other authors.
Methods – The morphology of this species is examined using light microscopy (LM) and scanning electron microscope (SEM).
Key results – Our observations correspond with Héribaud's (1903) description of *Melosira sphaerica*. It is an initial cell of an unknown *Aulacoseira* that is either extinct or does not form auxospores in recent waters. But we do not agree with Loseva's (1980) identification of this species found in the upper Pliocene deposits from the locality Omara (Russia) in the Kama river (Volga's tributary) basin.
Conclusion – *A. sphaerica* remains considered as a Late Pliocene fossil, endemic in the south of France (Massif Central, Escandorgue).

Key words – Diatom, initial cell, auxospore, Late Pliocene, freshwater, *Aulacoseira*, France, Massif Central, Escandorgue.

INTRODUCTION

The maar of Nogaret (fig. 1) is situated in the Escandorgue volcanic massif, south of the French Massif Central. This limestone plateau, largely covered by thick layers of basalt, is situated at a mean altitude of 700 m. K/Ar ages of the regional volcanic activity range from 2.0 to 1.9 My.

The maar is filled with calcareous laminites rich in diatoms, interbedded with pyroclastic layers and silt. Large mammal fossils found on top of the lakebeds belong to the St Vallier biozone (Villafranchian stage), which is 2.0 to 1.7 My old (Bruggal et al. 1990).

A taxonomic diatom study (Cornet 1991) has shown that *Aulacoseira sphaerica* (Hérib.) Simonsen were present in the upper part of the core NO II made by Leroy & Seret (1992). The valve morphology and the fine structure of this species have been studied using light and scanning electron microscopy techniques.

MATERIAL AND METHODS

Populations of *Aulacoseira sphaerica* were present in the samples of the upper part of the core NO II made by Leroy & Seret (1992), between a depth of 407 and 59 cm.

The samples were cleaned with hydrochloric acid (10%) and cold hydrogen peroxide (30%). Suspensions of cleaned diatoms were rinsed several times with distilled water. For light microscopy (LM), permanent mounts were made with Naphrax® (refraction index = 1.74).

Diatoms were viewed with an Axiophot light microscope at a magnification of 1,000 × under oil immersion and photographed with an Olympus digital camera.

For scanning electron microscopy (SEM), aliquots of clean material were air-dried on aluminium stubs and coated with gold. The photomicrographs were obtained using a Philips XL 20 and a JEOL 7500F.

RESULTS

The frustules (figs 2 & 3) are composed of two hemispherical silica valves, lacking the classic distinction between mantle and valve face. But we can distinguish the 'mantle' pattern of straight pervalvar rows of areolae and random arrangement of coarse areolae on the valve 'face'. There is no sharp demarcation between the 'mantle' and the valve 'face' (fig. 2). The valves are joined by a distinct hyaline collum (fig. 3C). The frustules also lack spines.

Near the collum, the areolae form short straight pervalvar rows, 12–14 in 10 µm (figs 2 & 3). The height of a row is about 6 µm. Each row is composed of (2–)3–7 areolae, 8–12 in 10 µm. The shape of these areolae varies between slit-like ovals to circular apertures of variable length (fig. 3C). The valve 'face' is covered with irregularly spaced areolae varying in size. They are coarser than those of the 'mantle', 7–8 in 10

Figure 1 – Location map of Nogaret and Ceyssac.

µm, sometimes quite small, circular and also crescent-shaped (figs 2–5).

The areolae appear to be loculate, i.e. with constricta at one surface relative to the other (figs 3–5). Scanning electron microscopy shows the vela occluding the areolae (figs 4 & 5). Despite the erosion and/or dissolution that has occurred in some frustules, it appears that *A. sphaerica* possesses an internal cribrum that represents a form of velum that is perforated by pores.

The diameter of the valves ranges between 15 to 30 µm measured on 167 frustules (fig. 6). The mean diameter is 22.5 µm.

So far, we were unable to find rimoportulae on the interior surfaces and the openings of these structures onto the exterior surface were not evident.

DISCUSSION

This species has been described for the first time by Héribaud in 1903 from Ceyssac (Massif Central) as *Melosira sphaerica* (fig. 7). In 1967, A. Ehrlich studied new samples from Ceyssac but did not find *A. sphaerica*. Our observations point out that the spherical frustules observed in Nogaret correspond to Héribaud's description and figures (table 1, fig. 7).

