

## MORPHOGRAPHIC REVISION OF THE ORDER VOLVOCALES AND CHLOROCOCCALES FROM GIRNA RIVER NEAR JALGAON REGION MAHARASHTRA, INDIA

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### ABSTRACT

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Volvocales and Chlorococcales represent an important orders of aquatic phototrophs, it is interesting group resembles like animal as well as algae or plant. In this study, we aimed to revolutionized our knowledge and understanding of conventional taxonomy of different genus of order from Girna river Jalgaon region of Maharashtra, India. Sample were taken from three locations at Girna river. Twenty two species of Volvocales and Chlorococcales were observed under Light microscopic (LM), and identified till forms level. All members of Volvocales and Chlorococcales species were taxonomically determined and are described for the first time from these areas. They were listed and presented with morphological descriptions,

dimensional information and photographic information. Green flagellates with elongate, ovoid, spindle-like shape cells, varying in length from 15 to 500  $\mu\text{m}$ , and with one or two flagella originating within an anterior of the cell. Volvocales have two methods of locomotion involves helical rotation of the cell and most species exhibit, when swimming stops and other is wiggling method. Chloroplasts vary in shape, size, number per cell and pyrenoid type. The chloroplasts are grass-green and contain chlorophylls.

**KEYWORDS:** Taxonomic, Volvocales, Chlorococcales, flagellates, wiggling, phototrophs, Chlamydomonadaceae and Volvocaceae.

### INTRODUCTION

Members of Chlorococcales and Volvocales can inhabit fresh water as well as marine water. However, they are most commonly found in water bodies such as streams, ponds, and lakes.

They are also accurse in polluted water bodies like ditches, inland water and pools that are full of organic matter and they often make the water appear green because of their chloroplast. An idea habitat for Euglena would have plenty of exposure to the sunlight (such as a surface of a pond) for the organism to conduct photosynthesis, as well as be rich in organic matter where it can find carbon-based food.

The Volvocales include chiefly the microscopic genera of the green algae in which the thallus is one-celled and generally motile throughout life. The unicell is furnished with 2 rarely 4 whiplash type flagella of equal length. This is the only order of the green algae in which the vegetative cell is actively motile. In some genera the motile cells are joined into groups to form an Organisation called a colony. A colony is an aggregation of individuals mechanically held together generally in a gelatinous sheath. The individuals in the colony have little or no dependence upon others. The colonies included in this order have a definite number of cells arranged in a specific manner. This type of colony is called a coenobium. The coenobia are motile. The order Volvos:mks, therefore, includes both unicellular and colonial forms which occur widely in fresh water plankton. They are absent from the sea. Almost all the representatives are fresh water. Many of them prefer water rich in nitrogen and organic substances and thus occur in quiet pools. The order comprises at least six families with aboUt 60 genera and about 500 species. Of these Chlamydomonadaceae and Volvocaceae are described here. A mention, however, be made of another small family of the order. It is Polyblepharidaceae. All the members of this family are naked. Polyblepharides, a member of this family only divides asexually by longitudinal division into two.

General Characteristics. The order includes unicellular, coenocytic and colonial, non-►otile forms. Motility is confined to the gametes and zoospores only. The thallus is non-motile. Vege' tative division of the cell is absent. Division takes place only at the time of reproduction. Unlike the Volvocales, the nuclear division in the reproductive cells is not immediately followed by cleavage of cytoplasm. There is thus a tendency for the cells in the Chlorococcales to become multinucleate for a short while. Even the unicellular forms do not multiply by binary fission. The vegetative cell in most species resembles Chlamydomonas in having a well-defined cell wall, a single nucleus and a single, massive parietal chloroplast with a single pyrenoid but differs in the absence of flagella, eyespot and contractile vacuoles. Some species reproduce by the formation of biflagellate zoospores but some are azoosporic and reproduce by aplanospores. The order comprises about 173 genera and 1,079 species. Of

these 208 species have been reported from India. Chlorococcum, Chlorella, Scenedesmus, Pediastrum, Hydrodictyon, Characiurn, and Protosiphon are the most important genera. Most of the members occur as fresh water plankton. Only a few species of Chlorella, -Characium and Oocystis are marine. Some live in the moist soil, on walls and bark of trees. Some live in symbiotic relationship with fungi to form lichens and in the lower animals.

