



Diatom flora of Batrepalli Waterfalls, Anantapuramu, Andhrapradesh, India

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Abstract

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The present paper deals with 27 diatom flora belongs to 15 genera from Batrepalli waterfalls and nearby two water ponds of Kadiri area Anantapuramu district Andhra Pradesh located between 14°14'0"N 78°10'40"E. 15 genera represented by *Achnanthes*(1), *Anomoeoneis*(1), *Aulacoseira*(2), *Bacillaria* (1), *Cocconeis*(1), *Cymbella* (3), *Diploneis* (1), *Encyonema* (2), *Eunotia*(1), *Gomphonema* (2), *Navicula* (1), *Nitzschia* (8), *Rhoicosphenia* (1), *Rhopalodia* (1), *Synedra* (1). Based on morphological characteristics *taxonomic key* was prepared to the genera represented more than two species in above mentioned genera.

Keywords: Batrepalli, waterfalls, diatoms, Andhra Pradesh.

Introduction

Systematics of diatoms was studied by several Algologists such as Desikachary (1952, 54, 54a, 54b, 57), Gonzalves & Gandhi (1952), Gandhi (1955, 56, 57, 57b, 58, 67), Krishnamurthy (1954), Venkataraman (1939) from India and Munwar (1970, 74), Seenayya (1972, 79), Venkatswarulu (1969, 70, 76), Zafar (1964, 67, 68, 75) represented few diatoms, sepecially from Hyderabad region of the then Andhra Pradesh.

It is evident from the literature that there is no specific taxonomic exploration of diatoms from Andhra Pradesh, except sporadic representations as a part of ecological and limnological studies. Hence present work is first of its kind in adding diatom flora to the Algal diversity data base of Andhra Pradesh. In the present study all the reports are the first distributional records to the Anantapuramu district and twenty one taxa are new reports to the State.

Batrepalli waterfalls, one of the most attractive tourist spot in this area, is located near Kadiri in Anantapuramu district between 14°14'0"N 78°10'40"E at an altitude of 300 – 389 msl and it flows in the months of September to December in rainy season. The water flow starts from Mallalamma temple in the forest of Nigidi and connected to Batrepalli pond. The water available is stagnant in ponds, pools and puddles all around the year.

Materials and Methods

Samples were collected randomly from different spots in above specified area during December 2014. Collections were made using planktonic mesh net (pore size 40 µm) in open waters, epiphytic forms were by brushing technique and along with the stray flakes of leaves, encrustations from wet rock boulders. All the collected matter were fixed with 4% formalin. Diatoms were cleaned by following hot H₂O₂ method. Then the cleaned silica frustules were mounted with DPX and permanent slides were prepared, 5-10 slides were observed under the Olympus CH20i Biological microscope, photo micrographs were taken by Olympus E-420 digital SLR camera. Taxonomic identifications were made by consulting publications of Venkataraman(1939), Gandhi(1952-1970), Krishnamurthy (1954), Desikachary (1987-1989), B.N. Prasad and M.N. Srivatsava (1992), R.K. Gupta (2005) and with additional help of Hustedt's (1930), Cleve-Euler's (1951-55). Samples were deposited in the department of Botany Sri Krishnadevvaraya University.

Results and Discussion

Twenty seven taxa, represented by 15 genera has been reported from the area. All the taxa were reported for the first time from Anantapuramu. Genus *Eunotia* is first time reported from Andhra Pradesh and Telangana States while 21 taxa i.e *Aulacoseira granulata* var. *angustissima*, *Bacillaria paradoxa*, *Cocconeis placentula* var. *placentula*, *Cymbella affinis*, *C. tumida*, *C. turgidula*, *Diploneis elliptica*, *Encyonema mesianum*, *E. silesiacum*, *Eunotia lunaris*, *Gomphonema gracile f major*, *G. truncatum*, *Navicula cryptocephala*, *Rhoicosphenia abbreviate*, *Rhopalodia giabba*, *Nitzschia acicularis*, *N. archibaldii*, *N. fonticola*, *N. linearis*, *N. obtusa* var. *schweinfurthii*, *Synedra rumpens* were first time reported from Andhra Pradesh.