Loseva (1980) found also spherical frustules in the upper Pliocene deposits from the locality Omara (Russia) in the

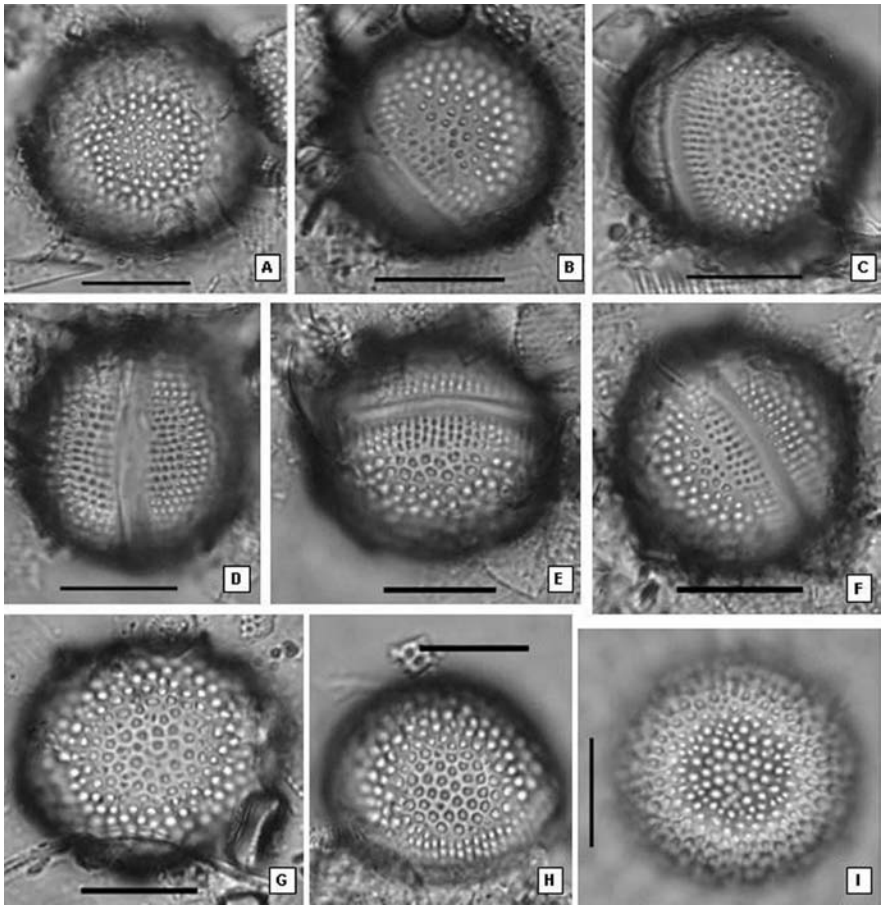

Figure 2 – Light micrographs of *Aulacoseira sphaerica*, initial cell with hemispherical valve and lacking spines. Scale bars = 10 µm.

