

**ALGAL FLORA  
OF  
DEHRADUN DISTRICT  
UTTARANCHAL**

**R. K. GUPTA**

**BOTANICAL SURVEY OF INDIA**

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भारतीय वनस्पति सर्वेक्षण  
BOTANICAL SURVEY OF INDIA

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## FOREWORD

The Botanical Survey of India since its reorganisation in 1954 has been engaged in the floristic survey of unexplored and under-explored parts of the country. The district Dehradun, now a part of Uttaranchal that covers an area of ca. 3,080 sq. km. The present work represents the first such endeavour as a part of B.S.I. activity in bringing out a comprehensive floristic account of 318 species and 3 varieties of algae belonging to 122 genera, 51 families, 24 orders and 7 classes viz., Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Euglenineae, Rhodophyceae and Myxophyceae (*sensu* Fritsch, 1935, 1945).

The challenging task of collection, identification and meticulous presentation deserves high appreciation, with the firm belief that this treatise will be of immense help to the students, researchers, environmentalists, foresters and all others who are interested in the identification, conservation and utilization of the algal wealth of this region in particular and the Indian sub-continent in general.

**B. R. Chaudhary**

## PREFACE

The present work on the Algal flora of Dehradun district, Uttaranchal has been carried out to assess and inventorise the algal diversity in an area encompassing varied ecoclimatic zones. The flora has a rich assemblage of many interesting algae. Unfortunately, the area being a tourist spot, is subjected to severe anthropogenic activities which are causing extreme stress conditions on the algal habitats.

The flora deals with taxonomic treatment of 321 taxa, of which, 150 belonging to Chlorophyceae, 81 to Myxophyceae, 53 to Bacillariophyceae, 18 to Euglenineae, 5 to Xanthophyceae and 2 each to Dinophyceae and Rhodophyceae, each with original citation, description, phenology, habitat, association, field numbers, etc. Taxonomic keys and camera lucida drawings of all taxa have also been provided.

The author is grateful to Dr. M. Sanjappa, Director, Botanical Survey of India, Kolkata for the facilities and to Dr. D. K. Singh, Joint Director, Botanical Survey of India, Northern Circle, Dehradun for encouragement and critically going through the manuscript with valuable suggestions. Thanks are also due to Shri A. T. Durgadas, Artist, Botanical Survey of India, Northern Circle, Dehradun for making some of the illustrations and Shri Sanjay Uniyal, Data Entry Operator, Botanical Survey of India, Northern Circle, Dehradun for computer typesetting scanning of illustrations and formatting of the manuscript.

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**R. K. Gupta**

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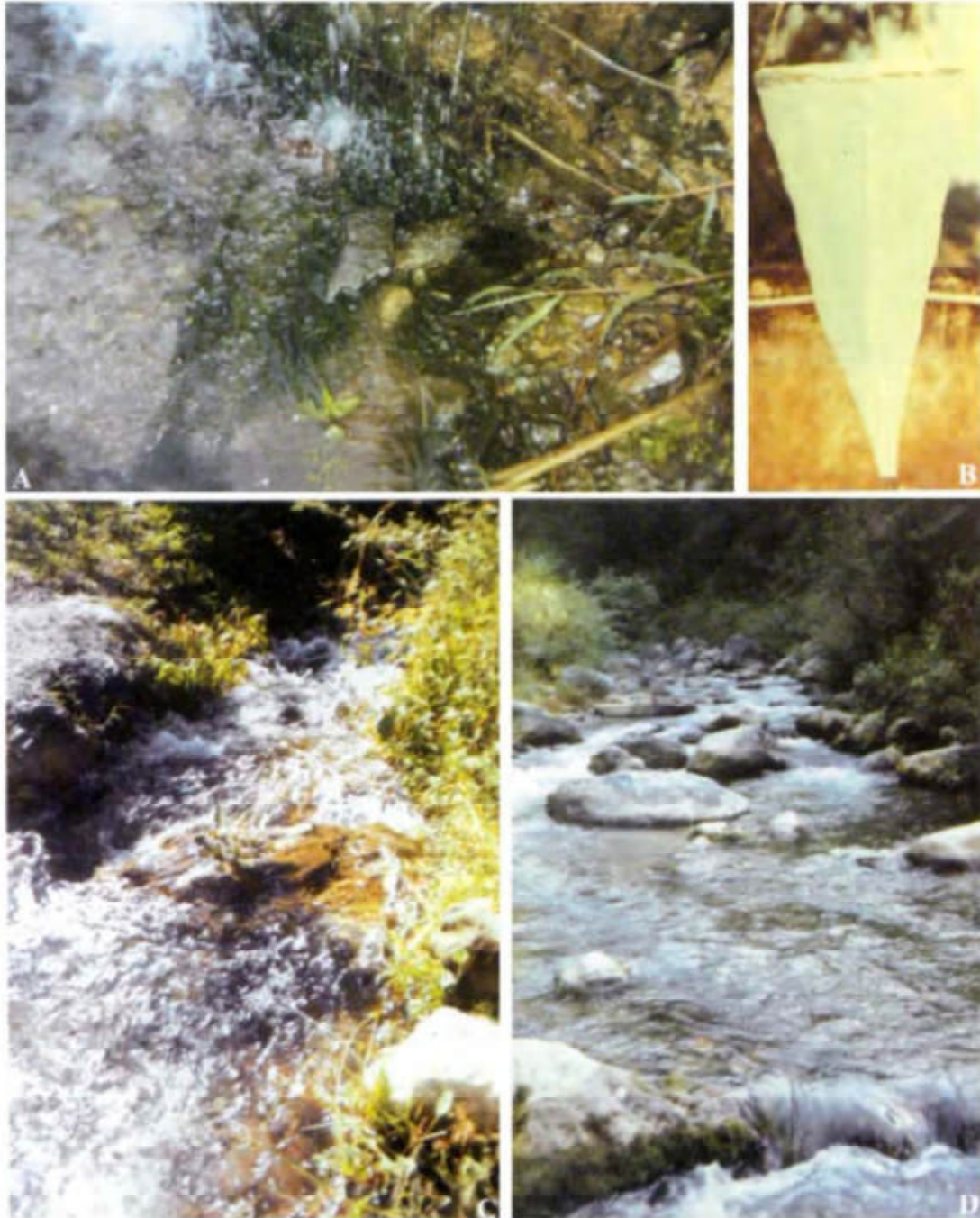


Fig. 1 : A. Clusters of algae. B. Plankton net. C. *Nostoc commune* Vaucher ex Bornet & Flahault attached on moist rock. D. Mountain Streams at sahiya.

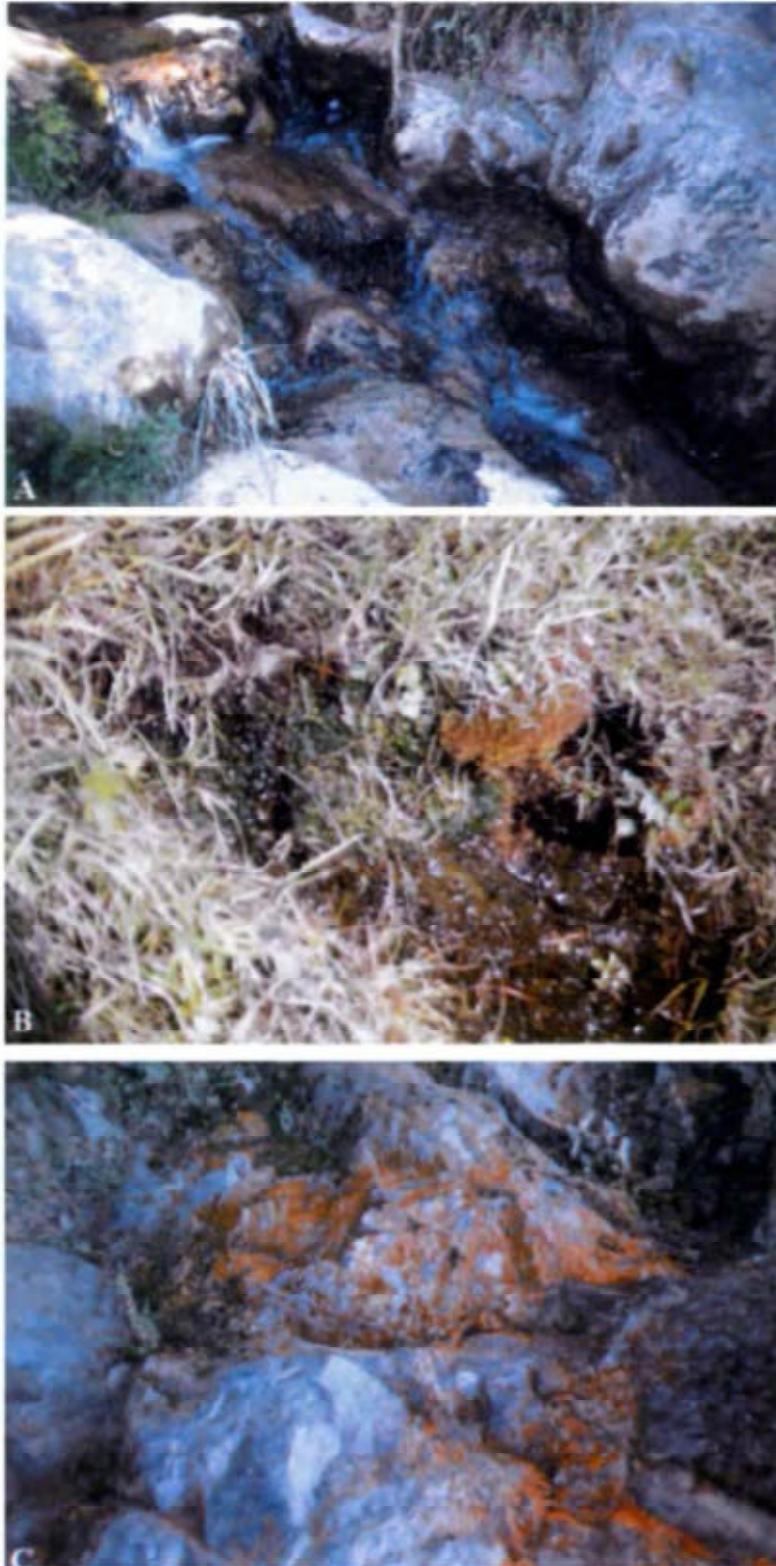


Fig. 2 : A. *Oscillatoria princeps* Vaucher ex Gomont attached on moist rock  
B. Algal mixture on moist soil. C. *Trentepohlia aurea* (L.) Martius on rock.



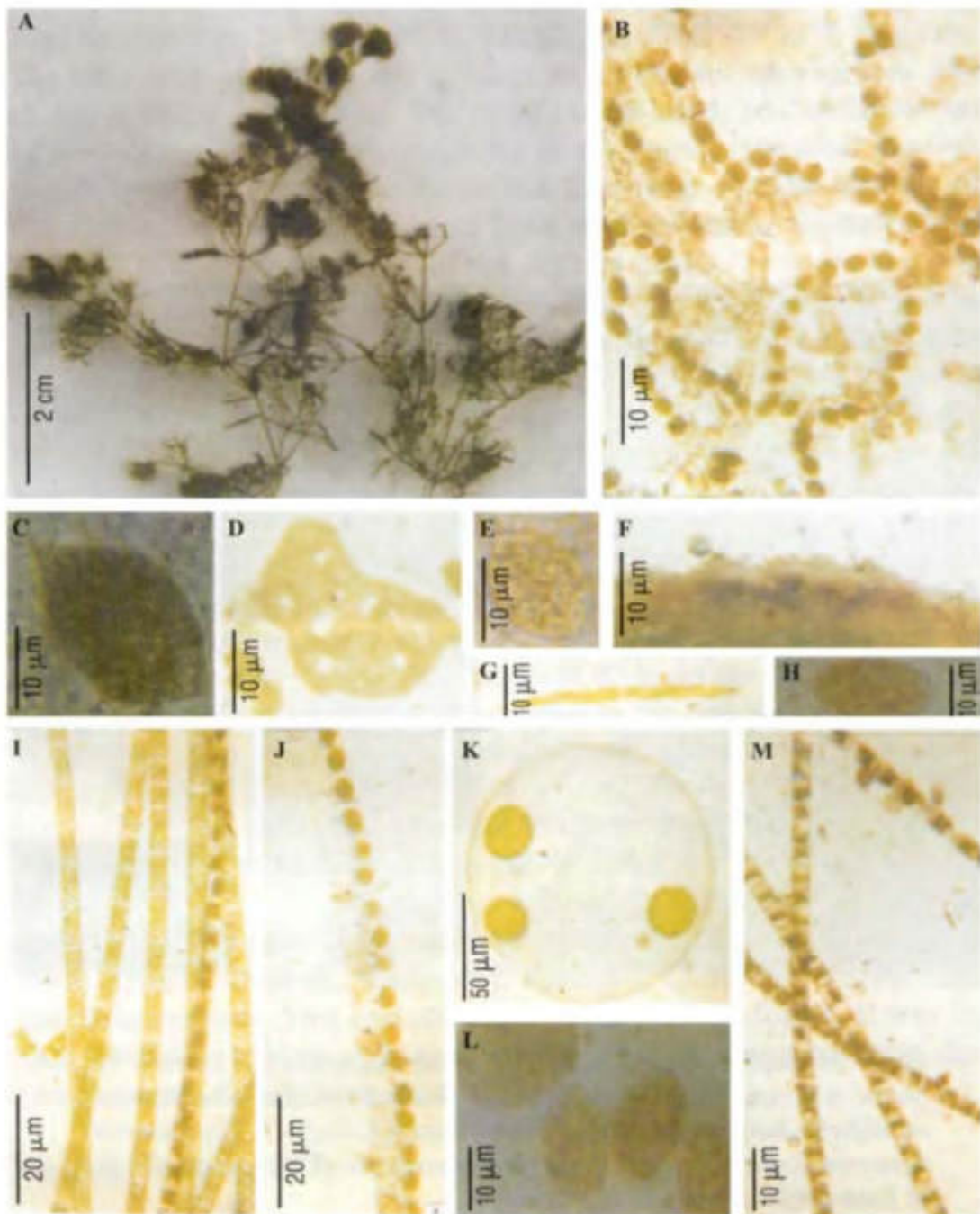
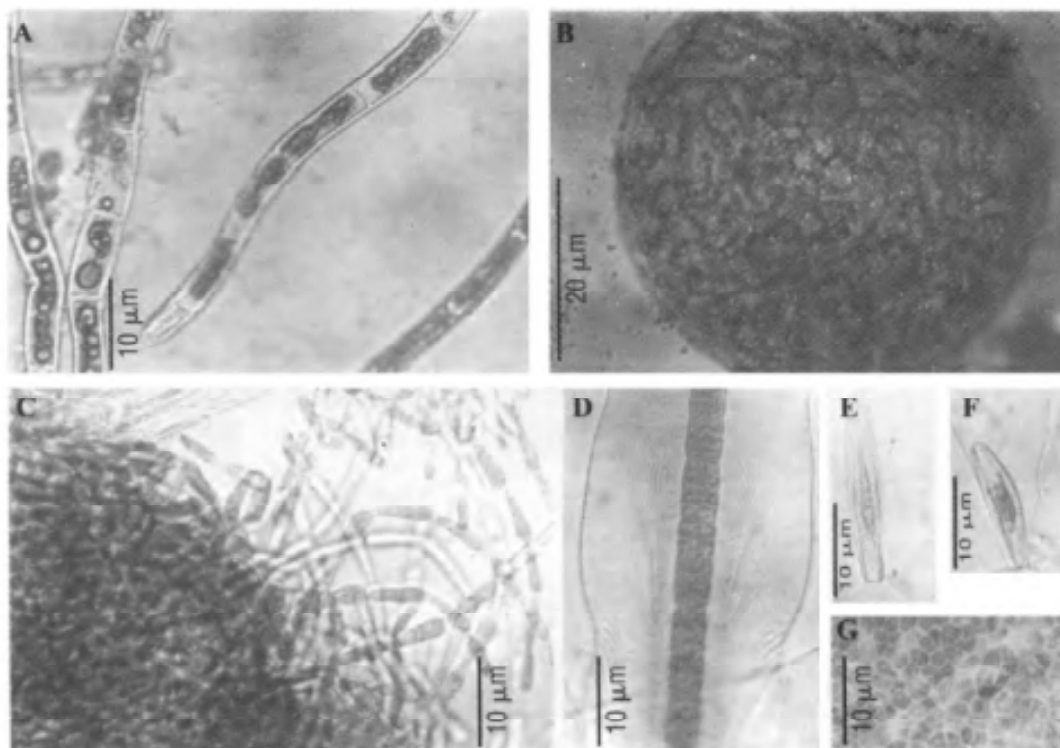


Fig. 3 : A. *Nitella hyaline* (DC.) Agardh ; B-M : B. *Spirogyra gracilis* (Hassall) Kutz. scalariform conjugation C. *Euglena polymorpha* Dangeard D. *Microcystis aeruginosa* Kutz. E. *Trachelomonas intermedia* Dangeard F. T.S. of *Cephaleuros virescens* Kunze G. *Closterium moniliferum* (Bory.) Ehr. H. *Trachelomonas volvocina* Ehr. I-J *Spirogyra rivulris* (Hassall) Rabenh. with scalariform conjugation K. *Volvox aureus* Ehr. L. *Euglena elastica* Prescott M. *Ulothrix zonata* (Weber & Mohr) Kutz.



**Fig. 4 : Microphotographs A-G : A *Treantepohlia aurea* (L.) Martius B. *Nostoc commune* Voucher ex Bornet & Flahault C. *Batrachospermum moniliforma* Roth D. *Petalonema striato-theca* R.K.Gupta E. *Gomphonema olivaceum* (Lyng.) Kutz. F. *Gomphonema parvulum* (Kutz.) Grun. G.T.S. of *Entermorpha intestinalis* (L.) Grev.**

## INTRODUCTION

Dehradun district (including Chakrata, Mussoorie and Shiwalik hills) lies between 29°57' 30°57'N latitude and 77°40'-78°20' E longitude. The total area of the district, is *ca* 3080 sq km out of which *ca* 479 sq. km is under forest cover. The district is bounded by Tehri Garhwal in the North, Shiwalik submountains in the South, Himachal Pradesh in the West and Pauri Garhwal in the East (Fig. 1). The altitude of the district varies from 250 m to 2850 m. Khadamba, situated about 20 km North from Chakrata is the highest peak.

Dehradun is one of the most beautiful open valleys enclosed by the Shiwalik hills and the outer scarp of the Himalaya. It is considered to have been the abode of Acharya Drona, who sought solitude in the area for meditation. Dronacharya was seeking a solitary place for the execution of his devotion and so he came to the valley of the Doon.

The name 'Dehra' refers to the town which sprang up around a temple presumably built by the religious Guru Ram Rai in 1699 A.D. and Doon (Dun) means a valley. The Doon valley is surrounded by the Himalaya on the North, the Shiwalik hills on the South, the river Ganges on the East and the river Yamuna on the West. Its flora is significant from the scientific, cultural and utilitarian viewpoints.

There has been no comprehensive taxonomic study on the algal flora of the district except Khan (1970) and Khan and Rawat (1972), containing a check list of only 46 species of green and blue-green algae, mainly collected from Doon valley *viz.*, Dakpathar, Prem nagar, Clement town, Ajabpur, Doiwala, Ranipokhri, Karanpur, Lachiwala, Kishan nagar and Sahasradhara. This include mainly free floating forms. It was the first attempt to explore and taxonomically evaluate, enumerate the algal components of Dehradun district.

### Geology and Soil :

Dehradun belongs to Tectonic group and consists of lower and upper Tertiary rocks and sedimentary river deposits. The Shiwalik system, under which part of Dehradun falls, comprises sandstones, grits, conglomerates, pseudoconglomerates, clays, and silts. The river beds consist of water-borne debris of the granite core of the Himalaya, with scattered conglomerate boulders, calcareous tuffs, small rounded stones, loose river gravel, and sand. The soil is alluvial and of high fertility.

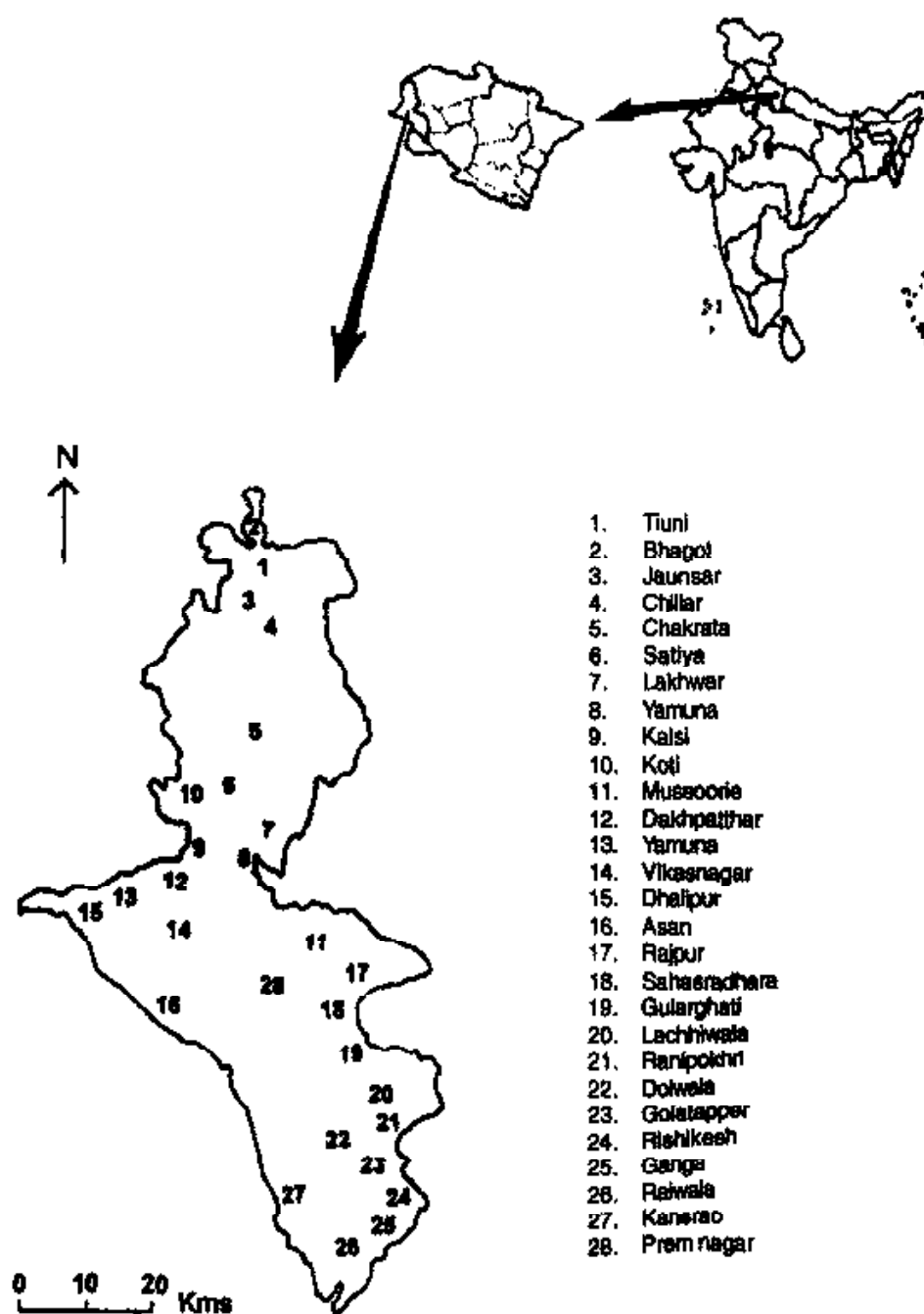


Fig. 1 : Map of Dehradun district showing the collection sites.

**Climate :**

Vegetation depends on climatic, edaphic and biotic factors. Thus high annual rainfall, high relative humidity, high temperature, and small variations in these factors characterize the rather monotonous environment of the rich and luxuriant flora.

While the hilly regions of the district experience pleasantly cool summers and severe winters, the valley shows moderate summer months and very cold winter.

**Temperature :**

May and June are the hottest months (40-41°C), and December and January are the coldest when the temperature reaches the freezing point. Generally the temperature increases from February onward, and decreases from July onward.

**Rainfall :**

The South-East monsoon strikes the valley in the mid-June, and bursts unabated from July onward until the middle or even the end of September. The subsequent period October-December constitutes retreating monsoon. The North-East monsoon sweeps the valley through January and February bringing in occasional showers often accompanied by hail. The period from March to mid June constitutes the hot season characterized by the absence of rain or by scanty rainfall. The average annual rainfall is approximately 2000-2125 mm.

**Snowfall :**

Snowfall is seen during winter in Mussoorie and Chakrata hills, above 1500 m. elevations.

**Relative Humidity :**

The relative humidity is generally the highest during the monsoon months and the lowest during the hot weather. The maximum is in July August and the minimum in April May.

**Wind :**

During the first half of the monsoon, the wind usually blows South-West to North-West and is often accompanied by torrential rains

resulting in the uprooting of tall trees. In the second half of the monsoon, winds are nearly normal with occasional hailstorms. The summer season, especially May and June, experiences thunder storms accompanied with hails and squalls of considerable velocity.

Due to its varied topography, high annual rainfall, high relative humidity, high temperature, with little variations, exhibiting a rich algal flora.

### GENERAL VEGETATION

The flora of Dehradun district is broadly classified into three forms viz. Tropical, Subtropical and Temperate. A major part of the district is covered by forests. The *Shorea robusta* (Sal) is the principal species, up to an elevation of 1000 m, between 1000-1500 m mixed forests of *Bauhinia variegata* (Kachnar), *Ficus bengalensis* (Bargad), *Toona ciliata* (Tun), *Firmiana fulgens* (Gudala/Khardala), *Aegle marmelos* (Bel), *Garuga pinnata* (Kharpat), *Rhamnus triquetra* (Gaunt), *Pistacia khinjuk* (Kakar/Kakroi), *Erythrina suberosa* (Dauldhak), *Acacia catechu* (Khair), *Albizia lebbek* (Siris), *Woodfordia fruticosa* (Dawi), *Mitragyna parvifolia* (Kaim), and *Euphorbia royleana* (Thor) are the common trees and shrubs; above 1500 m to 2500 m the mixed forests gradually gets replaced by *Pinus roxburghii* (Chir Pine), *Quercus leucotrichophora* (Banjoak) and *Rhododendron arboreum* (Burans); between 2500-2850 m *Quercus semecarpifolia* (Kharsu Oak), *Quercus dilatata* (Moru Oak), *Betula alnoides* (Kath Bhuj), *Cedrus deodara* (Deodar/Cedar), *Pinus wallichiana* (Kail), *Picea smithiana* (Roi) and *Angelica glauca* (Choru) are common.

Algae are ubiquitous highly diversified group of plants, placed at the lowest rung of the ladder of evolution of life. Algal flora of the district is very rich due to its climatic and diverse habitat. The district with chains of mountains on its three sides has got numerous drainages, watersheds, which provides wide range of ecological diversity and congenial environment for the growth of algae. The humus covered hill slopes are quite favourable for cyanobacteria and desmids.

For the purpose of algal studies, the Dehradun district broadly divided into three phycogeographical zones (Figs. 2, 3), viz. Doon Valley (250 m - 990 m); Shiwalik range (990 m - 1320 m) and Himalayan range (1320 m - 2850 m).