Aulacoseira Thwaites 1848

1. Valves diameter 4-6 µm, connecting spines short.....*A. granulata* var. *granulata*

1. Valves diameter >6 µm, connecting spines long.....*A. granulata* var. *angustissima*

Aulacoseira granulata var. *angustissima* (O.F.Muller) Simonsen (Pl.1.f.1)

SYNONYM(S): *Melosira granulata* (Ehrenberg) Ralfs in Pritchard

Hustedt, F., A. Pascher's Die Susswasser 1930, p.88, fig. 45. Venkataraman, G., 1939. A Systematic account of S.Indian Diatoms. p. 297, fig. 2.

Frustules cylindrical, join face-to-face form filamentous colonies, diameter 4-12 µm, mantle height 6-15 µm. Rows of mantle areolae in linking valves curved slightly to right. Separation valves often with 1-2 very long spines.

Aulacoseira granulata (Ehrenberg) Simonsen var. *granulata* (Pl.1.f.2)

Hustedt, F., A. Pascher's Die Susswasser 1930, p.87, fig. 44, Venkataraman, G., 1939. A Systematic account of S.Indian Diatoms. p. 296, fig. 1. Gandhi H.P. Diatoms from Kolhapur, 1958 pl.1, figs. 1-2, Jiunn-Tzong Wu et.al Vol. 1, 2011, p.122-23, pl. 6, figs. a-k.

Frustules cylindrical, form colonies, diameter 4-6µm, mantle height 8-15 µm . Rows of mantle areolae in linking valves curved slightly to right. Separation valves often with 1-2 short spines.

Synedra Ehrenberg 1830

Synedra rumpens Kützing (Pl.1.f.4)

Hustedt,F., 1930. p. 156, fig. 175; Prasad, B. N. and Srivastava, M. N. 1992. Vol 1, p. 168, pl. 24. fig. 16.

Valves solitary, linear-lanceolate, slightly tapering towards apices, apices faintly undulate rounded. Length 65-95 µm, breadth 2-3 µm, striae 10-16 in 10 µm.

Eunotia Ehrenberg 1837

Eunotia lunaris (Ehrenberg) Schaarschmidt (Pl.2.f.5)

Hustedt, Fr., Rabenhorst's Kryptogamenflora, Bd. VII, Teil 2, life 1-4,1931-32,p. 302, fig. 769 a, b., Krishnamurthy V. 1954, Contribution to the diatom south., p.358, fig.12.

Valves dorsiventral, symmetrical to the transapical axis. Dorsal margin convex, ventral margin concave. Apices rounded to rostrate. Length 50 µm, breadth 2-4 µm, striae 10-15 in 10 µm.

Cocconeis Ehrenberg 1837

Cocconeis placentula var. *placentula* Ehrenberg (Pl.1.f.3)

Tiffany, L.H. & Britton, M.E. (1952) (Pl.64, fig. 735, Pg. 241). Prasad, B. N. and Srivastava, M. N. (1992) Vol 1, p.198, pl.27, fig.6.

Valves elliptic to linear-elliptic and relatively flat. Axial area narrow, central area circular or oval. Length 30-45 µm, breadth 12-18 µm, striae 14-16 in 10 µm.

Achnanthes Bory de Saint-Vincent 1822

Achnanthes exigua Grunow (Pl.1.f.5)

Cleve, P. T. & Grunow, A. (1880). Ser. 4 17(2): 1-121, pls I-VII; Gandhi H.P.1960 On the diatom flora vsna village,p. 562, fig.9-10, Jiunn-Tzong Wu et.al 2011, p. 200-204, pl 45-46, figs e – i & a – c.

Valves linear-elliptical to elliptical-lanceolate. Apices broadly rostrate or subrostrate. Length 5-10 µm, breadth 4-8 µm, striae fine, unresolvable in the present specimen.

Rhoicosphenia Grunow 1860

Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot (Pl.1.f.6)

BASIONYM: *Gomphonema abbreviatum Agardh 1831*

Lange-Bertalot 1980: 586, figs 1A, 3C-D, 5A, Jena et al, 2006 Algae Volume 21(4): 377-392, p.388, pl 2 fig.33.