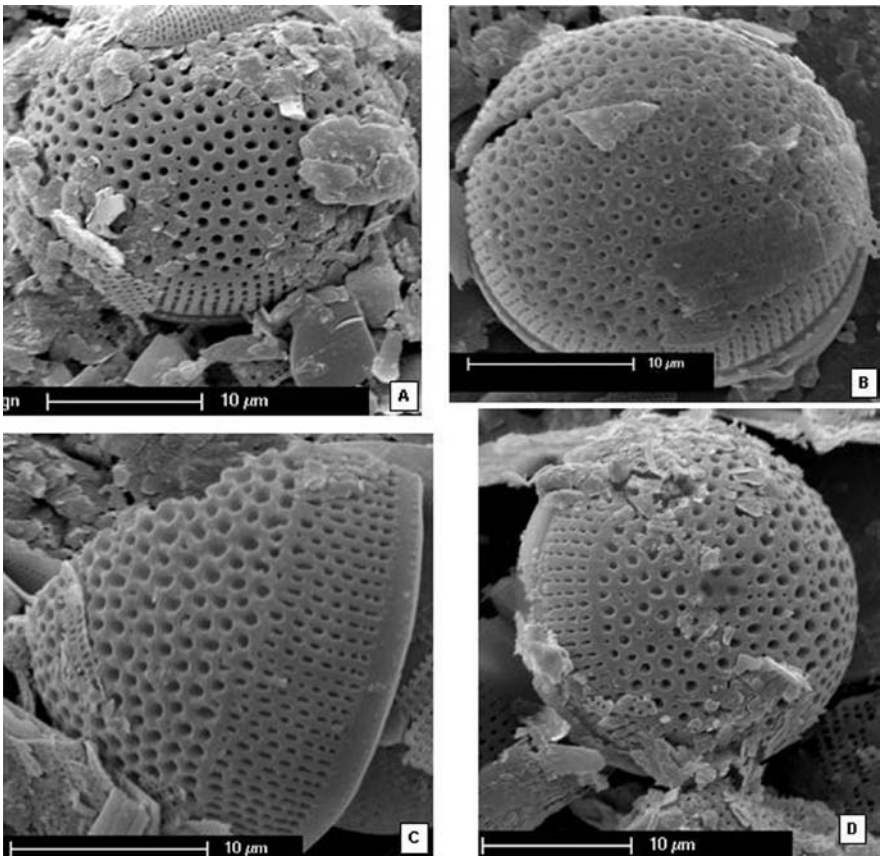

Figure 3 – Scanning micrographs of *Aulacoseira sphaerica*. External views of hemispherical valve; note the lack of spines, the rows of areolae on the "mantle", the randomly arranged areolae on valve "face" and the collum.

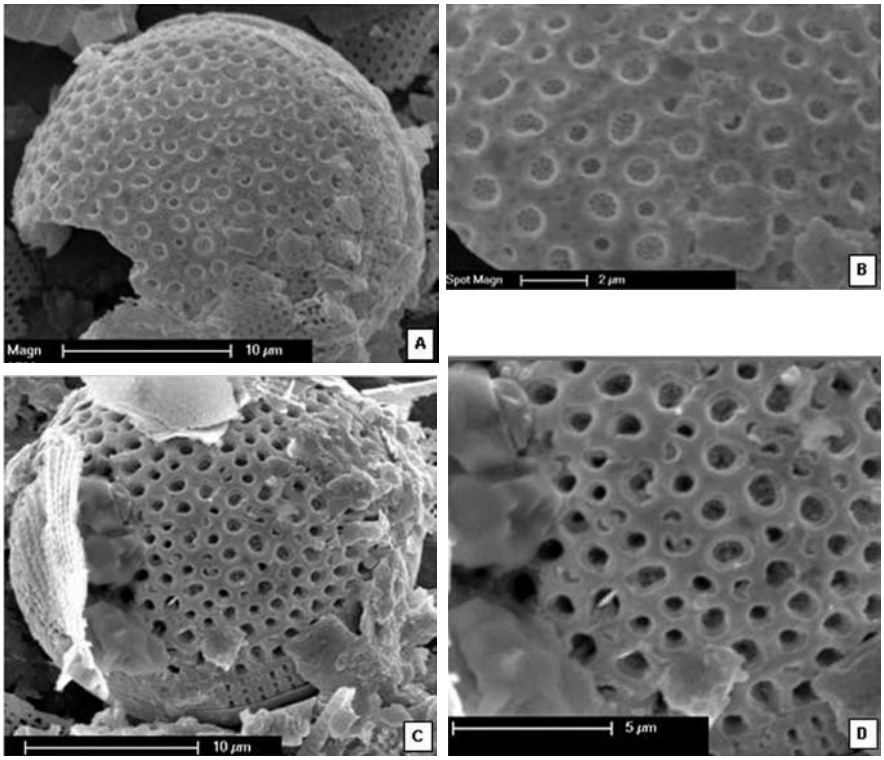

Figure 4 – Scanning micrographs of *Aulacoseira sphaerica*: B, detail of A showing the different sizes of loculate areolae and the cribra; D, detail of C showing the loculate areolae and the eroded cribra.