The order is divided into a large number of families. The chief. among these are Chlorellaceae, Selenastraceac, Dictyosphaeriaceae, Hydrodictyaceae, Coelastraceao, and Protosiphonaceae. Here Chlorellaceae, Hydrodictyaceae and Protosiphonaceae are discussed in some detail.

## MATERIALS AND METHODS

Algal materials were collected in specimen bottles at the beginning of the experiment. Attached algal material collected with forceps or by hand, greenish surface water was collected between 8 to 9 am. Algal sample were collected at monthly interval, during July 2013 to December 2013. Greenish water algae were collected in acid washed container bottles, Photographs taken by Nikon camera and sketches were made by using camera lucida. Identification of diatoms was mostly based on the key given by ....., and remaining preserved in the 4% formalin for further taxonomic investigation.

## CLASS - CHLOROPHYCEAE

### Order- Volvocales

### Family- Chlamydomonadaceae

Genus Sphaerellopsis Kors., 1925

Sphaerellopsis fluviatilis (Stein) Pascher

pl. 1, fig. 1

M.O.P. Iyengar and T. V. Desikachary, p. 234, f. 129 (5, 18 - 28), 1981.

Cell 16.8 p.m long and 12.9 [tm in broad, pale green, ellipsoid to ovoid; protoplast seperated away from the cell envelope; anterior end attenuated, posterior end rounded. Chloroplast cup shaped with a basal pyrenoid; contractile vacuoles two; flagella as long as the body. (Coll. No. 142)

Distribution in India: Orissa (Philipose, 1958); Maharashtra (Balakrishnan, 1972).

Genus Chlamydonephris Ettl, H. and O., 1959

Chlamydonephris impressa (Pascher) Ettl, H. and O.

pl. 1, fig. 2

M.O.P. Iyengar and T. V. Desikachary, p. 247, f. 139 (3 & 5), 1981.

Cells 10 - 11.7 pm in diameter, green, ellipsoidal, subspherical or reniform with a depression at the anterior end, rounded at the posterior end; cell wall close to protoplast; papilla absent; biflagellate, flagella close and inserted in the anterior depression; chloroplast discoid; pyrenoid present; contractile vacuoles two and apical. (Coll. Nos. 143, 145)

**Distribution in India: ?**

Genus *Chloromonas* Gobi, 1899

*Chloromonas dahlemensis* Gerloff

pl. 1, fig. 3

M.O.P. Iyengar and T. V. Desikachary, p. 255, f. 144(3), 1981

Cell 16.8  $\mu$ m long and 10.5  $\mu$ m broad, ellipsoidal to ellipsoid cylindrical, broadly rounded at both ends; papilla present, broadly rounded; flagella 1 1/2 times as long as the body; chloroplast cupshaped, reaching up to the anterior end; pyrenoid absent; eye spot median. (Coll. Nos. 176, 195).

Distribution in India: Tamil Nadu (Iyengar and Desikachary, Lc.); Maharashtra (Jawale and Kumawat, 2000).

Genus *Chlamydomonas* Ehr., 1833

*Chlamydomonas iyengari* Mitra

pl. 1, fig. 4

M.O.P. Iyengar and T. V. Desikachary, p. 274, f. 154, 1981.

Cells 9.4 - 11.3  $\mu$ m long and 5.1 - 6.6  $\mu$ m broad, subspherical or slightly oblong with a thin wall, posterior end broadly rounded, anterior end narrowing to a truncate hyaline papilla; flagella 1 1/2 - 2 times long as the body, arising from a small cytoplasmic beak below the middle of the papilla; chloroplast cup-shaped, extending almost to the anterior end; pyrenoid at the base; base slightly thickened; nucleus near the middle of the cell. (Coll. Nos. 155, 194)

Distribution in India: U.P. (Mitra, 1951) *Chlamydomonas microsphaera* Pascher and Jahoda  
pl. 1, fig. 5

M.O.P. Iyengar and T. V. Desikachary, p. 275, f. 155 (1), 1981.

