

## *Seminavis aegyptiaca* sp. nov., a new amphoroid diatom species from estuary epilithon of the River–Nile Damietta Branch, Egypt

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**Abstract:** During a recent floristic–taxonomic study on the algal flora, including diatoms, from the estuary of the Damietta Branch of the Nile in Egypt, an interesting epilithic diatom species belonging to the genus *Seminavis* (Naviculaceae) was collected and investigated using both light and scanning electron microscopy. This new diatom species shares morphologically some taxonomic diagnostic features with other related taxa such as *S. insignis*, *S. robusta*, and *S. ventricosa*. However, it still differs by having ventral central striae that are shorter and more or less straight in the middle of the smaller frustules to be clearly radiate in the larger ones and then become geniculate and only radiate near the poles, the central raphe endings are externally more distantly spaced than in the similar species, the elongate central nodule is internally less prominent, and the areola density is much denser. Therefore, we here describe it as *Seminavis aegyptiaca* sp. nov. Hydrochemical analyses revealed that *S. aegyptiaca* commonly inhabits typical marine, with a weak tendency towards brackish water, habitats. It was found to be tolerant to meso–eutrophic, nutrient–enriched conditions, based on the data available on seasonal concentrations of N and P compounds. These findings not only contribute to the inventory of Egyptian diatoms, but also increase our understanding of the autecology and distribution of this relatively poorly–known diatom genus.

**Key words:** benthic diatoms, Egypt, morphotaxonomy, new species, *Seminavis*, the Nile River

## INTRODUCTION

*Seminavis* D.G. Mann was first described by MANN in ROUND et al. (1990), where he separated it from its most closely related genus *Amphora* Kützinger based on the following key taxonomic features: (1) two plate–like, girdle–appressed plastids of unequal size; (2) uniseriate striae with apically–elongate, slit–like areolae; (3) several distinct ultrastructural characters of the raphe sternum and girdle bands. The aforementioned diagnostic characters make *Seminavis* a member of the family Naviculaceae sensu stricto (ROUND et al. 1990; COX 1999), despite the strong dorsiventrality that is the main feature shared with the genus *Amphora*. Moreover, a cladistic study by COX & REID (2004), mainly based on protoplast and frustule characteristics on the generic relationships within

the suborder Naviculineae, placed the genus *Seminavis* within the *Navicula* subclade. The valve symmetry shift in *Seminavis* is thus perhaps the most extreme within the family Naviculaceae, leading not only to the development of amphoroid shapes but also involving a change in the organization of cell division and valve ontogeny (ROUND et al. 1990).

During the last three decades, many taxonomic studies were carried out on the genus *Seminavis*, resulting in the description or transfer of several species (e.g., DANIELIDIS & MANN 2002, 2003; DANIELIDIS et al. 2006; GARCIA 2007; WACHNICKA & GAISER 2007; TALGATTI et al. 2017). In parallel, certain taxa in closely allied genera, e.g. *Cymbella* C.A. Agardh, underwent in–depth taxonomic revision. For instance, TALGATTI et al. (2014) studied the type material of *Cymbella* (*Encyonema*) *grossestriata* var. *recta* Frenguelli from Argentina and

fresh specimens collected from southern Brazil, and proposed the newly described taxon *Seminavis norae* (Metzeltin, Lange–Bertalot et García–Rodríguez) Talgatti et Torgan because it shared the key characteristics of the genus *Seminavis*. Twenty–three species have been described in the genus *Seminavis* so far, in particular thanks to the significant taxonomic work over the last years. From the molecular and phylogenetic standpoints, little is known about the evolutionary position of these taxa. However, BRUDER & MEDLIN (2008) suggested that the genus *Seminavis* is monophyletic in origin, and had arisen from the *Navicula* sensu stricto group. Ecologically, *Seminavis* mainly inhabits brackish and marine habitats (GUIRY & GUIRY 2019).

Considerable morphotaxonomic studies carried out on the diatom flora of different Egyptian inland–water habitats, including the main basin and branches of the Nile River (e.g., FOGED 1980; SHAABAN 1994; HAMED 2008; SHAABAN et al. 2012; EL–OTIFY & ISKAROS 2015; ABDEL–SATAR et al. 2017; EL–SHEEKH et al. 2018), did not use scanning electron microscopy (SEM), thus unintentionally neglecting ultrastructural details which play a crucial role in accurate species delimitation. As a consequence, very little information is available for Egypt on the diversity and autecology of diatoms belonging to *Seminavis* and other morphologically similar amphoroid taxa [e.g., *Seminavis strigosa* (Hustedt) Danieledis et Economou–Amilli as cited in DANIELIDIS & MANN (2003), recorded under the name *Amphora strigosa* Hustedt in the desert springs of Ayun Musa and Wadi Islet in the Sinai Peninsula, and *Seminavis robusta* D.B. Danielidis et D.G. Mann – originally *Amphora angusta* var. *ventricosa* (W. Gregory) Cleve – that was recently reported by SALEH (2009) from the desert inland saline spring ‘Ain El–Araes’ in the Siwa Oasis (Western Desert of Egypt) during her recent monographic study on the order Naviculales in Egypt].

