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EOLIMNA BECARESII SP. NOV., A NEW DIATOM TAXON FROM A SPANISH SHALLOW LAKE

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NOTE

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Keywords: new taxon, epiphytic diatom, *Chara*, Mediterranean region, biogeography

In 2003 during a biological survey carried out on the shallow lakes located on the northern Iberian plateau, a diatom community dominated by an unknown *Eolimna* sp. was found as an epiphyte on *Chara connivens* in Lake Constanzana (Spain). Detailed light and scanning electron microscopy observations allowed the description of this new species. Differential diagnostic criteria with respect to similar taxa, especially *E. archibaldii* J.C. Taylor & Lange-Bertalot, together with ecological implications of this finding, are briefly discussed.

INTRODUCTION

During the recent decades, several diatom genera have been separated from *Navicula* Bory sensu lato on the basis of a more thorough knowledge of frustule morphology and ultrastructure. One of these new genera, described within the family Naviculaceae, is *Eolimna* Lange-Bertalot & W. Schiller (Schiller & Lange-Bertalot 1997). Distinctive features of this genus include cell size, structure of the areolae and the perforated valvocopula (Beszteri *et al.* 2001). Up to date, only 19 species have been validly described or transferred to this genus (Fourtanier & Kociolek 2008), mainly by Moser *et al.* (1998) in a study of New Caledonia diatom flora. However, several small naviculoid species provisionally placed in *Navicula* sect. Minusculae (Krammer & Lange-Bertalot 1986, Moser *et al.* 1998) are awaiting revision or combination in a more suitable genus such as *Fallacia* Stickle & D.G. Mann, *Chamaepinnularia* Lange-Bertalot & Krammer, *Navigiolum* Lange-Bertalot *et al.* or *Eolimna*. Moreover, recent taxonomic works have unmasked the actual species diversity within *Eolimna* from different regions of the world (Werum & Lange-Bertalot 2004, Metzeltin & Lange-Bertalot 2007). This note reports on an epiphytic diatom community dominated by *E. becaresii* sp. nov. found in Lake Constanzana, Spain.

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MATERIALS AND METHODS

A biological survey was conducted in selected permanent shallow lakes on the northern Iberian plateau in summer 2003. The studied lakes are located in the Duero River basin, mostly having a Mediterranean climate, with harsh winters and relatively mild summers, as well as an endorheic precipitation regime, with low rainfall during summer and a considerable inter-annual variability in average precipitations (Blanco *et al.* 2007). From a geological point of view, this basin consists of thin post-Tertiary deposits. The lakes in question constitute recharge areas with edaphic or lithological impermeability, and are generally affected by severe anthropogenic impacts (Fernández-Aláez *et al.* 2002).

Lake Constanzana (Ávila Province, Spain; 40° 56' 19" N, 4° 52' 20" W, 870 m a.s.l., Fig. 1) is small (0.3 ha), shallow (mean depth: 0.89 m) and hypertrophic (total phosphorus: 2132 $\mu g \cdot L^{-1}$, total nitrogen: 125 $\mu g \cdot L^{-1}$). The turbidity level is high (Secchi depth: 55 cm). Further limnological characteristics are listed in Table 1. About 10% of the lake bottom is covered by *Chara* L. mats. The surrounding emergent vegetation is dominated by *Eleocharis palustris* (L.) R. Braun. Three samples of epiphytic algae growing on *Chara connivens* Salzm. ex A. Braun. were collected following the methodology described in Blanco & Bécares (2006). Clean frustule suspensions were obtained after oxidation of the organic matter with hot hydrogen peroxide 30% v/v. Carbonate inclusions were removed adding a few drops of hydrochloric acid (Blanco *et al.* 2008). Permanent microscopic slides were mounted using a refractive resin (Naphrax®). Light microscopy (LM) photographs were taken with a light microscope Leica® DM–RB equipped with a Leica® DC500 camera. Scanning electron microscopy (SEM) photographs were obtained using a Leica® Stereoscan 430i.

Fig. 1. Geographic location of Constanzana Lake in Spain (black dot).

Table 1. Measured limnological variables in Lake Constanzana, 23/07/2003. Data from Conty (2007), average values (n = 2).