Cell 10.5  $\mu$ m in diameter, spherical; cell wall thick; papilla small, truncated; chloroplast large, reaching anteriorly upto the papilla; pyrenoid basal and laterally; eye spot large, flake like, median; nucleus central; flagella about as long as the cell. (Coll. Nos. 143, 175).

**Distribution in India:** Tamil Nadu (Iyengar and Desikachary, /c.)

*Chlamydomonas sphagnophila* Pascher var. *indica* (Mitra) Desikachary. pl. 6, fig. 6

M.O.P. Iyengar and T. V. Desikachary, p. 288, f. 163 (1-23), 1981.

Cell 11.7  $\mu$ m long and 8.6  $\mu$ m broad, broadly ellipsoidal, both ends rounded; cell wall thin; papilla absent; flagella 11/4 - 11/2 times as long as the body; chloroplast cupshaped, large, reaching upto the anterior ends; pyrenoid lateral, above the median level; nucleus central, below the pyrenoid. (Coll. Nos. 135, 154, 155).

**Distribution in India:** U.P. (Mitra, 1951)

*Chlamydomonas pseudotetraolaris* Iyengar pl. 1, fig. 7

M.O.P. Iyengar and T. V. Desikachary, p. 297, f. 151 (2), 1981.

Cells 6 - 10  $\mu$ m in diameter, spherical, papilla absent; chloroplast lateral with a single median pyrenoid, slightly lobed near the region of the pyrenoid; flagella about 11/4 as long as the body; contractile vacuoles 2; nucleus more or less median. (Coll. Nos. 133, 148, 149).

**Distribution in India:** Tamil Nadu (Iyengar and Desikachary, Lc.)

Genus *Tetrahymena* Senn, 1897

*Tetrahymena multifilis* (Klebs) Wille em. Pascher pl. 1, fig. 8

M.O.P. Iyengar and T. V. Desikachary, p. 319, f. 181 (2-8), 1981.

Cell 12.1  $\mu$ m long and 9.4  $\mu$ m broad, colourless, ellipsoidal or ovoid, anterior and posterior ends rounded, sometimes narrowing at the anterior end; cell wall distinct and slightly removed away from the protoplast, especially at the posterior end; papilla present; quadriflagellate; chloroplast absent; pyrenoid present located posterior to the nucleus; contractile vacuoles 2, and anterior. (Coll. No. 145)

**Distribution in India:** ?

Genus *Pyramichlamys* Ettl, H and O., 1959

*Pyramichlamys cordiformis* (Carter) Ettl, H and O. pl. 1, fig. 9

M.O.P. Iyengar and T. V. Desikachary, p. 324, 1981.

Cell 16.8 µm long and 9.8 µm broad, compressed; with a broad and narrow side; in front view ellipsoidal, cordate; with a regular anterior depression, posterior broadly rounded; papilla absent; quadriflagellate, somewhat longer than the cell; chloroplast cupshaped, reaching up to anterior end, pyrenoid basal, eyespot broad discoid. (Coll. Nos. 140, 154)

**Distribution in India:** Maharashtra (Carter, 1859); U. P. (Venkataraman, 1957); W Bengal (Philipose, 1960)

Family - Phacotaceae

*Dysmorphococcus indicus* Iyengar pl. 1, fig. 10

M.O.P Iyengar and T. V. Desikachary, p. 338, f. 193 (3-6), 1981.

Cell 10 µm in diameter and protoplast 5.9 µm in diameter; lorica spherical, golden brown, smooth, somewhat compressed at anterior end; chloroplast cup shaped thick with a single pyrenoid; biflagellate, as long as body; contractile vacuole 2, anterior. (Coll. No. 155)

**Distribution in India:** Tamil Nadu (Iyengar and Desikachary, Lc.)

Genus *Phacotus* Perty, 1852

*Phacotus subglobosus* Pascher pl. 1, fig. 11

M.O.P. Iyengar and T. V. Desikachary, p. 355, f. 205 (14-16), 1981.