Fig. 2 : Phycogeographical algal zones in Dehradun district

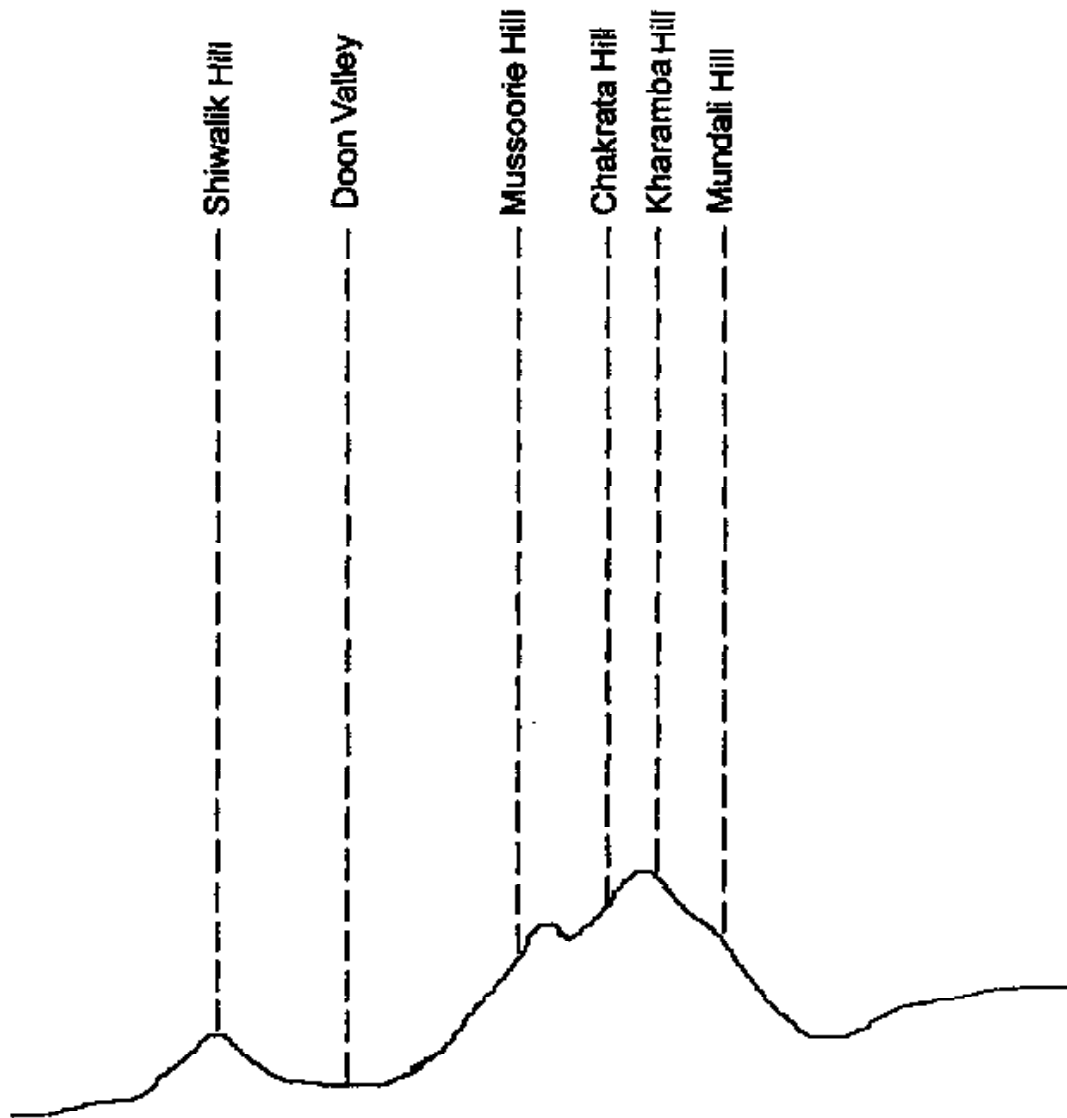


Fig. 3 : North-South LS of Dehradun district.



**1. Doon valley :** It lies between 30°00' - 30°30' N latitude and 77°30' - 78°15' E longitude, covers an area of *ca* 1280 sq km. Mainly the members of Chlorophyceae (Volvocales, Chlorococcales, Ulotrichales, Cladophorales, Chaetophorales, Oedogoniales, Conjugales, Siphonales and Charales); Myxophyceae (Chroococcales, Chamaesiphonales, Pleurocapsales, Nostocales and Stigonematales); Bacillariophyceae (Pennales); Rhodophyceae (Bangiales, Nemalionales); Euglenineae (Euglenales); Dinophyceae (Dinoflagellata) and Xanthophyceae (Heterotrichales, Heterosiphonales, Heterochloridales, Héterococcales) were recorded.

**2. Shiwalik range :** It lies between 29°45' - 30°30' N latitude and 77°30' - 78°30' E longitude, covers an area of *ca* 300 sq km. Mainly represents the members of Chlorophyceae (Chlorococcales, Oedogoniales and Conjugales) and Bacillariophyceae (Pennales, Centrales).

**3. Himalayan range :** It lies between 30°15' - 31°0' N latitude and 77°45' - 78°15' E longitude, covers an area of *ca* 1500 sq km. The area comprises member of Chlorophyceae (Conjugales specially desmids and Siphonales); Bacillariophyceae (Pennales); Xanthophyceae (Heterotrichales) and Myxophyceae (Chroococcales, Nostocales, Stigonematales).

In Dehradun district five distinct ecological habitats of algae are mainly observed *viz.* terrestrial, epiphyte, aquatic, parasite and aerial.

**1. Terrestrial :** Growing on moist humus condition of soil. The common genera are *Vaucheria*, *Botrydium*, *Protosiphon*, *Oedocladium*, and *Botrydiopsis*.

**2. Epiphyte :** Growing on the attached form belonging to genera *Coleochaete*, *Bulbochaete*, *Uronema* and *Gloeotrichia*.

**3. Aquatic :** Majority of the algae growing in the aquatic environment are *Spirogyra*, *Mougeotia*, *Volvox*, *Hydrodictyon*, *Pediastrum*, *Ulothrix*, *Microspora*, *Cladophora*, *Pithophora*, *Oedogonium*, *Zygnema*, *Peridinium*, *Tribonema*, *Batrachospermum*, *Compsopogon*, *Spirulina*, *Oscillatoria*, *Merismopedia*, *Phormidium*, *Gloeocapsa*, *Lyngbya*, *Cylindrospermum*, *Anabaena*, *Rivularia*, *Fragilaria*, *Eunotia*, *Cymbella*, *Synedra*, *Euglena*, *Trachelomonas* and *Phacus*.

**4. Parasite :** *Cephaleuros* is the only genus growing as parasite on the leaves and twigs of *Thea*, *Magnolia*, etc.

**5. Aerial :** Growing above the ground *viz.* *Trentepohlia*.

The Doon valley are most fragile area for algal growth due to its microclimate and different vegetation type *viz.* Hydrophytic, Rheophytic, Deciduous or monsoon forest. It has both tropical and temperate algal elements and phytogeographically, it occupies a unique position.

In the taxonomic survey a total of 122 genera, 318 species and 3 varieties have been identified, spread over 7 classes of algae which is presented below (Table-1).

**Table 1 :** Class-wise representatives of algae from Dehradun

Sl. No.	Class	Order	Family	Genera	Species	Varieties
1.	Chlorophyceae	9	24	55	160	3
2.	Myxophyceae	5	11	35	81	---
3.	Bacillariophyceae	2	7	19	53	---
4.	Euglenineae	1	2	5	18	---
5.	Xanthophyceae	4	4	5	5	---
6.	Dinophyceae	1	1	1	2	---
7.	Rhodophyceae	2	2	2	2	---
<b>Total</b>		<b>24</b>	<b>51</b>	<b>122</b>	<b>318</b>	<b>3</b>

The classes, orders, families and genera of algae have been arranged according to Fritsch system of classification (1935, 1945) whereas species under each genus are arranged alphabetically. Taxonomic keys for classes, order, families, genera and species have been provided.

## **COLLECTION, PRESERVATION AND METHODS OF STUDYING THE FRESHWATER ALGAE**

The freshwater algae show an ability to tolerate a wide range of environmental conditions. Under natural conditions, they usually grow in mixed communities which may include many species and genera. Field study provides information about the site, environment, season and size and shape of the living algal thallus in its natural surroundings. Many algae can be tentatively identified by their appearance, shape and colour of thallus in a particular habitat.

### **Collection of Materials :**

A good number of containers are first required for the collection of algal specimens. Approximately 30 ml tarsan specimen tubes were used for the collection of algae. The tubes made up of plastic are satisfactory for algal collection.

Quarterly collections were made over four year from the various localities of Dehradun district. Methods for collection of algal samples differ with the habit and habitat of an alga. Filamentous algae were collected from mass growths by hand. Subaerial algae growing attached to tree barks, on damp walls, or other such substrata were collected by scraping with a scalpel and then picked up with the help of a forceps. Soil algae have been collected with the help of a sharp scalpel or knife. While collecting such samples, the soil should be avoided as far as possible and should not be allowed to dry. Phytoplankton have been collected by towing a plankton net of fine bolting silk. Certain smaller forms (nannoplanktons), however are not retained in the net. These are collected by subjecting a sample of water to gentle filtration through a millipore membrane filter of 0.45  $\mu\text{m}$  to 0.80  $\mu\text{m}$  pore size. Microscopic forms of algae were also collected by squeezing of aquatic angiosperms, especially those which feel slippery or slimy.

Algal samples were collected from various freshwater biotopes viz. ditches, puddles, pools, ponds, reservoirs, waterfalls, streams, rivers, paddy fields, moist soil, swamps and marshes of Dehradun district. The specimen tubes are filled with algae to not more than quarter of their capacity. To avoid deterioration corks have been removed immediately after return from the collection site, so that they may be well aerated. Apart from collecting algae, submerged twigs, stones and dead culm of aquatics were also collected because some algae may also remain associated with these materials. Detailed field note is necessary if several

collections are made from the same body of water to ensure the return on the right spot from where the previous collections were made. The specimen tubes were numbered and requisite notes were maintained in a field book for future reference.

Streams and rivers are poor source of algae in comparison to stagnant water, but in the present study streams and rivers were not ignored.

About 855 algal samples have been collected having the field nos. 93101 to 93200, 94801 to 94898, 96201 to 96300, 97901 to 97932, 97933 to 97946, 97947 to 98000 and 98601 to 98649 during 1997, 1998, 1999, 2000 and 2001 from the various localities of Dehradun district (Fig. 1).

#### **Preservation :**

The methods used for the preservation of algae for future examination depend upon the purposes for which the algae are desired and upon the algae to be preserved. Material for taxonomic studies will be preserved in liquid state.

The simplest procedure is to add 4% solution of commercial formalin (4 ml of 40% commercial formalin in 96 ml of distilled water; 40% commercial formalin is regarded as 100% for purpose of calculation), then 2-3 drops of 5% glycerine is added just to minimise the evaporation.

Collections preserved in liquids may become dry over a period of time. Such dried-out collections cannot be restored by adding more liquid. The glycerine prevents complete drying out of the collections and enables one to add more liquid periodically and thus save the material for longer time.

Formalin-acetic acid-ethyl alcohol (FAA) have also been used for preservation. It is suitable if material is later to be prepared for staining. In this samples are preserved in a mixture of 50 ml of 95% ethyl alcohol, 5 ml of glacial acetic acid, 10 ml of 40% commercial formalin, and 35 ml of water.

#### **Methods of Study :**

The present taxonomic study has been undertaken on a calibrated compound microscope with 10 $\times$ , 40 $\times$  and 100 $\times$  immersion objectives

and 10× eye piece. It is also necessary to examine algal association in each slide. The standard size of slide (25 × 75 × 1 mm) and cover glass (15 × 15 × 0.17 mm) have been used throughout the work.

Algal study requires an accurate and detailed camera lucida drawing. The drawings have been made with mirror type camera lucida using pencil. Accurate measurements are essential for determination of species and variety, which have been taken with the help of a calibrated ocular micrometer and stage micrometer.

The preparation of diatoms for taxonomic study involves a cleaning of cell. The diatoms are not usually found in very pure state in nature as they contain organic matter and sand, etc. The diatoms have to be cleaned before observing them under microscope for the taxonomic study. It is, therefore, necessary not only to clear the frustules but also to get rid of the other unwanted matter accompanying the diatoms. The material is treated with hydrochloric acid to remove calcareous material. It is then dried, washed and treated with concentrated sulphuric acid and few crystal of potassium dichromate and kept for one hour. Finally the material is washed with distilled water to make it suitable for study.

Algae have been studied in living as well as preserved state. The colour, shape and size of vegetative cells, nature and number of chloroplast, number and length of flagella, nature of cell wall, pellicle, number of nucleus and pyrenoid, position of canal and reservoir, food reserve, ornamentation and reproduction are the taxonomic parameters, which are employed in the identification of algae. The identification of different taxa has been done with the help of pertinent literature.

#### KEY TO THE CLASSES

- |  |                      |
|--|----------------------|
| 1a. Cells procaryotic                    | 7. Myxophyceae       |
| b. Cells eucaryotic                      | 2                    |
| 2a. Flagella absent                      | 3                    |
| b. Flagella present                      | 4                    |
| 3a. Cell wall impregnated with silica    | 3. Bacillariophyceae |
| b. Cell wall not impregnated with silica | 6. Rhodophyceae      |
| 4a. Reserve food starch                  | 1. Chlorophyceae     |
| b. Reserve food otherwise                | 5                    |
| 5a. Thecal plate present                 | 4. Dinophyceae       |
| b. Thecal plate absent                   | 6                    |
| 6a. Flagella heterokontae                | 2. Xanthophyceae     |
| b. Flagella isokontae                    | 5. Euglenineae       |

## 1. CLASS : CHLOROPHYCEAE

Thallus motile or nonmotile, unicellular, colonial, palmellate, coccoid, heterotrichous, siphonous, unbranched or branched filamentous; free-floating or attached; cells contain chloroplast of various shape which dispersed differently in each group of organisms; chlorophyll (grass-green) predominant with a and b; reserve food starch; starch test with iodine positive; pyrenoid one or many, in a few genera it is absent; nucleus one or many; vacuole present; eyespot present or absent; cell wall composed of cellulose and pectose; flagella 2, 4 or 8 of equal length and attached in the anterior end; asexual reproduction by zoospore, akinete, aplanospore, hyphospore, and autospore, sexuality isogamous, anisogamous and oogamous.

Chlorophyceae (green algae) constitutes one of the major group of algae occurring in various freshwater, marine and terrestrial habitats.

## KEY TO THE ORDERS

1a. Nodes and internodes present	9. Charales
b. Nodes and internodes absent	2
2a. Thallus unicellular or colonial	3
b. Thallus branched or unbranched	4
3a. Thallus motile in vegetative condition	1. Volvocales
b. Thallus non motile in vegetative condition	2. Chlorococcales
4a. Sexual reproduction by conjugation	7. Conjugales
b. Sexual reproduction not by conjugation	5
5a. Thallus heterotrichous	5. Chaetophorales
b. Thallus not heterotrichous	6
6a. Cells coenocytic	8. Siphonales
b. Cells not coenocytic	7
7a. Cap cell present	6. Oedogoniales
b. Cap cell absent	8
8a. Chloroplast elaborate; multinucleate	4. Cladophorales
b. Chloroplast parietal or girdle shaped; uninucleate	3. Ulotrichales

## 1. Order : Volvocales

Thallus unicellular or colonial, motile throughout vegetative existence; colonial envelope gelatinous; uninucleate; flagella two or four, equally long and anteriorly placed; chloroplast parietal cup shaped; pyrenoids one or more; eyespot single; asexual reproduction by cell division, zoospores, sexuality isogamous, anisogamous or oogamous.

## KEY TO THE FAMILIES

- |  |                       |
|--|-----------------------|
| 1a. Cells bearing pseudocilia  | 3. TETRASPORACEAE     |
| b. Cells bearing flagella  | 2                     |
| 2a. Cells interconnected, united to form<br>globular colonies            | 2. SPHAERELLACEAE     |
| b. Cells with or without interconnected,<br>never form globular colonies | 1. CHLAMYDOMONADACEAE |

## 1. CHLAMYDOMONADACEAE

## KEY TO THE GENERA

- |   |                  |
|---|------------------|
| 1a. Thallus unicellular                   | 2                |
| b. Thallus colonial                       | 3                |
| 2a. Thallus biflagellate                  | 2. CHLAMYDOMONAS |
| b. Thallus quadriflagellate               | 1. CARTERIA      |
| 3a. Colony quadrangular flat plate        | 4. GONIUM        |
| b. Colony spherical or subspherical       | 4                |
| 4a. Cells spherical, arranged loosely     | 3. EUDORINA      |
| b. Cells subspherical, arranged compactly | 5. PANDORINA     |

## 1. CARTERIA Diesing emend. Dill

Cells unicellular, spherical; flagella four, equal, arising from anterior end; chloroplast cup-shaped; pyrenoid present or absent; contractile vacuoles many, scattered; eyespot present; reproduction by longitudinal cell division, sexuality isogamous, anisogamous or oogamous.

**1. *Carteria klebsii* (Dang.) France emend. Troitskaja** in Die Süßwasser-Flora 4: 151. 1927; Iyengar & Desikachary, *Volvocales* 315. fig. 180: 1. 1981.

## Pl. 1, Fig. 1

Cells ellipsoid or ellipsoid-cylindric, narrow at anterior end, 12.83-15.38  $\mu\text{m}$  long, 6.17-9.53  $\mu\text{m}$  broad; papilla rounded; cell wall thin; flagella 4; chloroplast cup-shaped, reaching up to anterior end; pyrenoid 1; eyespot present; contractile vacuole 2.

*Phenology* : August.

Attached on moist sand at Raiwala, associated with certain filamentous green algae (96243).

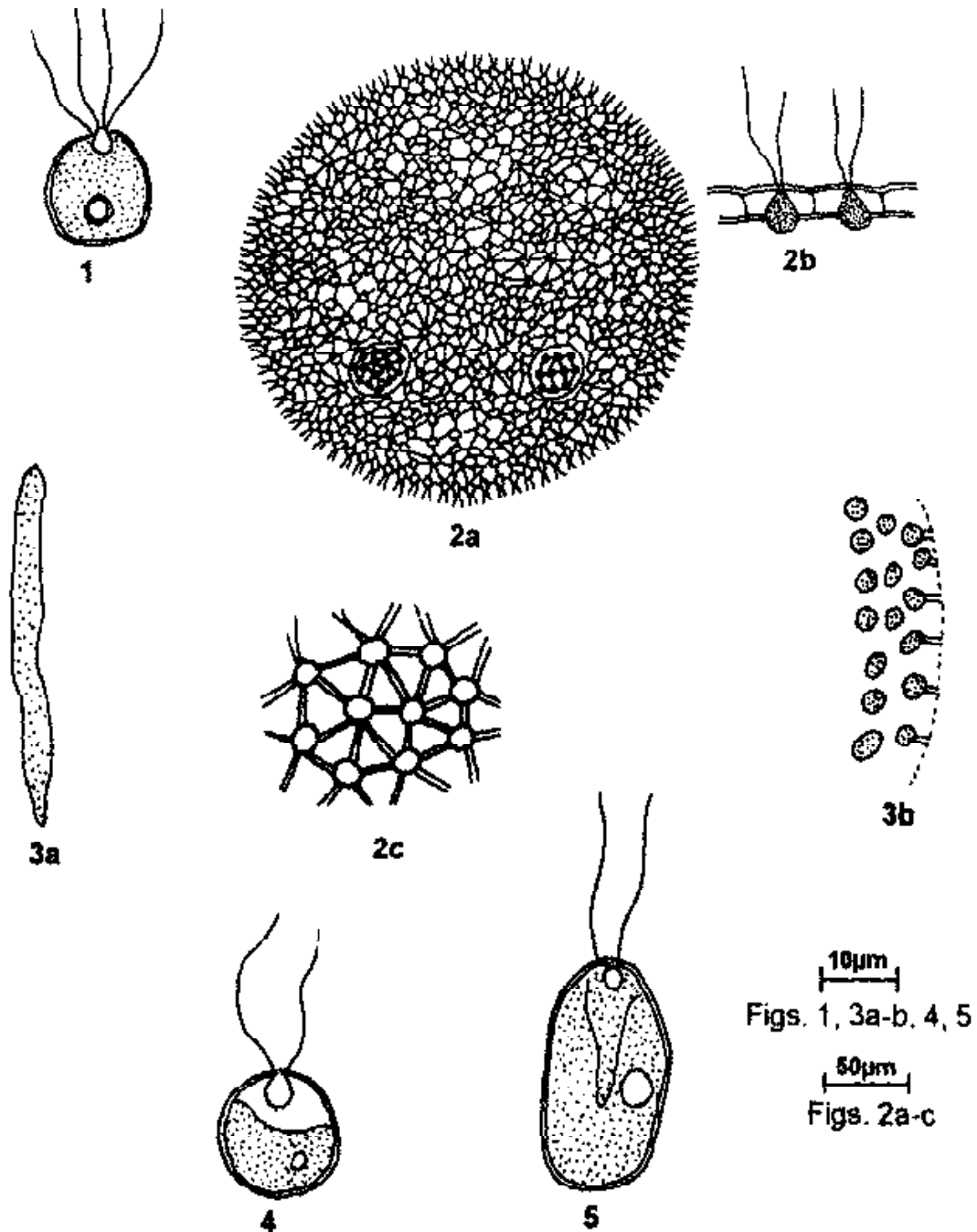


Plate-1 : Figs. 1-5 : 1. *Carteria klebsii*; 2a. *Volvox aureus*; 2b. Marginal portion showing arrangement of cells; 2c. Internal structure of thallus; 3a. *Tetraspora cylindrica*; 3b. Internal structure showing pseudocilia; 4. *Chlamydomonas globosa*; 5. *Chlamydomonas gloeogama*.



## 2. CHLAMYDOMONAS Ehr.

Cells globose, ovoid, fusiform or ellipsoid; papilla present or absent; flagella two equal, arising from anterior end; uninucleate; vacuoles present; eyespot present or absent; chloroplast cup-shaped; pyrenoid one; reproduction by longitudinal or transverse cell division, sexuality isogamous, anisogamous or oogamous.

## KEY TO THE SPECIES

- |                                      |                        |
|--------------------------------------|------------------------|
| 1a. Cells spherical; pyrenoids axial | 1. <i>C. globosa</i>   |
| b. Cells elliptic; pyrenoids lateral | 2. <i>C. gloeogama</i> |

**1. *Chlamydomonas globosa*** Snow in U.S. Fish. Comm. Bull. 1902: 389. pl. 1. fig. 3. 1903; Iyengar & Desikachary, *Volvocales* 263. figs. 147: 1-3. 1981; Prasad & Misra, *Freshwater algal Fl. Andaman and Nicobar Islands* 2. pl. 1. fig. 5. 1992; Anand, *Ind. freshwater microalgae* 23. fig. 58. 1998.

**Pl. 1, Fig. 4**

Cells solitary, globose, 12.38-13.45  $\mu\text{m}$  broad; papilla absent; gelatinous sheath not prominent; flagella 2, slightly longer than cell; chloroplasts parietal, cup-shaped; nucleus 1 centrally arranged; contractile vacuoles 1, below the flagella; pyrenoid 1 axial.

*Phenology* : May December.

Free swimming in a cemented tank at Manabkendra under exposed condition (93195); free swimming in a small puddle at Chakrata near temple, associated with diatoms (94868).

**2. *Chlamydomonas gloeogama*** Kors. in *Die Süßwasser-Flora* 4: 267. fig. 225. 1927; Iyengar & Desikachary, *Volvocales* 291. fig. 169: 17. 1981.

**Pl. 1, Fig. 5**

Cells elliptical to cylindrical, 10.17-14.83  $\mu\text{m}$  long, 4.37-6.28  $\mu\text{m}$  broad; cell wall gelatinous; papilla present; flagella 2, shorter than cell; chloroplasts cup-shaped reaching upto anterior end; pyrenoid 1 lateral; vacuoles 2.

*Phenology* : November.

Planktonic in a ditch at Mohand under exposed condition (94843).

## 3. EUDORINA Ehr.

Colony spherical, ellipsoidal or cylindrical, with 16-32-64 cells arranged in tiers from one another and near the periphery of the hyaline, gelatinous envelope; cells same or different sizes, biflagellate, spherical; envelope symmetric or with posterior projections; contractile vacuoles 1-2; eyespot one; chloroplast cup-shaped with radial striations; pyrenoids one or more; reproduction by autocolony or zoospores, sexuality anisogamous.

## KEY TO THE SPECIES

- |                                       |                            |
|---------------------------------------|----------------------------|
| 1a. Colonial cells similar in size    | 2                          |
| b. Colonial cells not similar in size | 3                          |
| 2a. Chloroplast without striations    | 2. <i>E. elegans</i>       |
| b. Chloroplast with striations        | 1. <i>E. charkowiensis</i> |
| 3a. First tier of 4 cells smaller     | 3. <i>E. illinoisensi</i>  |
| b. First 2 tiers of 12 cells smaller  | 4. <i>E. indica</i>        |

1. *Eudorina charkowiensis* (Kors.) Pascher in Die Süßwasser-Flora 4: 441. fig. 402. 1927; Iyengar & Desikachary, Volvocales, 433. figs. 256, 257: 1-4. 1981. *Pandorina charkowiensis* Kors. 1923.

## Pl. 2, Fig. 1

Colony ellipsoidal with mucilage layer, 38.36-40.47  $\mu\text{m}$  long, 25.45-30.52  $\mu\text{m}$  broad; cells 32 of same size, ovate, 13.23-15.16  $\mu\text{m}$  long, 7.14-10.52  $\mu\text{m}$  broad, anterior and posterior end flat or slightly rounded, arranged in tiers; chloroplast cup-shaped with longitudinal striations; pyrenoids 4-5.

*Phenology* : December.

Free swimming in a ditch at Chakrata near temple, associated with other members of Volvocales (94868).

2. *Eudorina elegans* Ehr. in Monatsber, Akad. wiss. Berlin 1831: 78. pl. 2. fig. 10. 1833; Iyengar & Desikachary, Volvocales, 429, figs. 252, 254. 1981; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 5. pl. 1. fig. 1. 1992; Anand, Ind. freshwater microalgae, 25. fig. 67, 1998.

## Pl. 2. Figs. 2a-b

Colonies spherical, 40.39-42.82  $\mu\text{m}$  broad; cells 32 of same size, spherical evenly disposed near the periphery of hyaline gelatinous envelope, 13.16-15.23  $\mu\text{m}$  broad; biflagellate; chloroplast 1 parietal; pyrenoid 1.

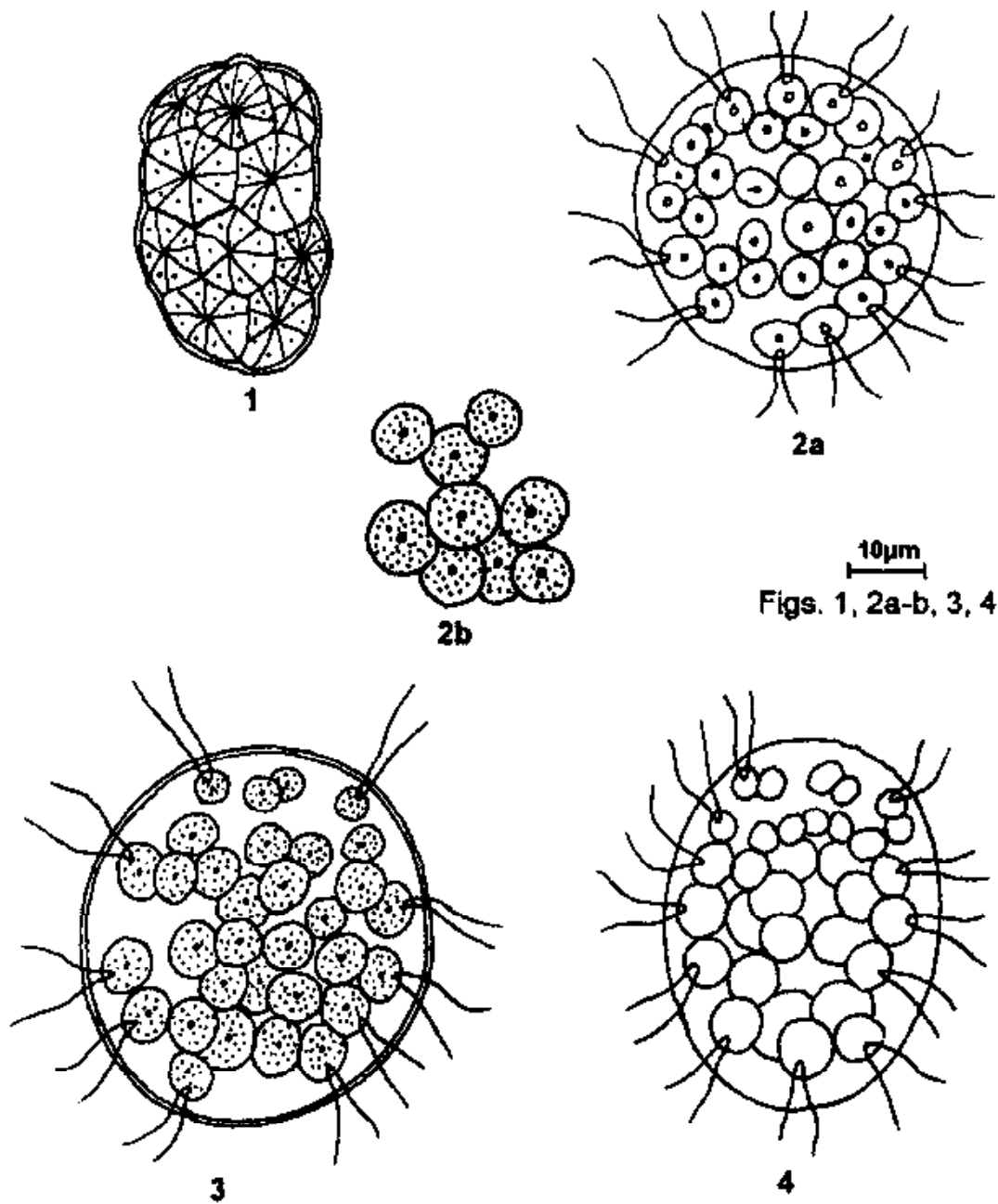


Plate-2 : Figs. 1-4 : 1. *Eudorina charkowiensis*; 2a-b. *Eudorina elegans*;  
3. *Eudorina illinoisensis*; 4. *Eudorina indica*.