T (°C)	24.0
pH	7.8
$[O_2]$ ($mg \cdot L^{-1}$)	6.97
[Chlorophyll a] ($\mu g \cdot L^{-1}$)	16.0
$[NH_4^+]$ ($mg \cdot L^{-1}$)	40.3
Total organic carbon ($\mu g \cdot L^{-1}$)	19.1
Soluble reactive phosphorus ($mg \cdot L^{-1}$)	1.55
Conductivity ($\mu S \cdot cm^{-1}$)	283.0
Turbidity (NTU)	19.80
Total suspended solids ($mg \cdot L^{-1}$)	17.73
Volatile suspended solids ($mg \cdot L^{-1}$)	6.50

OBSERVATIONS AND DISCUSSION

Eolimna becaresii S. Blanco & Ector sp. nov. (Figs 2–54).

Descriptio: Frustula aspectu cinguli angusta. Valvae rhombico-lanceolatae, apicibus cuneatis rotundatis nonnunquam paulo protractis, 5.2–5.8 µm longae, 2.2–2.7 µm latae. Raphe modice curvata filiformis cum poris centralibus expansis guttiformibus. Extrema centralia et terminalia declinata in directiones oppositos. Raphosternum elevatum super facie valvae. Area axialis angustissima linearis. Area centralis circiter elliptica, delimitata 1–2 striis abbreviatis utrimque, saepe areolis sporadicis. Striae transapicales 30–40 in 10 µm radiantes omnio. Areolae uniseriatae, cum foraminibus circularibus, circiter 45–70 in 10 µm, non aspectabilia microscopio photonico. Limbus cum areolis apicaliter uniseriatis.

Description: Frustules narrow in girdle view (Figs 46, 51). Valves rhombic-lanceolate with cuneate, rounded, sometimes slightly protracted ends (Figs 2–54). Valve length 5.2–5.8 µm, width 2.2–2.7 µm. In external view, raphe filiform, slightly curved, with drop-like central pores and curved to one side of the valve, while the terminal fissures are deflected to the opposite side (Figs 44–46, 49, 51–54). External sternum elevated from the valve face (Figs 44–46, 49, 51–54). In internal view, raphe straight (Figs 47, 48, 50). Helictoglossae prominent (Fig. 50). Axial area narrow, linear. Central area somewhat elliptic, delimited by one or two shorter striae on either side (Figs 45–54), sometimes with isolated areolae (Fig. 44). 30–40 transapical striae in 10 µm, moderately to strongly radiant throughout (Figs 2–54). Uniseriate areolae, with rounded foramina, ca. 45–70 in 10 µm (Figs 44–54), not resolvable in LM (Figs 2–43). A single row of areolae in the mantle, at the end of each stria (Figs 44, 46, 49, 51, 52).

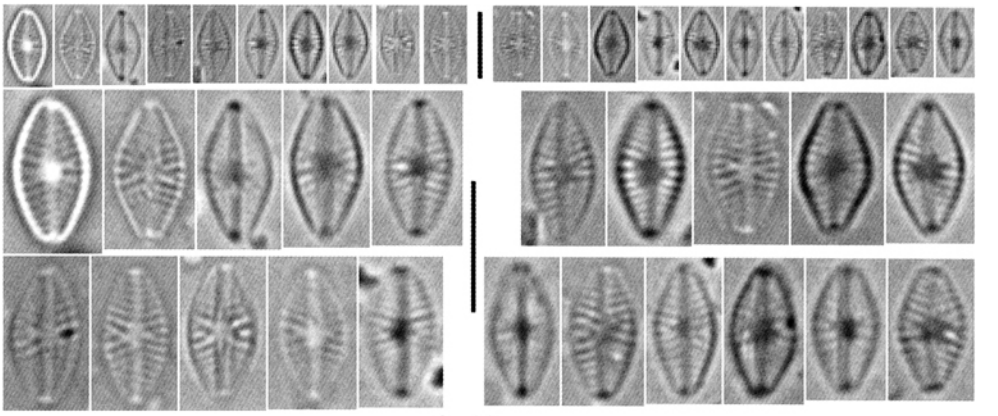
Holotype: BR-4134, deposited at the National Botanical Garden, Meise, Belgium. Figs 2–49. Epiphyton collected from *Chara connivens* by S. Blanco on 23/07/2003.

Type locality: Lake Constanzana, Spain (40° 56' 19" N, 4° 52' 20" W).