In this paper, using both light and scanning electron microscopy, we describe a new species within the genus *Seminavis* collected from the epilithon of the estuary of the Damietta Branch (the Nile River, Egypt), during our recent in–depth floristic–taxonomic and bioassessment studies on the algal communities in this pivotal but highly–impacted habitat.

## MATERIALS AND METHODS

**Study site.** The Damietta Branch is one of the two main branches of the Nile River, splitting North of Cairo and extending to the East over a distance exceeding 240 km until reaching the Mediterranean Sea. It has an average width of about 280 m and a depth ranging between 12 and 20 m. It is dammed ca. 20 km inland of the river mouth by an artificial dam known as Faraskur Dam Barrage (KHEDR 1998), forming the estuary (Fig. 1). Along its main basin, the Damietta Branch serves as an important water resource for agricultural, domestic, and industrial activities (NEGM et al. 2017). However, this vital water artery and its estuary are negatively influenced by fish

farming, in addition to wastewater and agricultural discharges (ELREFAEY et al. 2017). Sampling sites along the estuary were arranged towards the Mediterranean Sea as follows: site 1 (31°24'54.8"N, 31°48'17"E), site 2 (31°25'29.5"N, 31°48'4.6"E), site 3 (31°26'41.2"N, 31°47'39.2"E), site 4 (31°27'42"N, 31°48'7.8"E), site 5 (31°28'31.6"N, 31°49'29.7"E), and site 6 (31°31'35.6"N, 31°50'38.3"E).

**Diatom sampling, preparation, and identification.** Thirty diatom samples (epilithon), on which this study is based, were seasonally collected starting from April 28<sup>th</sup> 2015 (spring season of 2015) to April 27<sup>th</sup> 2016 (spring of 2016), from six different localities along the estuary of the River–Nile Damietta branch during our recent in–depth floristic–taxonomic study, following the European standard methods for sampling diatoms in running waters (EN 15708 2009). Samples were treated with hydrogen peroxide (33%) and hydrochloric acid (37%), to remove organic matter. After several rinses in distilled water, the diatoms were mounted with Naphrax®, a synthetic mounting medium with a high refractive index of 1.74. Light microscope (LM) observations were conducted using a Zeiss Axioskop 2 microscope (Zeiss, Jena, Germany) equipped with phase–contrast and with an Axiocam digital camera. Scanning electron microscopy (SEM) observations were made at the MUSE – Museo delle Scienze, Trento, Italy using a LEO XVP scanning electron microscope (Carl Zeiss SMT Ltd., Cambridge, UK) at high vacuum on gold–coated prepared material. Measurements on at least 30 different specimens representative of the size–diminution series were made to obtain ranges and averages of the morphological and ultrastructural features. Diatom micrograph images were arranged in plates with Adobe Photoshop CS6. Permanent mounts (including the holotype shown in bold in the list below) were deposited at both Algae Lab, Botany and Microbiology Department, Faculty of Science, Al–Azhar University, Cairo, Egypt, and the Phycology Unit (No. 341), Botany Department, Faculty of Science, Ain Shams University; Thiers 2018), Cairo, Egypt

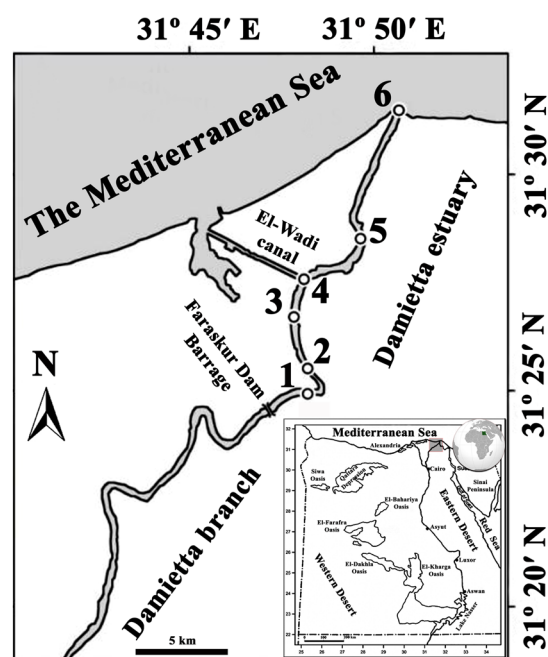


Fig. 1. Location of the sites where *Seminavis aegyptiaca* sp. nov. was sampled.