*Phenology* : December.

Free swimming in a ditch at Chakrata near temple, associated with other members of Volvocales (94868).

**3. *Eudorina illinoisensis*** (Kofoid) Pascher in Die süßwasser-Flora 4: 443. figs. 404, 405. 1927; Iyengar & Desikachary, Volvocales, 431. fig. 37: 3. 1981. *Pleodorina illinoisensis* Kofoid 1898.

Pl. 2, Fig. 3

Colonies spherical, 40.23-51.74  $\mu\text{m}$  broad with smooth envelope; cells 32 spherical, first tier of 4 somatic cells, 8.17-10.12  $\mu\text{m}$  broad, gonidial cells, 12.36-14.82  $\mu\text{m}$  broad; chloroplast 1 cup-shaped; pyrenoids 1-4.

*Phenology* : December.

Free floating in a puddle at Sahiya, associated with species of *Microspora* (94859).

**4. *Eudorina indica*** Iyengar in J. Linn. Soc. Bot. 49: 339. pl. 28, figs. 2, 12, 13. 1933; Iyengar & Desikachary, Volvocales, 429 fig. 255. 1981.

Pl. 2, Fig. 4

Colonies subglobose, 48.76-52.68  $\mu\text{m}$  long, 34.38-37.52  $\mu\text{m}$  broad with mucilaginous layers; cells arranged in tiers of two different sizes, first two tiers of 12 cells, 9.36-12.42  $\mu\text{m}$  broad, rest cells 14.38-19.26  $\mu\text{m}$  broad; chloroplast cup-shaped; contractile vacuoles 2; flagella 2 longer than the cell; pyrenoids 3-5.

*Phenology* : December.

Free floating in a ditch of cultivated land at Sahiya, associated with certain diatoms (94858).

#### 4. GONIUM Müller

Colony flat, quadrangular with rounded corners; cells 4 or 16 embedded in a common gelatinous matrix and connected by gelatinous strands; cells ovoid to pyriform; flagella two of equal length; chloroplast single cup-shaped; pyrenoid one or more; contractile vacuole two in each cell; eyespot single; reproduction by coenobia, sexuality isogamous.

## KEY TO THE SPECIES

- |                              |                        |
|------------------------------|------------------------|
| 1a. Colony 4 celled          | 3. <i>G. sociale</i>   |
| b. Colony 16 celled          | 2                      |
| 2a. Cells compactly arranged | 1. <i>G. compactum</i> |
| b. Cells loosely arranged    | 2. <i>G. pectorale</i> |

1. ***Gonium compactum*** Iyengar, Iyengar & Desikachary, *Volvocales* 413. figs. 241: 1-8. 1981.

Pl. 3, Figs. 1a-b

Colonies quadrate, 42.63-46.23  $\mu\text{m}$  broad; margin parallel; cells 16 spherical, compactly arranged, 10.18-13.72  $\mu\text{m}$  broad; biflagellate; chloroplast cup-shaped; pyrenoid 1.

*Phenology* : December.

Free floating in a ditch at Asan near bridge, associated with *Hydrodictyon rateculatum* (94869).

2. ***Gonium pectorale*** Müller, *Vermium terrestrium et fluvialium seu animalium infusorium, helminthicorum et testacearum* 1: 60. 1773; Biswas in *Rec. Bot. Surv. India* 15(1): 63. pl. 2. figs. 14a-d. 1949; Iyengar & Desikachary, *Volvocales* 411. figs. 236, 237. 1981; Prasad & Misra, *Freshwater algal Fl. Andaman and Nicobar Islands*, 3. pl. 1, fig. 2. 1992; Anand, *Ind. freshwater microalgae* 25. fig. 65. 1998.

Pl. 3, Fig. 2

Colonies quadrangular, flat with rounded corners, 53.78-58.47  $\mu\text{m}$  broad, consisting of 16 cells with 4 central and 12 peripheral, connected to each other by gelatinous matrix, possessing open spaces between them and a large space at the centre; cells ovoid to pyriform 9.37-11.53  $\mu\text{m}$  long, 7.5-9.18  $\mu\text{m}$  broad; flagella 2 at anterior end; chloroplast parietal cup-shaped; pyrenoid 1.

*Phenology* : May.

Planktonic in a temporary stagnant water near Varubala pond, associated with other members of *Volvocales* (94801).

3. ***Gonium sociale*** (Duj.) Warming in *Bot. Tidsskr.* 9: 82. 1876.

Pl. 3, Fig. 3

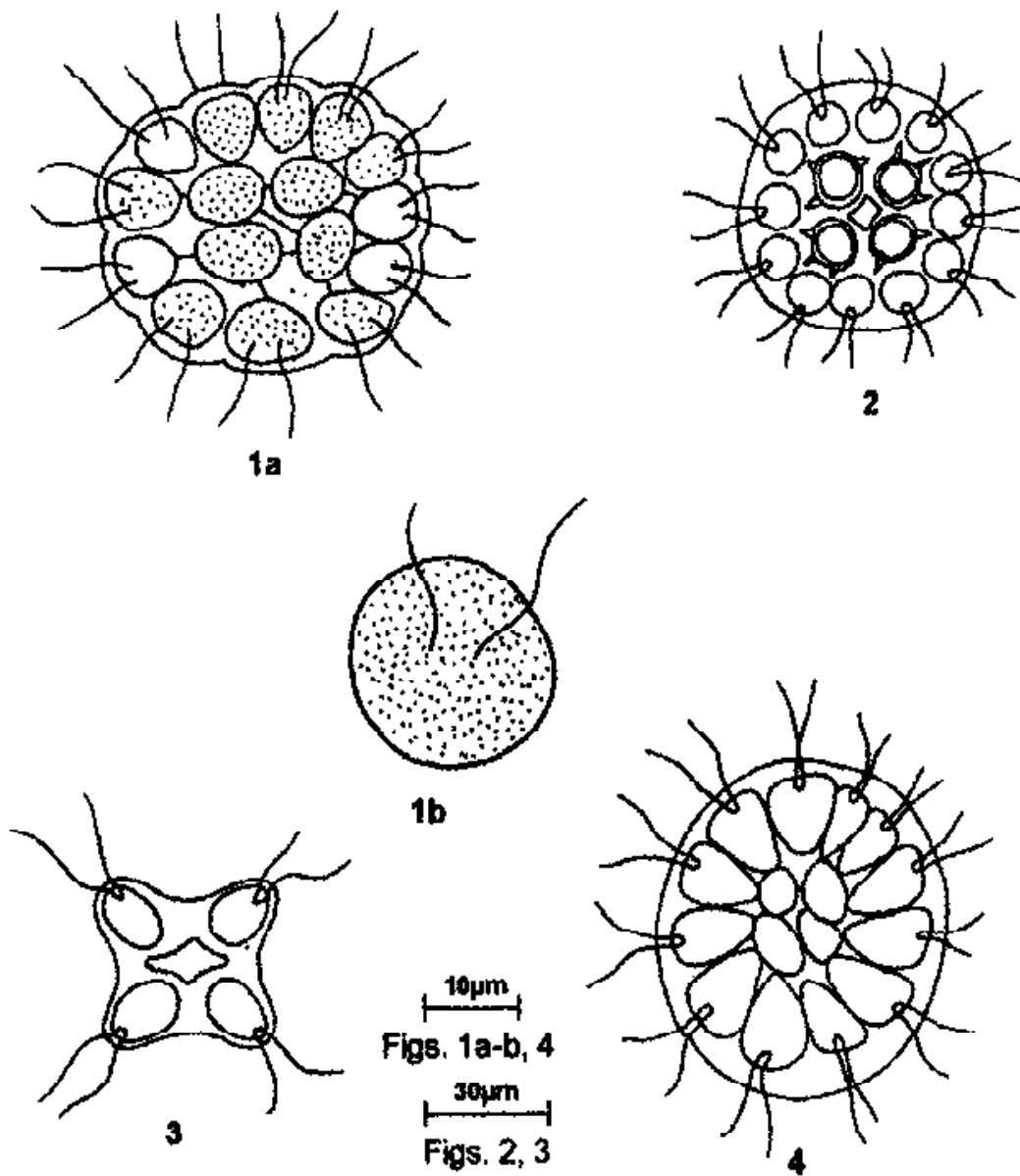


Plate - 3 : Figs. 1-4 : 1a-b. *Gonium compactum*; 2. *Gonium pectorale*;  
3. *Gonium sociale*; 4. *Pandorina morum*.

Colony quadrangular flat with 4 projected rounded corners, 28.37-36.43  $\mu\text{m}$  long, 26.93-34.71  $\mu\text{m}$  broad, with rectangular space in central portion; cells 4 ovoid, 13.18-18.68  $\mu\text{m}$  long, 12.37-14.56  $\mu\text{m}$  broad, embeded outward and enclosed by gelatinous matrix; chloroplast parietal cup-shaped; pyrenoid 1.

*Phenology* : May.

Free floating in a puddle at Chandrabani, associated with species of *Spirogyra* (94805).

## 5. PANDORINA Bory

Colony spherical or subspherical, motile; cells 16 pyriform to angular, mutually compressed, embedded in a homogeneous envelope, with or without protuberance; biflagellate; chloroplast single cup-shaped; pyrenoid one or more; eyespot one; contractile vacuoles two; reproduction by autocolony or zoospores, sexuality anisogamous.

1. *Pandorina morum* (Müller) Bory in Encycl. Meth. 600. 1824; Biswas in Rec. Bot. Surv. India 15(1): 63. pl. 2. fig. 15. 1949; Iyengar & Desikachary, Volvocales, 417. fig. 243. 1981; Prasad & Misra, Fresh water algal Fl. Andaman and Nicobar Islands, 4. pl. 1. fig. 3. 1992; Anand, Ind. freshwater microalgae, 95. fig. 66. 1998; Kant & Gupta, Algal Fl. Ladakh 70. pl. 17. fig. 9; pl. 91, fig. 1. 1998.

### Pl. 3, Fig. 4

Colonies sub-spherical to ellipsoid with 16 cells, 35.74 - 37.23  $\mu\text{m}$  long, 27.65-30.58  $\mu\text{m}$  broad; cells pyriform to angular, mutually compressed and enclosed in a prominent gelatinous envelope; flagella 2 at the flattened distal end; chloroplast 1 parietal shaped; contractile vacuoles 2; pyrenoid 1.

*Phenology* : May.

Free swimming in a cemented tank at Manabkendra, associated with members of Chlorococcales (94807).

## 2. SPHAERELLACEAE

### 1. Volvox L. emend. Ehr.

Colony globose hollow spherical composed of several cells; cells ovoid, biflagellate arranged at the periphery of gelatinous envelope, directed

outward, interconnected by protoplasmic strands; chloroplast single, cup-shaped; pyrenoid; eyespot; nucleus single; contractile vacuoles 2-6; reproduction by daughter colonies, sexuality oogamous.

1. *Volvox aureus* Ehr. in Abh. Kgl. Akad. wiss. Berlin 1931: 77. 1832; Iyengar & Desikachary, *Volvocales*, 468. figs. 24: 1-12, 274. 1981; Anand, *Ind. freshwater microalgae*, 25. fig. 69. 1998.

Pl. 1, Figs. 2a-c

Colonies spherical, 327. 43-346.27  $\mu\text{m}$  broad, contained *ca* 1300-3200 celled; cells ovoid, 4.23-5.96  $\mu\text{m}$  broad, connected with one another by delicate cytoplasmic strands; sheath confluent; chloroplast circular parietal plate shaped; contractile vacuoles 2 at anterior end; flagella 2; daughter colonies 2 in posterior side.

*Phenology* : August.

Free floating in a shallow puddle at Raiwala, associated with *Oedogonium* sp. (96242).

### 3. TETRASPORACEAE

#### 1. TETRASPORA Link

Thallus tubular expanded; cells spherical; pseudocilia present; chloroplast parietal, bell shaped, covering the entire wall; pyrenoid one; reproduction by zoospore or fragmentation, sexuality isogamous.

1. *Tetraspora cylindrica* (Wahl.) C.A. Agardh, *Icones Algarum Europaeorum* 613. 1828; Anand, *Ind. freshwater microalgae*, 25. fig. 63. 1998.

Pl. 1, Figs. 3a-b

Thallus irregularly lobed; holdfast pointed; cells rounded, 14.72-16.26  $\mu\text{m}$  broad, arranged in single layer, surrounded by mucilage; pseudocilia present; chloroplast parietal; pyrenoid 1.

*Phenology* : February.

Attached on stone in a stagnant water at Doiwala near sugar factory, associated with *Enteromorpha* sp. (94878).



## 2. Order : Chlorococcales

Cells unicellular or colonial; non motile; uninucleate or multinucleate; chloroplast reticulate or parietal; pyrenoids absent or one to several; cell wall smooth, warty or spiny; a sexual reproduction by autospores, zoospores or aplanospores, sexuality isogamous to oogamous.

## KEY TO THE FAMILIES

- |  |                    |
|--|--------------------|
| 1a. Cells cylindrical, polygonal<br>or flat spherical                            | 4. HYDRODICTYACEAE |
| b. Cells not as above  | 2                  |
| 2a. Cells arranged one or two rows, connected by<br>mucilaginous pads            | 5. COELASTRACEAE   |
| b. Cells neither arranged one or two rows,<br>nor connected by mucilaginous pads | 3                  |
| 3a. Cells definite shape; autospore not formed                                   | 1. CHLOROCOCCACEAE |
| b. Cells different shapes; autospore formed                                      | 4                  |
| 4a. Cells spherical, ovoid, ellipsoid<br>or sub-cylindrical                      | 2. OOCYSTACEAE     |
| b. Cells club-shaped, fusiform, acicular,<br>lunate or ovate-cunate              | 5. SELENASTRACEAE  |

## 1. CHLOROCOCCACEAE

## KEY TO THE GENERA

- |   |                 |
|---|-----------------|
| 1a. Cells fusiform, adhesive disc present | 1. CHARACIUM    |
| b. Cells spherical, adhesive disc absent  | 2               |
| 2a. Chloroplast parietal                  | 2. CHLOROCOCCUM |
| b. Chloroplast axial                      | 3. TREBOUXIA    |

## 1. CHARACIUM A. Br. ex Kütz.

Cells unicellular, fusiform or elliptic; epiphytic; uninucleate or multinucleate; chloroplast single parietal plate; pyrenoids one or many; reproduction by zoospores, sexuality isogamous.

## KEY TO THE SPECIES

- |  |                      |
|--|----------------------|
| 1a. Epiphytic on filamentous algae         | 2                    |
| b. Epizoic on crustacea                    | 3                    |
| 2a. Cells oblique lanceolate; stalk absent | 3. <i>C. nasutum</i> |

- |                                   |                         |
|-----------------------------------|-------------------------|
| b. Cells ellipsoid; stalk short   | 1. <i>C. apiculatum</i> |
| 3a. Cells club-shaped to pyriform | 4. <i>C. orissicum</i>  |
| b. Cells ellipsoid to ovoid       | 2. <i>C. debaryanum</i> |

**1. *Characium apiculatum*** Rabenh. in Hedwigia 1: 85. pl. 1. fig. 2. 1855; Philipose, Chlorococcales, 84. fig. 9. 1967; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 9. pl. 1. fig. 8. 1992; Kant & Gupta, Algal Fl. Ladakh, 77. pl. 18. fig. 8. 1998.

Pl. 4, Fig. 1

Cells ellipsoid, 68.38-83.52  $\mu\text{m}$  long, 22.23-25.41  $\mu\text{m}$  broad with one margin more convex than other; apex rounded with stumpy apical point; chloroplast 1, parietal laminate; pyrenoids 3-5; stalk short thick and colourless with broad base.

*Phenology* : August.

Epiphytic on *Spirogyra* sp. in a slowly flowing water at Golatapper (96227).

**2. *Characium debaryanum*** (Reinsch) De Toni, Sylloge Algarum Ominum Hucusque Cognitarum-1. Chlorophyceae, 628. 1889; Philipose, Chlorococcales, 85. fig. 12. 1967; *Dactylococcus debaryanus* Reinsch 1875.

Pl. 4, Fig. 2

Cells ellipsoid to obovoid, 32.16-36.74  $\mu\text{m}$  long, 22.40-24.17  $\mu\text{m}$  broad; anterior portion rounded; stalk short stout, colourless with basal adhesive disc; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : August.

Epizoic on Copepods at Raiwala (96237).

**3. *Characium nasutum*** Rabenh. in Hedwigia 1: 85. fig. 1. 1855; Philipose, Chlorococcales, 82. fig. 6. 1967.

Pl. 9, Fig. 3

Cells lanceolate, slightly oblique, 42.23-49.85 long, 19.3-20.24 broad; apex portion pointed, 4.13-6.45  $\mu\text{m}$  long, 2.23-3.19  $\mu\text{m}$  broad; chloroplast 1, parietal; pyrenoids 5-6; stalk absent.

*Phenology* : October - January.

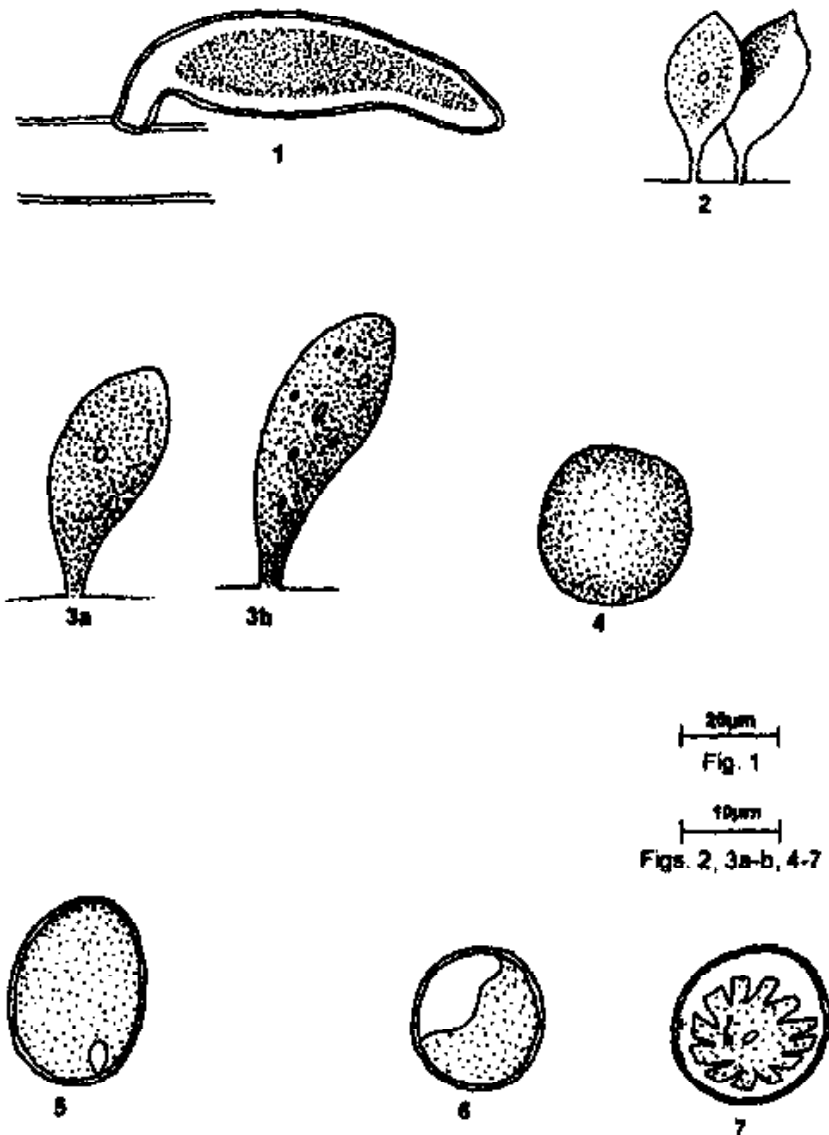


Plate 4 : Figs. 1-7 : 1. *Characium apiculatum*; 2. *Characium debaryanum*; 3a-b. *Characium orissicum*; 4. *Chlorococcum humicolo*; 5. *Chlorococcum infusionum*; 6. *Chlorococcum vitiosum*; 7. *Trebouxia humicola*.

Epiphytic on *Hydrodicton reticulatum* at Asan reservoir (93173).

4. *Characium orissicum* Philipose, Chlorococcales, 84. fig. 11. 1967.

Pl. 4, Figs. 3a-b

Cells club-shaped, 24.27-26.47  $\mu\text{m}$  long, 7.65-10.53  $\mu\text{m}$  broad; apex rounded with gradually attenuated base forming short stalk; chloroplast parietal; pyrenoid 1.

*Phenology* : March.

Epizoic on Copepods under moist shadey condition at Mohand (96205).

## 2. CHLOROCOCCUM Fries

Cells spherical or ellipsoid, solitary or gregarious in temporary colonies; terrestrial or aquatic; cell wall smooth; chloroplast parietal, bell-shaped or spherical; pyrenoids single or many; uninucleate or multinucleate; contractile vacuoles present or absent; reproduction by aplanospores or zoospores, sexuality isogamous.

## KEY TO THE SPECIES

- |   |                         |
|---|-------------------------|
| 1a. Thallus aquatic; chloroplast with notch         | 2. <i>C. infusionum</i> |
| b. Thallus terrestrial; chloroplast without notch   | 2                       |
| 2a. Chloroplast half-filling; pyrenoid absent       | 3. <i>C. vitiosum</i>   |
| b. Chloroplast completely filling; pyrenoid present | 1. <i>C. humicola</i>   |

1. *Chlorococcum humicola* (Näg.) Rabenh., Flora Europaea Algarum Aquae Dulcis et sub-marinae 58. 1868; Philipose, Chlorococcales, 73. fig. 3. 1967; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 8. pl. 1. fig. 6. 1992; Kant & Gupta, Algal Fl. Ladakh, 75. pl. 18. figs. 2a, b; pl. 95. fig. 6; pl. 93. fig. 1. 1998; *Cystococcus humicola* Næg. 1849.

Pl. 4, Fig. 4

Cells spherical, 8.73-14.25  $\mu\text{m}$  broad; wall smooth; chloroplast parietal completely filling; pyrenoid 1; multinucleate; contractile vacuoles absent.

*Phenology* : August.

Luxuriantly grow on moist soil at Raiwala, forming green films in association with *Botrydium* sp. (96240).

**2. *Chlorococcum infusionum*** (Schrank) Menegh. in Mem. Reale Acad. Sci. Torino 5: 27. pl. 2. fig. 3. 1842; Philipose, Chlorococcales, 73. fig. 1. 1967; Kant & Gupta, Algal Fl. Ladakh, 75. pl. 18. figs 1a, b; pl. 94. fig. 4. 1998.

**Pl. 4, Fig. 5**

Cells spherical solitary, 14.63-20.19  $\mu\text{m}$  broad; wall smooth; chloroplast hollow sphere with a notch on one side; pyrenoid 1; uninucleate; contractile vacuoles absent.

*Phenology* : February.

Planktonic in a puddle at Lachiwala, near picnic place (94877).

**3. *Chlorococcum vitiosum*** Printz in K. norske vidensk. Selsk. Skr. 1920: 10. pl. 1. figs. 31-51. 1921; Philipose, Chlorococcales, 73, fig. 2. 1967.

**Pl. 4, Fig. 6**

Cells spherical, 9.35-13.37  $\mu\text{m}$  broad; cell wall smooth; chloroplast parietal covering half of the cell, with even edge; nucleus 1 centrally located; pyrenoid absent.

*Phenology* : August.

On moist soil at Raiwala, associated with members of Ulotrichales (96239).

### 3. TREBOUXIA Puymaly

Thallus unicellular, spherical with thin cell wall; chloroplast one axial with wrinkled or lobed peripheral margins; pyrenoid one centrally located; uninucleate; reproduction by zoospores, sexuality isogamous.

**1. *Trebouxia humicola*** (Treboux) West & Fritsch, A treatise on the British freshwater algae 106. fig. 23k. 1927; Philipose, Chlorococcales, 75. fig. 4. 1967; Anand, Ind. freshwater microalgae 28. fig. 72. 1998. *Cystococcus humicola* Treboux 1912.

**Pl. 4, Fig. 7**

Cells unicellular spherical, 12.47-15.24  $\mu\text{m}$  broad; wall thin; chloroplast axial with irregular peripheral lobes and extended up to cell wall; pyrenoid 1 centrally located.

*Phenology* : July - August.

On the moist barks of *Magnolia* sp. at Birpur, associated with *Parmelia* a foliose lichen (96243).

## 2. OOCYSTACEAE

### KEY TO THE GENERA

- |  |                 |
|--|-----------------|
| 1a. Cells curved                                   | 2. NEPHROCYTIUM |
| b. Cells without curved                            | 2               |
| 2a. Living in association with blue green algae    | 1. GLAUCOCYSTIS |
| b. Not living in association with blue green algae | 3. OOCYSTIS     |

### 1. GLAUCOCYSTIS Itzigsohn

Colonies free floating or attached with 2, 4, 8, 16 cells surrounded by persistent mother cell walls; cells spherical, elliptical or reniform with vermiform or irregularly shaped endophytic blue green cyanelles; chromatophores absent; reproduction by autospores.

### KEY TO THE SPECIES

- |   |                             |
|---|-----------------------------|
| 1a. Cells with less than 20 radiating vermiform cyanelles | 2. <i>G. nostochinearum</i> |
| b. Cells with more than 20 radiating vermiform cyanelles  | 1. <i>G. cingulata</i>      |

1. *Glaucocystis cingulata* Bohlin in K. Svenska Vetensk Akad. Handl. 23(7): 13, pl. 1, figs. 9-13, 1897; Philipose, Chlorococcales 188, fig. 102, 1967; Kant & Gupta, Algal Fl. Ladakh, 86, pl. 20, fig. 12; pl. 92, fig. 3, 1998

Pl. 5, Fig. 1

Colonies spherical, 52.23-78.18  $\mu\text{m}$  broad; cells ovoid to spherical, 22.27-30.68  $\mu\text{m}$  long, 12.86-18.46  $\mu\text{m}$  broad, with more than 20 radiating deep blue green cyanelles; membrane colourless, 2.11-3.14  $\mu\text{m}$  thick; equatorial groove ridge.

*Phenology* : August.

Planktonic in a rain water puddle, under exposed condition at Raiwala, associated with certain cyanobacteria (96238).

2. *Glaucocystis nostochinearum* Itzigsohn, Flora Europaea Algarum

Aquae Dulcis et sub-marinae 417. 1868; Philipose, Chlorococcales 188. fig. 101. 1967.

**Pl. 5, Fig. 2**

Colonies ellipsoidal, 2-4 cells enclosed within the old mother cell wall, 40.17-50.36  $\mu\text{m}$  long, 32.15-47.67  $\mu\text{m}$  broad; cells oblong to elliptic, 17.38-25.76  $\mu\text{m}$  long, 12.22-16.81  $\mu\text{m}$  broad, each cell with less than 20 radiating vermiform cyanelles; cell wall uniformly thick, chromatophore absent.

*Phenology* : August.

Planktonic in a small pond near Satyanarayan, along with certain cyanobacteria and few filaments of *Spirogyra* sp. (96232).

**2. NEPHROCYTIUM Näg.**

Colonies free-floating with 2, 4, 8, 16 cells, enclosed within the partially gelatinized mother cell wall; cells ovoid, or fusiform to kidney-shaped, arranged spirally or irregularly within the colonial envelope; chloroplast single, parietal; pyrenoid one; reproduction by autospores.

**KEY TO THE SPECIES**

- |  |                          |
|--|--------------------------|
| 1a. Cells crescent shaped, ends pointed  | 3. <i>N. lunatum</i>     |
| b. Cells kidney shaped, ends not pointed | 2                        |
| 2a. Cells 13-16 $\mu\text{m}$ broad      | 1. <i>N. agardhianum</i> |
| b. Cells 20-25 $\mu\text{m}$ broad       | 2. <i>N. hydrophilum</i> |

**1. *Nephrocytium agardhianum* Näg.** Die Gattung Einzelliger Algen, physiologische und Systematische Bearbeitet 79. pl. 3. figs. a-p. 1849; Philipose, Chlorococcales. 189. fig. 104. 1967; Kant & Gupta, Algal Fl. Ladakh 85. pl. 20. fig. 14. 1998. *Nephrocytium naegelii* Grunow 1868, *Selenococcus farcinialis* Schmidle 1903.

**Pl. 6, Fig. 5**

Colonies ovate with 4-8 cells within a gelatinous envelope, 45.78-56.87  $\mu\text{m}$  broad; cells kidney-shaped with broadly rounded ends, 13.48-15.56  $\mu\text{m}$  long, 3.53-5.63  $\mu\text{m}$  broad, arranged spirally; chloroplast 1, parietal; pyrenoid 1.

*Phenology* : August.

Planktonic in a small pond near Satyanarayan alongwith certain cyanobacteria (96231).