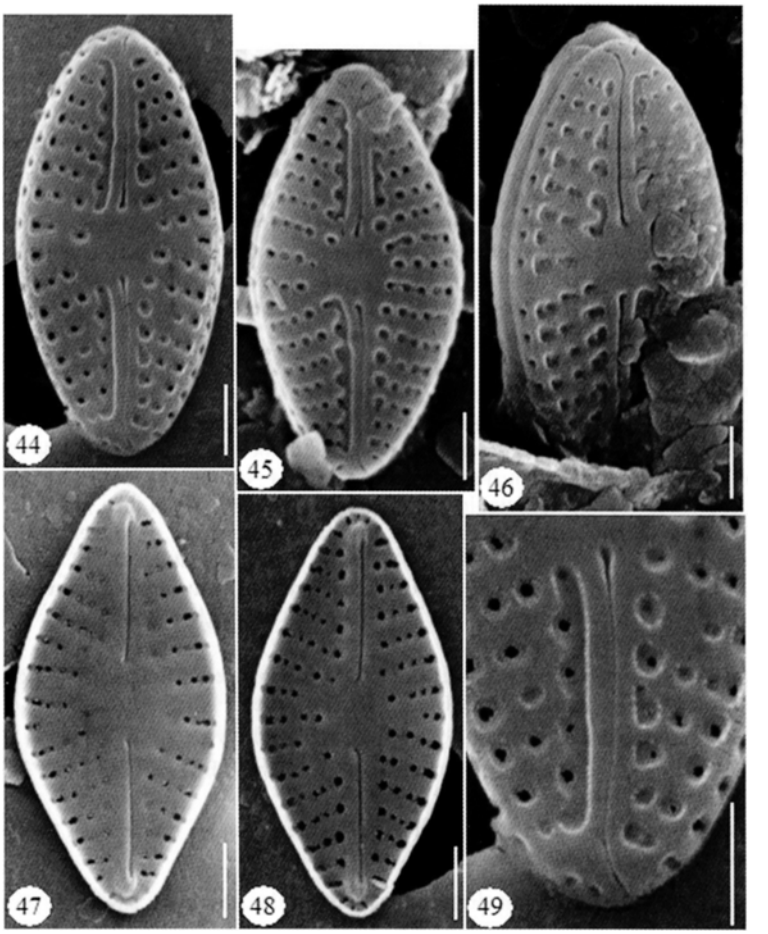
Isotypes: ZU6/75 (Hustedt Collection, Bremerhaven, Germany), BM 101343 (The Natural History Museum, London, United Kingdom).

Etymology: The species is dedicated to Prof. Dr Eloy Bécares, Spanish limnologist, for his contribution to the knowledge of shallow lakes.

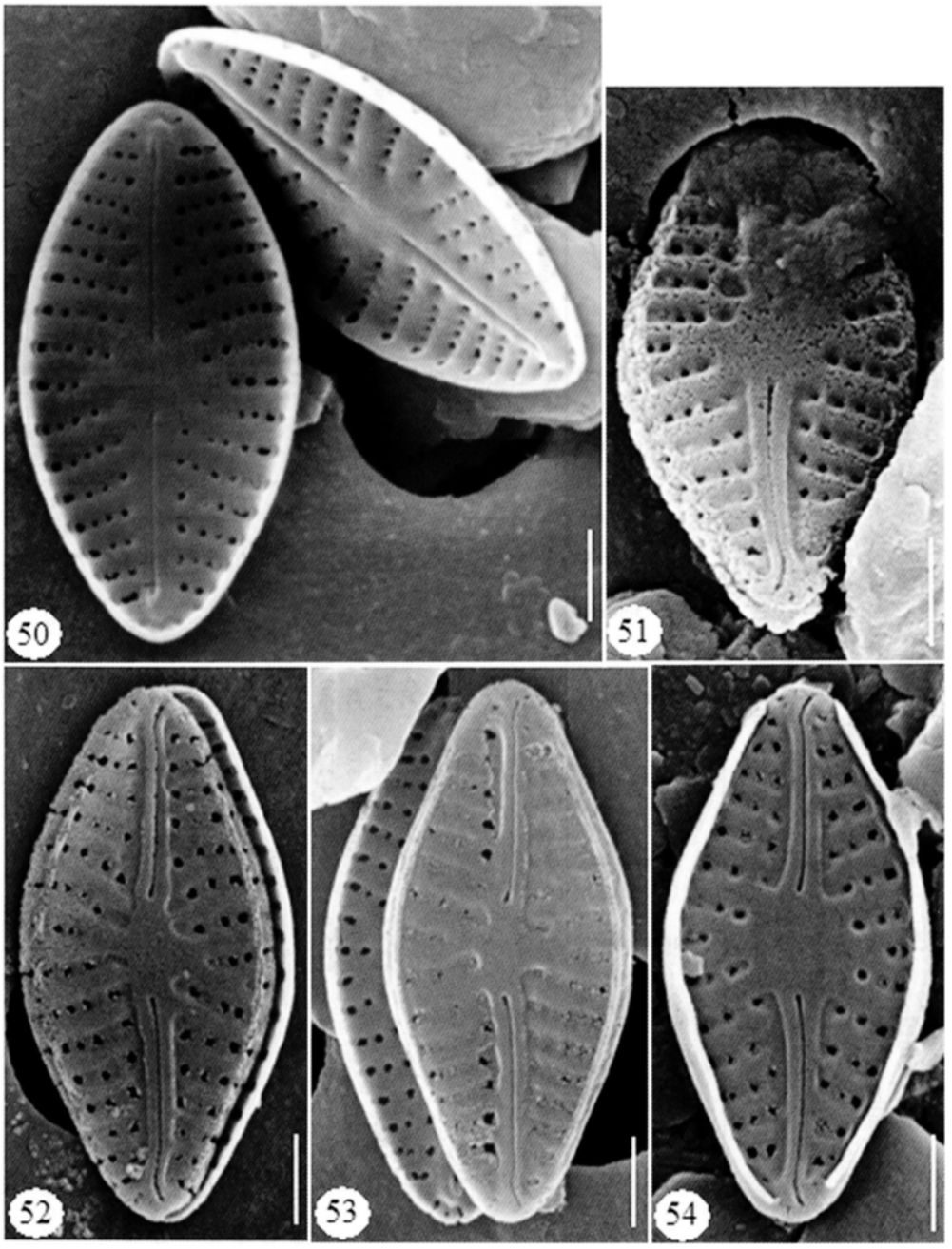
E. becaresii was the dominant diatom taxon in all the epiphytic samples, with an average relative abundance of 57 ± 8% (mean ± S.E.). Accompanying species, e.g. *Cocconeis euglypta* Ehrenberg, *Navicula cryptocephala* Kützing, *Hippodonta hungarica* (Grunow) Lange-Bertalot, are indicative of moderate to high nutrient concentrations.