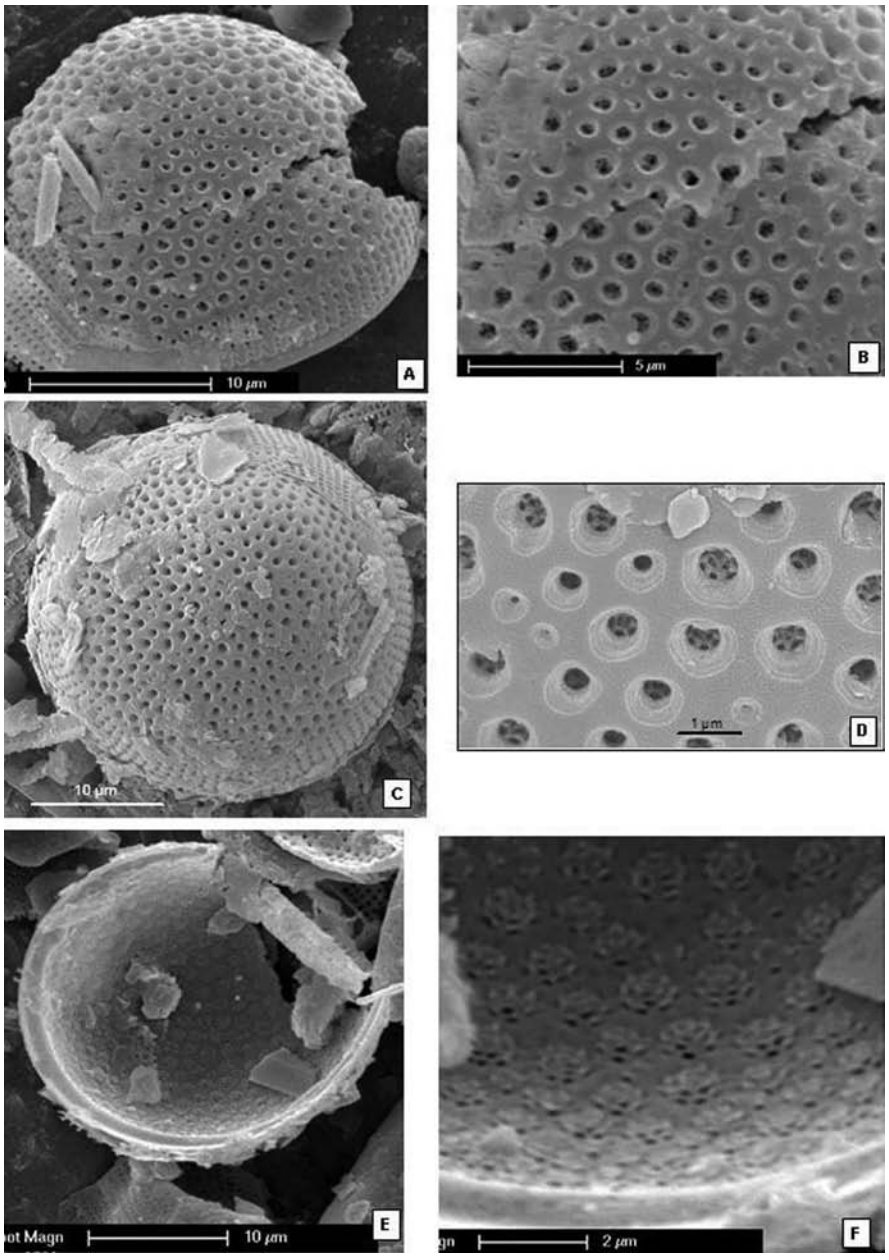

Figure 5 – Scanning micrographs of *Aulacoseira sphaerica*: A–D: External views; B, detail of A showing the loculate areolae and the eroded vela; D, detail of C showing the loculate areolae and the cribra; E & F: Internal views; F, detail of E showing the velar plates on the inner surface.

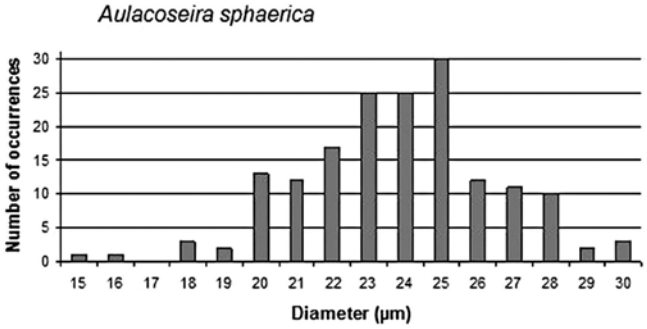

Figure 6 – Morphometric data for *A. sphaerica*: number of occurrences versus valve diameter measured on 167 frustules.

Table 1 – Description of *Aulacoseira sphaerica*.
The numbers are those quoted by the authors.