Frustules heteropolar, bent in girdle view. Valves linear-lanceolate. Apices rounded to rostrate. Length 10-55 µm, breadth 3-8 µm, striae 8-10 in 10 µm.

Diploneis Ehrenberg in Cleve 1894

Diploneis elliptica (Kützing) Cleve (Pl.1.f.7)

Basionym *Navicula elliptica Kützing 1844*

Hustedt, Bacil, 1930, p.250, fig. 395; Cleve-Euler, Dial, Schwed Finn., III, 1953, '78, f. 646 b (= *D. elliptic av. genuine Meister*), Gandhi H.P.1959 Fresh water diatoms.Sagar. Mysore. p.315, figs.10-11, Pandey U.C. & Pandey D.C. 1980, Diatom flora of India, p. 352, fig.34.

Valves elliptical, apices broadly rounded, central area small. Length 20-115 µm, breadth 10-60 µm, striae 10-14 in 10 µm.

Anomoeoneis Pfitzer 1871

Anomoeoneis sphaerophora E.Pfitzer (Pl.1.f.8)

Hustedt, Bacil, 262, fig.422; Cleve-Euler, A, Plat, Schwed, Finn.,III, 1953, 202, f. 928 a (= *A sphaerophora v., genuine A Cl.,*), Venkataraman, G., 1939. A Systematic account of S.Indian. p. 324, fig.75.

Valves lanceolate to elliptical-lanceolate. Apices broadly rounded to capitate. Length 50-55 µm, breadth 15-18 µm, striae, 16-18 in 10µm.

Navicula Bory de Saint-Vincent 1822

Navicula cryptocephala Kützing Pl.1.f.9)

Tiffany, L.H. and Britton, M.E., 1952. p.255,pl. 69.fig. 767. Prasad, B. N. and Srivastava, M. N. (1992) Vol 1, p. 204 pl. 29, fig. 2.

Valves lanceolate, apices protracted, axial area narrow, straight. central area large circular. Length 15-25 µm, breadth 5-10 µm, striae 12-16 in 10µm.

Cymbella Agardh 1830

1. Apices rostrate, broadly rounded, central area large, striae coarse.....*C. tumida*

1. Apices protracted, truncate, central area narrow, striae radial:

2. Apices truncate; ventral valve concave at centre, central striae unequal ventral ones

Small

.....*C. affinis*

2. Apices protracted, ventral valve straight at center, central striae equal

.....*C. turgidula*

***C. affinis* Kützing (Pl.1.f.10)**

Tiffany, L.H. and Britton, M.E., 1952. p.279, pl. 72.fig. 856. Prasad, B. N. and Srivastava, M. N. (1992) Vol 1, p. 266 pl. 34, fig.5. RK Gupta, Botanical Survey of India,2005 p. 179, pl. 54.fig.11, Jiunn-Tzong Wu et.al 2011, p. 306- 307, pl. 98 figs. a-f.

Valves strongly dorsi-ventral, apices subrostrate to rostrate, dorsal margin strongly arched, ventral margin slightly concave or flat. Ventral striae at centre smaller than dorsal, gap indicates presence of stigma, stigma not clear in LM. Length 20-30 µm, breadth 4-6 µm, striae in middle 8-12 µm, 12-14 in 10 µm towards the ends.

***C. tumida* (Brébisson) van Heurck (Pl.1.f.11)**

Van Heurck 1880: 64; pl. 2: fig. 10, Gandhi H.P.1960 Diatom Flora of Bombay&Sal. p. 104, fig. 65-66, Jiunn-Tzong Wu et.al 2011, p. 321, pl 105, figs. b-f

Valves strongly dorsiventral, semilanceolate, dorsal margin strongly convex, ventral margin straight, slight expansion in the centre, apices rostrate broadly rounded. Length 40-100 µm, breadth 10-25 µm. Dorsal striae in the middle 8-12 in 10 µm and 12-14 in 10 µm towards the ends.