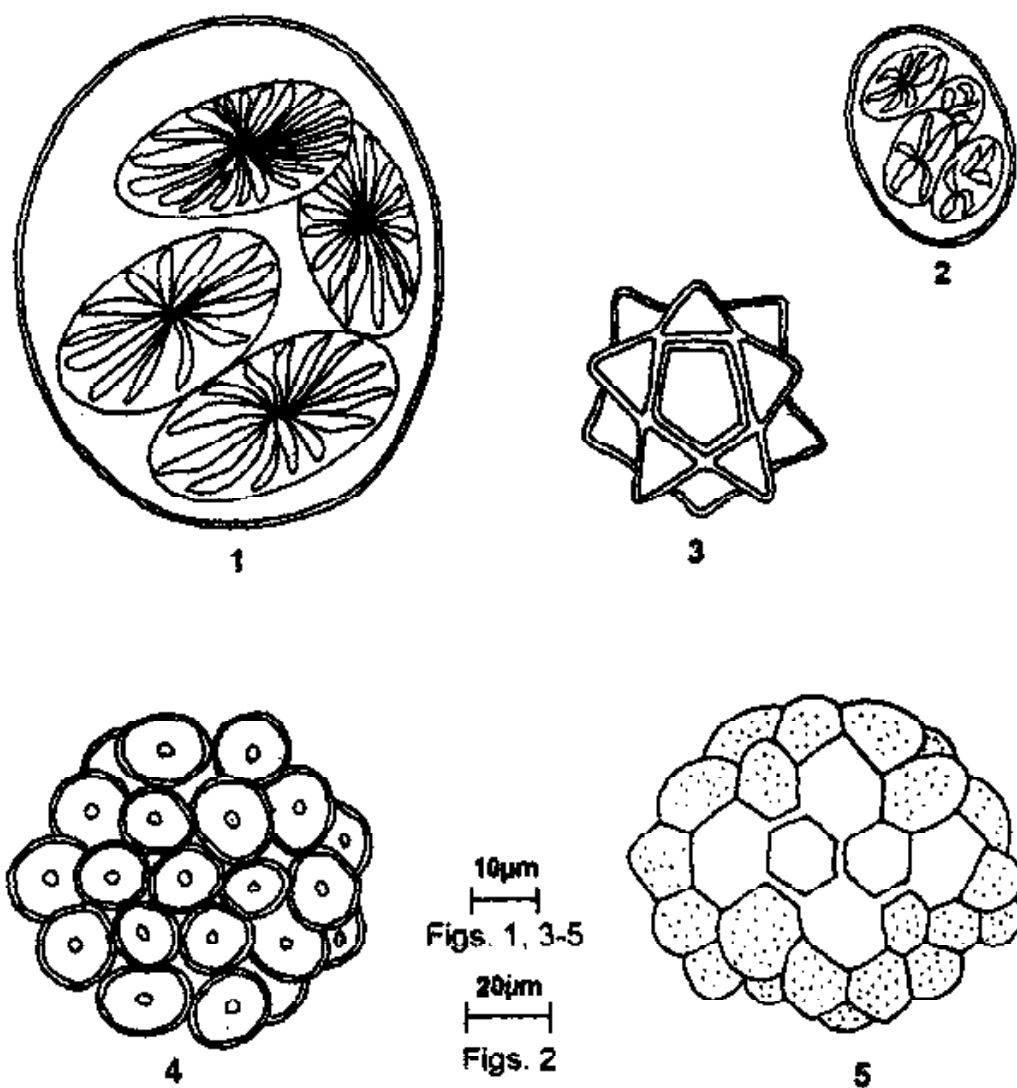


Plate 5 : Figs. 1-5 : 1. *Glaucocystis cingulata*; 2. *Glaucocystis nostochinearum*; 3. *Coelastrum proboscideum*; 4. *Coelastrum microporum*; 5. *Coelastrum sphaericum*.



2. *Nephrocytium hydrophilum* (Turner) Wille in Engler und Prantl Die Natürlichen Pflanzenfamilien Nächtrage zum Teil 1. 59. 1909; Philipose, Chlorococcales. 191. fig. 105. 1967; *Hydrocystis hydrophila* Turner.

**Pl. 6, Fig. 6**

Colonies of 4 cells enclosed by colourless gelatinous envelope; cells kidney-shaped with rounded ends, 30. 18-34.75  $\mu\text{m}$  long, 21.35-24.27  $\mu\text{m}$  broad; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : August.

Planktonic in a rain water puddle at Satyanarayana along with members of green algae (96230).

3. *Nephrocytium lunatum* W. West in J.R. micr. Soc., 12: 736, pl. 10. fig. 49. 1892; Philipose, Chlorococcales 189. fig. 103. 1967.

**Pl. 7, Fig. 1**

Colonies spherical to ovate with hyaline gelatinous envelope, 40.74-52.17  $\mu\text{m}$  long, 27.43-32.35  $\mu\text{m}$  broad; cells 4-8 curved, crescent shaped, 15.12-18.25  $\mu\text{m}$  long, 5.23-7.38  $\mu\text{m}$  broad, with one side convex and other concave; ends pointed; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : August.

Planktonic in a rain water puddle at Raiwala, associated with certain cyanobacteria (96237).

**3. OOCYSTIS Näg.**

Cells free floating, ovoid, ellipsoid, fusiform or cylindrical; solitary or form colonies; cells oval or ellipsoid with rounded or pointed ends; cell wall smooth or sometimes with polar nodules; chloroplasts one or many parietal, discoid, laminate, or reticulate; pyrenoids present or absent; reproduction by autospores.

**KEY TO THE SPECIES**

- |                                   |                        |
|-----------------------------------|------------------------|
| 1a. Cells with polar nodules      | 2                      |
| b. Cells without polar nodules    | 3                      |
| 2a. Chloroplast 12-25 disc shaped | 7. <i>O. solitaria</i> |

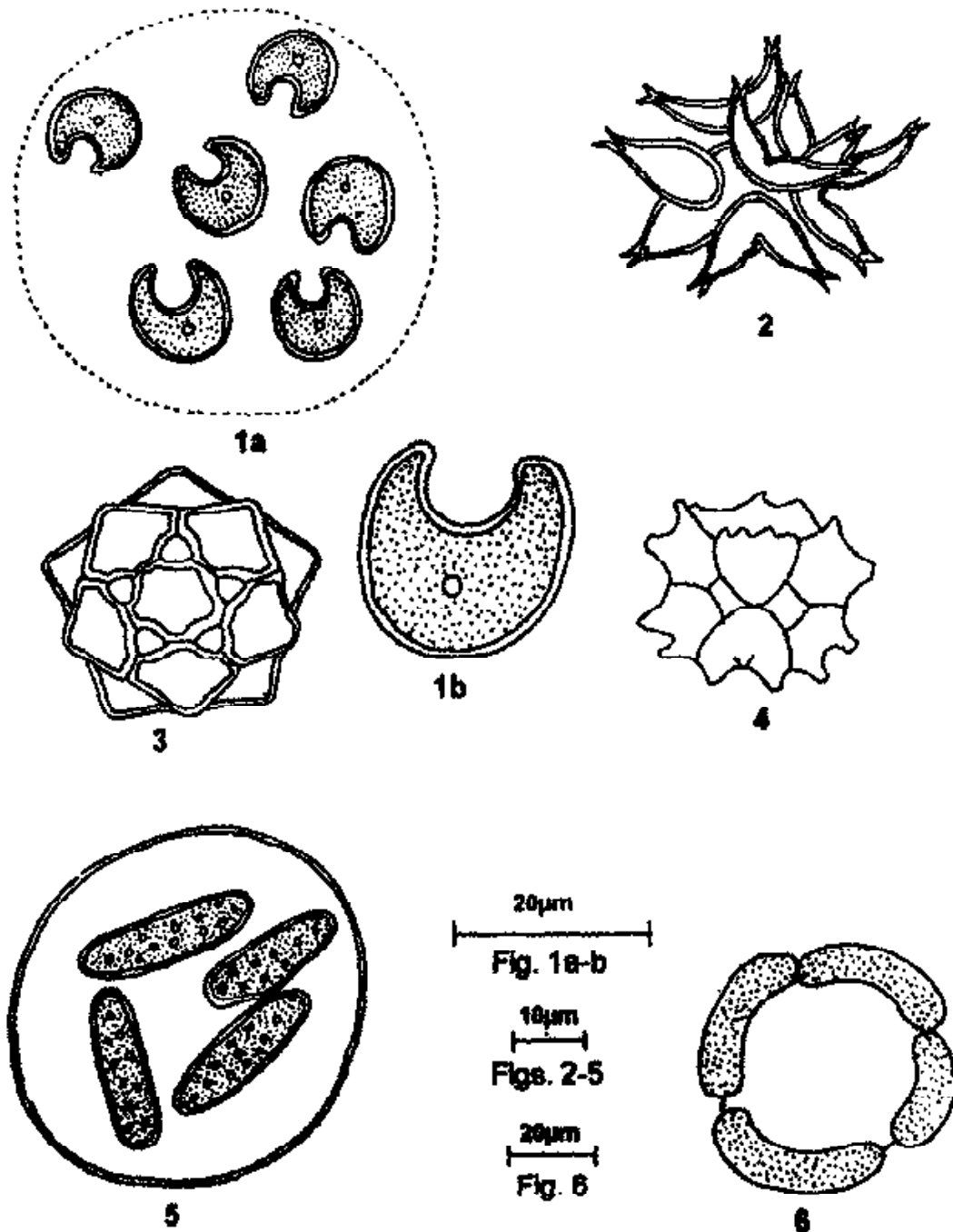


Plate - 6 : Figs. 1-6 : 1(a-b) *Kirchneriella obesa*; 2. *Sorastrum spinulosum*; 3. *Coelastrum cambricum*; 4. *Coelastrum cubicum*; 5. *Nephroclytium agardhianum*; 6. *Nephroclytium hydrophilum*.

- |  |                         |
|--|-------------------------|
| b. Chloroplast 4-10 angular shaped                       | 2. <i>O. crassa</i>     |
| 3a. Cells ellipsoid to rounded                           | 4                       |
| b. Cells oblong or oblong ellipsoid                      | 5                       |
| 4a. Cells 9-14 $\mu\text{m}$ broad; chloroplast parietal | 1. <i>O. borgei</i>     |
| b. Cells 23-40 $\mu\text{m}$ broad; chloroplast discoid  | 3. <i>O. gigas</i>      |
| 5a. Envelope of colony lemon-shaped                      | 4. <i>O. macrospora</i> |
| b. Envelope of colony not lemon-shaped                   | 6                       |
| 6a. Chloroplasts 2-3 not occupying the entire cells      | 6. <i>O. pusilla</i>    |
| b. Chloroplast 1 occupying the entire cell               | 5. <i>O. naegelii</i>   |

1. *Oocystis borgei* Snow in Fish. Bull. U.S. 22: 379. pl. 2. figs. 7: 1-5. 1903; Philipose, Chlorococcales 183. fig. 93. 1967; Kant & Gupta, Algal Fl. Ladakh 85. pl. 20. fig. 11. 1998. *Oocystis gigas* var. *borgei* Lemm. 1904.

Pl. 7, Fig. 3

Colonies, 2, 8 cells; cells ellipsoid with rounded ends, 11.52-14.15  $\mu\text{m}$  long, 9.27-10.15  $\mu\text{m}$  broad; polar nodules absent; chloroplast 2-4, parietal; pyrenoid 1.

*Phenology* : March.

Planktonic in a puddle at Mohand, associated with *Mougeotia* sp. (96204).

2. *Oocystis crassa* Wittr. in Bot. Notiser 1879: 117. 1880; Philipose, Chlorococcales 181. fig. 91. 1967.

Pl. 7, Fig. 2

Cells solitary, ellipsoid with polar nodules at poles, 14.62-22.45  $\mu\text{m}$  long, 12.18-17.76  $\mu\text{m}$  broad; chromatophores parietal 4-10; pyrenoid 1.

*Phenology* : December.

Planktonic in shallow pools at Chakrata, associated with filamentous green algae (94862).

3. *Oocystis gigas* Archer in Quart J. micr. Sci. N.S. 17: 104. 1877; Philipose, Chlorococcales 183. fig. 94a. 1967; Kant & Gupta, Algal Fl. Ladkah, 85. pl. 20. fig. 11. 1998.

Pl. 7, Fig. 4

Colonies 4 celled with rounded envelope; cells ellipsoid with rounded

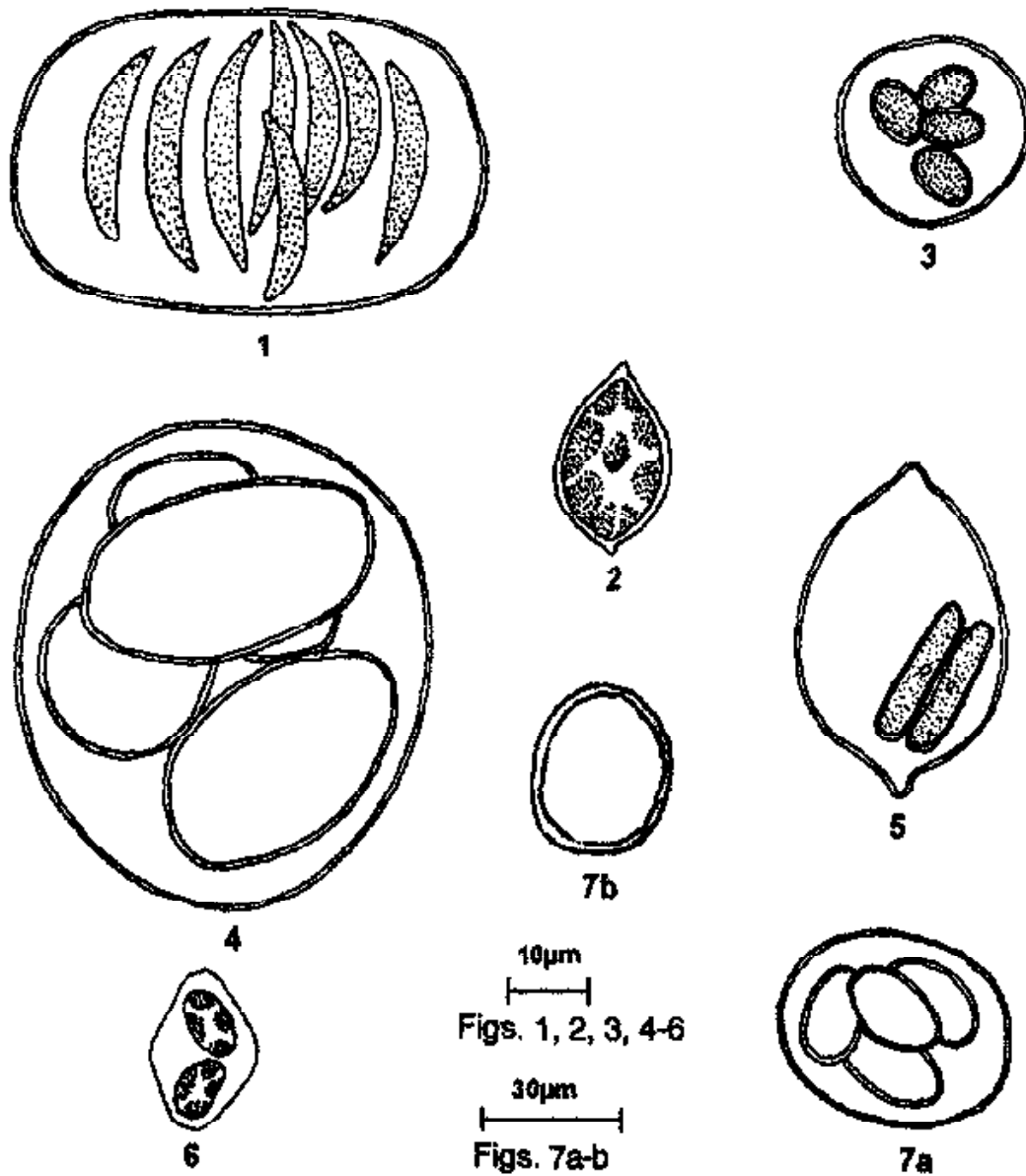


Plate-7 : Figs. 1-7 : 1. *Nephrocytium lunatum*; 2. *Oocystis crassa*; 3. *Oocystis borgei*; 4. *Oocystis gigas*; 5. *Oocystis macrospora*; 6. *Oocystis pusilla*; 7a-b. *Oocystis naegelii*.

ends, 42.81-44.54  $\mu\text{m}$  long, 30.49-35.95  $\mu\text{m}$  broad; polar nodules absent; chloroplasts discoid, 4-5; pyrenoid 1.

*Phenology* : March.

Planktonic, in a rain water pools at Mohand, associated with *Oedogonium* sp. (96203).

4. *Oocystis macrospora* (Turner) Brunthaler in Pascher's Die Süßwasser-flora Deutschlands Heft 5. Chlorophyceae 127. fig. 109. 1915; Philipose, Chlorococcales 184. fig. 96. 1967; *Hydrocystium macrosporum* Turner 1892.

Pl. 7, Fig. 5

Colonies 2-4 celled, 47.56-49.45  $\mu\text{m}$  long, 40.25-58.17  $\mu\text{m}$  broad; envelope lemon shaped; cells elongate-ellipsoid to oblong with rounded ends, 38.23-42.12  $\mu\text{m}$  long, 18.22-22.32  $\mu\text{m}$  broad; polar nodules absent; chloroplast discoid; pyrenoid 1.

*Phenology* : June.

Planktonic in a puddle at Rober's cave, associated with filamentous green algae (96213).

5. *Oocystis naegelii* A. Br., Algarum unicellularum genera nova et minus cognita 94. 1855; Philipose, Chlorococcales 185. fig. 98. 1967; Kant & Gupta, Algal Fl. Ladakh 85. pl. 20. fig. 9; pl. 94. fig. 6, 1998.

Pl. 7, Figs. 7a-b

Colonies 2-4 cells with close envelope; cells ovoid to oblong with rounded ends, 19.23-22.32  $\mu\text{m}$  long, 12.5-13.86  $\mu\text{m}$  broad; membrane thick; polar nodules absent; chloroplast 1, parietal; pyrenoid absent.

*Phenology* : August.

Free floating in a puddle at Raiwala, associated with other members of green algae (96239).

6. *Oocystis pusilla* Hansgirg in S.B. Öst Akad. Wiss. 1890; 9. 1890. Philipose, Chlorococcales 184. 1967. *Oocystis naegelii* var. *minutissima* Bernard 1908.

Pl. 7, Fig. 6

Cells elongate-ellipsoid with truncate to rounded ends, 12.32-15.17  $\mu\text{m}$  long, 7.42-9.18  $\mu\text{m}$  broad; membrane thin; polar nodules absent; chromatophores 4-5 parietal plate; pyrenoid absent.

*Phenology* : August.

Planktonic in a puddle at Raiwala, associated with members of green algae (96241).

7. *Oocystis solitaria* Wittr. in Bot. Notiser 1879: 24. figs. 1-5. 1879; Philipose, Chlorococcales 180. figs. 89-94. 1967.

Pl. 9, Fig. 2

Colony elongate, 23.15-25.36  $\mu\text{m}$  long, 20.39-22.42  $\mu\text{m}$  broad; cells ellipsoid, 16.43-18.31  $\mu\text{m}$  long, 8.89-12.42  $\mu\text{m}$  broad; wall thick; polar nodules present; chloroplasts 12-15, disc shaped; pyrenoids 2-3.

*Phenology* : March.

Planktonic in a cemented tank at Jharipani, associated with *Scenedesmus* sp. (93183).

### 3. SELENASTRACEAE

#### KEY TO THE GENERA

- |  |                   |
|--|-------------------|
| 1a. Cells fusiform to acicular; mucilaginous envelope absent | 1. ANKISTRODESMUS |
| 1b. Cells curved or lunate; mucilaginous envelope present    | 2. KIRCHNERIELLA  |

#### 1. ANKISTRODESMUS Corda

Thallus solitary or clustered in fascicular colonies; mucilaginous envelope absent; cells acicular to fusiform with acute apices, straight, curved or sigmoid and often twisted one another; chloroplast single parietal; pyrenoid present or absent; reproduction by autospore.

#### KEY TO THE SPECIES

- |                                |                       |
|--------------------------------|-----------------------|
| 1a. Cells acicular not twisted | 1. <i>A. falcatus</i> |
| b. Cells sigmoid twisted       | 2                     |

- 2a. 4-8 cells twisted around one another  
 b. 2-4 cells form fasciculate bundles
3. *A. spiralis*  
 2. *A. sigmoidis*

**1. *Ankistrodesmus falcatus*** (Corda) Ralfs, The British Desmidiaceae 180. pl. 34. figs. 3a-d. 1848. Philipose, Chlorococcales 211. figs. 121 a, e 1967; Kant & Gupta; Algal Fl. Ladakh 90. pl. 21. fig. 15, pl. 91. fig. 2, pl. 22. figs. 1a, b. 1998. *Micrasterias falcata* Corda 1835. *Ankistrodesmus fusiformis* Corda 1838, *Raphidium fasciculatum* Kütz. 1845, *Raphidium polymorphum* var. *falcatum* (Corda) Rabenh. 1868.

**Pl. 8, Fig. 1**

Cells acicular not twisted around each other, 40.37-47.15  $\mu\text{m}$  long, 4.24-6.20  $\mu\text{m}$  broad; apices acute; chloroplast 1, parietal; pyrenoid absent.

*Phenology* : August.

Planktonic in a small pond at Raiwala, associated with other members of Chlorococcales (96238).

**2. *Ankistrodesmus sigmoides*** (Rabenh.) Brühl & Biswas in J. Dep. Sci. Calcutta Univ. 4: 12. pl. 3. fig. 22. 1922; Philipose, Chlorococcales 211. fig. 120. 1967. *Raphidium polymorphum* var. *sigmoideum* Rabenh. 1863.

**Pl. 8, Fig. 2**

Cells sigmoid, solitary or fasciculate bundles of 2-3, fusiform, slender, gradually attenuated from the middle towards the ends, 26.36-28.16  $\mu\text{m}$  long, 2.14-3.10  $\mu\text{m}$  broad; ends acute; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : December.

Planktonic in a ditch at Chakrata near bus stand (94862).

**3. *Ankistrodesmus spiralis*** (Turner) Lemm. in Arch. Hydrobiol. u. planktonk 4: 176. 1908; Philipose, Chlorococcales 210. figs. 119a-c. 1967; Kant & Gupta, Algal Fl. Ladakh 90. pl. 22. fig. 2a, pl. 92. fig. 5. 1998. *Raphidium spirale* Turner 1892, *Raphidium polymorphum* var. *turneri* W. & G.S. West 1902, *Ankistrodesmus falcatus* var. *spiralis* (Turner) G.S. West 1904, *Raphidium turneri* (West) Bernard 1908.

**Pl. 8, Fig. 3**

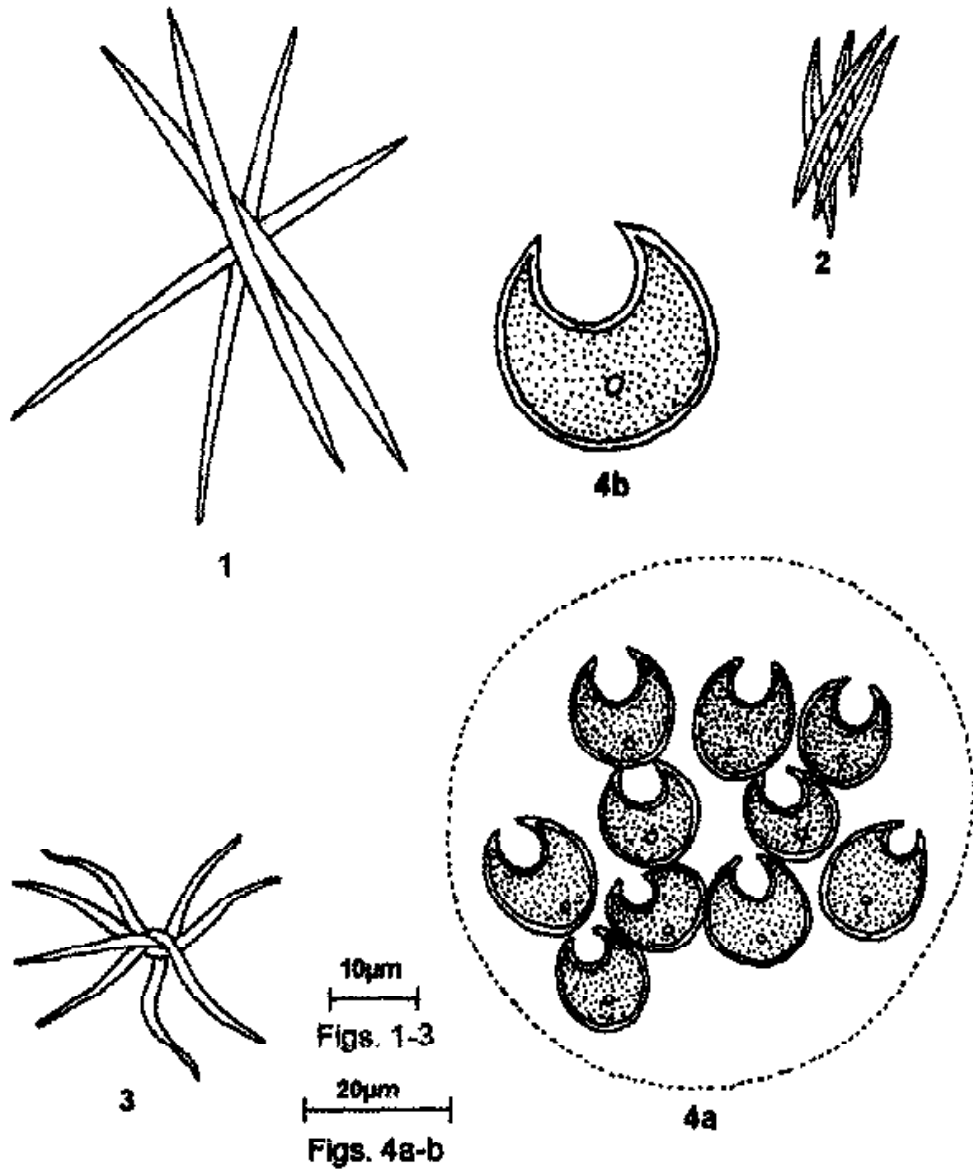


Plate - 8 : Figs. 1-4 : 1. *Ankistrodesmus falcatus*; 2. *Ankistrodesmus sigmoides*; 3. *Ankistrodesmus spiralis*; 4a-b. *Kirchneriella lunaris*.



Colonies 4-8 or more cells; cells acicular with acute apices, spirally twisted around one another in the mid region, but free at the ends, 22.54-30.16  $\mu\text{m}$  long, 2.17-3.20  $\mu\text{m}$  broad; chloroplast 1, parietal; pyrenoid absent.

*Phenology* : December.

Planktonic in an agricultural field at Sahiya, associated with certain cyanobacteria (94854).

## 2. KIRCHNERIELLA Schmidle

Colonies free-floating with lunate to sickle-shaped; cells curved or spirally twisted with pointed or rounded ends, lie close to each other with irregular arrangement; envelope homogeneous; chloroplast single, parietal; pyrenoid single; reproduction by formation of 4-8 autospores in each cell.

### KEY TO THE SPECIES

- 1a. Cells lunate to sickle-shaped with pointed ends      1. *K. lunaris*  
 b. Cells lunate with bluntly rounded ends                      2. *K. obesa*

1. *Kirchneriella lunaris* (Kirchn.) Moebius in Abh. Senkenb. naturf. Ges. 18: 331, 1894; Philipose, Chlorococcales 222. fig. 131, 1967; Anand, Ind. freshwater microalgae 40. fig. 130. 1998. *Raphidium convolutum* var. *lunare* Kirchn. 1878, *Kirchneriella lunata* (Kirchn.) Schmidle 1893.

**Pl. 8, Figs. 4a-b**

Colonies spherical to ellipsoid with a faint outer gelatinous envelope, 47.28-49.15  $\mu\text{m}$  broad; cells 4 or 8, flattened, crescent shaped, strongly curved with pointed ends, arranged irregularly, 8.56-13.43  $\mu\text{m}$  long, 4.38-7.25  $\mu\text{m}$  broad; chloroplast 1, nearly filling the cell; pyrenoid 1.

*Phenology* : December.

Planktonic in a puddle at Sahiya, associated with certain diatoms (94855).

2. *Kirchneriella obesa* (W. West) Schmidle in Ber. naturf. Ges. Freiburg 7: 16. 1893; Philipose, Chlorococcales 224. fig. 132, 1967. *Selenastrum obesum* W. West 1892.

**Pl. 6, Figs. 1a-b**

Colonies spherical with gelatinous envelope, 32.27-36.38  $\mu\text{m}$  broad; cells 4-8 lunate, ends almost near to each other with rounded ends, outer side convex, inner side nearly parallel, arranged irregularly, 8.20-12.56  $\mu\text{m}$  long, 3.15-5.78  $\mu\text{m}$  broad; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : December.

Planktonic in a puddle at Chakrata, associated with *Rhizoclonium* sp. (94867).