Table 1. Average (minimum – maximum) values for selected chemical and physical variables measured at sites where *Seminavis aegyptiaca* sp. nov. was collected.

Parameters	Average (min – max)
Temperature (°C)	23.5 (15.9 – 34.4)
pH	7.89 (6.19 – 8.46)
Total alkalinity (mg.l <sup>-1</sup> )	224.8 (145 – 385)
Conductivity (mS.cm <sup>-1</sup> )	42.79 (27.7 – 58)
T.D.S. (g.l <sup>-1</sup> )	28.6 (17.7 – 40.6)
Na <sup>+</sup> (g.l <sup>-1</sup> )	9.56 (5.2 – 17)
K <sup>+</sup> (mg.l <sup>-1</sup> )	110.53 (60 – 360)
Ca <sup>2+</sup> (mg.l <sup>-1</sup> )	490.46 (240.6 – 761)
Mg <sup>2+</sup> (mg.l <sup>-1</sup> )	295.41 (111 – 1336.5)
Cl <sup>-</sup> (g.l <sup>-1</sup> )	13.83 (1.76 – 19.72)
SO <sub>4</sub> <sup>2-</sup> (mg.l <sup>-1</sup> )	1601.5 (975 – 2404)
HCO <sub>3</sub> <sup>-</sup> (mg.l <sup>-1</sup> )	213.18 (102 – 385)
CO <sub>3</sub> <sup>2-</sup> (mg.l <sup>-1</sup> )	12.63 (4.8 – 43.2)
NO <sub>2</sub> <sup>-</sup> (µg.l <sup>-1</sup> )	124 (7 – 655)
NO <sub>3</sub> <sup>-</sup> (µg.l <sup>-1</sup> )	162 (60 – 300)
NH <sub>4</sub> <sup>+</sup> (µg.l <sup>-1</sup> )	5361 (34 – 19720)
SRP (µg.l <sup>-1</sup> )	204 (30 – 450)
SiO <sub>2</sub> (mg.l <sup>-1</sup> )	1.26 (0.2 – 3.89)
Cu (µg.l <sup>-1</sup> )	27.8 (1 – 244)
Zn (µg.l <sup>-1</sup> )	23.9 (17 – 284)
Al (µg.l <sup>-1</sup> )	10.1 (6 – 103)
Ba (µg.l <sup>-1</sup> )	10.6 (5 – 30)
Cr (µg.l <sup>-1</sup> )	8.3 (3 – 44)
Pb (µg.l <sup>-1</sup> )	4.6 (3 – 51)

under accession numbers: PBA–DIAT 1501–1518, 1537–1554, 1573–1590, 1609–1626, 1645–1662. The terminology for valve morphology is based on ROUND et al. (1990).

**Hydrochemical characterization.** Water sampling for the hydrochemical analyses was conducted using polyethylene bottles which had been previously cleaned with ultrapure water and superpure nitric acid (1%). Water temperature (°C), pH, electrical conductivity (EC, mS.cm<sup>-1</sup>), and total dissolved solids (TDS, g.l<sup>-1</sup>) were measured in situ using the calibrated portable Temp/pH/EC/T.D.S. HANNA HI 991301 meter. Total alkalinity, major ions and nutrients were analyzed following standard procedures and methods (CLESCERI et al. 2000). Concentrations of major ions, including sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), calcium (Ca<sup>2+</sup>) and magnesium (Mg<sup>2+</sup>), were measured using ionic chromatography (ICS 1500 Dionex Corp.). Bicarbonate (HCO<sub>3</sub><sup>-</sup>), carbonate (CO<sub>3</sub><sup>2-</sup>), chloride (Cl<sup>-</sup>) and sulphate (SO<sub>4</sub><sup>2-</sup>) concentrations were determined according to CHAPMAN & PRATT (1978). Nutrient concentrations, namely

nitrite (NO<sub>2</sub><sup>-</sup>), nitrate (NO<sub>3</sub><sup>-</sup>), ammonium (NH<sub>4</sub><sup>+</sup>) and soluble reactive phosphorus (SRP), were analysed by molecular absorption spectrometry and silica (as SiO<sub>2</sub>) was estimated by the molybdosilicate method (CLESCERI et al. 2000).

