

## TAXONOMY OF SOME PENNATE DIATOMS FROM KALLAR KAHAR LAKE, DISTRICT CHAKWAL, PAKISTAN

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### ABSTRACT

Kallar Kahar Lake, an inland brackish water body is situated in District Chakwal, Pakistan. This lake is rich in phytoplankton, but facing shortage of water inflow resultantly rapidly drying. Therefore it was worthwhile to record diatomic flora of the lake and its tributaries before extinction. During the survey, a total of 17 pennate diatoms belonging to 10 genera, 7 families and 5 orders were identified. Algal species such as *Caloneis tenuis*, *C. schumanniana*, *C. bacillum*, *C. molaris*, *C. macedonica*, *C. undulata*, *Diademsis confervaceoides*, *Diploneis elliptica*, *Entomoneis paludosa*, *Eunotia minor*, *Gomphonema parvulum* var. *parvulum*, *G. truncatum*, *Haslea spicula*, *Luticola cohnii*, *Mastogloia belaeensis* and *Seminavis strigosa* were new record for Pakistan. Based on results it can be concluded that conservation status of the newly reported species should be determined for their management in future.

**Key words:** Pennate diatom, Kallar Kahar Lake, District Chakwal, Brackish water.

### INTRODUCTION

Kallar Kahar Lake is situated in the salt range, District Chakwal, Pakistan. It is shallow Lake (mean depth 1.11 m), 135 km away from Islamabad, the capital city on the motorway, joining Lahore to Islamabad. It has monsoon climate that occurs during July to August. The rain and fresh water springs contribute to the variation of lake volume and area (1- 1.15 Km<sup>2</sup>). The water of the lake is brackish in nature due to continuous flow of sulphur salts from the hill outskirts, and it is not used for drinking or agricultural purposes. In the past it was used as an effluent disposal pond by the settlers of Kallar Kahar town.

Considerable studies on diatoms have been conducted to identify material from ponds, puddles, ditches and streams (Abdul-Majeed, 1935; Sarim and Khan, 1960; Tariq-Ali *et al.*, 2006a, b, d; Tariq-Ali *et al.*, 2007; Husna *et al.*, 2007; Tariq-Ali *et al.*, 2008a, b; Kubra and Leghari, 2008; Leghari *et al.*, 2009). Only a few studies are reported dealing with diatom flora of Lakes in Pakistan (Leghari *et al.*, 1986, 1999, 2000, 2005; Munir *et al.*, 2012). The objective of this paper was to record the diversity of pennate diatoms in the Kallar Kahar Lake and its tributaries.

### MATERIALS AND METHODS

**Algal Sampling:** Algal samples were collected from various sites in the Lake and tributaries. Metaphyton samples were collected with bucket from each lake site. Epilithic algae were collected with a toothbrush and knife

from the rocky surfaces on the edge and stones inside flowing water of the tributaries. The algal samples were preserved in jars containing 2 to 3% formalin.

**Microscopic Analysis:** Diatoms samples (10 ml) were acid cleaned and 1 ml cleaned sample was mounted on slides with Naphrax® (Stevenson *et al.*, 2009). All algal samples were identified by using a Leica DMLB microscope® and the diatoms were identified at 100x magnification to the lowest taxonomic level (Krammer and Lange-Bertalot, 1997 a, b, c; Lange-Bertalot, 2001; Hofman *et al.*, 2011; Siver and Hamilton, 2011).

### RESULTS AND DISCUSSION

In all, 17 species belonging to 10 genera 7 families and 5 orders were identified. The taxonomy of all investigated species is as follows:

#### Family Diadesmidaceae

##### Key to genera:

- 1a. Central area have stigma, raphe straight ....1. *Luticola*
- 1b. Central area lack stigma, raphe simple  
or T- shaped..... 2. *Diademsis*

#### 1. *Luticola* D.G. Mann in Round *et al.* (1990).

Symmetrical valves with apices protracted; striae punctate, central area have stigma; raphe straight; plastid single, two lobed and central pyrenoids.