#### 4. HYDRODICTYACEAE

##### KEY TO THE GENERA

- |   |                 |
|---|-----------------|
| 1a. Colony macroscopic, net shape               | 1. HYDRODICTYON |
| b. Colony microscopic, plate or spherical shape | 2               |
| 2a. Colony flat plate                           | 2. PEDIASTRUM   |
| b. Colony spherical                             | 3. SORASTRUM    |

##### 1. HYDRODICTYON Roth

**Thallus macroscopic free floating; cells cylindrical, attached at end walls, repeatedly to form net-like colonies, commonly known as water-net; wall smooth; chloroplast reticulate; multinucleate; pyrenoid single or many; vacuole present; reproduction by zoospores, sexuality isogamous.**

**1. *Hydrodictyon reticulatum* (L.) Lagerheim in K. svenska. vetenskakad. Förh. 40: 71, 1883; Biswas in Rec. Bot. Surv. India 15(1): 68. pl. 3. fig. 29. 1949; Philipose, Chlorococcales 134. fig. 48. 1967; Anand, Ind. freshwater micro algae 32. fig. 90. 1998; Kant & Gupta, Algal Fl. Ladakh 81. pl. 19. fig. 6. 1998. *Conferva reticulata* L. 1753, *Hydrodictyon utriculatum* Roth 1800, *Hydrodictyon pentagonum* Vauch. 1800.**

##### Pl. 9, Figs. 1a-c

Colonies reticulate; meshes pentagonal or hexagonal; cells elongate cylindrical, 51.20-54.86  $\mu\text{m}$  long, 9.14-10.97  $\mu\text{m}$  broad; wall smooth double layered; chloroplast reticulate; multinucleate; pyrenoid many.

This unique alga is able to reproduce very rapidly because each cell of the net in turn produces a new cylindrical net of small cells

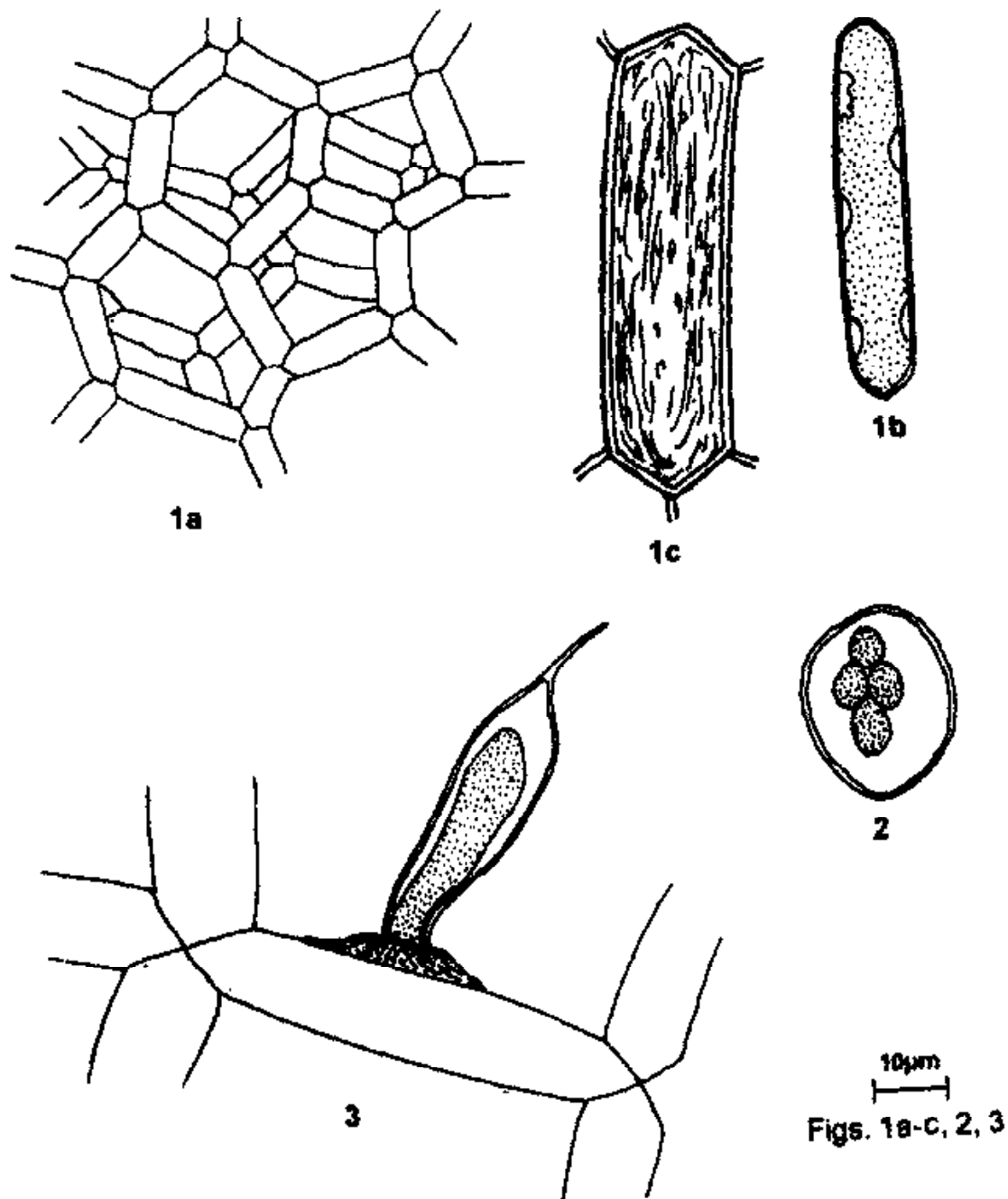


Plate - 9 : Figs. 1-3 : 1a. *Hydrodictyon reticulatum*, 1b-c. Single cylindrical cell; 2. *Oocystis solitaria*; 3. *Characium nasutum*.

within it, which upon escape enlarge enormously, each cell again producing a net.

*Phenology* : Throughout the year.

Free floating densely in a shallow rivulets with slow wave action of water at Gullar ghati, associated with unicellular diatoms and few *Closterium* sp. (93160, 93163, 93164); free floating in a slowly flowing water at Vikasnagar near tea garden (93184); free floating near Varubala pond (94806); free floating in a small puddle at Mohand (94825, 94833); free floating and densely growing at Asan reservoir (94869).

## 2. PEDIASTRUM Meyen

Colonies flat circular; cells 8-16-32 polygonal with or without perforations; peripheral cells bi or tetra-lobed; walls smooth or granulated; chloroplast single parietal, disc-shaped; pyrenoids one or many; multinucleate; reproduction by zoospores, sexuality isogamous.

### KEY TO THE SPECIES

- |   |                       |
|---|-----------------------|
| 1a. Outer face of marginal cells with single projection       | 2                     |
| b. Outer face of marginal cells with two projections          | 3                     |
| 2a. Side view of cells straight or concave                    | 4. <i>P. simplex</i>  |
| b. Side view of cells convex                                  | 3. <i>P. ovatum</i>   |
| 3a. Outer face of marginal cells straight or slightly concave | 2. <i>P. muticum</i>  |
| b. Outer face of marginal cells with deep emarginations       | 1. <i>P. boryanum</i> |

1. *Pediastrum boryanum* (Turpin) Menegh. in *Linnaea* 14: 210. 1840; Philipose, *Chlorococcales* 118. fig. 40a. 1967; Prasad & Misra, *Freshwater algal Fl. Andaman and Nicobar Islands* 10. pl. 1. fig. 4. 1992. Anand, Ind. *Freshwater microalgal* 32. fig. 91. 1998; Kant & Gupta, *Algal Fl. Ladakh* 81. pl. 23. fig. 4, pl. 24. fig. 7, pl. 25. fig. 5, pl. 100. fig. 4, pl. 101. figs. 1 & 2, pl. 102. fig. 2. 1998; *Hierella boryana* Turpin 1828, *Micrasterias boryana* Ehr. 1838, *Euastrum pentangulare* Corda; 1839, *Pediastrum granulatum* Kütz. 1845.

Pl. 10, Figs. 3a-b

Colonies circular to slightly oval, compact of 16 or 32 cells, 60.39-82.9  $\mu\text{m}$  broad; cells, 12.97-14.63  $\mu\text{m}$  long 9.31-11.14  $\mu\text{m}$  broad, with

10 cells in outer ring, 5 in inner side and 1 in centre or 15 cells in outer ring, 16 in inner side, 1 in centre, without intercellular space; inner cells polygonal with straight sides; marginal cells with two short spines in outer face, 4.31-6.25  $\mu\text{m}$  long; wall smooth; chloroplast parietal; pyrenoids 4-6; multinucleate.

*Phenology* : March, December and January.

Free floating in a roadside cemented tank at Jharipani, associated with *Scenedesmus*, *Oocystis* and *Chlorogloea* sp. (93183); free floating in a ditch at Lachiwala, Hardwar road, associated with *Rhizoclonium* and diatoms mixture (93169, 93170).

2. *Pediastrum muticum* Kütz. Species Algarum 193. 1849; Philipose, Chlorococcales 117. fig. 38. 1967; Kant & Gupta, Algal Fl. Ladakh 80. pl. 24. fig. 6, pl. 26. fig. 1, pl. 99. fig. 30. 1998.

Pl. 12, Fig. 6

Colonies 16 celled flat rounded without perforations, 40.72-47.49  $\mu\text{m}$  broad; inner cells 4.23-5.89  $\mu\text{m}$  long, 7.21-7.88  $\mu\text{m}$  broad; outer face of peripheral cells straight or slightly concave, 8.46-9.23  $\mu\text{m}$  long, 4.56-5.19  $\mu\text{m}$  broad; outer wall emarginate with two projections; cell wall smooth; pyrenoids present.

*Phenology* : May, December and January.

Planktonic in a ditch at Kaunwala, near wine factory, Hardwar road, associated with *Spirogyra* and some diatoms species (931689); free floating in a ditch at Bharuwala pond, associated with *Scenedesmus* sp. (93197).

3. *Pediastrum ovatum* (Ehr.) A. Br., Algarum unicellularum genera nova et minus cognita 81. 1855; Philipose, Chlorococcales 115. fig. 37. 1967. *Asterodictyon ovatum* Ehr. 1845, *Pediastrum ovatum* var. *microporum* Lemm. 1915, *Pediastrum sturmlii* Reinsch 1867, *Pediastrum sturmlii* var. *radlans* Lemm. 1915, *Pediastrum sturmlii* var. *echinulatum* (Witt. & Nordst.) Lemm. 1915, *Pediastrum simplex* var. *sturmlii* (Reinsch) Wille 1887, *Pediastrum simplex* var. *typica* Brühl & Biswas 1922, *Pediastrum schroeteri* Lemm. 1899.

Pl. 10, Fig. 1

Colonies flat 8 cells, 45.36-47.49  $\mu\text{m}$  broad; peripheral cells, 15.17-18.53  $\mu\text{m}$  long, 10.32-12.63  $\mu\text{m}$  broad without perforation; central cell

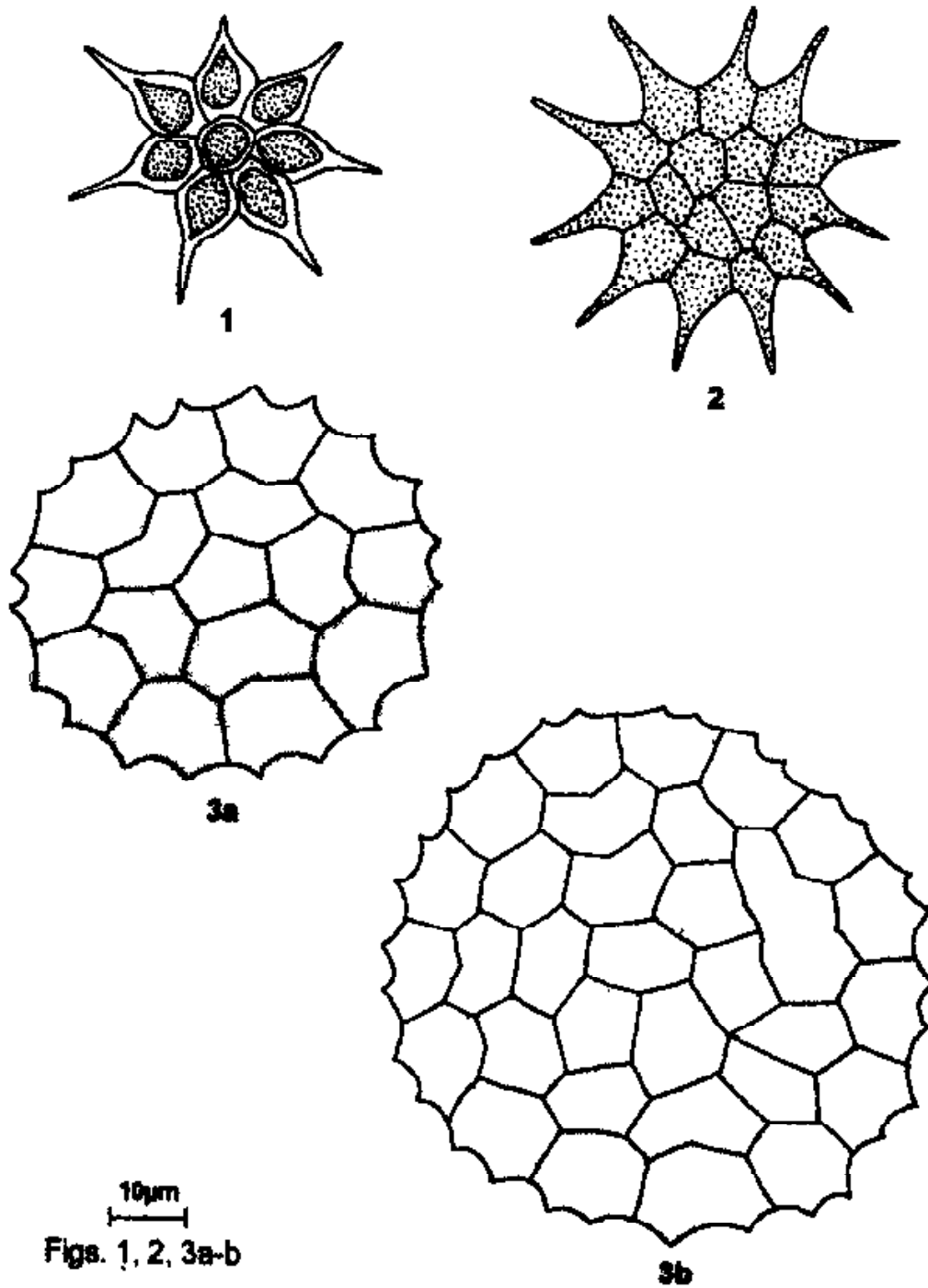


Plate - 10 : Figs. 1-3 : 1. *Pedastrum ovatum*; 2. *Pedastrum simplex*; 3a. *Pedastrum boryanum*, 16 cells colony; 3b. 32 cells colony.

1, 7.49-9.25  $\mu\text{m}$  broad; marginal cells convex with single projection; cell wall smooth; chloroplast parietal shape; pyrenoid absent.

*Phenology* : March.

Planktonic in a ditch at Asan reservoir, associated with *Spirogyra* filaments (93186).

**4. *Pediastrum simplex*** Meyen in Nova Acta Phys. Med. Acad. Caes. Leop. Carol. Nat. Curr. 14(2): 772. pl. 43. figs. 1-5. 1829; Biswas in Rec. Bot. Surv. India 15(1): 66. pl. 2. fig. 6. 1949; Philipose, Chlorococcales 113. figs. 36a-c. 1967; Kant & Gupta, Algal Fl. Ladakh 80. pl. 23. figs. 1-7, pl. 99. fig. 2, pl. 100. fig. 3, pl. 102. fig. 9. 1998; *Pediastrum simplex* var. *granulatum* Lemm. 1897, *Pediastrum simplex* var. *typica* Brühl & Biswas 1922.

**Pl. 10, Fig. 2**

Colonies flat circular of 16 cells, 56.21-58.33  $\mu\text{m}$  broad; cells 22.32-25.92  $\mu\text{m}$  long, 8.13-12.34  $\mu\text{m}$  broad, inner cells straight, outer side of peripheral cells extended to form single horn like projections, sides of cells straight or concave margins; intercellular space absent; cell wall smooth; chloroplast parietal.

*Phenology* : December January.

Planktonic in a stagnant water at Lachiwala, Hardwar road, associated with *Spirogyra* sp. (93169).

### 3. *SORASTRUM* Kütz.

Colonies spherical, 4, 16, 32, 64 celled; cells subglobose, reniform or pyriform with one to four spines from outer face and gelatinous stalk from inner side; stalk united at centre to form mucilaginous sphere; chloroplast parietal; pyrenoid one; reproduction by zoospores.

**1. *Sorastrum spinulosum*** Näg.. Die Gattung Einzelliger Algen, Physiologische und systematische Bearbeitet 99. figs. Da-d. 1849; Philipose, Chlorococcales 132. fig. 47. 1967; Anand, Ind. freshwater microalgae 32. fig. 95. 1998; Kant & Gupta, Algal Fl. Ladkah 81. pl. 19. fig. 5, Pl. 94. figs. 1-3. 1998. *Sorastrum cornutum* Reinsch 1875, *Sorastrum spinulosum* var. *crassispinosum* Hansgirg 1886, *Sorastrum crassispinosum* (Hansg.) Bohlin 1897, *Sorastrum indicum* Bernard 1908.

**Pl. 6, Fig. 2**

Colonies 4-32 cells, 30.64-35.15  $\mu\text{m}$  broad; cells reniform to cuneate, angle three with short stalk, 12.18-16.24  $\mu\text{m}$  long, 14.52-18.21  $\mu\text{m}$  broad; spines 4 from outer face, 4.35-7.23  $\mu\text{m}$  long; chloroplast parietal; pyrenoid 1.

*Phenology* : December.

Free floating at the edge of ditch along with *Gomphonema* sp. at Chakrata (94866).

## 5. COELASTRACEAE

### KEY TO THE GENERA

- |  |                |
|--|----------------|
| 1a. Colonies spherical to polygonal          | 1. COELASTRUM  |
| b. Colonies flat                             | 2              |
| 2a. Cells parallel with longitudinal axes    | 3. SCENEDESMUS |
| b. Cells not parallel with longitudinal axes | 2. CRUCIGENIA  |

### 1. COELASTRUM Näg.

Colony hollow sphere, rarely polygonal to pyramidal with 4-8-16-32 or more cells; cell spherical, ovoid or pyramidal, closely adjoined and compressed; cell wall thick to form polar outgrowths; chloroplast parietal cup-shaped or diffuse; pyrenoid one; reproduction by autocolony.

### KEY TO THE SPECIES

- |   |                           |
|---|---------------------------|
| 1a. Cells with apical thickenings                               | 2                         |
| b. Cells without apical thickenings                             | 4                         |
| 2a. Cells with three polar truncate                             | 2. <i>C. cubicum</i>      |
| b. Cells with single polar truncate                             | 3                         |
| 3a. Cells pyramidal, 6-sided                                    | 4. <i>C. proboscideum</i> |
| b. Cells spherical, 10-12 sided                                 | 1. <i>C. cambricum</i>    |
| 4a. Cells spherical to ovoid with inter-cellular spaces smaller | 3. <i>C. microporum</i>   |
| b. Cells ovoid with inter-cellular spaces larger                | 5. <i>C. sphaericum</i>   |

1. *Coelastrum cambricum* Archer in Quart. J. micr. Sci. 8: 65. 1868; Philipose, Chlorococciacs 230. fig. 138a. 1967; Kant & Gupta,



Algal Fl. Ladakh 91. pl. 22. fig. 11, pl. 93. fig. 6. 1998. *Coelastrum pulchrum* Schmidle 1892.

**Pl. 6, Fig. 3**

Colonies spherical with 32-celled, 35.27-38.65  $\mu\text{m}$  broad; cells spherical, thickened at poles, 10-12 sided connected to each other by 4-6 short gelatinous flat truncate projections, 8.15-11.38  $\mu\text{m}$  broad; inter spaces between cells circular to triangular.

*Phenology* : December.

Planktonic in a shallow pools at Sahiya (94857).

2. *Coelastrum cubicum* Næg., Die Gattung Einzelliger Algen, Physiologische und systematische Bearbeitet 98. pl.5c. fig. 2. 1849; Philipose, Chlorococcales 231. fig. 139. 1967. *Coelastrum naegeli* Rabenh. 1868. *Coelastrum cornutum* Lemaire 1894.

**Pl. 6, Fig. 4**

Colonies subspherical, 22.36-26.45  $\mu\text{m}$  broad; cells six-sided with three obliquely truncate polar processes, 12.55-18.40  $\mu\text{m}$  broad; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : December.

Planktonic in a small pond at Sahiya, associated with *Nostoc* sp. (94854).

3. *Coelastrum microporum* Næg., Algarum Unicellularum genera nova et minus cognito 70. 1855; Philipose, Chlorococcales 228. fig. 135. 1967; Anand, Ind. freshwater microalgae 34. fig. 97. 1998; Kant & Gupta, Algal Fl. of Ladakh 91. pl. 22. figs. 14a, b, pl. 93. figs. 10, 11. 1998. *Coelastrum robustum* Hantzsch 1864. *Coelastrum indicum* Turner 1892, *Coelastrum sphaericum* var. *compactum* Moebius 1892.

**Pl. 5, Fig. 4**

Colonies spherical, composed of 8-64 cells, 25.27-42.75  $\mu\text{m}$  broad; cells spherical to ovoid interconnected by short, scarcely discernible gelatinous processes, with small inter-cellular spaces, 5.16-9.32  $\mu\text{m}$  broad; chloroplast parietal; pyrenoid 1.

*Phenology* : November.

Planktonic in a shallow puddle at Mohand, associated with *Spirogyra* sp., (94839).

4. *Coelastrum proboscideum* Bohlin, Fasc. 26: 1240. 1877; Philipose, Chlorococcales 229. fig. 137. 1967; Anand, Ind. freshwater microalgae 34. fig. 98. 1998; Kant & Gupta, Algal Fl. Ladakh 91. pl. 93. fig. 8. 1998. *Coelastrum microporum* f. *typica* Wolle 1887, *Coelastrum irregulare* Schroeder 1897, *Coelastrum pseudocubicum* Schroeder 1897.

**Pl. 5, Fig. 3**

Colonies pyramidal or cubical, consisting of 8, 16, 32 cells, 25.28-32.59  $\mu\text{m}$  broad; cells truncately conical, enclosed by a gelatinous sheath and joined along lower lateral walls, 12.56-15.13  $\mu\text{m}$  broad; cell wall slightly thickened at poles; chloroplast 1, parietal; pyrenoid 1.

*Phenology* : November.

Planktonic in a ditch at Mohand, associated with filamentous conjugalian algae (94836).

5. *Coelastrum sphaericum* Næg., Die Gattung Einzelliger Algen, Physiologische und Systematische Bearbeitet 98. pl. 5c. figs. 1 a-d. 1849; Philipose, Chlorococcales 229. fig. 136. 1967; Kant & Gupta, Algal Fl. Ladakh 91. pl. 22. fig. 12. pl. 93. fig. 9. 1998. *Coelastrum naegelii* Rabenh. 1868.

**Pl. 5, Fig. 5**

Colonies spherical to ellipsoid, consisting of 4,8,16,32 regularly arranged cells; cells, 30.46-36.68  $\mu\text{m}$  broad, ovoid, compressed with narrow end directed outwards; sides of cells flattened and outer free side curved, 7.18-10.24  $\mu\text{m}$  broad; inter-cellular spaces large; chloroplast 1, parietal; pyrenoid 1.

*Phenology* : May.

Planktonic in a puddle at Chandrabani, associated with filamentous conjugalian algae (94804).

## 2. CRUCIGENIA Morren

Colony spherical, with 16-64 cells; cells flattened, spherical, ovoid

ellipsoid, triangular, trapezoidal or rhomboidal; chloroplast 1-4 parietal or discoid; pyrenoid one; reproduction by autocolony.

### KEY TO THE SPECIES

- |                                       |                            |
|---------------------------------------|----------------------------|
| 1a. Cells apiculate                   | 1. <i>C. apiculata</i>     |
| b. Cells not apiculate                | 2                          |
| 2a. Colony with large space at centre | 3. <i>C. fenestrata</i>    |
| b. Colony with small space at centre  | 3                          |
| 3a. Colony longer than broad          | 4                          |
| b. Colony as long as broad            | 5                          |
| 4a. Cells ovoid to ellipsoid          | 5. <i>C. rectangularis</i> |
| b. Cells rhomboidal                   | 2. <i>C. crucifera</i>     |
| 5a. Cells triangular                  | 6. <i>C. tetrapedia</i>    |
| b. Cells spherical to quadrate        | 4. <i>C. quadrate</i>      |

1. ***Crucigenia apiculata*** (Lemm.) Schmidle in Allg. Bot. Z. 6: 234. 1900; Philipose, Chlorococcales 238. fig. 146. 1967. *Staurogenia apiculata* Lemm. 1889, *Tetrastrum apiculatum* (Lemm.) Brunthaler 1915, *Crucigenia reniforme* Swirenko 1926.

Pl. 11, Fig. 1

Colony quadrate, 12.38-15.58  $\mu\text{m}$  long, 9.12-13.56  $\mu\text{m}$  broad; cells 4 ovate, rhomboidal or triangular, with 1 short cone-shaped apiculation on cell wall at free outer apex, 6.48-9.73  $\mu\text{m}$  long, 4.70-7.18  $\mu\text{m}$  broad; chloroplast disc-shaped; pyrenoids 2.

*Phenology* : May.

Planktonic in a pond at Varuwala, associated with species of *Spirogyra* (93189).

2. ***Crucigenia crucifera*** (Wolle) Collins in Tufts Coll. Stud. 2(3): 170. 1909; Philipose, Chlorococcales 240. fig. 149. 1967. *Staurogenia crucifera* Wolle 1877, *Staurogenia cruciatum* Wolle 1887, *Crucigenia cruciata* (Wolle) Schmidle 1900.

Pl. 11, Fig. 2

Colonies 4 celled, rhomboidal, with slightly concave sides and central rectangular opening, 11.52-12.98  $\mu\text{m}$  long, 9.36-11.23  $\mu\text{m}$  broad; cells elongate with outer free margin concave and inner straight or slightly convex, 5.14-7.12  $\mu\text{m}$  long, 3.17-5.16  $\mu\text{m}$  broad; chloroplast disc-shaped; pyrenoid 1.

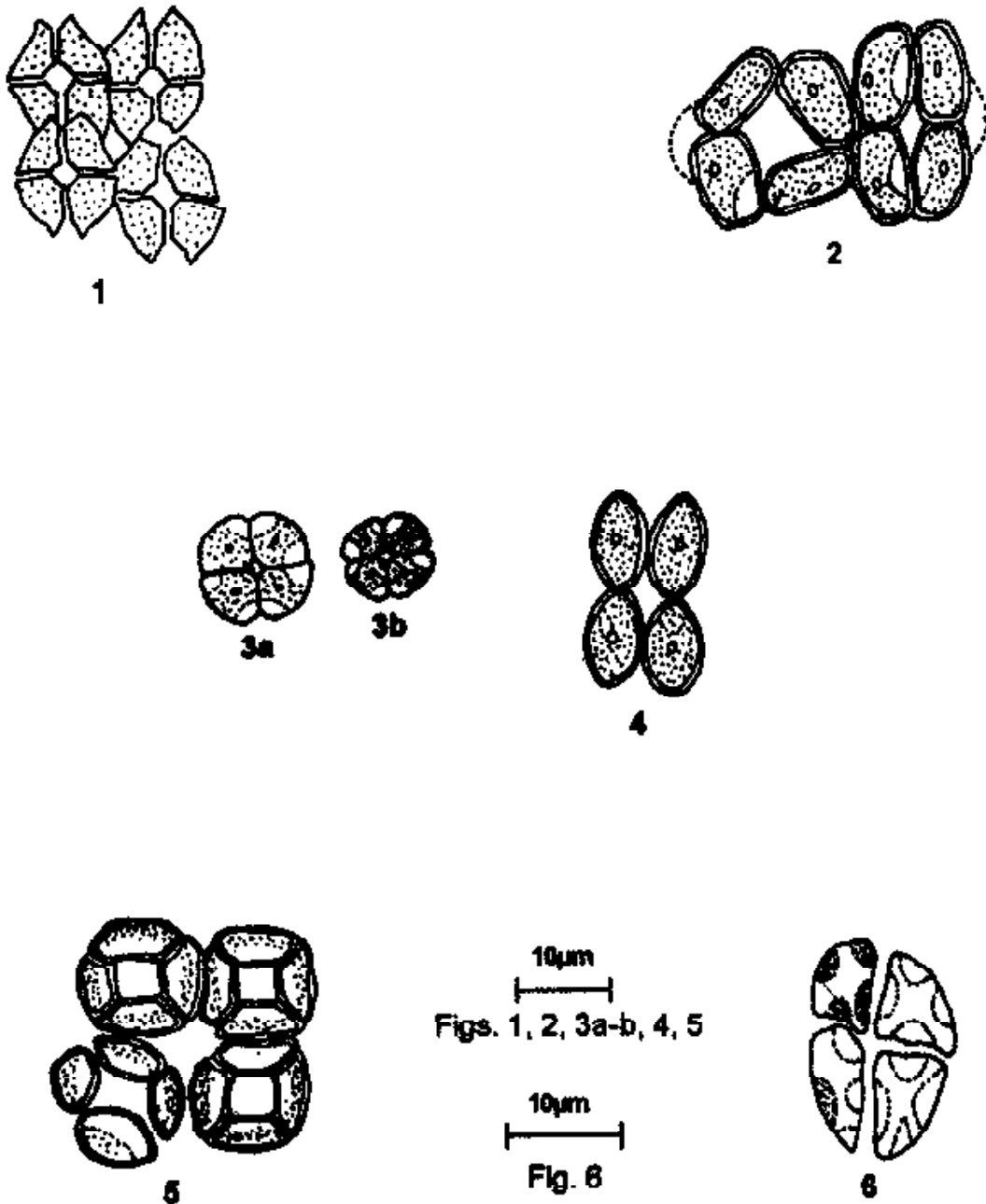


Plate - 11 : Figs. 1-6 : 1. *Crucigenia apiculata*; 2. *Crucigenia crucifera*; 3a-b. *Crucigenia quadrata*; 4. *Crucigenia rectangularis*; 5. *Crucigenia fenestrata*; 6. *Crucigenia tetrapedia*.