Figs 2-43. *Eolimna becaresii* sp. nov. Holotypus, LM, valve view. Scale bars = 5 μm.



Figs 44-49. *Eolimna becaresii* sp. nov. Type material. SEM. **Figs 44-46.** External valve view. **Figs 47, 48.** Internal valve view. **Fig. 49.** External valve view, detail of the pole. Scale bars = 1 μm.



Figs 50-54. *Eolimna becaresii* sp. nov. Type material. SEM. **Fig. 50.** Internal valve view. **Figs 51-54.** External valve view. **Fig. 51.** Somewhat desilicified valve, tilted view. **Figs 52, 53:** Two valves of the same frustule. **Fig. 54.** Valve with copulae. Scale bars: 1 μm.

Table 2. Main characteristics of taxa close to *Eolimna becaresii* sp. nov. When available, data were collected from the protologues or measured on the illustrations of the types. Codes: **Outline**: 1: elliptic; 2: elliptic-lanceolate; 3: rhombic; 4: rhombic-elliptic; 5: rhombic-lanceolate; **Ends**: 1: acutely rounded; 2: broadly to acutely rounded; 3: not protracted; 4: rostrated; 5: slightly protracted. **Striae**: 1: moderately radiant; 2: parallel throughout; 3: parallel to weakly radial in the centre; 4: parallel, radiant at the ends; 5: radiant throughout; 6: radiant, convergent at the ends; 7: strongly radiant; 8: weakly radiant throughout. **Central area**: 1: absent; 2: small, roundish; 3: straight, irregular; 4: transapically expanded; 5: wide, lanceolate. **Type habitat**: 1: epilithic; 2: epipelic; 3: epiphytic; 4: epipsammic; 5: fossil. **Distribution**: 1: known only from the type country; 2: broader distribution. * *Navigiolum* sp. = "*Navigiolum* (?nov.) spec." in Lange-Bertalot *et al.* (2003), pl. 26, Figs 6–8. "-" = unavailable data.