***C. turgidula* Grunow (Pl.1.f.12)**

Schmidt, A. et al. 1875: pl. 9: fig.23-26, Hustedt, F., A. Pascher's Die Susswasser 1930, p.362, Fig. 670, Alakananda, B.; Karthick, B.; Mahesh, M. K; Ramachandr, T.V. 2011, Diatom based pollution. p. 47, fig. CTGL, Jiunn-Tzong Wu et.al 2011 V-I, p. 322-323, pl. 106, figs. b-e.

Valves slightly dorsi-ventral, broadly lanceolate, dorsal margin strongly convex, ventral margin straight. Apices blunt, rostrate to truncate sometimes protracted. Length 30-45 µm, breadth 10-15 µm, striae radial, 9-11 in 10 µm in the middle and 12-14 in 10 µm towards the ends.

***Encyonema* Kützing 1833**

1. Ventral margin slightly concave at centre, curved at ends, apices cuneate out

rostrate.....*E. mesianum*

1. Ventral margin straight, apices cuneate.....*E. silesiacum*

***E. mesianum* (Cholnoky) D.G.Mann. (Pl.2 f.1)**

Basionym *Cymbella mesiana* Cholnoky

Round, F.E., Crawford, R.M. & Mann, D.G. 1990 pp. i-xi, 1-747, Suresh 2013, List of Algae. Kerala fig.105, Jiunn-Tzong Wu et.al 2011 V-I, p. 332-333, pl.111, figs. a-b.

Valves dorsi-ventral, symmetrical to transapical axis. Dorsal margin strongly arched, ventral margin slightly concave at the center and slightly curved at the ends of the valve. Apices bluntly rounded. Length 30-68 µm, breadth 8-12 µm, striae 8-10 in 10 µm in the middle and 15-18 in 10 µm towards the ends.

***E. silesiacum* (Bleisch) D.G.Mann (Pl.2 f.2)**

Synonym *Cymbella ventricosa* Kützing 1844 pro parte; *Cymbella ventricosa* var. *silesiaca* (Bleisch)

Hustedt, F., A. Pascher's Die Susswasser 1930, p.359, Fig. 661, Gandhi H.P. Diatoms from Partabgarh, 1955, p. 326, fig. 28, Jiunn-Tzong Wu et.al 2011, p.334-335, pl. 112.figs.b-j.

Valves dorsiventral, symmetrical to the transapical axis. Dorsal margin arched and ventral margin straight. Apices rounded to rostrate. Length 14-45 µm, breadth 7-15 µm, striae 10-22 in 10µm.

Gomphonema Ehernberg 1832

1. Valve linear lanceolate, rhombic, apices narrowly rounded on both poles, valves 40-100 µm long

.....*G. gracile*.

1. Valves clavate, apices truncate, sub-capitate at head pole, narrowly rounded at tail, valve

15-60 µm long.....*G. truncatum*.

***G. gracile f. major* Grunow (Pl.2 f.3)**

Hustedt, Bacil, 376, f 700(*Gomphonema lanceolatum* Ehr.,; Cleve-Euler, Dial, Schwed Finn., IV, 1955, f. 1281 a-b, (*Ggracile av. Genuinum* May.) Gandhi HP (1958). Fresh water diatoms.Partabgarh, p. 328, fig. 32, Jiunn-Tzong Wu et.al 2011, p.356-357, pl 123, figs a– h.

Valves slightly asymmetrical to transapical axis and symmetrical to apical axis. Valves lanceolate, apices narrowly rounded to narrowly sub-rostrate. Length 40-100 µm, breadth 5-10 µm.

***G. truncatum* Ehrenberg (Pl.2 f.4)**

Synonym *Gomphonema capitatum* Ehrenberg 1838; *Gomphonema turgidum* Ehrenberg 1854; *Gomphonema constrictum var. truncatum* (Ehrenberg) Gutwinski 1887.

Jiunn-Tzong Wu et.al 2011, p. 372-373, pl 131, figs. a-d. Sangita P and Sailendra Prasad B 2012 Preliminary report of diatoms from Assam, p.57, fig.6.

Valves clavate, with tumid center, apices broadly rounded to broadly sub-capitate head pole, narrowly rounded tail pole. Length 15-60 µm, breadth 8-20 µm, striae 10-14 in 10µm.