## RESULTS

***Seminavis aegyptiaca* A.A. Saber, El–Belely, El–Refaey, El–Gamal, Blanco et Cantonati sp. nov. (Figs 2–10, 11–17)**

**Light microscopy (Figs 2–10):** Valves lanceolate to rhombic–lanceolate, with more or less obtusely rounded ends. Valve length (27.5) 30–75 µm, valve width 7.5–10.0 µm. Dorsal margin distinctly convex. Ventral margin straight, particularly in small frustules (Figs 2–3), to slightly convex in the larger specimens (Figs 4–9). Length–to–breadth ratio ca. 5.0–7.5. The axial area is almost two times wider on the dorsal side than on the ventral one, with a central roundish expansion on the ventral side, particularly in the larger valves. The axial area is separated from the ventral side and the gibbous dorsal part by grooves, which in LM have the appearance of dark lines running along the raphe. The raphe is straight, running parallel to the ventral margin, and ventrally displaced with respect to the midline of the valve. The central raphe endings are slightly expanded and deflected ventrally and relatively close to each other (Figs 4, 6), while the terminal raphe fissures are hooked dorsally. The dorsal striae are more or less radiate in the central part of the valve, (16) 17–19 in 10 µm, and becoming denser, 19–21 in 10 µm, near the apices. The ventral striae are shorter and more or less straight in the middle of the smaller specimens to become clearly radiate in the larger ones, then become geniculate and only radiate near the poles, (14) 15–17 in 10 µm at the valve center, much denser and relatively parallel at the poles, 19–21 in 10 µm near the apices. The cingulum is simple and unornamented (Fig. 10).

**Scanning electron microscopy (Figs 11–14 external views, Figs 15–17 internal views):** The valve face is curving into a deep dorsal mantle whilst the ventral mantle is reduced. Externally, the stria areolae in general have the typical *Seminavis* morphology with uniseriate, apically–elongate, slit–like openings (Figs 11–13). Areola density (n = 25) is 55–60 in 10 µm. The ridge on which the raphe runs is prominent, and slightly dorsally–bent near the apices (Figs 11–12). The central raphe endings are slightly expanded and deflected to the ventral side, and close to each other (Fig. 13). The valvocopula (Figs 14–15) is composed of three plain and unornamented bands, first being much wider, the second reduced to a small ligulate segment occupying the gaps left at poles by the ends of band I (Fig. 15), and the third one being a narrow abvalvar element (Fig. 14). Internally, the valve structure in general resembles that of all other *Seminavis* species. The internal areola openings are also slit–like



(Figs 15–17). The raphe is positioned within a straight rib and slightly dorsally-bent near the apices (Figs 15–16). The central raphe endings are placed within a small, elongate and markedly less prominent nodule (Fig. 16). The raphe branches end apically in an extended, ventrally bent, horseshoe-like helictoglossa. A single row of simple pores is present beyond the helictoglossa at both valve apices (Fig. 17).

**Etymology:** The specific epithet refers to the Latin name of Egypt, *Aegyptus*, to highlight the discovery of this new diatom species in this country.

**Holotype:** The original material of *Seminavis aegyptiaca* sp. nov. (slide and suspension of prepared material) was deposited in the collections of the Phycology Unit (No. 341), Botany Department, Faculty of Science, Ain Shams University in Cairo (Egypt) (CAIA), accession code: PBA-DIAT 1501. This material, partially shown here in Figs 2–10, was collected by Ahmed A. El-Refaey on April 28<sup>th</sup> 2015.

**Isotypes:** Diatom collection of the MUSE – Museo delle Scienze, Trento, Italy: cLIM004 DIAT 3515 (including a diatom mount, and an aliquot of cleaned material); Botanischer Garten und Botanisches Museum Berlin-Dahlem, Zentraleinrichtung der Freien Universität Berlin, Germany (B): B 40 0044891 (slide) and B 40 0044892 (cleaned material). It was also registered on the Phycobank.

**Registration:** <http://phycobank.org/102069>

**Type locality:** Estuary epilithon of the River–Nile Damietta Branch (31°24'54.8"N, 31°48'17"E, elevation 2.6 m a.s.l.).

**Ecology and co-occurring diatom species:** *Seminavis aegyptiaca* sp. nov. was mostly found in the estuary epilithon of the River–Nile Damietta branch (Egypt) with an average relative abundance > 5% throughout the whole study period. These localities were characterized by warm, circumneutral to moderately alkaline waters with very high conductivity (water temperature: 15.9–34.4 °C; pH: 6.19–8.46, average: 7.89; conductivity: 27.7–58.0 mS.cm<sup>-1</sup>; average total dissolved salts: 28.58 g.l<sup>-1</sup>). In general, *S. aegyptiaca* seems to prefer typical marine habitats rich in sodium–chloride and sulphate salts, with a weak tendency to expand towards brackish waters. Regarding the trophic status, the estuary of the River–Nile Damietta branch can be classified as a eutrophic habitat based on N (seasonal average values of NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, and NH<sub>4</sub><sup>+</sup> were 124, 162, and 5361 µg.l<sup>-1</sup>, respectively) and P (SRP up to 450 µg.l<sup>-1</sup>) concentrations. Cu, Zn, Al, Ba, Cr, and Pb were the heavy elements having high concentrations due to different human impacts (including agriculture) highly affecting the estuary (Check Table 1 for more details). Noticeably, some of the localities where *S. aegyptiaca* was found were contaminated by motor oils, gasoline, and solid wastes, in addition to being influenced by fish farming. Therefore, it can be concluded that this diatom species