	Valve length	Valve width	Valve L/W	Striae / 10 µm	Areolae / 10 µm	Outline	Ends	Striae	Central area	Type habitat	Distribution	Ecology
Chamaepinnularia evanida (Hustedt) Lange-Bertalot	9.0-11.0	3.5-4.5	2.4-2.6	23	10	5	5	6	3	1	2	Oligosaprobic, oligotrophic lakes
Eolimna archibaldii J.C. Taylor & Lange-Bertalot	5.5-6.5	2.8-3.5	1.9-2.0	32-36	70-90	4	3	5	2	1	1	Polluted, turbid waters
Eolimna lepidula (Manguin) Metzeltin & Lange-Bertalot	9.5-12.0	4.5-5.0	2.1-2.4	23-25	~60	2	3	7	4	3	2	Acidic waters
Fallacia indifferens (Hustedt) D.G. Mann	6.0-8.0	2.5-3.0	2.4-2.7	40	-	2	3	5	3	1	2	-
Navicula biskanteri Hustedt	8.0-12.0	4.0-5.0	2.0-2.4	24	-	2	5	8	1	4	2	Sea coasts
Navicula chloridorum Cholnoky	11.0-11.5	5.5-6.5	2.2-2.3	26	-	5	5	2	2	-	1	Brackish waters
Navicula coccinella Metzeltin et Lange-Bertalot	7.5-8.5	4.0-5.0	1.7-1.9	15-17	35	1	3	1	4	1	1	Moderately to high conductivity waters
Navicula hecateia Cholnoky	6.5-9.0	2.5-3.0	2.6-3.0	28	-	5	1	5	1	-	1	-
Navicula lamii Manguin	6.0-8.0	2.5-3.0	2.4-2.7	>30?	-	1	3	3	3	1	2	Alkaline, eutrophic water
Navicula microrhombus (Cholnoky) Schoeman & R.E.M. Archibald	6.0-7.0	4.4-5.0	1.4	22-30	-	3	2	5	1	-	1	-
Navicula mucicoloides Hustedt	8.0-10.0	5.0	1.6-2.0	24-27	-	3	1	4	2	-	2	-
Navicula pascuorum Cholnoky	8.0-14.0	3.5-4.0	2.3-3.5	-	-	5	3	-	1	-	2	-
Navicula paul-schulzii Witkowski & Lange-Bertalot	7.0-16.0	3.5-5.5	2.0-2.9	21-24	30	2	4	1	1	2	2	Sea coasts
Navicula perparva Hustedt	10.0-13.0	4.0	2.5-3.2	21	-	5	5	6	3	1	2	Aerophilous, alcaliphilous
Navicula seminuloides var. *delicatula* Stone	5.0-15.0	3.0-6.0	1.7-2.5	20-24	-	1	1	1	2	5	1	-
Navicula seminuloides var. *sumatrana* Hustedt	8.0-9.0	4.0	2.0-2.2	18-21	66-70	2	3	8	3	-	2	-
Navicula vanidica Cholnoky	7.0-9.0	3.0-3.5	2.3-2.6	24-30	-	5	-	1	3	1	2	Mountainous rivers
Navigiolum sp. *	10.0	4.0	2.5	17	-	5	5	1	5	-	1	-
Eolimna becaresii S. Blanco & Ector sp. nov.	5.2-5.8	2.2-2.7	2.2-2.4	30-40	45-70	4	3	5	2	3	1	Hypertrophic lake

According to its morphological features this new taxon belongs to the genus *Eolimna* (Schiller & Lange-Bertalot 1997, Moser *et al.* 1998). To our knowledge, this is the smallest species described within this genus, with the exception of certain small forms of *E. minima* (Grunow) Lange-Bertalot. The most closely related species is *E. archibaldii* J.C. Taylor & Lange-Bertalot (Taylor & Lange-Bertalot 2006), described from samples collected in the Vaal River, South Africa. This species has become dominant in certain degraded and polluted reaches within the river. According to Taylor & Lange-Bertalot (2006), *E. archibaldii* might have been misidentified as *Navicula indifferens* Hustedt (= *Fallacia indifferens* (Hustedt) D.G. Mann) and other *Navicula* in earlier studies, thus suggesting a wider geographical distribution of *E. archibaldii*. In LM, *E. becaresii* can be easily distinguished from *E. archibaldii* by the valve width (always < 3 μm in the examined specimens of the type population of *E. becaresii*), and the higher length/width ratio (> 2). In SEM, *E. becaresii* presents a distinctly lower density of areolae (45–70 areolae in 10 μm against 70–90 in *E. archibaldii*). The two taxa also differ in their ecology: whereas *E. archibaldii* was found at the type locality in the riverine epilithon, the population of *E. becaresii* found in Spain is present as an epiphyte in lentic habitats. Both type localities have noticeably different physical and chemical characteristics, those measured in Constanzana Lake correspond to a hypertrophic status (see Table 1). The high relative abundance of *E. becaresii* may indicate optimal conditions for the growth of this species.

Taylor & Lange-Bertalot (2006) discuss several morphologically similar naviculoid taxa closely related to *E. archibaldii*. Most of them can be readily distinguished from *E. archibaldii* and *E. becaresii* in LM. Table 2 summarizes the main diagnostic features of the latter and other small species. In the light of these results, it is evident that no other small-celled *Eolimna* taxon possesses morphological characteristics similar to *E. becaresii*.

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