*Phenology* : March.

Planktonic in a road side cemented tank at Mussoorie, associated with members of Ulotrichales (93181).

**3. *Crucigenia fenestrata*** (Schmidle) Schmidle in Allg. bot. Z. 6: 234. 1900; Philipose, Chlorococcales 238. fig. 147. 1967. *Staurogenia fenestrata* Schmidle 1897.

Pl. 11, Fig. 5

Colony rectangular with central space, 8.47-13.75  $\mu\text{m}$  broad; cells 4 trapezoidal, 6.23-8.53  $\mu\text{m}$  long, 3.15-4.86  $\mu\text{m}$  broad; outer wall convex with rounded ends; lateral and inner walls straight; chloroplast disc-shaped; pyrenoid 1.

*Phenology* : January.

Free floating in a swamp area at Lachiwala, associated with diatoms mixture (93172).

**4. *Crucigenia quadrata*** Morren in Ann. Sci. nat. Bot. 20: 415. pl. 15. figs. 1-5. 1830; Philipose, Chlorococcales 241. fig. 152. 1967; Kant & Gupta, Algal Fl. Ladakh 92. pl. 92. fig. 7, pl. 93. fig. 2. 1998. *Pediastrum quadratum* (Morren) Menegh. 1840, *Staurogenia quadrata* (Morren) Kütz. 1849.

Pl. 11, Figs. 3a-b

Colonies quadrate consisting of circular plate of 4 rectangular celled, 9.38-12.16  $\mu\text{m}$  broad; cells spherical with rounded corners, cruciately arranged with space at centre, 2.53-5.47  $\mu\text{m}$  broad; outer wall convex, lateral walls straight; chloroplasts parietal disc; pyrenoid present or absent.

*Phenology* : March.

Planktonic in a small Pool at Mussoorie, associated with *Microspora* sp. (93179).

**5. *Crucigenia rectangularis*** (A. Br.) Gay, Recherches sur la developpement et la classification de quelques algues vertes 100. pl. 15. fig. 151. 1891; Philipose, Chlorococcales 238. fig. 148. 1967; Kant & Gupta, Algal Fl. Ladakh 92. pl. 22. fig. 16, pl. 92. fig. 6. 1998. *Staurogenia rectangularis* A. Br. 1855.

Pl. 11, Fig. 4

Colonies rectangular, 4-celled with small rectangular space at centre, 12.71-20.17  $\mu\text{m}$  long, 8.15-13.74  $\mu\text{m}$  broad; cells elongate ovoid, contact with poles and sides, 5.36-9.22  $\mu\text{m}$  long, 4.19-6.36  $\mu\text{m}$  broad; chloroplast 1-4, parietal disc; pyrenoid 1.

*Phenology* : August.

Planktonic in a road side ditch at Asan, associated with *Spirogyra gracilis* (93124).

6. *Crucigenia tetrapedia* (Kirchn.) W. & G.S. West in Trans. R. Irish Acad. (B) 32: 62. pl. 1. figs. 11-12, 1902; Anand, Ind. freshwater microalgae 34. fig. 110. 1998; Kant & Gupta, Algal Fl. Ladakh 92. pl. 92. fig. 10. 1998. *Staurogenia tetrapedia* Kirchn. 1880, *Lemmermannia tetrapedia* (Kirchn.) Lemm. 1904.

Pl. 11, Fig. 6

Colonies quadrate 4 celled with rectangular space at centre, 15.36-18.22  $\mu\text{m}$  long, 10.25-14.72  $\mu\text{m}$  broad; cells flattened and triangular with rounded ends, 5.45 - 8.38  $\mu\text{m}$  broad; outer sides of cells concave; chloroplast parietal plate; pyrenoid 1.

*Phenology* : August.

Planktonic in a puddle at Asan, associated with *Spirogyra gracilis* (93122).

### 3. SCENEDESMUS Meyen

Colony flat plate of 2-4-8 cells; cells acicular, ellipsoid, ovoid or cylindrical, with parallel longitudinal axis, arranged one or two rows; cell wall smooth, with or without lateral ridges; uninucleate; chloroplast parietal; pyrenoid single; reproduction by autocolony.

### KEY TO THE SPECIES

- |                                       |                         |
|---------------------------------------|-------------------------|
| 1a. Cells without spines              | 2                       |
| b. Cells with spines                  | 4                       |
| 2a. Cell arranged linear              | 3. <i>S. bljugatus</i>  |
| b. Cell not arranged linear           | 3                       |
| 3a. Cells acicular and curved         | 1. <i>S. acuminatus</i> |
| b. Cells erect and spindle            | 4. <i>S. obliquus</i>   |
| 4a. Cells oblong with lateral contact | 2. <i>S. armatus</i>    |

- b. Cells ovoid-cylindrical not with lateral contact

5. *S. quadricauda*

1. *Scenedesmus acuminatus* (Lagerheim) Chodat in Mater. pour la Flore Crypt. Suisse 1(3): 211. fig. 88. 1902; Biswas in Rec. Bot. Surv. India 15(1): 71. pl. 3. figs. 34a-c. 1949; Philipose, Chlorococcales 251. fig. 161. 1967; *Selenastrum acuminatum* Lagerheim 1883, *Scenedesmus falcatus* Chodat 1894. *Scenedesmus obliquus* var. *acuminatus* Playfair 1912.

Pl. 12, Fig. 5

Colonies curved arranged in single series; cells 4 lunate, fusiform with sharp pointed ends, 49.56-56.23  $\mu\text{m}$  long, 5.28-6.97  $\mu\text{m}$  broad; cell wall smooth; spines or teeth absent; chloroplast parietal; pyrenoid 1.

*Phenology* : December-March.

Free floating in a stagnant water at Gullar ghati, associated with members of Ulotrichales (93160).

2. *Scenedesmus armatus* (Chodat) G.M. Smith in Trans. wis. Acad. Sci. Arts Lett. 18(2): 460. pl. 28. fig. 53, pl. 29. figs. 90-93, pl. 30. figs. 109-110. 1916; Philipose, Chlorococcales 261. fig. 171. 1967; Anand, Ind. freshwater microalgae 34. fig. 100. 1998; Kant & Gupta, Algal Fl. Ladakh 96. pl. 31. fig. 4. pl. 97. fig. 4. 1998; *Scenedesmus quadricauda* var. *acutiformis* Schmidle 1900, *Scenedesmus hystrix* var. *armatus* Chodat 1902, *Scenedesmus quadricauda* Biswas 1934, *Scenedesmus quadricauda* var. *armatus* (Chodat) Dedussenko 1953.

Pl. 12, Fig. 4

Colonies flat; cells oblong, ellipsoid with ends rounded, arranged in single linear series, 8.19-15.32  $\mu\text{m}$  long, 4.11-7.93  $\mu\text{m}$  broad; terminal cells with single curved spine at each pole, 8.28-10.39  $\mu\text{m}$  long; chloroplast parietal; pyrenoid 1.

*Phenology* : December-April.

Planktonic in a small puddle at Gullar ghati, associated with *Spirogyra* and few diatoms species (93157).

3. *Scenedesmus bifugatus* (Turpin) Kütz. in Linnaea 8: 607. 1833; Philipose, Chlorococcales 252. figs. 164c, e, f. 1967; Prasad & Misra,

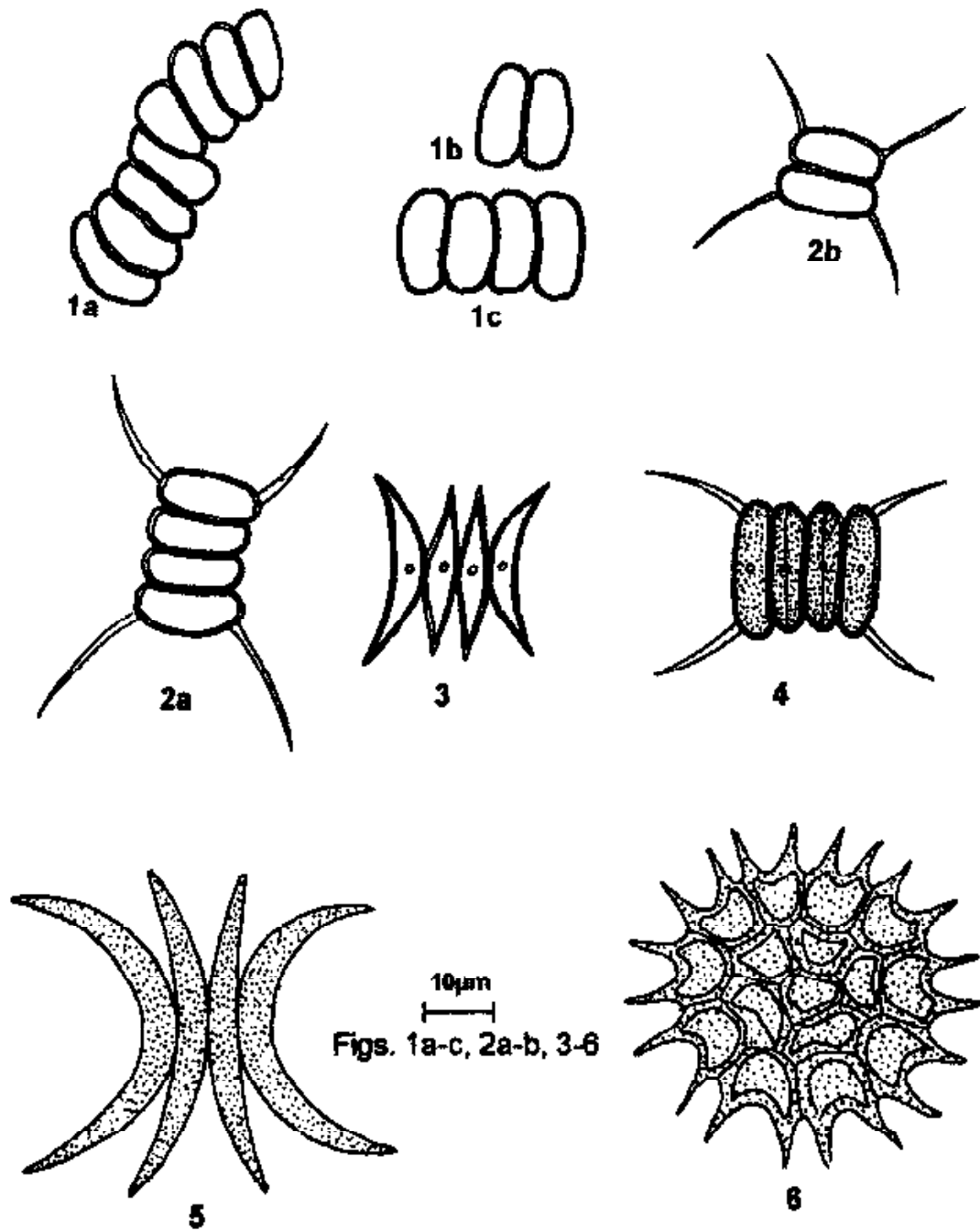


Plate - 12 : Figs. 1-6 : 1a. *Scenedesmus bijugatus*, 1b. 2 cells colony, 1c. 4 cells colony; 2a. *Scenedesmus quadricauda*, 2b. 2 cells colony; 3. *Scenedesmus obliquus*; 4. *Scenedesmus armatus*; 5. *Scenedesmus acuminatus*; 6. *Pedastrum muticum*.



Freshwater algal Fl. Andaman and Nicobar Islands 35. pl. 5. fig. 1. 1992; Anand, Ind. freshwater microalgae 34. fig. 101. 1998; Kant & Gutpa, Algal Fl. Ladakh 94. pl. 27. figs. 2, 6, 8, 27, 28, pl. 29. figs. 9, 14, pl. 30. figs. 27a, b, pl. 96. fig. 4, pl. 98. figs. 2, 7, 1998. *Achnanthes quadrijuga* Turpin 1820, *Achnanthes bijuga* Turpin 1828, *Scenedesmus obtusus* Meyen 1829, *Scenedesmus quadricauda* var. *ecornis* Ralfs 1848, *Scenedesmus variabilis* de wilde. 1849, *Scenedesmus variabilis* var. *ecornis* de Wilde. 1893, *Scenedesmus bjuga* (Turpin) Lagerheim 1893, *Scenedesmus ecornis* (Ralfs) Chodat 1926.

Pl. 12, Figs. 1a-c

Colonies flat or slightly curved consisting of 2-4-8 cells arranged in single linear series, 65.63-74.28  $\mu\text{m}$  long, 4.78-8.53  $\mu\text{m}$  broad; cells oblong, ellipsoid to ovoid with rounded both ends, 14.76-18.28  $\mu\text{m}$  long, 3.65-7.31  $\mu\text{m}$  broad; cell wall smooth; chloroplast 1 parietal; pyrenoid 1.

*Phenology* : March.

Free floating in a cemented tank at Jharipani, associated with other species of *Scenedesmus* (93183).

4. *Scenedesmus obliquus* (Turpin) Kütz. in Linnaea 8: 609. 1833; Biswas in Rec. Bot. Surv. India 15(1): 71. pl. 3. fig. 35. 1949; Philipose, Chlorococcales 248. fig. 159. 1967; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 38. pl. 5. fig. 2. 1992; Kant & Gupta, Algal Fl. Ladakh 94. pl. 27. figs. 9 & 21, pl. 30. fig. 28. 1998; Anand, Ind. freshwater microalgae p. 34. fig. 104. 1998. *Achnanthes obliqua* Turpin 1820, *Scenedesmus acutus* Meyen 1829, *Scenedesmus acutus* var. *obliquus* Rabenh., 1868, *Scenedesmus obliquus* forma *Parvus* Bernard 1908.

Pl. 12, Fig. 3

Colonies composed of 4 erect cells arranged in single series, 42.18-47.93  $\mu\text{m}$  long, 3.46-6.12  $\mu\text{m}$  broad; cells fusiform, 9.53 - 22.32  $\mu\text{m}$  long, 2.87-5.46  $\mu\text{m}$  broad, intermediate cells more or less straight with slightly convex sides, outer side of terminal cells concave; cell wall smooth; spines absent; chloroplast parietal; pyrenoid 1.

*Phenology* : December.

Planktonic in a stagnant water at Gullar ghati, associated with species of *Spirogyra* (93162).

**5. *Scenedesmus quadricauda*** (Turpin) Brebisson in Mem. Soc. Sci. nat. Cherbourg 4: 66. 1835; Biswas in Rec. Bot. Surv. India 15(1): 71. pl. 3. fig. 36, 1949; Philipose, chloroccales 283. fig 187a. 1967; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 40. pl. 5. fig. 13. 1992. Kant & Gupta, Algal Fl. Ladakh 98. pl. 30. fig. 20. 1998; Anand, Ind. freshwater microalgae 34. fig. 105. 1998. *Achnanthes quadricauda* Turpin 1820, *Scenedesmus caudatus* Corda 1834, *Scenedesmus quadricauda* f. *minor* Turner 1892, *Scenedesmus quadricauda* var. *typicus* Brunthaler 1915.

Pl. 12, Figs. 2a-b

Colonies 2-4 celled, 37.32-43.72  $\mu\text{m}$  long, 2.14-3.23  $\mu\text{m}$  broad; cells oblong-cylindrical with rounded ends, arranged in single linear series and closely attached to one another along lateral walls, 16.45-18.28  $\mu\text{m}$  long, 5.48-6.79  $\mu\text{m}$  broad; poles terminal with slightly curved; spines, 10.97-13.71  $\mu\text{m}$  long, 0.98-1.36  $\mu\text{m}$  broad; cell wall smooth; chloroplast parietal; pyrenoid 1.

*Phenology* : March - May.

Free floating in a cemented tank at Jharipani, associated with *Pediastrum boryanum* (93183); free floating in a ditch of Varuwala pond alongwith other species of *Scenedesmus* sp. (93197).

### 3. Order : Ulotrichales

Thallus consisting of simple uniseriate, unbranched filament, composed of cylindric barrel-shaped or cellular expanse; free floating or attached; mostly inhabitants of freshwater; uninucleate; cell wall two layers; chloroplast one parietal plate, laminate, reticulate or cup-shaped; pyrenoids one or more; reproduction by fragmentation, zoospores, aplanospores or akinetes, sexuality isogamous or anisogamous.

### KEY TO THE FAMILIES

- |   |                   |
|---|-------------------|
| 1a. Thallus parenchymatous                    | 3. ULVACEAE       |
| b. Thallus unbranched filament                | 2                 |
| 2a. Chloroplast parietal plate or band shape  | 1. ULOTRICHACEAE  |
| b. Chloroplast parietal net shape or areolate | 2. MICROSPORACEAE |

### 1. ULOTRICHACEAE

### KEY TO THE GENERA

- |                                  |              |
|----------------------------------|--------------|
| 1a. Filaments without basal cell | 1. HORMIDIUM |
| b. Filaments with basal cell     | 2            |

- 2a. Apex cell pointed or curved 3. URONEMA  
 b. Apex cell not pointed or curved 2. ULOTHRIX

1. *HORMIDIUM* Kütz. 1843

Filaments unbranched, without basal or terminal cell; cells cylindrical; cell wall thin and slightly slimy; chloroplast parietal plate or disc-shaped, extending half or less the circumference of cell; uninucleate; pyrenoid one; reproduction by fragmentation, akinetes or zoospores, sexuality isogamous.

KEY TO THE SPECIES

- 1a. Cells broader, 10 to 14  $\mu\text{m}$  broad 1. *H. flaccidum*  
 b. Cells narrow, 3 to 7  $\mu\text{m}$  broad 2  
 2a. Cells 5-7  $\mu\text{m}$  broad, 1-3 times long 3. *H. subtile*  
 b. Cells 3-4  $\mu\text{m}$  broad, 5 to 10 times long 2. *H. scopulinum*

**1. *Hormidium flaccidum* (Kütz.) A. Br.** Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen 341. 1896; Heering in Pascher's Süßwasser Flora 6: 45. figs. 48-49. 1914; Ramanathan, Ulotrichales 81. pl. 21. figs. a-f, pl. 22. figs. a-e. 1964; Anand, Ind. freshwater microalgae 41. fig. 136. 1998; Kant & Gutpa, Algal Fl. Ladakh 104. pl. 34. fig. 10, pl. 36. fig. 7. 1998. *Ulothrix flaccida* Kütz. 1833, *Stichococcus flaccidus* (Kütz.) Gay 1891.

Pl. 13, Fig. 1

Filaments long unbranched; cells cylindrical not constricted at cross walls, 16.24-25.92  $\mu\text{m}$  long, 11.23-12.53  $\mu\text{m}$  broad; wall thin; chloroplast 1 parietal plate covering half cell; uninucleate; pyrenoid 1.

*Phenology* : September.

Free floating in a road side ditches at Mothranowala, associated with diatoms mixture (96245).

**2. *Hormidium scopulinum* (Hazen) Smith** Freshwater Algae U.S. 147. 1950; Ramanathan, Ulotrichales. 84. pl. 22. figs. s-u 1964. *Stichococcus scopulinus* Hazen 1902, *Gloeotila scopulina* (Hazen) Heering 1914.

Pl. 13, Fig. 2

Filaments long unbranched; cells cylindrical, without constriction at cross wall; cells. 30.95-32.15  $\mu\text{m}$  long. 3.17-3.97  $\mu\text{m}$  broad; chloroplast folded plate covering half cell; uninucleate; pyrenoid 1.

*Phenology* : August.

Attached on moist soils forming grass green patches at Golatappar (96228).

**3. *Hormidium subtile* (Kütz.) Heering** in Pascher's Süßwasserflora 6: 47. fig. 54. 1914. Ramanathan, Ulotrichales 83. pl. 22. figs. f-h, 1964; Kant & Gupta, Algal Fl. Ladakh 104. pl. 34. figs. 8. 1998. *Ulothrix subtilis* Kütz. 1833, *Stichococcus subtilis* (Kütz.) Klercker 1896.

**Pl. 13, Figs. 3a-b**

Filaments unbranched; cells cylindrical, 17.22-20.38  $\mu\text{m}$  long, 5.38-6.74  $\mu\text{m}$  broad; cell wall thin; chloroplast elliptic covering half cell; pyrenoid 1.

*Phenology* : June.

Attached on exposed rocks with water dropping from cliffs at Sahasradhara, associated with desmids (96211).

## 2. *ULOTHRIX* Kütz.

Filaments simple unbranched, not apically attenuated; hold-fast present; cells cylindrical or slightly swollen, barrel-shaped; cell wall thin or thick; chloroplast single, girdle shaped or parietal band, occupying partly or fully encircling the protoplast; uninucleate; pyrenoids several; reproduction by zoospores, aplanospores or akinetes, sexuality isogamous.

### KEY TO THE SPECIES

- |                                       |                         |
|---------------------------------------|-------------------------|
| 1a. Cells constricted at cross wall   | 1. <i>U. tenerrima</i>  |
| b. Cells without constricted          | 2                       |
| 2a. Chloroplast parietal-plate shaped | 2. <i>U. variabilis</i> |
| b. Chloroplast band shaped            | 3. <i>U. zonata</i>     |

**1. *Ulothrix tenerrima* (Kütz.) Kütz.** Phyc. Gen. 253. 1843; Heering in Pascher's Süßwasser-Flora 6: 32. figs. 28-30. 1914; Ramanathan, Ulotrichales 37. pl. 10. figs. a-c. 1964; Prasad & Misra, Freshwater

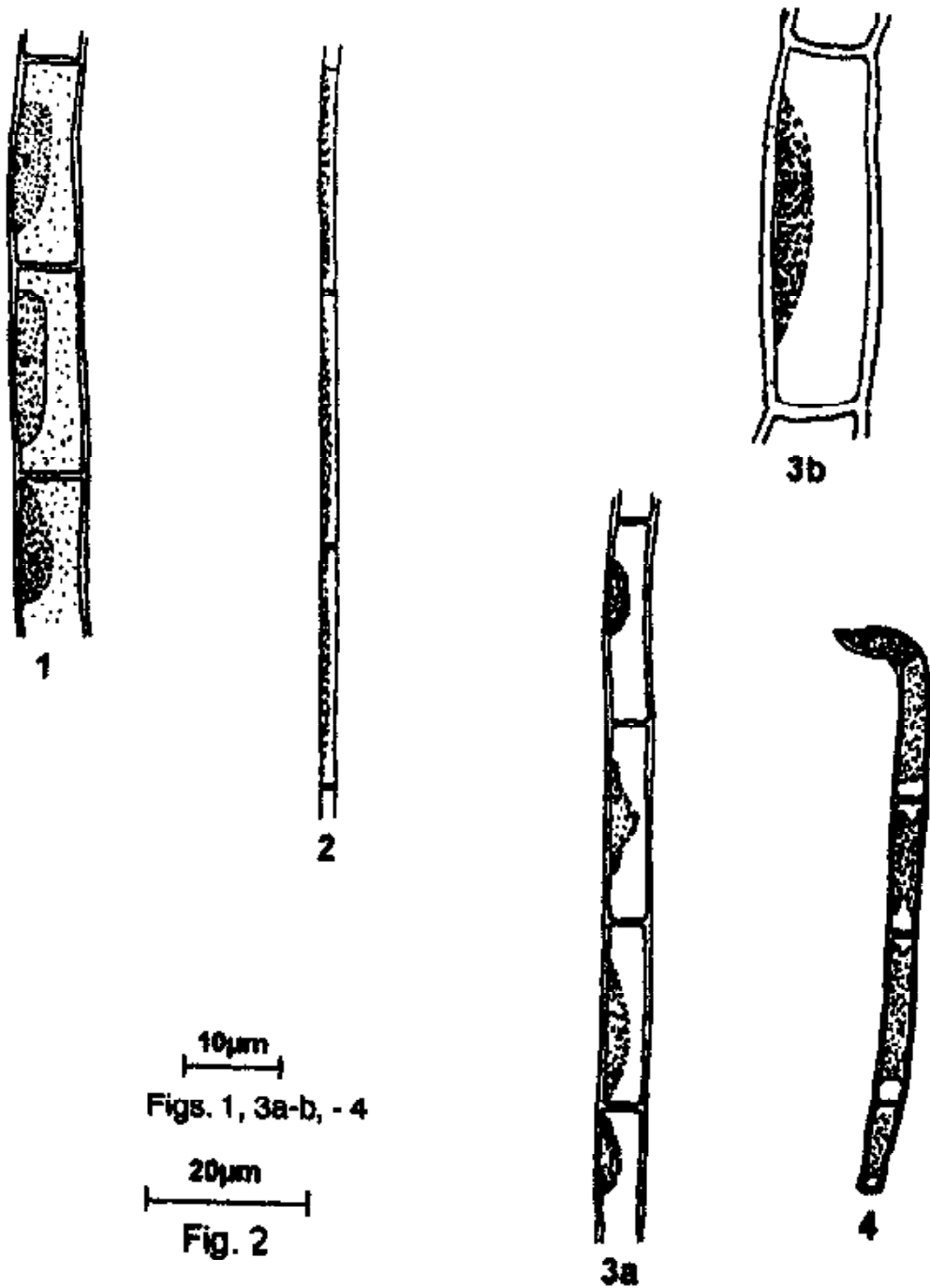


Plate - 13 : Figs.1-4 : 1. *Hormidium flaccidum*; 2. *Hormidium scopulinum*; 3a-b. *Hormidium subtile*; 4. *Uronema africanum*.

algal Fl. Andaman and Nicobar Islands 44. pl. 6. figs. 7. 1992; Kant & Gupta, Algal Fl. Ladakh 102. pl. 32. fig. 10. pl. 105. fig. 5. 1998.

**Pl. 14, Figs. 1a-b**

Filaments long unbranched; cells cylindrical, constricted at cross-wall, 6.21-10.52  $\mu\text{m}$  long, 8.58-9.89  $\mu\text{m}$  broad; cell wall thin and mucilaginous; chloroplast 1, girdle shaped, irregularly folded, encircling more than half circumference of cell; uninucleate; pyrenoid 1.

*Phenology* : Throughout the year.

Attached on moist rock in stagnant water at Sahasradhara, associated with *Rhizoclonium* and few filaments of *Spirogyra* (93140, 93144); attached on submerged twig at Asan reservoir, associated with *Rhizoclonium* sp. (93188); attached on stone at Varubala pond, associated with *Mougeotia* sp. (93199); attached on small puddle at Mohand, associated with species of *Rhizoclonium* and *Microspora* (94823).

2. *Ulothrix variabilis* (Kütz.) Kütz., Sp. Alg. 346 1849; Heering in Pascher's Süßwasser-Flora 6: 32. fig. 27. 1914; Ramanathan, Ulotrichales 39. pl. 10. figs. d-f, 1964; Kant & Gupta, Algal Fl. Ladakh 102. pl. 32. fig. 6, pl. 105. fig. 1. 1998. *Hormidium variabile* Kütz. 1833, *Ulothrix subtilis* var. *variabilis* Kirchn. 1896.

**Pl. 14, Fig. 2a-b**

Filaments long, entangled; cells cylindrical without constriction, 14.63-15.47  $\mu\text{m}$  long, 4.56-6.18  $\mu\text{m}$  broad; cell wall thin; chloroplast parietal-plate not complete circular in mid region; pyrenoids 6-7; nucleus 1.

*Phenology* : Throughout the year.

Attached on wet soil near Yamuna river (93177); free floating in a ditch at Gullar ghati, associated with cyanobacteria and few diatoms (93160, 93157); free floating in a ditch at Mohand, associated with diatoms and desmids (94828).