##### Key to species:

- 1a. Valves with broad poles elliptic to linear-elliptic.....1. *L. cohnii*
- 1b. Valves with acute round poles,

rhombic-elliptic or rhombic-lanceolate.....2. *L. mutica*

**1. *Luticola cohnii* (Hilse) D. G. Mann (1990), Fig.15**

**Source of Identification:** Hofmann *et al.* (2011), Table 66, Fig. 31

**Basionym:** *Navicula cohnii* (Hilse) Lange-Bertalot 1985

**General characters:** Length of cell 11.9 µm, diameter 4.9 µm; striae 20 /10 µm, punctate, radiate; valves symmetrical with broad round ends, elliptic to linear elliptic; central area expanded with stigma axial area linear-elliptic; single plastid.

**Distribution:** Antarctica, Australia, Europe and America.

**2. *Luticola mutica* (Kutzing) D.G. Mann (1990), Fig.14**

**Source of Identification:** Hofmann *et al.* (2011), Table 45, Fig. 36

**Basionym:** *Navicula mutica* Kutzing 1844

References: Hussain *et al.*, 1984: 83; Tariq-Ali *et al.*, 2006a: 438; Husna *et al.*, 2007: 57.

**General characters:** Length of cell 16.9 µm, diameter 6.7 µm; striae 20 /10 µm, punctate, radiate; valves rhombic-elliptic or rhombic-lanceolate with acute round ends; axial area linear or lanceolate.

**Distribution:** Europe, America and Asia: China Iran and Pakistan (Lahore).

**2. *Diadesmis* Kutzing (1844)**

Valve linear to linear-lanceolate, small, in chains; raphe silicified not visible under light microscope, ends of raphe simple or T- shaped; striae parallel; chromatophore single, lobed.

***Diadesmis confervaceoides* Lange-Bertalot and U. Rumrich (2000), Fig.8**

**Source of Identification:** Siver and Hamilton (2011), Table 184, Fig. 14

**Synonym:** *Diadesmis confervacea* Kutzing 1844; *D. peregrina* W. Smith 1857; *Navicula confervacea* var. *hungarica* Grunow in Van Heurck 1880; *N. confervacea* var. *peregrine* Grunow in Van Heurck 1880

**General characters:** Length of cell 14.1 µm, diameter 5.3 µm; striae 24 /10 µm.

**Distribution:** Europe, America and Asia (China and Iran).

**Family:** Diploneidaceae

**3. *Diploneis* Ehrenberg (1844)**

Valve shape elliptic to panduriform; striae punctate, have alveola; plastids two, pyrenoids single in each; raphe straight, with visible, thick longitudinal canals on either side.

***Diploneis elliptica* (Kutzing) Cleve (1891), Fig.9**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 108, P. 659, Fig.4

**Basionym:** *Navicula elliptica* Kutzing 1844

**General characters:** Cells length 18.2 µm, diameter 10 µm; striae 15/10 µm.

**Distribution:** America, Europe, Australia and Asia (China).

**Family:** Entomoneidaceae

**4. *Entomoneis* Ehrenberg (1845)**

Cell solitary frustule twisted along the apical axis, panduriform; keeled raphe in each valve; plastids two and large.

***Entomoneis paludosa* (W. Smith) Reimer (1975), Fig.11**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 204. P. 855, Fig. 3

**Synonym:** *Amphiprora paludosa* W. Smith 1853

**General characters:** Cells length 56.8 µm, diameter 12 µm; striae 23/10 µm.

**Distribution:** Australia, North America and Europe.

**Family:** Eunotiaceae

**5. *Eunotia* Ehrenberg (1837)**

Cells solitary or in cluster, sessile; valves curved or arcuate; raphe excentric in concave side; rectangular girdle view; plastids two, laminate.