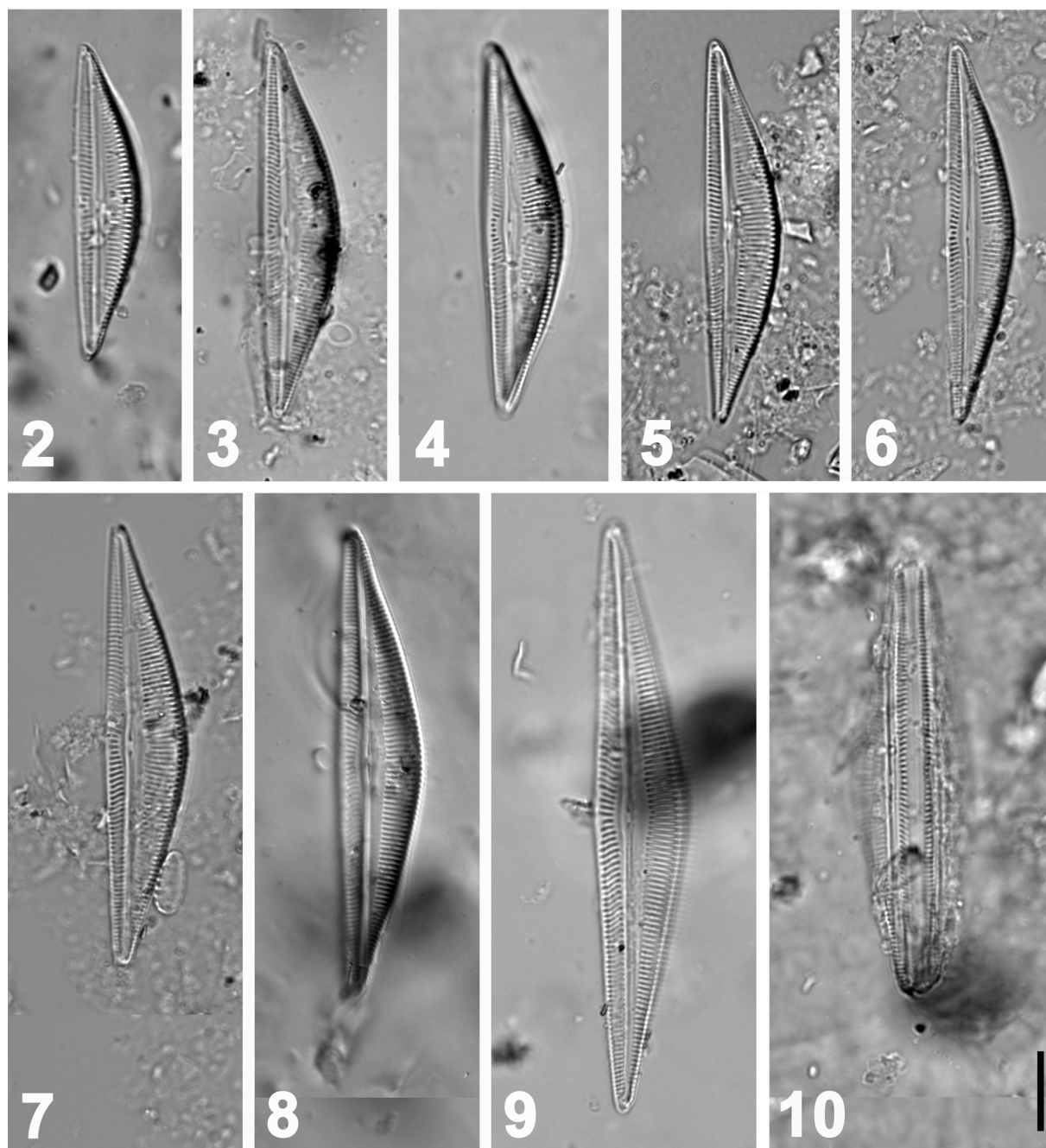
is tolerant to different types of pollution.

The diatom species most common (> 20%) in the slides in which *S. aegyptiaca* were recorded: *Cyclotella stylorum* Brightwell, *Achnanthes brevipes* var. *intermedia* (Kützing) Cleve, *Fallacia* sp. Stickle et D.G. Mann, *Halamphora coffeaeformis* (Agardh) Z. Levkov, *Navicula tri-punctata* (O.F. Müller) Bory, *Nitzschia clausii* Hantzsch, *Nitzschia frustulum* (Kützing) Grunow, *Nitzschia gracilis* Hantzsch, *Nitzschia kurzeana* Rabenhorst, *Opephora* sp. Petit, *Psammodiscus nitidus* (W. Gregory) Round et D.G. Mann, and *Tabularia fasciculata* (C. Agardh) D.M. Williams et Round.