3. *Ulothrix zonata* (Weber & Mohr) Kütz. in Flora. 16: 519. 1833; Heering in Pascher's Süßwasser-Flora 6: 35. figs. 35-36. 1914; Printz in Hydrobiologia 24: 18. pl. 3. figs. 1-12. 1964; Ramanathan, Ulotrichales 30. pl. 1. figs. a-b, pl. 3. figs. a, g-i, pl. 4. figs. a-h, pl. 5. figs. a-

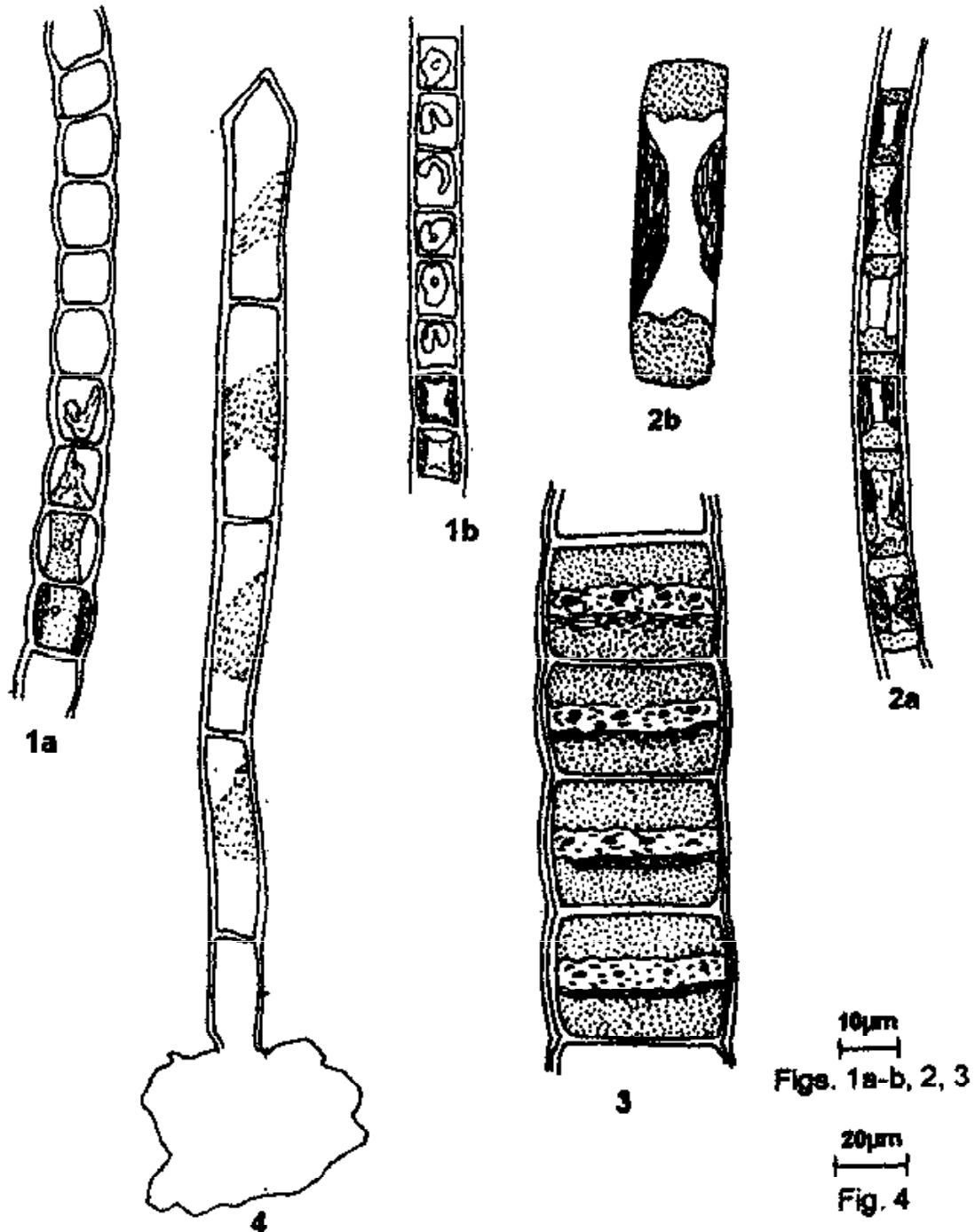


Plate 14 : Figs. 1-4 : 1a-b. *Ulothrix tenerrima*; 2a-b. *Ulothrix variabilis*; 3. *Ulothrix zonata*; 4. *Uronema elongatum*.

n, pl. 6. figs. a-j. 1964; Anand, Ind. freshwater microalgae 44. fig. 140. 1998; Kant & Gupta, Algal Fl. Ladakh 102. pl. 32. fig. 8, pl. 33, fig. 2, pl. 105. figs. 2, 7. 1998.

**Pl. 14, Fig. 3**

Filaments unbranched attached by modified basal cell; cells slightly swollen, 29.26-58.52  $\mu\text{m}$  long, 31.18-45.71  $\mu\text{m}$  broad; cell wall thin; chloroplast band shaped, complete circular in mid region; pyrenoids 6-8; nucleus 1.

*Phenology* : December March.

Attached on twig of Angiosperm in a shallow water of Yamuna, associated with *Spirogyra* sp. (93177); attached in a small puddle at Mussoorie along with *Microspora* (93181); attached in a Puddle at Mohand, associated with *Fragilaria* and *Microspora* sp. (94830).

**3. URONEMA Lagerheim**

Filaments unbranched, uniseriate; cells cylindrical; terminal cell pointed, straight or curved; basal cell attached; cell wall thin; chloroplast parietal-plate; nucleus one; pyrenoids one or two; reproduction by fragmentation, zoospores, or aplanospores.

**KEY TO THE SPECIES**

- |   |                            |
|---|----------------------------|
| 1a. Terminal cell straight                                    | 2                          |
| b. Terminal cell curved                                       | 3                          |
| 2a. Cells 3.5-7.00 $\mu\text{m}$ broad                        | 2. <i>U. confervicolum</i> |
| b. Cells 9.00-11.00 $\mu\text{m}$ broad                       | 4. <i>U. gigas</i>         |
| 3a. Cells 7.0-9.5 $\mu\text{m}$ broad, apical cell swollen    | 3. <i>U. elongatum</i>     |
| b. Cells 2.5-5.0 $\mu\text{m}$ broad, apical cell not swollen | 1. <i>U. africanum</i>     |

1. *Uronema africanum* Borge in Hedwigia 68: 96. pl. 1. figs. 2 a-d. 1928; Ramanathan, Ulotrichales 51. pl. 13. figs. h-l. 1964; Kant & Gupta, Algal Fl. Ladakh 103. pl. 33. fig. 6. 1998.

**Pl. 13, Fig. 4**

Filaments unbranched; basal cell elongate slightly tapering towards base, 9.16-10.24  $\mu\text{m}$  long, 2.28-3.53  $\mu\text{m}$  broad; terminal cell curved with pointed end; cells cylindrical, constricted, 10.42-16.26  $\mu\text{m}$  long, 3.18-4.68  $\mu\text{m}$  broad; chloroplast parietal, filling complete cell; uninucleate; pyrenoid 1-2.



*Phenology* : May.

Epiphytic on submerged aquatic plant in Varubala pond, associated with members of Chaetophorales (93198).

2. *Uronema confervicolum* Lagerheim in Malphigia 1: 518. pl. 1. 1887; Heering in Pascher's Süßwasser-Flora 6: 36. fig. 37. 1914; Ramanathan, Ulotrichales 50. pl. 13. figs. a-g. 1964; Kant & Gupta, Algal Fl. Ladakh 103. pl. 33. figs. 7a, b, pl. 105. fig. 6. 1998.

Pl. 15, Figs. 1a-b

Filaments unbranched, slightly curved, consisting of many cells; basal cell, 17.28-22.54  $\mu\text{m}$  long, 3.52-3.98  $\mu\text{m}$  broad; cells cylindrical, constricted, 12.32-22.48  $\mu\text{m}$  long, 4.25-6.17  $\mu\text{m}$  broad; apical cell pointed, 20.35-25.38  $\mu\text{m}$  long; chloroplast laminate, filling complete cell; pyrenoids 1-3.

*Phenology* : October.

Epiphytic on *Rhizoclonium* sp. in a slowly flowing stream at Sahasradhara (93152).

3. *Uronema elongatum* Hodgetts in New Phytol. 17: 159. figs. 1-11. 1918; Ramanathan, Ulotrichales 51. pl. 14. figs. a-g. 1964; Printz in Hydrobiologia 24: 36. pl. 6. figs. 9-11. 1964; Kant & Gupta, Algal Fl. Ladakh 103. pl. 32. fig. 4, pl. 33. fig. 8, pl. 103. fig. 4, pl. 106. fig. 2. 1998.

Pl. 14, Fig. 4

Filaments straight; cells cylindrical, 30.48-58.72  $\mu\text{m}$  long, 6.23-9.46  $\mu\text{m}$  broad; terminal cell unsymmetrically, slightly swollen and curved with acuminate tip; basal cell gradually attenuated and fixed to substratum by small cushion; cell wall thin; chloroplast parietal, folded plate, extending two third length of cell; pyrenoids 1 - 2.

*Phenology* : November.

Epiphytic on *Oedogonium* sp. under expose condition at Mohand, associated with *Closterium* sp. (94843).

4. *Uronema gigas* Vischer in Beih. bot. Centralbl. 51(Abt. A): 74. abb. 32. figs. 1-18. 1933; Ramanathan, Ulotrichales 53. pl. 14. figs.

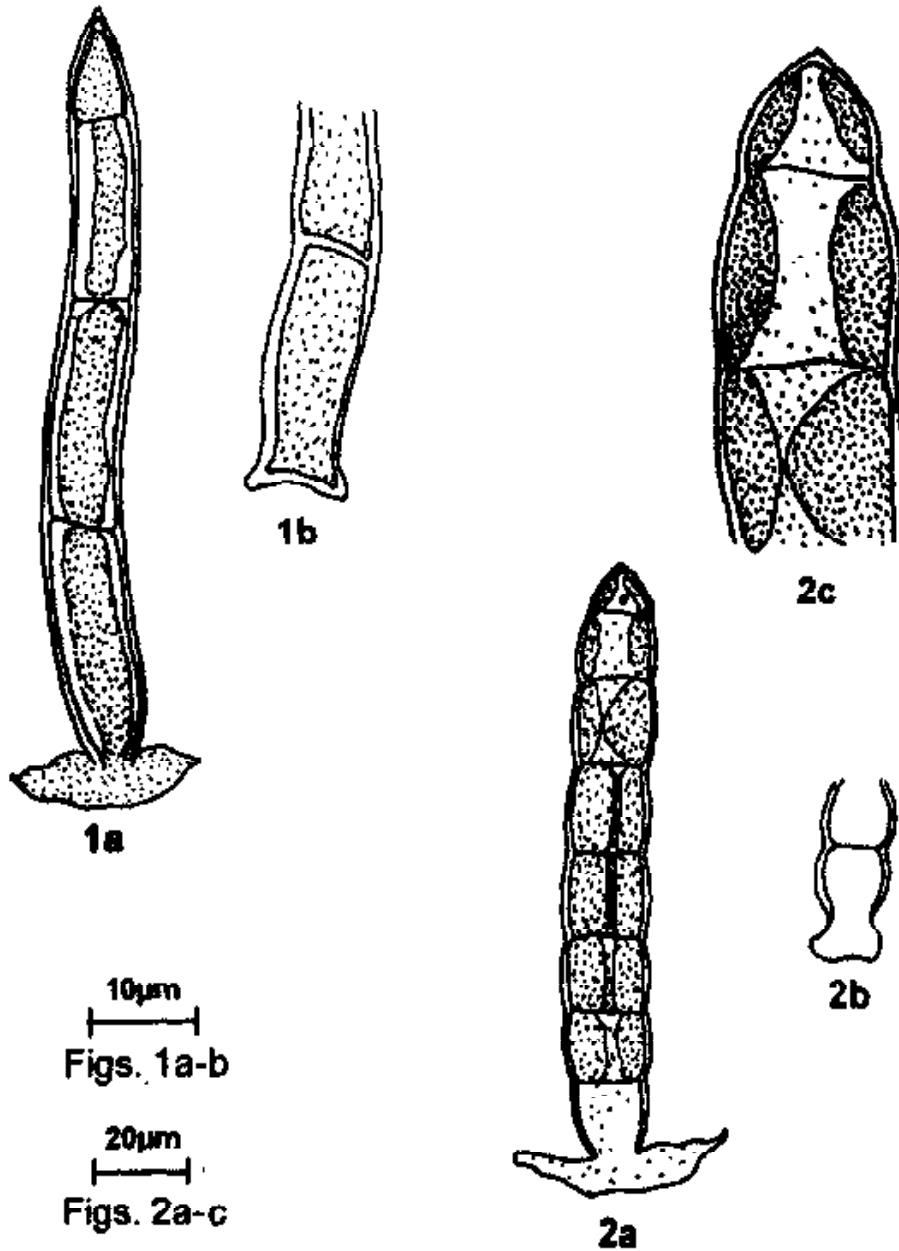


Plate - 15 : Figs. 1-2 : 1a. *Uronema confervicolum*, 1b. Basal cell; 2a. *Uronema gigas*, 2b. Basal cell, 2c. Apical cell.

h-u. 1964; Anand, Ind. Freshwater microalgae 44. fig. 139. 1998.

**Pl. 15, Figs. 2a-c**

Filaments straight or faintly curved; septa slightly constricted; cells, 10.29-18.43  $\mu\text{m}$  long, 8.53-10.78  $\mu\text{m}$  broad; terminal cell attenuated; basal cell with attaching disc; chloroplast 1 parietal, occupying most part of cell; pyrenoids 2-3.

*Phenology* : October.

Epiphytic on *Chara* sp. in a puddle at Sahasradhara (93127).

**2. MICROSPORACEAE**

**1. MICROSPORA Thuret**

Filaments unbranched; cells cylindrical or slightly swollen barrel shaped; cell wall thin or thick, overlapping in mid region and composed of two articulated H-shaped pieces; uninucleate; chloroplast parietal-plate, perforate or reticulate net like; pyrenoids absent; reproduction by fragmentation, aplanospores, akinetes or zoospores.

**KEY TO THE SPECIES**

- |   |                       |
|---|-----------------------|
| 1a. H-shaped structure prominent in vegetative condition    | 1. <i>M. amoena</i>   |
| b. H-shaped structure not prominent in vegetative condition | 2                     |
| 2a. Chloroplast perforated covering only margin of cells    | 3. <i>M. willeana</i> |
| b. Chloroplast reticulate covering throughout cells         | 2. <i>M. floccosa</i> |

1. *Microspora amoena* (Kütz.) Rabenh., Fl. Eur. Alg. 3: 321. 1868; Heering, in Pascher's Süßwasser-Flora 6: 154. fig. 222. 1914; Printz in Hydrobiologia 24: 78. pl. 16. figs. 11-15. 1964; Ramanathan, Ulotrichales 132. pl. 29. figs. a-c, j-w, pl. 30. figs. a, d-f, f, pl. 31. figs. a-d, pl. 37. figs. a-e. 1964; Kant & Gupta, Algal Fl. Ladakh 106. pl. 35. fig. 3, pl 104. fig. 12. 1998.

**Pl. 16, Figs. 3a-b**

Filaments unbranched; cells cylindrical, slightly constricted at cross

walls, 41.56-46.39  $\mu\text{m}$  long, 22.49-24.13  $\mu\text{m}$  broad; cell wall thick, 2.69-3.23  $\mu\text{m}$  broad; H-shaped structure prominent in midregion; lamellation absent; chloroplast parietal perforated, irregularly thickened, completely covering cell wall; nucleus 1; akinetes globose, light brown, 20.21-24.34  $\mu\text{m}$  broad, wall thick.

*Phenology* : Throughout the year.

Free floating in a shallow swamps at Sahasradhara, intermingled with other green algae (93140); free floating in a ditch at Gullar ghati, associated with *Pithophora* and diatoms mixture (93162); free floating in a small ditch at Mohand, associated with species of *Rhizoclonium* and *Ulothrix* (94823, 94830, 94840); free floating in a puddle at Sahiya, associated with species of *Spirogyra* and *Fragilaria* (94858, 94859); free floating in a road side ditches at Chakrata (94864).

**2. *Microspora floccosa*** (Vaucher) Thuret in Ann. Sci. nat. Bot. ser. 14: 222. pl. 17. figs. 4-7. 1850; Heering in Pascher's Süßwasser-Flora 6: 152. figs. 214, 215. 1914; Ramanathan, Ulotrichales 120. pl. 29. figs. g.h. pl. 30. figs. k-p, pl. 32. figs. b, m-u, pl. 33. figs. a-l, 1964; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 48. pl. 6. figs. 11, 12. 1992; Kant & Gupta, Algal Fl. Ladakh 105. pl. 35. fig. 4, pl. 104. fig. 7. 1998.

#### Pl. 16, Fig. 2

Filaments unbranched; cells cylindrical, slightly constricted at cross wall, 22.72-29.13  $\mu\text{m}$  long, 14.18-15.43  $\mu\text{m}$  broad; cell wall thin; H-shaped structure not prominent; chloroplast parietal reticulate; uninucleate; akinetes rounded light brown, arranged in series, 15.37-16.74  $\mu\text{m}$  broad; wall thick.

*Phenology* : August - January.

Free floating in a road side stagnant water near Asan barrage, associated with *Cymbella* sp. (93119, 93120); free floating in a ditch at Yamuna (93177); attached on moist wall at Mussoorie along with *Vaucheria* sp. (93179, 93181); free floating in a puddle at Gullar ghati, associated with *Spirogyra* sp. (93157).

**3. *Microspora willeana*** Lagerheim in Ber. dtsh. bot. Ges. 5: 414. 1887; Heering in Pascher's Süßwasser-Flora 6. fig. 213. 1914;

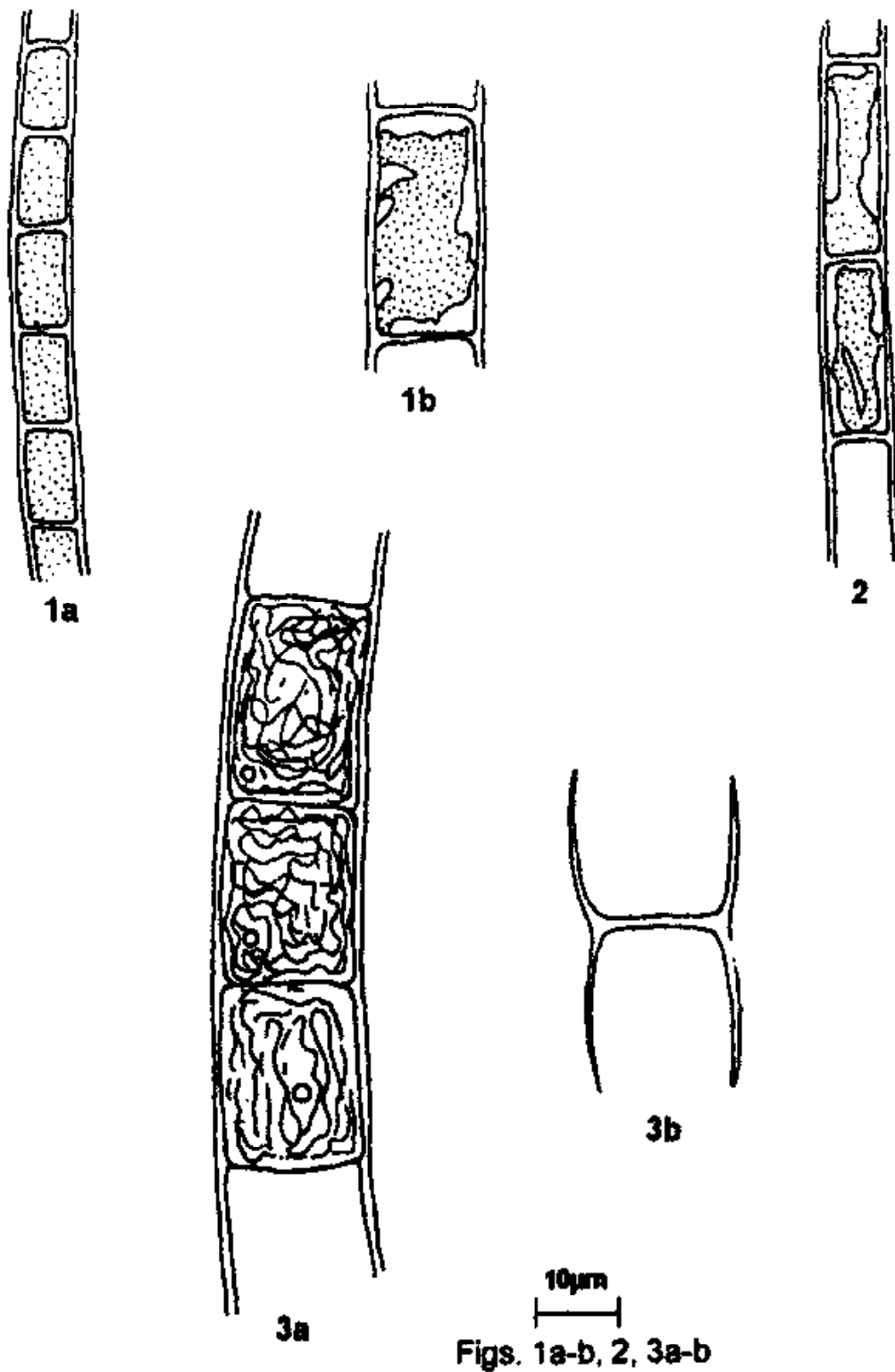


Plate - 16 : Figs. 1-3 : 1a. *Microspora willeana*, 1b. Single cell; 2. *Microspora floccosa*; 3a. *Microspora amoena*, 3b. H-shaped piece.

Ramanathan, *Ulotrichales* 122. pl. 32. figs. e-l, pl. 34. figs. a-o, 1964; Anand, *Ind. freshwater microalgae* 41. fig. 133. 1998; Kant & Gutpa, *Algal Fl. Ladakh* 105. pl. 35. fig. 5, pl. 104. figs. 6, 9. 1998.

**Pl. 16, Figs. 1a-b**

Filaments unbranched uniseriate, slightly constricted at cross walls; cell quadrate or slightly cylindrical, 11.23-25.48  $\mu\text{m}$  long, 10.34-15.52  $\mu\text{m}$  broad; cell wall thin; H-shaped structure not prominent; chloroplast perforated plate, covering only margin of side walls; pyrenoids absent; akinetes spherical, light brown arranged in series, 8.92-10.85  $\mu\text{m}$  broad, wall thick.

*Phenology* : Throughout the year.

Free floating in Yamuna river, intermingled with diatoms species (93173); free floating in a puddle at Kaunwala, Hardwar road, associated with diatoms mixture (93165); attached on an old submerged twig of angiosperms at Asan reservoir, associated with *Rhizoclonium* and *Ulothrix* sp. (93188); free floating in a ditch at Mohand, associated with *Fragillaria* sp. (94827).

### 3. ULVACEAE

#### 1. ENTEROMORPHA Link 1820

Thallus dark green, tubular; wall single layer; rhizoids present; cells polygonal; chloroplast parietal; pyrenoids present; reproduction by fragmentation or zoospores, sexuality isogamous or anisogamous.

1. *Enteromorpha intestinalis* (L.) Grev., *Algae britannicae* 179. 1830; *Ulva enteromorpha* var. *testinalis* L. 1881.

**Pl. 17, Figs. 1a-c**

Thallus dark green with hollow tubes, 9-12 cm long; tubular fronds inflated at intervals; rhizoids present at basal portion; cells angular, irregularly disposed by mutual compression, 13.38-18.27  $\mu\text{m}$  long, 10.98-16.57  $\mu\text{m}$  broad; uninucleate; chloroplast 1 parietal laminate, covering complete cell; pyrenoids 3-4.

*Phenology* : February.

Attached on submerged stones in slowly flowing water at Doiwala near wine factory, Hardwar road, associated with *Compsopogon* sp., (94878).

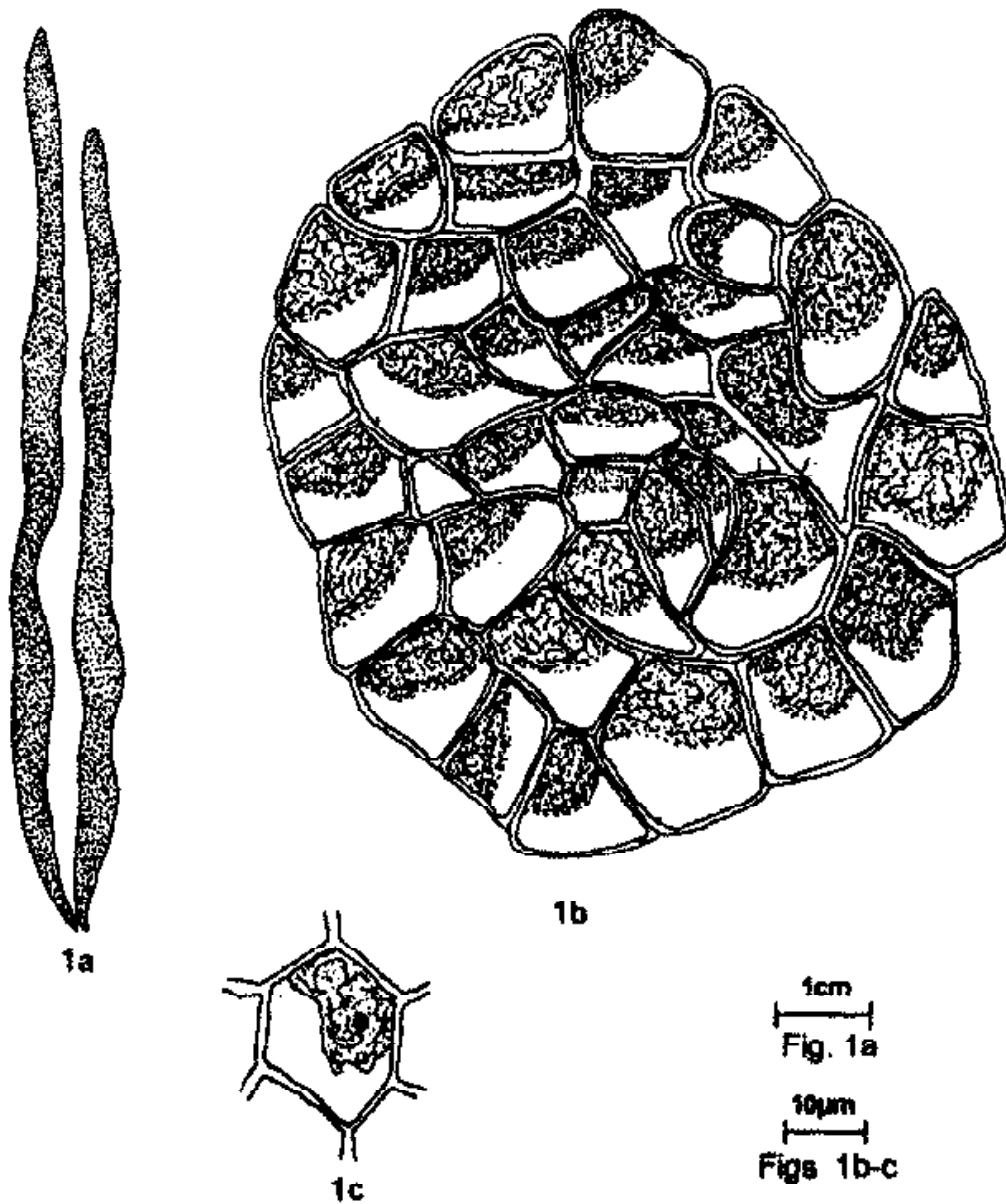


Plate 17 : Fig. 1 : 1a. *Enteromorpha intestinalis*, 1b. Surface view, 1c. Single cell with chloroplast.

## 4. Order : Cladophorales

Filaments unbranched or branched; attached or free floating; cells cylindrical; cell wall thick, lamellate; mucilaginous layer absent; apical cell rounded; setae or hair absent; chloroplast elaborate covering whole cell; multinucleate; pyrenoids numerous; reproduction by fragmentation, zoospores, aplanospores or akinetes, sexuality isogamous.

## 1. CLADOPHORACEAE

## KEY TO THE GENERA

- |  |                 |
|--|-----------------|
| 1a. Filaments unbranched or few branches | 3. RHIZOCLONIUM |
| b. Filaments freely branched             | 2               |
| 2a. Akinetes present                     | 2. PITHOPHORA   |
| b. Akinetes absent                       | 1. CLADOPHORA   |

## 1. CLADOPHORA Kütz.

Filaments profusely branched forming feathery tufts; attached; branch originate just beneath the septum, with alternate, opposite, or dichotomous or trichotomous; apices slightly tapering; cells cylindrical; cell wall thick or lamellate; mucilage absent; chloroplast parietal or reticulate, densely packed; multinucleate; pyrenoids many; reproduction by fragmentation, or zoospores, sexuality isogamous.