***Eunotia minor* (Kutzing) Grunow in Van Heurck (1881), Fig.10**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 142 P. 515, Fig.6

**Basionym:** *Himantidium minus* Kutzing 1844

**Synonym:** *Himantidium minus* Kutzing 1844; *Eunotia pectinalis* var. *minor* (Kutzing) Rabenhorst 1864; *E. pectinalis* var. *minor* (Kutzing) Grunow in Van Heurck 1881; *E. impressa* var. *angusta* (Kutzing) Grunow in Van Heurck 1881; *E. pectinalis* var. *minor* f. *impressa* (Ehrenberg) Hustedt 1930

**General characters:** Cells length 44.4 µm, diameter 8.6 µm; striae 10/10 µm.

**Distribution:** Europe

**Family:** Gomphonemataceae

**6. *Gomphonema* Ehrenberg nom. cons. (1832)**

Cells solitary, sessile and free floating, asymmetric in valve view, wedge shape in girdle view;

valves cuneate, clavate, lanceolate, with one end broader than the other; narrow axial area; straight raphe; striae transverse or slightly radiate; central area, sometimes extending to the margins, with asymmetrically placed dot; single chromatophore, pyrenoid single.

**Key to species:**

- 1a. Striae 11 in 10  $\mu\text{m}$  .....1. *G. parvulum*  
 1b. Striae 12 in 10  $\mu\text{m}$  .....2. *G. truncatum*

**1. *Gomphonema parvulum* (Kützinger) Kützinger (1849),** Fig.17

**Source of Identification:** Siver and Hamilton (2011), Table 99, Fig. 2

**Basionym:** *Sphenella parvula* Kützinger

**Synonym:** *Sphenella parvula* Kützinger 1844; *Gomphonema lagenula* Kützinger 1844; *Gomphonema micropus* Kützinger 1844

**References:** Zaman and Hussain, 2006: 81; Leghari and Ghafar, 2006: 169.

**General characters:** Length of cell 27.2  $\mu\text{m}$ , diameter 7.2  $\mu\text{m}$ ; striae 11 /10  $\mu\text{m}$ ; valve clavate-lanceolate, with slightly constricted end.

**Distribution:** Europe, Asia: Iran, Singapore and China and Pakistan: Peshawar, Islamabad (Rawal Dam) and Japan.

**2. *G. truncatum* Ehrenberg (1832),** Fig.13

**Source of Identification:** Krammer and Lange-Bertalot, (1997), Table 159, P. 761 .Fig.14.

**Synonym:** *Gomphonema constrictum* Ehrenberg 1832; *G. capitatum* Ehrenberg 1838; *G. aturgidum* Ehrenberg 1854

**General characters:** Length of cell 24.2  $\mu\text{m}$ , diameter 10  $\mu\text{m}$ ; striae 12 /10  $\mu\text{m}$ , transverse, radiate; valve very broad at one end and gradually taper from the middle to the end of the other pole or cone shape; one pole broadly round, other narrow round; central area irregular.

**Distribution:** Europe, Australia and New Zealand and Asia (Iran and China).

**Family:** Mastogloiaaceae

**7. *Mastogloia Thwaitesii* W. Smith (1856)**

Valves lanceolate, elliptic or rhomboid, with broad round ends, acute or rostrate; internal septa present, each with a central oval chamber and several linear perforations; axial area narrow; raphe straight, striae transverse; chromatophores two.

***Mastogloia belaensis* Voigt (1956),** Fig.12

**Source of Identification:** Lange-Bertalot (2000), Plate 74, Fig. 1

**General characters:** Length of cell 48.5  $\mu\text{m}$ , diameter 15.4  $\mu\text{m}$ ; striae 15 /10  $\mu\text{m}$ , punctate; valve broadly elliptic to lanceolate; central area broad.

**Distribution:** Florida

**Family:** Naviculaceae

**Key to genera:**

- 1a. Valve asymmetric.....1. *Seminavis*  
 1b. Valve symmetric:  
 2a. Valve spindle shaped..... 2. *Haslea*  
 2b. Valve elliptical linear or lanceolate..... 3. *Caloneis*

**8. *Caloneis* Cleve (1894)**

Cells solitary, free floating, linear or linear-lanceolate, with round, protracted capitate ends; striae parallel, radiate crossed by hyaline area; chromatophores two, pyrenoids two in each.