## DISCUSSION

In this study, *Seminavis aegyptiaca* sp. nov. is assigned to the genus *Seminavis* by virtue of possessing all key diagnostic features of this genus, particularly the valve morphology and details of the axial area, raphe, and areola construction (ROUND et al. 1990; DANIELIDIS & MANN 2002, 2003). The species most similar to ours are *Seminavis insignis* Álvarez-Blanco et S. Blanco, *S. robusta*, and *S. ventricosa* (W. Gregory) M. García-Baptista. *Seminavis aegyptiaca* can be distinguished from the aforementioned taxa, and others in this poorly investigated genus, by having (1) a much higher areola density; (2) central ventral striae being shorter and more or less straight in the middle of the smaller frustules to be clearly radiate in the larger ones, and then becoming geniculate and only radiate near the poles; (3) internally, the small, elongate central nodule is clearly less prominent; (4) the central raphe endings are externally more distantly spaced than in the mentioned species (Figs 2–17; Table 2). Additionally, all these morphologically similar taxa can be separated based on other taxonomic features. As regards *S. insignis*, (1) its valve width is narrower than *S. aegyptiaca* (5.0–7.5 µm vs. 7.5–10 µm, respectively), (2) the central raphe endings are deflected dorsally whilst in *S. aegyptiaca* they are slightly expanded, more distant, and deflected to the ventral side, (3) the dorsal striae are parallel in the central part, 20–26 in 10 µm, clearly radiate, and much denser at the poles, 24–28 in 10 µm (while *S. aegyptiaca* has radiate dorsal striae in the valve centre, 17–19 in 10 µm, and striae are becoming much denser, 19–21 in 10 µm, near the apices), (4) the ventral striae are much denser (19–23 in 10 µm at the valve centre and 22–26 in 10 µm at the poles vs. 15–17 in 10 µm at the valve middle and 19–21 in 10 µm near the apices in *S. aegyptiaca*), and (5) the areola density is much lower (48–52 in 10 µm).

Another very similar species is *Seminavis robusta*. However, it differs in the arrangement of the ventral striae, i.e. *S. robusta* has distinctly radiate ventral striae in the valve centre whilst in *S. aegyptiaca* the ventral striae are more or less straight in the centre of smaller frustules to be clearly radiate in larger ones. Additionally,



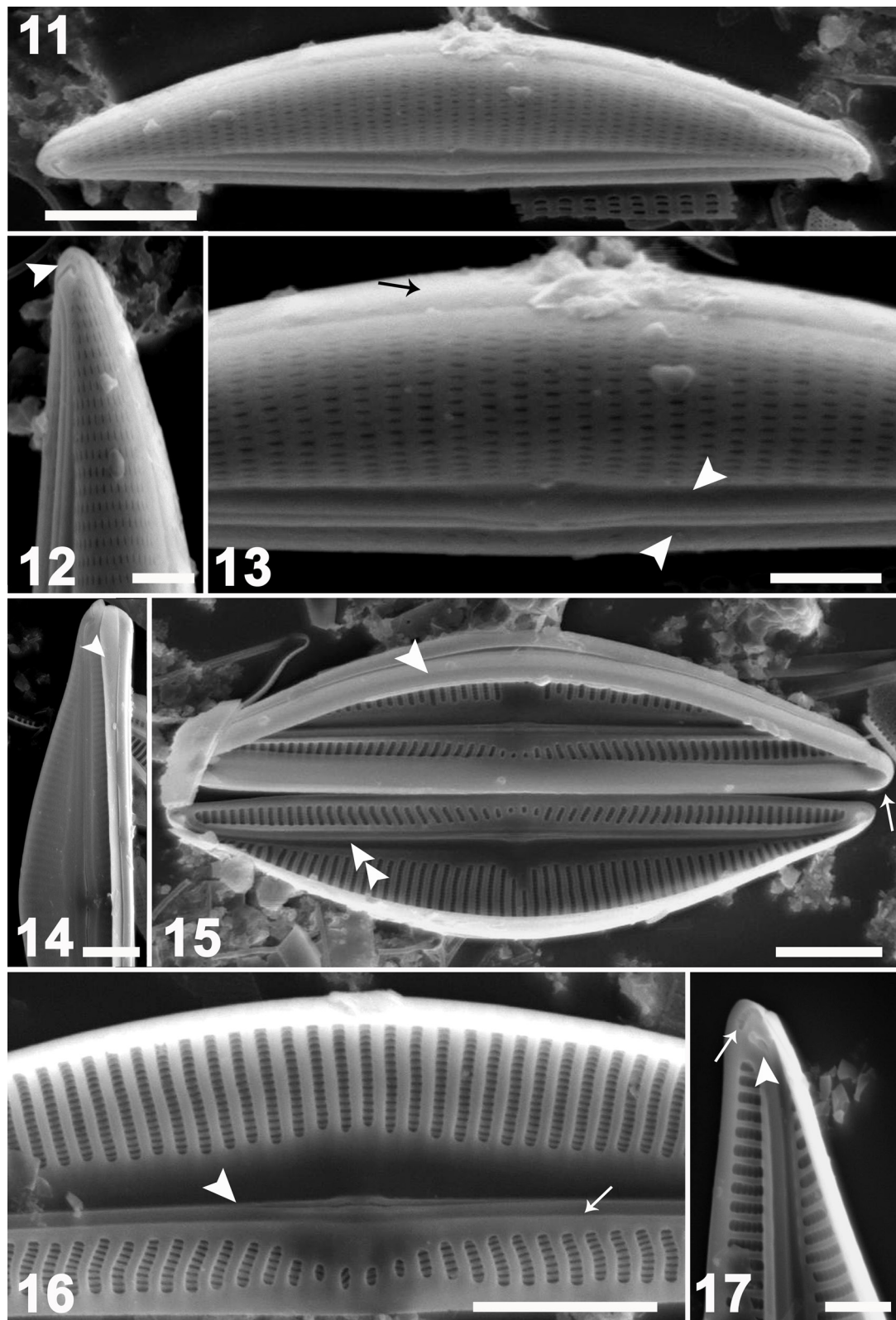
Figs 2–10. Light micrographs of *Seminavis aegyptiaca* sp. nov., showing the valve variability and girdle view of the holotype population. Scale bar 10  $\mu$ m.