Cell 8.6 µm in diameter; protoplast 6.7 µm in diameter; lorica rounded, smooth, protoplast not filling the lorica, pyriform with a narrow anterior end; flagella up to 2 1/2 times as long as the body; chloroplast cupshaped; eyespot in the anterior half; pyrenoid not well developed; contractile vacuole single and anterior. (Coll. Nos. 142, 157)

**Distribution in India:** Maharashtra (Gonzalves and Gangla, 1949)

Family-Volvocaceae Genus *Pandorina* Bory em. Ehr., 1824

Genus *Dysmorphococcus* Takeda, 1916

*Pandorina morum* (Muell.) Bory pl. 1, fig. 12

M.O.P. Iyengar and T. V. Desikachary, p. 418, f. 243 (2-8), 1981.

Colonies nearly spherical, 4-16 celled, embeded in a common matrix. Cell 7 pm long and broad, obovate, broad side turned towards outside, narrower and rounded posterior, towards the inside angular by mutual compression when closely packed. Chloroplast cupshaped with one basal pyrenoid; flagella 2, 2 to 2 1/2 times as long as the cell; emerging from two funnel-shaped opening in the outer conical envelope.(Coll. Nos. 109, 142, 145).

Distribution in India : Maharashtra (Gonzalves and Joshi, 1946; Kamat, 1968; Pingale, 1988; Nandan, 1993; Bodas, 1991); W. Bengal (Biswas, 1949); U.P. (Venkateraman, 1957; Singh, 1959); Rajasthan (Vyas, 1968); Assam (Carter, 1926); A.P. (Venkateswarlu, 1981); Delhi (Dakshini and Gupta, 1981); J, and K.(Kant and Vohra, 1999).

Order - Chlorococcales Family - Characiaceae

Genus Characium A. Braun ex Kuetz., 1849

Characium ambigulim Hermann ex Rabenhorst pl. 1, fig. 13

G.W. Prescott, p. 216, pl. 15, f. 11, 1962; M.T. Philipose, p. 82, f. 7, 1967.

Cells 12.2 - 33.2 pm long and 2.7 - 6.8 .1m broad, small, elongated and oblique. Apex in the form of a slightly bent hyaline beak. Attached by a short stalk without basal thickening. (Coll. Nos. 158, 163, 179)

Distribution in India: Maharashtra (Dixit, 1937; Freitas, 1980; Bodas, 1991); U.P. (Venkataraman, 1957); Assam (Alfred, 1978).

Characium cylindri cum Lambert pl. 1, fig. 14

T. Yamagishi, p. 47, pl. 2, f. 11 a-b, 1975.

Cells 40-41 [tm long and 9-9.7 jim broad, elongated cylindric and slightly curved with rounded ends; stalk short with colourless basal thickenings.

(Coll. No. 184).Distribution in India : ?

Characium indicum Patel and Isabella pl. 1, fig. 15

Patel and Isabella, p. 78, f.1, 1979.

Cells 24-29.2  $\mu\text{m}$  long and 4-4.3  $\mu\text{m}$  broad, slightly curved and more or less lanceolate, with both sides somewhat tapering gradually. Cells with a distinct short and stout stalk having small knob-like basal disc. Free end acute or somewhat rounded. Chloroplast single, parietal and with a pyrenoid. (Coll. No. 176)

**Distribution in India:** Gujarat (Patel and Isabella, / . c.); Maharashtra (Jawale and Kumawat, 2000)

*Characium philiposii* sp. nov.

pl. 1, fig. 16

Cells 37.8 - 40.2  $\mu\text{m}$  long and 8.2 - 10.1  $\mu\text{m}$  broad. Cells straight, clavate -lanceolate with constricted gradually attenuated apex to form long apiculate blunt apical point and narrowed gradually below into rounded base with short stalk. Margins somewhat undulate, the stalk thick with discoid basal thickening. (Coll. No. 198).

This form is nearer to *Characium apiculatum* A. Braun ex Kuetz. and *Characium angustum* A. Braun (Philipose, 1967) but differs in having cells smaller, clavate lanceolate, margins more or less undulate, anterior end constricted to form long apiculate rounded apex. Hence, it is considered here as a new species.