**Key to species:**

- 1a. Length of cells 20.2  $\mu\text{m}$  .....1. *C. tenuis*  
 1b. Length of cells more than 20.2  $\mu\text{m}$ :  
 2a. Central area narrow..... 2. *C. schumanniana*  
 2b. Central area broad:  
 3a. Striae 26 /10  $\mu\text{m}$  .....3. *C. bacillum*  
 3b. Striae 19 /10  $\mu\text{m}$  .....4. *C. molaris*  
 4a. Valve with protracted, capitate ends..5. *C. macedonica*  
 4b. Valve with round ends..... 6. *C. undulate*

**1. *Caloneis tenuis* (Gregory) Krammer(1985),** Fig.3

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 174, P. 793, Fig.8

**Synonym:** *Pinnularia tenuis* Gregory Krammer 1954; *P. gracillima* Gregory Krammer 1956.

**General characters:** Length of cells 20.2  $\mu\text{m}$ , diameter 4.3  $\mu\text{m}$ ; striae 23 /10  $\mu\text{m}$ , parallel, radiate in the middle, at the ends slightly convergent; valves linear to linear elliptic; Axial area variable, central area asymmetric.

**Distribution:** Reported from Europe.

**2. *Caloneis schumanniana* (Grunow) Cleve (1894),** Fig.6

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 171, P. 793, Fig. 2

**Synonym:** *Navicula schumanniana* Grunow 1880; *N. trochus* Schumann 186 non *N. trochus* Ehrenberg 1838; *Caloneis trochus* (Schumann) A. May 1941; *C. limosa* sensu Patrick in Patrick and Reimer 1966.

Plates:



Fig.1.*Caloneismolaris*



Fig.2.*Caloneisbacillum*



Fig.3.*Caloneistenuis*

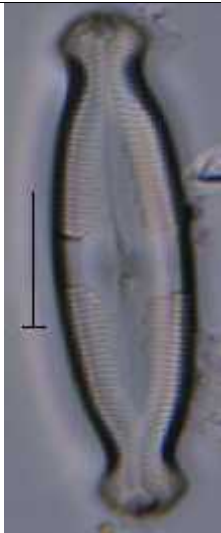


Fig.4.*Caloneismacedonica*

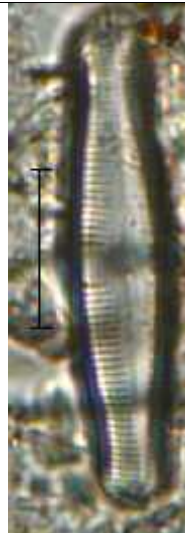


Fig.5.*Caloneisundulata*

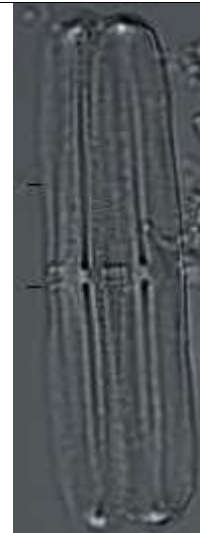


Fig.6.*Caloneisschumanniana*

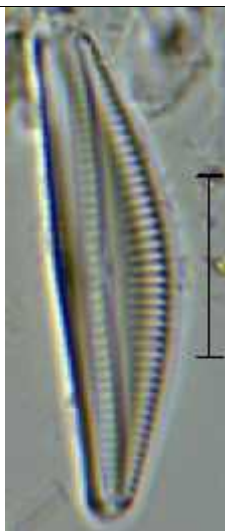


Fig.7.*Seminavisstrigosa*

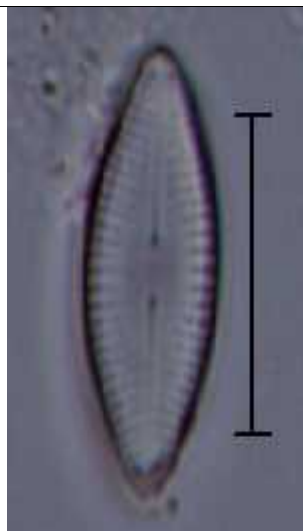


Fig.8.*Diadesmisconfervaceoides*

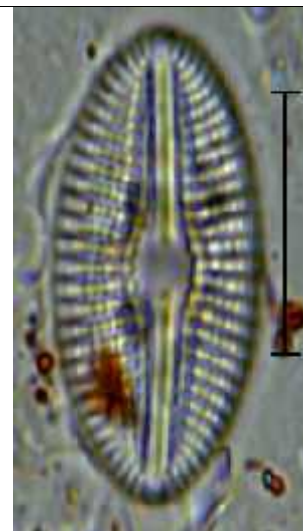
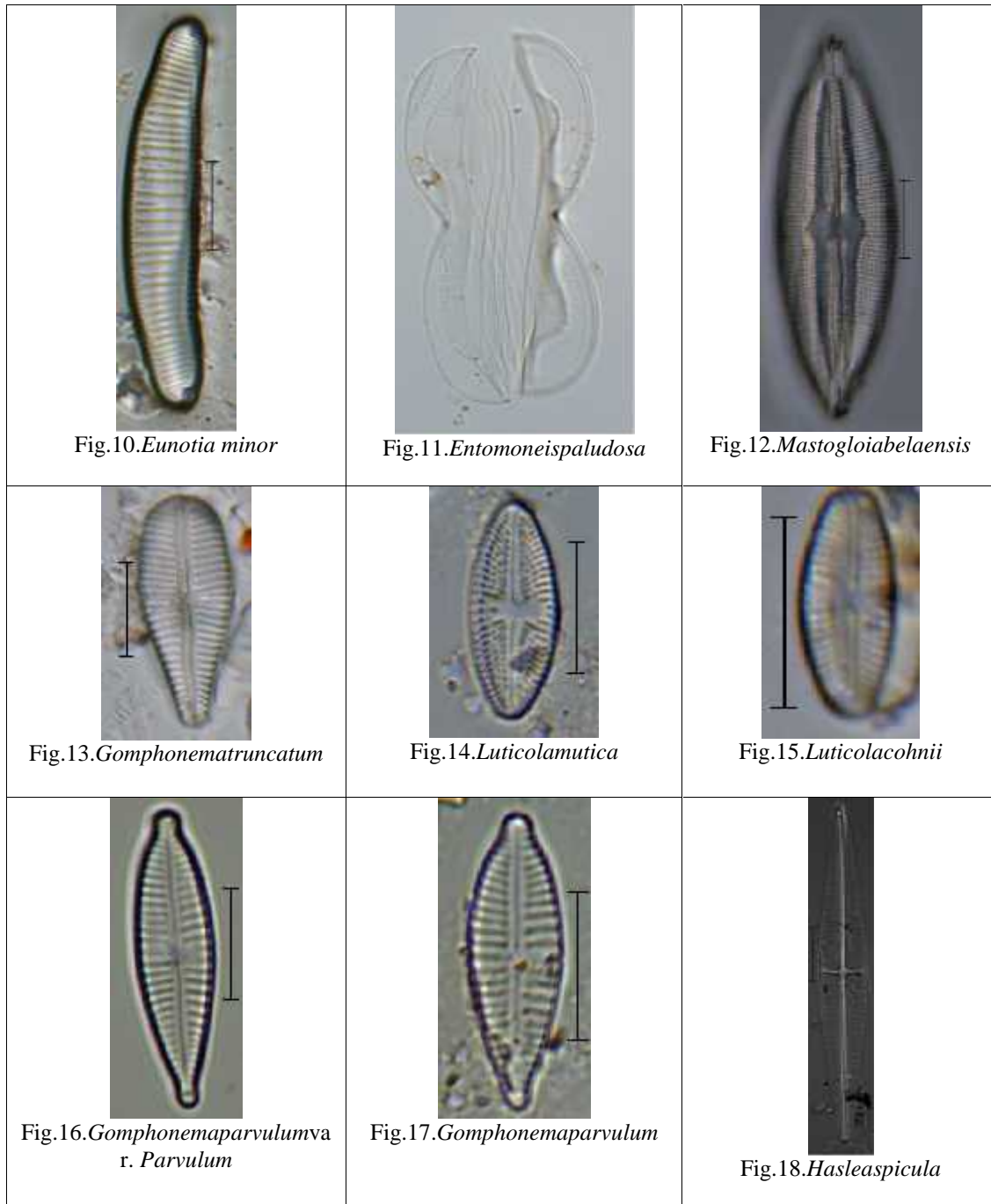


Fig.9.*Diploneiselliptica*



**General characters:** Length of cells 49.2  $\mu\text{m}$ , diameter 8.2  $\mu\text{m}$ ; striae 20 / 10  $\mu\text{m}$ , radiate in the middle, at the end parallel and radiate; valves linear, linear-elliptic to lanceolate; axial area lanceolate.