Rhopalodia O. Muller 1895

***Rhopalodia gibba* (Ehrenb.) O.Müll. (Pl.2 f.6)**

Hustedt, F., A. Pascher's Die Susswasser 1930, p.390, Fig740, Cleve-Eu`ler, A , plat. Schwed, Finn., V, 1952 : 44,-fig 1416 a, e (=R., *gibbs v. genuine* Grun.,) Jiunn-Tzong Wu et.al 2011(V-II), p .282-283, pl. 69, fig. d, P. K. Misra et.al 2012 Phytos 42 (2): 14-34 (2012) p. 32, pl.4, fig.1.

Frustule linearly lanceolate to lanceolate. Apices cuneate. Centre inflated. Length 45-140µm, breadth 6-12 µm. striae distinct, 12-18 in 10 µm. Valve traversed by prominent costae 6-8 in 10µm, raphe fibulate 6-8 in 10 µm.

***Nitzschia* Hassall 1845**

1. Poles long drawn-out, apices rostrate, striae unresolvable.....*N. acicularis*

1. Poles short, apices rostrate, capitate, striae resolvable:

2. Valves slightly sigmoid, apices cuneate, ventral valve margin notch is present

at centre.....*N. obtusa*

2. Valves linear to linear lanceolate, apices subcapitate, ventral valve margin notch is absent at center:

3. Valves linear, striae prominent, valve margin convex:

4. Fibulae prominent, striae 16-20 per 10 μm*N. amphibia*
4. Fibulae not prominent, dot like, striae 25-35 per 10 μm

.....*N. fonticola*

3. Valves linear lanceolate, striae fine, valve margin slight parallel:

5. Central rafe with nick, apices cuneate, valves 60-120 μm long
.....*N. linearis*

5. Central rafe area regular, apices knob like, rounded, valves 15-40 μm :

6. Keel on both valve margins.....*N. archibaldii*
6. Keel on one margin.....*N. palea*

***N. acicularis* (Kützing) W.Smith (Pl.2 f.7)**

Basionym *Synedra acicularis* Kutzing 1844

Kützing) W.Smith 1853: 43, pl. 15: fig. 122, Jiunn-Tzong Wu et.al 2011, p.269, pl 79, figs. a-c, Prakash Narayan and G.K. Barupal 2015 A systematic account of diatoms. Jodhpur, p.3438, pl.2, fig.11.

Frustules solitary, isopolar, bilaterally symmetrical, elongate linear to linear-lanceolate long drawn-out rostrate poles. Length 30-130 μm , breadth 2-6 μm , striae very fine unresolvable in the present specimen.

***N. amphibia* Grunow (Pl.2 f.8)**

Van Heurck, op, cit , 1896, p 403, pl. 17, kg, 563, Hustedt, F., A. Pascher's Die Susswasser 1930, p.414, Fig.793, Venkataraman, G., 1939. A Systematic account of S.Indian Diatoms. p.353, fig.149. Jiunn-Tzong Wu et.al (V-I) 2011, p.268-269, pl 79, figs. h-j.

Frustules isopolar, bilaterally symmetrical, linear-lanceolate. Length 20-70 μm , breadth 2-6 μm , striae 16-20 in 10 μm . Fibulae prominent.

***N. archibaldii* Lange-Bertalot (Pl.2 f.9)**

Lange-Bertalot 1980: 44; pl. 1, fig. 14-18; pl. 7, fig. 115-121, Supriya G, Sachin P, Meena D 2013, Phytoplankton diversity Rajaram reservoir, p. 263, s.no. 107.

Valves lanceolate, apices tapering to knob-like, rounded, length 15-40 μm , breadth 2-3 μm , striae 14-16 in 10 μm . Fibulae present on both margins.

***N. fonticola* (Grunow) Grunow (Pl.2 f.10)**

Basionym *Nitzschia kützingiana* var. *fonticola* Grunow in Cleve & Grunow 1880

Hustedt, F., A. Pascher's Die Susswasser 1930, p.415, Fig. 800, Krishnamurthy V. 1954. Contribution to the diatom south.Ind, p.379, fig.73, Jiunn-Tzong Wu et.al 2011, p. 276-277, pl 83, figs.d-g.