Genus *Schroederia* Lemm. em. Korshikov, 1898

*Schroederia setigera* (Schroeder) Lemm.

pl. 1, fig. 17

G.W. Prescott, p. 256, pl. 57, f. 4, 1962; T. Hortobagyi, p.46, f. 68-69, 1968; M. T. Philipose, p. 89, f. 17, 1967.

Cells 24.6-27  $\mu\text{m}$  long and 3.1-3.9  $\mu\text{m}$  broad, solitary, free floating, spindle shaped, straight or curved with ends produced into a long, delicate or stout seta which is curved or straight. Chloroplast single, parietal and with a single pyrenoid.

Spines 15.5-17.5  $\mu\text{m}$  long. (Coll. Nos. 145, 201).

**Distribution in India:** Orissa and Kerala (Philipose, / .c.); U.P. (Hortobagyi, 1969; Mittal and Sengar, 1988); Maharashtra (Kamat and Freitas, 1976; Ashtekar and Kamat, 1980; Tarar and Bodkhe, 1998b; Jawale and Kumawat, 2000); Gujarat (Patel and Isabella, 1979).



Family - Micractiniaceae.

Genus *Trochiscia* Kuetz., 1845

*Trochiscia granulata* (Reinsch) Hansg. var. *aerophila* (Printz) Printz pl. 1, fig.18

M. T. Philipose, p. 100, f. 240 a-b, 1967.

Cells 13.6-26.1 fAM in diameter, spherical with thick colourless membrane densely covered by short, coarse and irregularly disposed warts usually with blunt tips. Chloroplast parietal, bell shaped, covering the entire inner wall and without pyrenoid. (Coll. Nos. 152, 206)

Distribution in India : ?

Genus *Golenkinia* Chodat, 1894

*Golenkinia radiata* Chodat

pl. 1, fig. 19

G. W Prescott, p. 213, pl. 45, f. 3, 1962; M. T. Philipose, p. 102. f. 27, 1967.

Cells 4.7-7.5 jitm in diameter, solitary, free floating, spherical, with a thin cell wall covered by long hyaline setae. Setae 11.5 - 28.5 jim long. Chloroplast cup shaped and with a pyrenoid. (Coll. Nos. 155, 161, 176, 200, 208)

Distribution in India : Orissa (Philipose, l.c.); Bihar (Laal, 1976); Gujarat (Patel and Isabella, 1980); Maharashtra (Ashtekar and Kamat, 1980; Pingale, 1992); Delhi (Dakshini and Gupta, 1981); Rajasthan (Pandey et al, 1998)

Genus *Micractinium* Fresenius, 1858

*Micractinium pusiflum* Fresenius

pl. 1, fig. 20

G. W. Prescott, p. 287, pl. 66, f. 8, 1962; M. T. Philipose, p. 104, f. 29, 1967

Colonies free floating, composed of 4-8-16 or more cells arranged in groups of four, each group being quadrate or pyramidate. Cells 4.3-4.5 1.im in diameter, spherical with thin cell membrane with 2-5 long hyaline setae from their outer surface. Chloroplast single, parietal, cupshaped with a pyrenoids. Setae 20-35.1 pm long. (Coll. Nos. 155, 205)

**Distribution in India:** A.P., Orissa, M.P. (Philipose, lc.); Maharashtra (Kamat, 1968, 1974a; Ashtekar and Kamat, 1980; Pingale, 1988, 1992); U.P. (Chadha and Pandey, 1978); Gujarat (George Isabella and Patel, 1985)

Family - Treubariaceae

Genus Treubaria Bernard, 1908

Treubaria triappendiculata Bernard

pl. 1, fig. 21

M.T. Philipose, p.107, f. 32, 1967; T. Yamagishi, p. 21, p1.1, f.4, 1967.

Cells 8.6-10.1  $\mu$ m in diameter, solitary, free floating, 3-4 angled with broadly rounded angles and slightly concave or convex sides. Each angle with a long stout hyaline spine, with broad base and gradually tapering to form an acute apex. Chloroplast cupshaped with a pyrenoid. . Spines 11.7-13.6  $\mu$ m long. (Coll. Nos. 142, 201) Distribution in India : Orissa (Philipose, lc.); U.P. (Hortobagyi, 1969); Maharashtra (Deore, 1983; Tarar and Bodkhe, 1998).