**Distribution:** Reported from Europe, Australia and Asia (China).

**3. *Caloneisbacillum* (Grunow) Cleve (1894), Fig.2**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 173, P. 791, Fig. 4

**Basionym:** *Stauroneis bacillum* Grunow

**Synonyms:** *Stauroneis bacillum* Grunow 1860; *Navicula fasciata* Lagerstedt 1873; *Caloneis fasciata* (Lagerstedt) Cleve 1894; *Caloneis bacillaris* (Gregory) Cleve 1894

**References:** Hirano, 1971: 90.

**General characters:** Length of cells 26.4  $\mu\text{m}$ , diameter 6.1  $\mu\text{m}$ ; striae 26 /10  $\mu\text{m}$ , parallel; Valve area linear or lanceolate, broad, round ends; band like central area; raphe straight.

**Distribution:** Himalaya, Europe, America and Asia (Japan).

**4. *Caloneis molaris* (Grunow) Krammer (1985), Fig.1**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 174, P.793, Fig.21

**Synonym:** *Navicula molaris* Grunow Krammer 1863; *Pinnularia molaris* (Grunow) Cleve 1995; *Caloneis clevei* sensu Hustedt 1930

**General characters:** Length of cells 36.1  $\mu\text{m}$ , diameter 7.5  $\mu\text{m}$ ; striae 19 /10  $\mu\text{m}$  parallel radiate throughout, at the ends parallel convergent; valves linear lanceolate; broad central area, axial area variable, linear to broad lanceolate.

**Distribution:** Europe and South-West- Asia (Israel).

**5. *Caloneis macedonica* Hustedt (1945), Fig.4**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 175, P.795, Fig.7

**General characters:** Length of cells 36.9  $\mu\text{m}$ , diameter 7.9  $\mu\text{m}$ ; striae 22 /10  $\mu\text{m}$ , radiate in middle, convergent at the ends; valves linear-lanceolate, with protracted capitate poles; axial area linear, lanceolate, central area broad.

**Distribution:** Europe

**6. *Caloneis undulata* (Gregory) Krammer (1985), Fig.5**

**Source of Identification:** Krammer and Lange-Bertalot (1997), Table 176, P.794, Fig.6

**Synonym:** *Pinnularia undulata* Gregory 1854

**General characters:** Length of cells 31  $\mu\text{m}$ , diameter 6.6  $\mu\text{m}$ ; striae 22 /10  $\mu\text{m}$ , parallel and radiate in the middle, convergent at the ends; valve lanceolate, with round ends; axial area linear, central area broad; raphe filiform.

**Distribution:** Europe.

**9. *Haslea* R. Simonsen(1974)**

Cells solitary and fusiform; valve linear-lanceolate; striaetransverse and longitudinal; chloroplast two, plate like.

***Hasleaspicula* (Hickie) Lange-Bertalot(1997), Fig.18**

**Source of Identification:** Krammer and Lange-Bertalot (1997), P. 545, Fig. 5

**Synonym:** *Stauroneis spicula* Hickie 1874; *Navicula spicula* (Hickie) Cleve 1894

**General characters:** Length of cells 63.8  $\mu\text{m}$ , diameter 8.8 $\mu\text{m}$ ; striae /10  $\mu\text{m}$ , radiate, parallel; valves lanceolate or spindle shape, with round ends; axial area linear.

**Distribution:** Europe, Australia, America and New Zealand.

**10. *Seminavis* D.G. Mann (2003)**

Cells lanceolate to rhombic lanceolate with rounded ends; uniseriate striae; plastid two.

***Seminavis strigosa* (Hustedt) Danielidis et Economou-Amilliin Danielidis Mann 2003, Fig.7**

**Basionym:** *Amphora strigosa* Hustedt 1949

**General characters:** Cells lanceolate to rhombic lanceolate with rounded ends; length 26.6 $\mu\text{m}$ , diameter 6.0 $\mu\text{m}$ ; striae 17/ 10  $\mu\text{m}$ .

**Distribution:** USA: California, Asia: Israel and Thailand.

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