	Diameter	Number of rows /10 µm on "mantle"	Number of areolae /10 µm on the rows near the collum	Number of areolae/ 10 µm on the valve "face"
Héribaud (1903)	20–25 µm	12–13	-	7–8
This study	15–30 µm	12–14	8–12	7–8
Loseva (1980)	14–20 µm	-	16	11–16

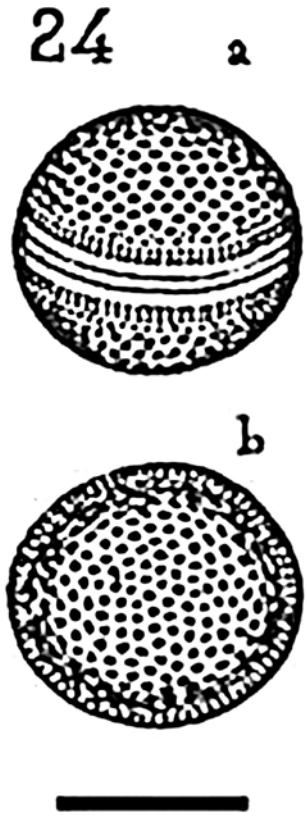

Figure 7 – *Melosira sphaerica* Héribaud from Héribaud (1903). Scale bar 10 µm.

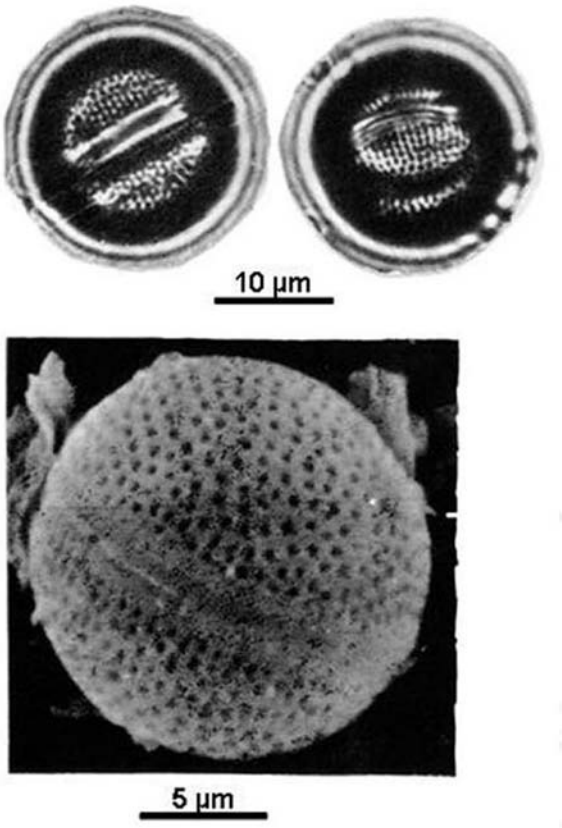

Figure 8 – *Aulacoseira sphaerica* from Loseva (1980).

Kama river (Volga's tributary) basin. She identified them as *Aulacoseira sphaerica* (Hérib.) Simonsen. But the ornamentation (fig. 8) differs from the Héribaud's description and our observations: the areolae are oval and maintain the same size on 'mantle' and valve 'face'; and we have counted 16 longitudinal rows in 10 µm on Loseva's photographs, to 12–14 in the Nogaret material.

The two hemispherical silica valves and the absence of spines define the initial cell of an auxospore according to the terminology of Round et al. (1990): the initial cell with its silica frustule is formed within the auxospore envelope, auxospore referring to the cell from the moment of plasmogamy.

The diameter size range of the valves, between 15 and 30 µm, is explained by the correlation that exists between sizes of gametangial and initial cell (Jewson 1992, Edlund & Bixby 2001). Smaller gametangia produce smaller initial cells, others factors being equal.

In Nogaret, these initial cells are always found solitary, without parent valves remained attached. This is the main reason why we cannot accurately identify the species of *Aulacoseira*. In agreement with Héribaud (1903) and Loseva (1980), this unknown *Aulacoseira* is either extinct or does not form auxospores in recent waters.

CONCLUSION

Due to the difference from Loseva's description, the distribution area of *Aulacoseira sphaerica* cannot expand to the Kama river basin. This species remains considered as an upper Pliocene fossil endemic initial cell of the south of France. Its distribution area may be extended 200 km to the south of the Massif Central, in the Escandorgue Massif.

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