Family- Hydrodictyaceae

Subfamily - Hydrodictyoideae

Genus Pediastrum Meyen, 1829

Pediastrum boryanum (Turpin) Menegh. var. longicorne Reinch

pl.1fig.22

G. W. Prescott, p. 222, pl. 47, f. 10, 1962; M. T. Philipose, p. 119, f. 40b, 1967.

Colonies circular, 8-16-32 celled, intracellular spaces absent. Cells 11.7-23.5  $\mu$ m long and 11.5  $\mu$ m broad. Sides of the cells straight or slightly emarginate. Peripheral cells with two long processes ending bluntly. Cell wall smooth. (Coll. Nos. 145, 153, 161, 200, 201, 202)

**Distribution in India:** Bihar and Orissa (Philipose, Lc.); Gujarat (Patel and Isabella, 1977a); J, and K.(Kant and Vohra, 1999).

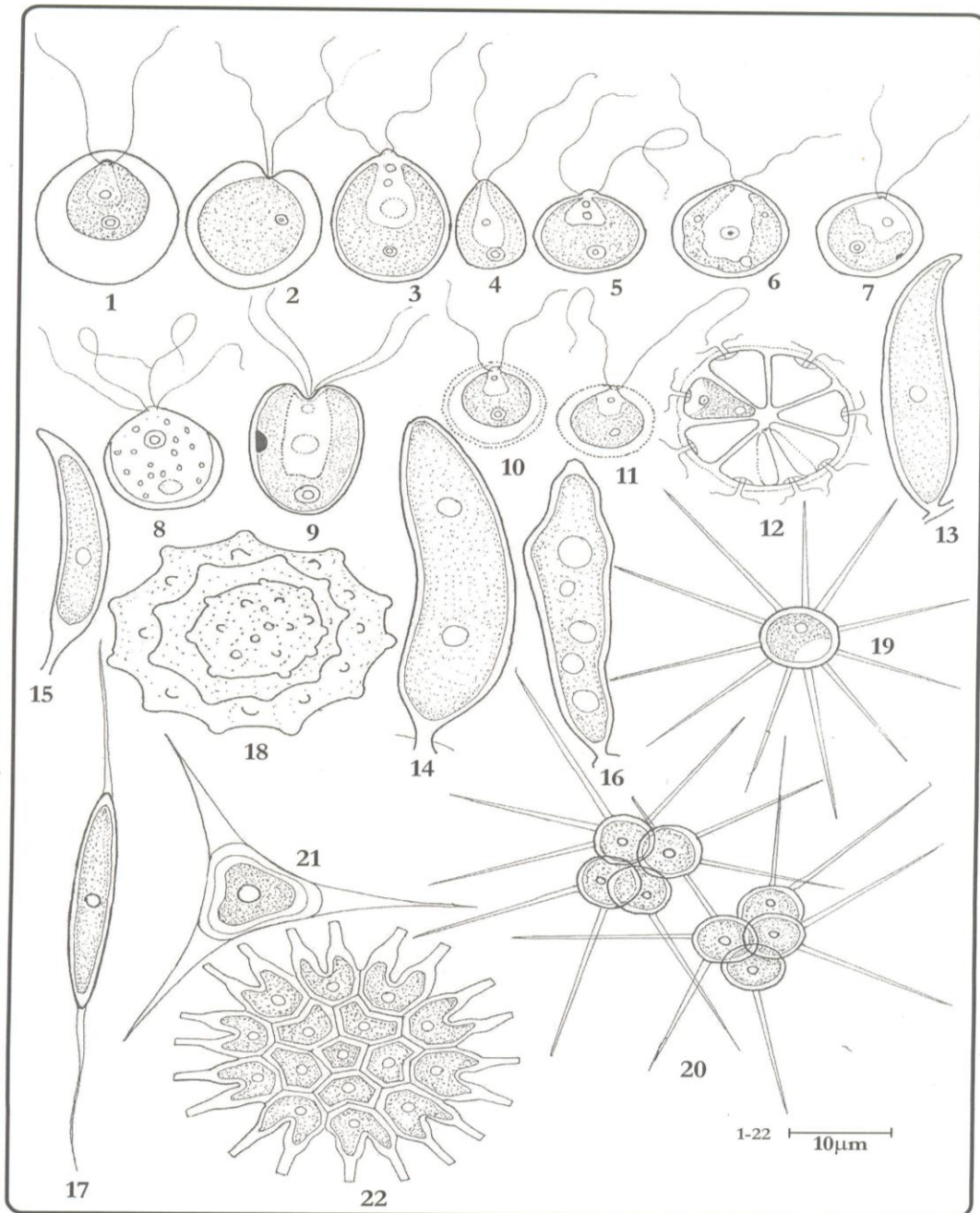


Plate No.1

## REFERENCES

1. A.P.H.A. Standard Methods for the Examination of Water and Wastewater (21st Edition), American Public Health Association, Washington DC, USA, 2005.
2. Barhate, V. P. and J. L. Tarar. The algal flora of Tapti river, Bhusawal, Maharashtra. *Phykos*, 1981; 75-78.
3. Baykal, T., Udoh, A. U. and Kazim, Y. The algal flora and seasonal variation of species abundance in Kilicozu stream (Kireshir) Turkey. *J. Phytol Res.*, 2001; 14(1): 43-54.
4. Berg, A. Some new species and form of the diatom 1837. *Bot. Not.*, 1939; 423-462.

5. Clair, L.L. and S. R. Rushforth. The diatomflora of the Goshen playa and West Meadow. *Nova Hedwigia*, 1978; 39: 191-210.
6. Cleve-Euler A. 1951-1955. Die Ditomeen von Schweden und Finnland-I-V. K. Svenska vetens Akad. Handl. Fjurde ser., 2:1-163; 3: 1-153; 4: 1-158: 1-255: 5: 1-232.
7. Deore, L.T. Studies on the freshwater algae of Maharashtra. *IBC.*, 1983; 1(2&3): 127-130.
8. Dixit S. S., Smol, D. F., Chales, E. F., Hughes, R. M., Pailsen, S. G. and Gary, B.C. Assessing water quality changes in the lakes of the northeastern United State using sediment diatoms. *Candian J. of Fisheries and Aq. Sci.*, 1999; 56(1): 131-152.