the raphe ridge is internally bearing the central slits on a longitudinal thickening. This key taxonomic feature is absent in *S. aegyptiaca*, which has a distinctly elongate and less prominent central nodule. Finally, the areola density in *S. robusta* (as it results from our own measurement made on the SEM image Fig. 50 in the original paper published by DANIELIDIS & MANN 2002) is much lower than that found in *S. aegyptiaca* (46–50 in 10  $\mu$ m vs. 55–60 in 10  $\mu$ m).

The last morphologically allied species is *Seminavis ventricosa* which is distinguished from *S. aegyptiaca* by having (1) larger frustules (51.5–101

$\mu$ m); (2) evidently drawn-out valve apices; (3) central raphe endings deflected ventrally but with central pores pointing towards opposite directions; (4) central part of the raphe entering a narrow ‘gorge’ before opening out again near the raphe endings; (5) much lower dorsal and ventral stria densities (*S. ventricosa* has 10–12.8 in 10  $\mu$ m for dorsal striae and 10–12.1 in 10  $\mu$ m for ventral striae); the central dorsal stria that is usually missing—at least on the adaxial side—or reduced, not reaching the axial area; (6) the dorsal side of the axial area that is wider internally than externally and that combines with the transapical costae to form small chambers at the





Figs 11–17. SEM images of *Seminavis aegyptiaca* sp. nov.: (11) external view of the whole valve; (12) external view of the pole showing the dorsally-hooked apical raphe fissure and the simple row of apical pores (arrowhead); (13) close-up view on the valve mid-section showing the ventrally-deflected central raphe endings, two grooves (arrowheads) on opposite sides of the axial raphe sternum, and wide dorsal mantle (arrow); (14–15) details of plain and unornamented valvocopula with a narrow abvalvar segmental element (arrowhead; Fig. 14), much wider central girdle band (arrowhead; Fig. 15), and the small ligulate segment occupying the gaps left at poles (arrow; Fig. 15). Note the rib on which the raphe runs and slightly dorsally-bent near the apices (double arrowheads); (16) internal central portion of the valve showing central raphe endings, the less prominent central nodule, striae pattern and chambering of ventral and dorsal striae. Note also the raphe rib (arrowhead) and the thickened rib-like extension of the ventral lamina (arrow); (17) close-up view on the internal pole region of the valve showing the ventrally bent, terminal helictoglossa (arrowhead) and the apical pit-like depression beyond the helictoglossa containing simple pores that open to the interior (arrow). Scale bars 5  $\mu$ m (11, 14–16), 2  $\mu$ m (12, 13, 17).

Table 2. Morphometric data of *Seminavis aegyptiaca* sp. nov. compared with other morphologically related species.