Frustules isopolar, bilaterally symmetrical, lanceolate, apices rostrate to subcapitate. Length 15-55 μm , breadth 3-6 μm , striae 20-35 in 10 μm . Fibulae small regularly placed.

***N. linearis* (Grunow) Hustedt (Pl.2 f.11)**

Basionym *Frustulia linearis* Agardh

Cleve-Eu`ler, A, plat. Schwed, Finn, V:1952, figs.1492 a, b (= *N. subtilis* v. *genuine* Hantzsch.), Hustedt, F., A. Pascher's Die Susswasser 1930, p.409, Fig.784, Gopinathan C. P. 1975, On distributional record diatoms from Ind. Seas., p. 235, fig. I.

Frustules solitary, isopolar, bilaterally symmetrical. Apices subcapitate. Raphe, constriction present at centre. Length 60-120 µm, breadth 4-7 µm, striae fine fibulae 2-5 in 10 µm.

***N. obtusa* W. Smith Grunow (Pl.2 f.13)**

1. Apices cuneate, curved.....*N. obtusa* var. *obtusa*

1. Apices cuneate, not curved.....*N. obtusa*

var. *Schweinfurthii*

Synonym *Bacillaria obtusa* (W. Smith) Elmore in Barbour 1895

Hustedt, F., A. Pascher's Die Susswasser 1930, p.422, Fig.817a, Cleve-Eu`ler, A, plat. Schwed, Finn, V, 1952: figs.1476 a-b (= *N. W. Sm. obtusa* v. *vulgaris* Gum.), , Prasad, B. N. and Srivastava, M. N. 1992. Vol 1, p. 299.pl.37.fig. 7., Jiunn-Tzong Wu et.al 2011, p.286-287, pl. 88.figs.a-f.

Valves linear, slightly sigmoid. Apices oblique wedge shaped. Length 70-105 µm, breadth 6-8 µm. Raphe system fibulate eccentric. Fibulae 6-10 in 10 µm. Striae very fine, resolvable under careful observation 18-25 in 10 µm.

***N. obtusa* var. *schweinfurthii* Grunow (Pl.2 f.12)**

Cleve-Eu`ler, A, plat. Schwed, Finn, V: 1952,figs.1476 c, d (= *N. W. Sm. obtusa* v. *schweinfurthii* Grun.,), Prasad, B. N. and Srivastava, M. N. 1992, Vol 1, p.300.pl.37.fig.1, Jiunn-Tzong Wu et.al 2011, p. 286-287, pl 88, fig. g.

Valves linear, moderately sigmoid, apices broadly rostrate. Raphe notched in the middle, fibulate, marginal. Length 80-145 µm, breadth 6-8 µm, striae unresolvable, fibulae 5-7 in 10 µm.

***N. palea* (Kützing) W.Smith (Pl.2 f.14)**

Basionym *Synedra palea* Kutzing 1844

Hustedt, F., A. Pascher's Die Susswasser 1930, p.416, fig.801 , Prasad, B. N. and Srivastava, M. N. 1992, Vol 1, p.303. pls. 35&37, figs.5&11, Jena et al, 2006 Algae Volume 21(4): 377-392, p.389, pl. 3 fig.25

Valves bilaterally symmetrical, usually linear-lanceolate. Apices shortly rostrate, subrostrate or subcapitate. Length 20-75 µm, breadth 2-6 µm, fibulae 8-12 in 10 µm.

***Bacillaria* Gmelin 1788**

***Bacillaria paradoxa* (O. F. Müller) Gmelin 1788 (Pl.2 f.15)**

Synonym *Nitzschia paradoxa* (Gmelin) Grunow in Cleve & Grunow 1880

Cleve Eu`ler, A, plat. Schwed, Finn, V: 1952, figs.1457 (= *N. paradoxa* v. *genuine* Nach Grunow.), Gopinathan C. P. 1984, Littoral diatoms of Southwest coast Ind.,p. 26, fig. 3(s-u).