9. Fritsch, F. E. Observations on phytoplankton of the river Tames *Ann. Bot.*, 1913; 17: 631-647.
10. Fogg, G.E., N.G. Carr and B.A. Whitton, *The Biology of Cyanobacteria*. Blackwell Science, Oxford, 1982; 491-514.
11. Foged N. Freshwater diatoms in Thailand. *Nova Hedwigia*, 1971; 22: 267-369.
12. Ganapati, S. V. and Chacko. P. J. An investigation of the river Godavari and effluent of paper mill pollution at Rajahmundry. *Proc. Indo- Pacific Fish. Con. Sec.*, 1940; 2: 1-5.
13. Gandhi, H.P. The freshwater diatoms from Radhanagari Kolhapur. *Ceylon J. Sci. Biol. Sect*, 1957a; 1: 45-47.
14. Gandhi, H.P. Freshwater diatomflora at the Panhalgarh Hillfort in the Kolhapure District. *Hydrobiologia*, 1959a; 14(2): 93-129.
15. Gonzalves, E. A. and D. B. Joshi. Fresh water algea near Bombay-I. The seasonal succession of algae in tank of Bandra. *J. Bom. Nat. Hist. Soc.*, 1946; 46: 144-176.
16. Griffiths, B. M. Studies in the phytoplankton of the lowland waters of Great Britain. IV: (1): 73-76. eutrophication. *Biovigyanam*, 1912; 5: 171-172.
17. Hortobagyi, T. New Scenedesmus taxa from the Budapest section of the Danube, *Ibid.*, 1980; 26(3&4): 317-337.
18. Iyengar, M. O. P. and G. Venkataraman. The ecology and Seasonal sccession of the river Cooum at Madras with specialreference to Diatomataceae. *J. Madras Univ*, 1951; 21: 140-192.
19. Kadri, C. A. and Sen, B. Diatoms (Bacillariophyta) in the phytoplankton of Keban Reservoir and their seasonal variations. *Turkish J. of Bot.*, 1998; 22(1): 25-33.
20. Khare, P. K. Phytoplankton as indicator of water quality and pollution status of Lodhe water reservoir from Tasgaon thasil (Maharashtra) *Indian J. Enviro. and Ecoplan.* of