Features / Species	<i>Seminavis aegyptiaca</i> sp. nov.	<i>Seminavis insignis</i>	<i>Seminavis robusta</i>	<i>Seminavis ventricosa</i>
Reference	this study	ÁLVAREZ-BLANCO & S. BLANCO (2014)	DANIELIDIS & MANN (2002)	(W. GREGORY) M. GARCIA-BAPTISTA (1993)
Valve morphology	lanceolate to rhombic–lanceolate with more or less obtusely rounded ends	semi–lanceolate with obtusely rounded apices	lanceolate to rhombic–lanceolate with obtusely rounded ends	lanceolate with evidently drawn–out apices
Valve length (µm)	(27.5–) 30–75	24.0–57.7	34–68	51.5–101
Valve width (µm)	7.5–10	5.0–7.5	6.5–9.5	6.0–10
L/W ratio	ca. 5–7.5	–	–	–
Raphe	straight, proximal endings externally more distant, deflected ventrally, and hooked dorsally at the apices. Internally, central raphe endings within a small and elongate nodule	straight, central ends deflected dorsally. Internally, central endings in a small elongate nodule	straight, the proximal endings deflected ventrally and apically hooked dorsally. Internally, raphe ridge bent dorsally, bearing the central slits on a longitudinal thickening	parallel and close to the ventral margin, with almost straight branches deflected ventrally at the centre and with central pores pointing in opposite directions. Internally, raphe on a rib which is turned towards the dorsal side and twists into the vertical position only at the centre and poles. Central raphe slits on a small, elongated nodule
Dorsal striae	more or less radiate at the valve middle, (16–) 17–19 in 10 µm, and becoming much denser, 19–21 in 10 µm, near the apices	parallel in the centre, 20–26 in 10 µm, but clearly radiate and denser at the poles, 24–28 in 10 µm	radiate at the valve middle, 17–20.7 in 10 µm, and much denser at the apices	weakly radial, 10–12.8 in µm, the middle stria is usually missing – at least on the adaxial side – or reduced, not reaching the axial area
Ventral striae	more or less straight at the middle of smaller frustules to radiate in larger ones, (14–) 15–17 in 10 µm. At the apices, much denser and relatively parallel, 19–21 in 10 µm	parallel throughout but slightly radiate at the centre, 19–23 in 10 µm at the valve centre, 22–26 in 10 µm at the poles	distinctly radiate in the middle, 16–19.3 in 10 µm, but much denser and parallel at the apices	10–12.1 in 10 µm and approximately the same size along the whole length of the valve
Number of areolae in 10 µm	55–60	48–52	46–50 [not indicated in the original paper but measured from the SEM image Fig. 50 in Danielidis & Mann 2002]	45–50 [not shown in the original paper but measured from the SEM images Figs 10–11, 13, 15 in Danielidis & Mann 2002]
habitat	weakly brackish to typical marine, epilithic species	epilithic marine species	marine species	marine species

adaxial ends of the striae which open to the cell interior; (7) lower areola density (i.e., 45–50 in 10 µm vs. 55–60 in 10 µm for *S. aegyptiaca*); the terminal areola of some dorsal striae being occasionally double and frequently stria discontinuities.

In spite of considerable previous investigations on the Egyptian inland–water diatoms, which were however mainly based on LM observations (e.g., SHAABAN 1994; HAMED 2008; MANSOUR et al. 2015; KHAIRY et al. 2017), it is likely that there are still some *Seminavis* species (often misidentified as *Amphora* in the past) overridden in the Egyptian inland–water habitats (A.A.S., unpublished data). These need to be studied well using both LM and SEM to accurately describe their taxonomic characteristics. In agreement with this hypothesis, the study of EL-SHAHED (2006) on the diatom flora of the periphytic assemblages of the west coast of the Red Sea and Suez Gulf revealed two diatom species belonging morphologically to the genus *Seminavis* but unfortunately there is no information available on their morphotaxonomic features. ‘*Seminavis* sp.1’ in his study (EL-SHAHED 2006, plate II, fig. 4) bears some resemblance with *S. aegyptiaca*.

From the ecological point of view, *Seminavis aegyptiaca* was so far only recorded from the estuary of the River–Nile Damietta Branch, and therefore detailed information about its autecological preferences is still lacking. However, there is a strong indication that it prefers typical marine waters, with only a weak tendency to extend into brackish waters. The preference of *Seminavis* species identified so far for brackish and marine habitats is well known and reported in the literature (e.g., ROUND et al. 1990; DANIELIDIS & MANN 2002, 2003; GARCIA 2007; WACHNICKA & GAISER 2007; ÁLVAREZ-BLANCO & BLANCO 2014; TALGATTI et al. 2014; RIOUAL et al. 2014; DE DECKER et al. 2018). More interestingly, at the type locality, the new species showed a considerable tolerance to high nutrient (N, P) levels, as well as to high concentrations of several heavy metals. Nutrient–enrichment tolerance was confirmed also by the co-occurring diatom species.

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