Valves linearly-lanceolate. Apices rostrate to cuneate or rounded. Length 30-80 µm, breadth 2-5 µm, striae 30-40 in 10 µm. Raphe system fibulate, subcentral. Fibulae small bars, linked at their bases by faint longitudinal lines giving a ladder-like appearance.

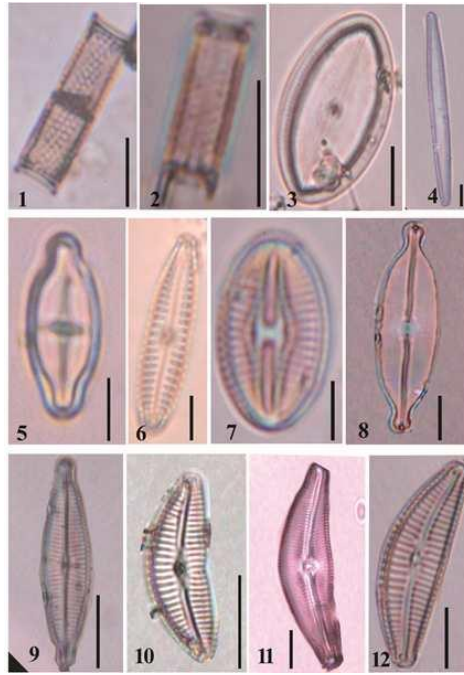


Plate-1: 1) *Aulacoseira granulata* var. *angustissima* (O.F.Muller) 2) *A. granulata* (Ehrenberg) Simonsen var. *granulata* 3) *Cocconeis placentula* var. *placentula* Ehrenberg 4) *Synedra rumpens* Kützing 5) *Achnanthes exigua* Grunow 6) *Rhoicosphenia abbreviate* (C.Agardh) Lange-Bertalot 7) *Diploneis elliptica* (Kützing) Cleve 8) *Anomooneis sphaerophora* E.Pfitzer 9) *Navicula cryptocephala* Kützing 10) *Cymbella affinis* Kützing 11) *C. tumida* (Brébisson) van Heurck 12) *C. turgidula* Grunow (Scale- 15 µm)

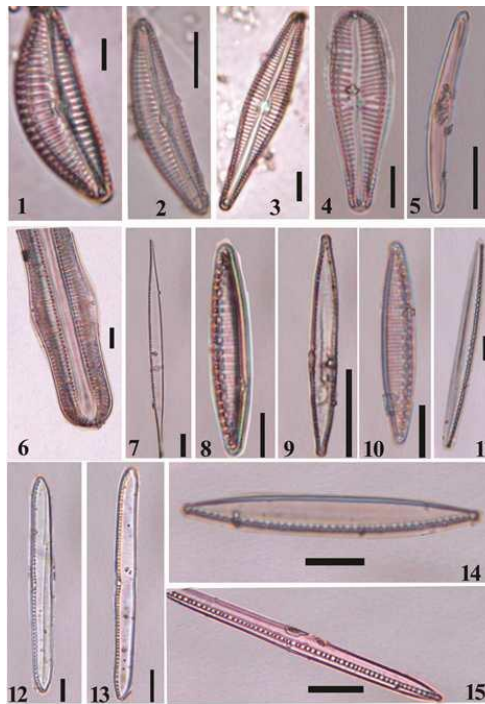


Plate-21) *Encyonema mesianum* (Cholnoky) D.G.Mann. 2) *E. silesiacum* (Bleisch) D.G.Mann 3) *Gomphonema gracile* f. *major* Grunow 4) *G. truncatum* Ehrenberg 5) *Eunotia lunaris* (Ehrenberg) Schaarschmidt 6) *Rhopalodia gibba* (Ehrenb.) O.Müll. 7) *Nitzschia acicularis* (Kützing) W.Smith 8) *N. amphibia* Grunow 9) *N. archibaldii* Lange-Bertalot 10) *N. fonticola* (Grunow) Grunow 11) *N. linearis* (Grunow) Hustedt 12) *N. obtusa* var. *schweinfurthii* Grunow 13) *N. obtusa* W. Smith Grunow 14) *N. palea* (Kützing) W.Smith 15) *Bacillaria paradoxa* (O. F. Müller) Gmelin (Scale- 15 µm)

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