- Turkwel gorge reservoir, and new manmade lake in northern Kenya. *Limnologica*, 1999; 29(4): 377-392.
21. Kumawat, D. A. Biodiversity, occurrence and succession of diatoms in Yawal and Raver tahasils of Jalgaon district, Maharashtra *J. Aqua. Biol.*, 2006; 21(2): 9-12.
  22. Kumawat, D. A. Biodiversity, occurrence and succession of diatoms in Yawal and Raver tahasils of Jalgaon district, Maharashtra *J. Aqua. Biol.*, 2006; 21(2): 9-12.
  23. Kumawat, D. A., Y. P. Malche, H.E. Rane, S.B. Patil, R.B. Borse and S.D. Vanjari. Diatoms from southern Satpura hill ranges of Maharashtra. genus - *Gomphonema agardh*. *J. Indian bot soc*, 2008; 87(1 & 2): 61-66.
  24. Kaul V. and Pandit A.K. Benthic communities as indicators of pollution with reference with wet land ecosystem of Kashmir. In proc. Workshop Biol. Indicators and Indices of Environ. Poll. Eds. A. R. zafar et al. Hyderabad, 1981; 33-52.
  25. Kaul V. Fotedar D. N. Pandit A. K. and Trisal C. L. Drawing comparative study of plankton population of some typical freshwater bodies of Jammu and Kashmir State. *Environ. Physico. Ecol. Plants*, 1978; 249-269.
  26. Merilainen, J.J., Juhani, H., Anssi, T., Arja, P., Kaj, G. and Pasi, R. Importance of diffuse loading and lake level changes to the eutrophication of an originally oligotrophic boreal lake - A paleolimnological diatom and chironomid analysis. *J. of Paleolimnology*, 2000; 24(3): 251-270.
  27. Narkhede, P. N, and Ragothaman, G. Some diatoms from Hatnur dam, Tapti River, Jalgaon district, Maharashtra state. *Indian Hydrobiology*, 2007; 10(2): 245-247.
  28. Narkhede, P. N, and Ragothaman, G. Some diatoms from Hatnur dam, Tapti River, Jalgaon district, Maharashtra state. *Indian Hydrobiology*, 2007; 10(2): 245-247.
  29. Rather, M. S. and Mir, A. M. A list of Diatoms from Paddy field soils of Kashmir. *Geobios new Report*, 1987; 6(1): 99-100.
  30. Sarode, P. T. and Kamat, N. D. Diatoms of Marathwada, Maharashtra-III. *Phykos*, 1983a; 22(1&2): 26-32.
  31. Sarode, P. T. and Kamat, N. D. The diatomflora of Vidarbha, India-I. *Bibliotheca Phycologic*, 1983b; 66: 259-319.
  32. Sarode, P. T. and Kamat, N. D. Freshwater diatoms of Maharashtra. Sai Prakashan, Aurangabad, 1984; 1-338.
  33. Sarode, P. T. and Kamat, N. D. The diatomflora of Nagpur, India. *Nova Hedwigia*, 198b; 32: 797-838.

34. Stoermer, E.F. & Smol, J.P. (eds) The diatoms: applications for the environmental and earth sciences. Cambridge University Press, Cambridge, 1999.
35. Somashekar, R. K. and S. N. Ramaswamy. Observation of chloride content and diatom flora of River Kapila. *Phykos*, 1988; 23: 2.
36. Venkataraman, G. Contribution to our knowledge of fresh water Diatoms of South India. Suptd. Govt. Press, Madras, 1957; 1-12.