## KEY TO THE SPECIES

- |  |                        |
|--|------------------------|
| 1a. Branching mainly toward upper portion of frond | 2. <i>C. glomerata</i> |
| b. Branching repeatedly throughout frond           | 1. <i>C. crispata</i>  |

1. *Cladophora crispata* (Roth) Kütz., Phycologia generalis oder Anatomie Physiologie und Systemkunde der Tange 264. 1843.

Pl. 18, Fig. 1

Thallus caespitose; branch repeatedly throughout frond; lateral branches tapering, 120.45-136.78  $\mu\text{m}$  long, 20.23-35.16  $\mu\text{m}$  broad; main axis straight, 123.78-138.14  $\mu\text{m}$  long, 42.28-73.25  $\mu\text{m}$  broad; cells cylindrical, slightly swollen, 117.65-124.27  $\mu\text{m}$  long, 18.68-21.17  $\mu\text{m}$  broad; apices rounded; cell wall thin; chloroplast reticulate arranged loosely; nucleus 8-10; pyrenoids 6-7.



*Phenology* : June July.

Attached on stone in a rapidly flowing shallow water at Aglahar river near Mussoorie band, Bhandar Koat gaon, associated with *Coconis* sp. (94818).

**2. *Cladophora glomerata* (L.) Kütz.**, *Phycologia germanica Deutschlands Algen in bündigen Beschreibungen* 212. 1845; Biswas in *Rec. Bot. Surv. India* 15(1): 76 pl. 5. figs. 49a-b 1949; Anand, *Ind. freshwater microalgae* 44. figs. 143. 1998; Kant & Gupta, *Algal Fl. Ladakh* 107. pl. 36. fig. 11. 1998.

**Pl. 18, Figs. 2a-b**

Thallus feathery tufts, deep green; branched, crowded in upper portion of main axis, 204.82-232.18  $\mu\text{m}$  long, 73.15-78.12  $\mu\text{m}$  broad; cells slightly attenuated toward apices, 127.37-131.52  $\mu\text{m}$  long, 38.74-43.96  $\mu\text{m}$  broad; apices pointed, 131.67-160.93  $\mu\text{m}$  long, 43.89-47.54  $\mu\text{m}$  broad; cell wall thick, stratified; chloroplast reticulate; nucleus 10-13; pyrenoids 7-9.

*Phenology* : Throughout the year.

Attached and free floating on flowing water stream at Yamuna, intermingled with diatoms mixture and few colony of *Pediastrum* (93176, 93189); attached on stone in slowly flowing water at Sahiya (94855).

## 2. PITHOPHORA Wittr.

Thallus branched, originated from beneath the septum; attached or free floating; cell cylindrical or slightly swollen; chloroplast parietal, covering entire wall; multinucleate; pyrenoids many; akinetes swollen, oblong, cylindrical or cask shaped, intercalary or terminal; reproduction by fragmentation or akinetes.

## KEY TO THE SPECIES

- |   |                        |
|---|------------------------|
| 1a. Filaments slender, akinetes cask-shaped                       | 2. <i>P. oedogonia</i> |
| b. Filaments stouter, akinetes cylindrical,<br>ovoid or irregular | 2                      |
| 2a. Akinetes same shape within same filament                      | 1. <i>P. mooreana</i>  |
| b. Akinetes variously shape within same filaments                 | 3. <i>P. varia</i>     |

**1. *Pithophora mooreana* Collins** in *Sci. ser.* 3(2): 97. 1912; Anand,

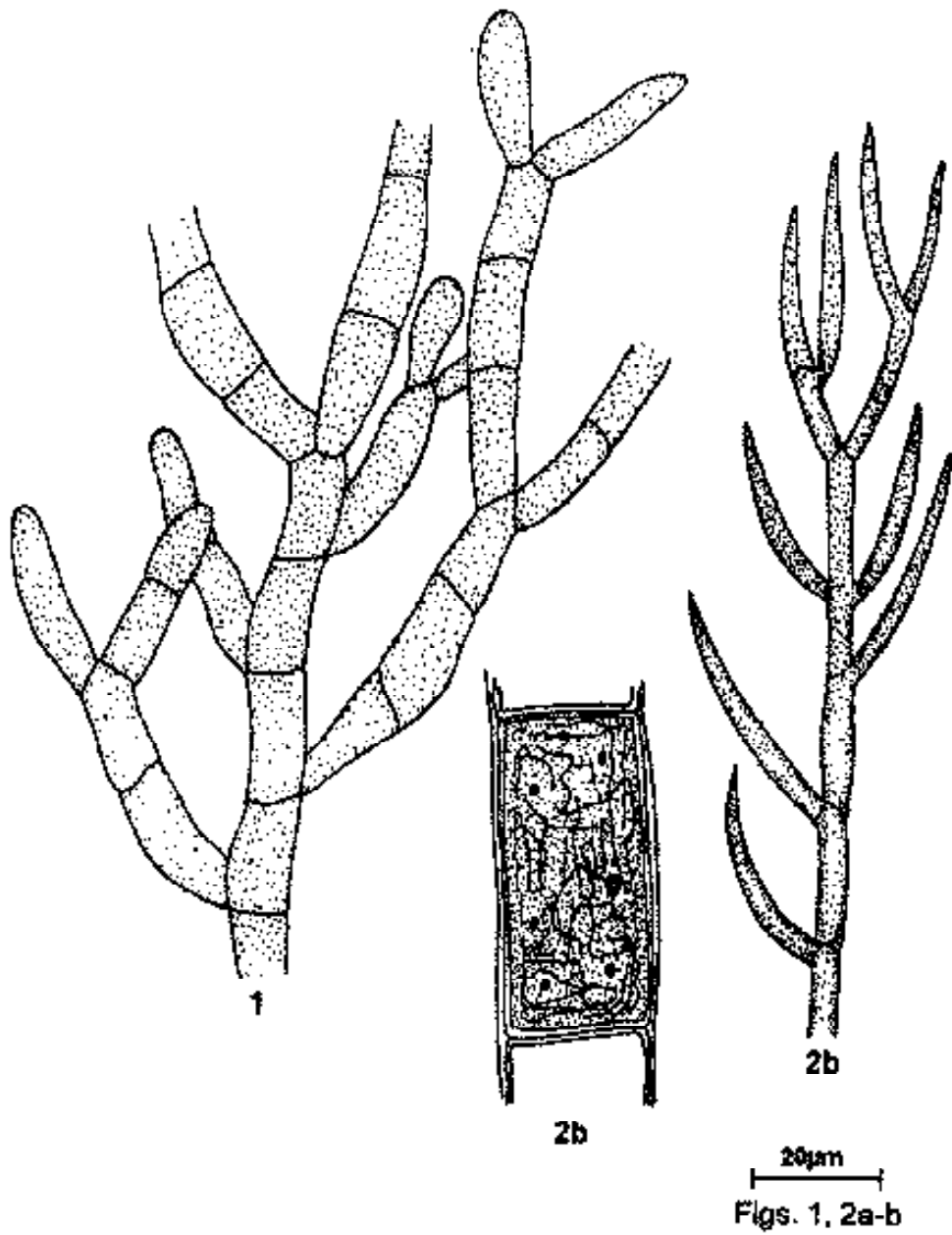


Plate 18 : Figs. 1-2 : 1. *Cladophora crispata*; 2a. *Cladophora glomerata*,  
2b. Single cell.

Ind. freshwater microalgae 44. fig. 142. 1998.

**Pl. 19, Figs. 1a-b**

Filaments highly branched, 112.23-116.43  $\mu\text{m}$  long, 53.34-61.92  $\mu\text{m}$  broad; lateral branches, 106.16-108.73  $\mu\text{m}$  long, 48.51-50.23  $\mu\text{m}$  broad; chloroplast parietal; nucleus 6-8; pyrenoids 4-6; akinetes brownish green, cylindrical with rounded end, terminal and intercalary, 121.29-135.49  $\mu\text{m}$  long, 78.24-88.17  $\mu\text{m}$  broad.

*Phenology* : December.

Attached on stone at Gullar ghati, associated with *Oedogonium*, *Spirogyra* and diatoms mixture (93162).

2. *Pithophora oedogonia* (Mont.) Wittr. in Sv. vet. Akad. Förhandl. 33(6): 55. 1877; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 55. pl. 7. figs. 3-5. 1992.

**Pl. 20, Figs. 2a, b**

Filaments slender, 435.38-442.17  $\mu\text{m}$  long, 78.82-81.22  $\mu\text{m}$  broad; cell wall thin; branch opposite; cells cylindrical, 275.28-290.38  $\mu\text{m}$  long, 67.57-72.16  $\mu\text{m}$  broad; chloroplast parietal; nucleus 5-7; pyrenoids 5-8; akinetes cask-shaped, 98.83-110.59  $\mu\text{m}$  long, 58.14-92.43  $\mu\text{m}$  broad.

*Phenology* : March.

Free floating in a puddle at Mohand, associated with *Microspora* sp. (96206).

3. *Pithophora varia* Wille in Phyc. Bor. Amer. 983. 1902; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 55. pl. 7. figs. 9, 10. 1992.

**Pl. 20, Figs. 1a-c**

Filaments sparsely, alternate branch, 830.25-836.26  $\mu\text{m}$  long, 80.51-84.78  $\mu\text{m}$  broad; cells cylindrical, 452.62-463.45  $\mu\text{m}$  long, 52.57-56.28  $\mu\text{m}$  broad; cell wall thin; chloroplast parietal; nucleus 6-8, pyrenoids 3-7; akinetes variable within same filaments, intercalary akinetes cylindrical to slightly ovate or angular, 174.62-176.18  $\mu\text{m}$  long, 59.82-65.27  $\mu\text{m}$  broad, terminal akinetes elongated, ovoid with blunt conical apex, 148.23-172.53  $\mu\text{m}$  long, 63.84-72.18  $\mu\text{m}$  broad.

*Phenology* : August October.

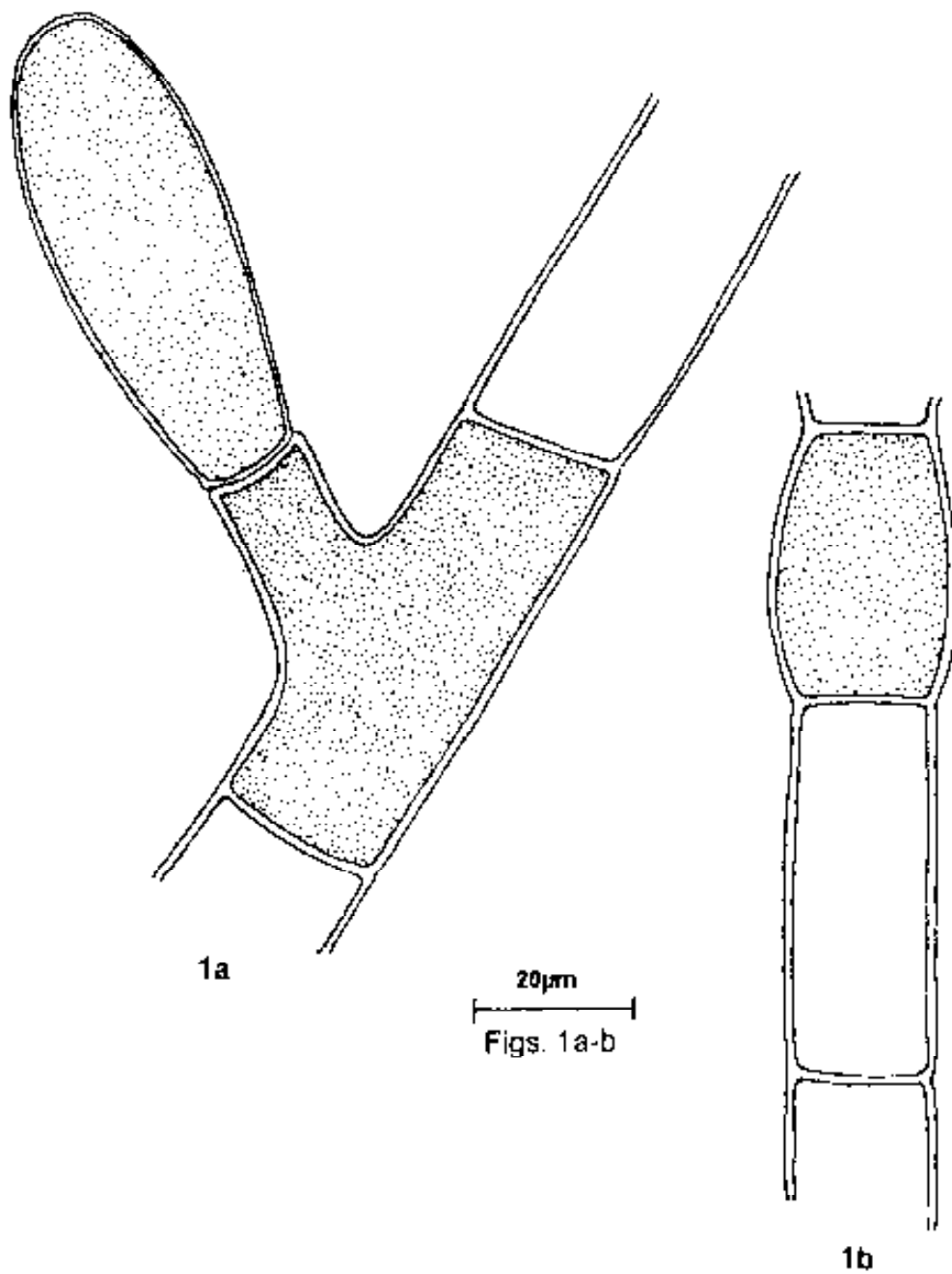


Plate - 19 : Fig. 1: 1a. *Pithophora mooreana* with terminal akinete, 1b. intercalary akinete.

Free floating in a puddle at Raiwala, associated with diatoms mixture (96240).

### 3. RHIZOCLONIUM Kütz.

Filaments coarse and wiry tangled floating mats, unbranched or with 1-2 celled branched; basal-distal differentiation absent; cells cylindrical; cell wall thick or thin; lamellate or without lamellate; chloroplast parietal, reticulate, dense or loose arranged; multinucleate; pyrenoids many; reproduction by fragmentation, zoospores or akinetes.

#### KEY TO THE SPECIES

- |  |                             |
|--|-----------------------------|
| 1a. Filaments branched                       | 2                           |
| b. Filaments unbranched                      | 3                           |
| 2a. Branches diameter smaller than main axis | 2. <i>R. fontanum</i>       |
| b. Branches diameter same than main axis     | 4. <i>R. hookeri</i>        |
| 3a. Cell wall thick and lamellate            | 1. <i>R. crassipellitum</i> |
| b. Cell wall thin without lamellate          | 3. <i>R. hieroglyphicum</i> |

1. *Rhizoclonium crassipellitum* West & West in Jour. Bot. 35. 1897.

Pl. 21, Fig. 2

Filaments coarse, wiry, unbranched, twisted, entangled; cells cylindrical, 226.76-248.71  $\mu\text{m}$  long, 58.52-63.39  $\mu\text{m}$  broad; cell wall thick and lamellate; chloroplast parietal; nucleus 6-8.

*Phenology* : March - December.

Attached on rock under flowing water at Sahasradhara, associated with *Gomphonema* sp. (93135, 93136, 93137, 93138, 93142, 93143, 93144, 93145, 93149, 93151, 93152, 93153), free floating in a small puddle at Mussoorie along with *Closterium* sp. (93182); free floating in the form of tangled mats at Gular ghati (93164); attached on stone at Mohand, associated with *Microspora*, *Sptrogyra* and *Ulothrix* sp. (94823, 94826); free floating in a puddle at Chakrata (94867).

2. *Rhizoclonium fontanum* Kütz., *Phycologia generalis* 261. 1843.

Pl. 21, Fig. 3

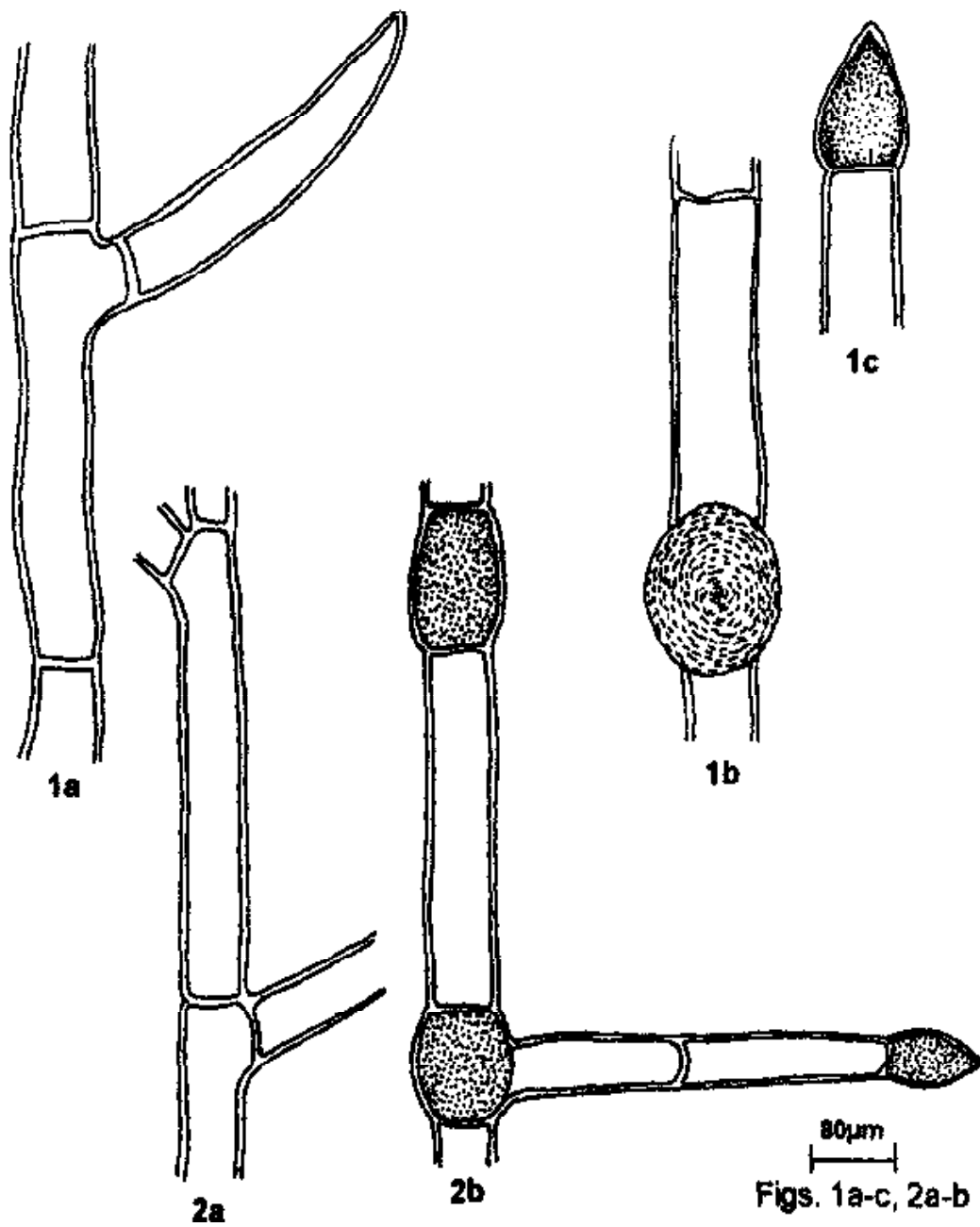


Plate - 20 : Figs. 1-2 : 1a. *Pithophora varia*, 1b. Intercalary akinete, 1c. Terminal akinete; 2a. *Pithophora oedogonia*, 2b. Intercalary and terminal akinete.

Filaments coarse, straight; branches multicellular, 62.57-71.94  $\mu\text{m}$  long, 16.72-17.83  $\mu\text{m}$  broad; cells cylindrical, 73.15-76.82  $\mu\text{m}$  long, 18.28-19.5  $\mu\text{m}$  broad; cell wall thick, 1.51-2.23  $\mu\text{m}$  broad; chloroplast reticulate; pyrenoids 7-9; nucleus 3-4.

*Phenology* : October - December.

Attached on rock in flowing water at Sahasradhara, associated with few diatoms mixture (93129, 93135, 93139, 93143, 93144, 93150, 93151).

**3. *Rhizoclonium hieroglyphicum*** (C.A. Ag.) Kütz., *Phycologia germanica* 206. 1845; West & West in *Ann. Roy. Bot. Gard. Cal.* 6(2): 183. 1907; Biswas in *Rec. Bot. Surv. India* 15(1): 75, fig. 47. 1949; Prasad & Misra, *Freshwater algal Fl. Andaman and Nicobar Islands* 56, pl. 7. figs. 7, 8. 1992; Anand, *Ind. freshwater microalgae* 44. figs. 141. 1998.

**Pl. 21, Fig. 1**

Filaments wiry, unbranched; septa uncontracted; cell wall thin, 1.87-2.96  $\mu\text{m}$  broad; lamination absent; cell cylindrical, 277.97-321.86  $\mu\text{m}$  long, 41.44-43.89  $\mu\text{m}$  broad; chloroplast parietal reticulate; nucleus 7-8; pyrenoids 4-8.

*Phenology* : Throughout the year.

Attached on rock under flowing water and also free floating in the form of tangled mats at Sahasradhara, associated with certain diatoms and desmids (93135, 93136, 93138, 93140, 93143, 93146, 93149); attached on moist soil at Gullar ghati (93160); attached on cemented tank at Mahabkendra (94807); free floating in a ditch at Mohand near bridge, associated with *Closterium* and *Fragilaria* sp. (94822, 94831, 94834, 94842); free floating in a puddle at Chakrata, associated with diatom sp. (94863).

**4. *Rhizoclonium hookeri*** Kütz. *Species algarum* 383. 1849.

**Pl. 21, Fig. 4**

Filaments crisp; branches, 393.87-397.88  $\mu\text{m}$  long, 74.12-75.72  $\mu\text{m}$  broad; cells cylindrical or irregularly flated, 392.92-398.21  $\mu\text{m}$  long, 73.15-76.8  $\mu\text{m}$  broad; chloroplast reticulate; nucleus 6-7; pyrenoids 3-4.

*Phenology* : October - December.

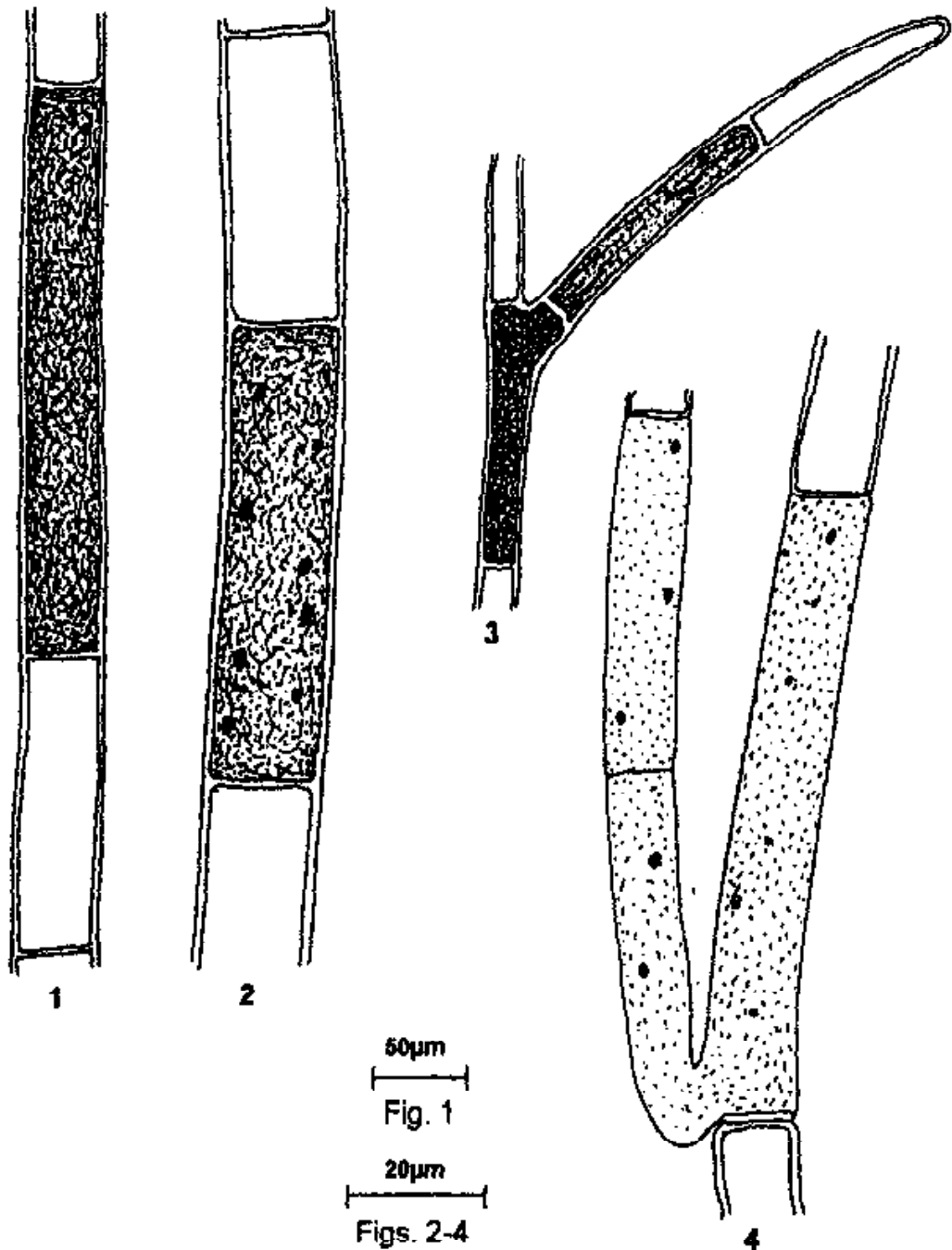


Plate 21 : Figs. 1-4 : 1. *Rhizoclonium hieroglyphicum*; 2. *Rhizoclonium crassipellitum*; 3. *Rhizoclonium fontanum*; 4. *Rhizoclonium hookertii*.



Attached on rock under flowing water at Sahasradhara, associated with few trichomes of *Oscillatoria* sp. (93128, 93130, 93131, 93140, 93142, 93145); attached on stone at Aglahar river near Mussooie band, Bhandar Koat gaon (94817); attached on submerged twig at Asan reservoir (93188); free floating in a small ditch at Mohand, associated with *Fragilaria* and *Mougeotia* sp. (94841).

### 5. Order : Chaetophorales

Thallus heterotrichous, differentiation consists of prostrate and erect system of branched or unbranched filaments, one of the systems may be more developed than other or unicellular, cushion-shaped; attached or parasites; setae present or absent; rhizoids present or absent; chloroplast parietal laminate or girdle shaped; pyrenoids one or more or absent; uninucleate; sporangia present or absent; reproduction by zoospores or aplanospores, sexuality isogamous, anisogamous or oogamous.

#### KEY TO THE FAMILIES

- |   |                     |   |
|---|---------------------|---|
| 1a. Thallus cushion shaped; sporangia present   | 2. TRENTEPOHLIACEAE | 2 |
| b. Thallus not cushion shaped; sporangia absent |                     | 2 |
| 2a. Thallus unicellular                         | 4. PLEUROCOCCACEAE  |   |
| b. Thallus heterotrichous                       |                     | 3 |
| 3a. Erect system well developed                 | 1. CHAETOPHORACEAE  |   |
| b. Prostrate system well developed              | 3. COLEOCHAETACEAE  |   |

#### 1. CHAETOPHORACEAE

##### KEY TO THE GENERA

- |   |                  |   |
|---|------------------|---|
| 1a. Erect system well developed               |                  | 2 |
| 1b. Erect system rudimentary                  |                  | 3 |
| 2a. Thallus enclosed in gelatinous sheath     | 1. CHAETOPHORA   |   |
| 2b. Thallus not enclosed in gelatinous sheath | 2. STIGEOCLONIUM |   |
| 3a. Thallus creeping; setae present           | 3. APHANOCHAETE  |   |
| 3b. Thallus irregularly compact; setae absent | 4. PROTODERMA    |   |

#### 1. CHAETOPHORA Schrank

Thallus consist of highly branched filaments arising from less developed prostrate cells and enclosed by gelatinous matrices of definite shape; branches tapering to either blunt point or long multicellular hair;

chloroplast single parietal band; pyrenoids one or more; reproduction by zoospores, sexuality isogamous.

### KEY TO THE SPECIES

- |   |                        |
|---|------------------------|
| 1a. Colony sub-globose to flattened; branches fasciculate | 2. <i>C. elegans</i>   |
| 1b. Colony globose to obovoid; branches not fasciculate   | 1. <i>C. attenuata</i> |

1. ***Chaetophora attenuata*** Hazen in Mem. Torr. Bot. Club 11: 213. 1902; Saxena in Bull. Nat. Bot. Gard., Lucknow 57 : 23. 1962.

Pl. 22, Figs. 1a-b

Colonies gelatinous, globose to obovoid, 665.38-682.72  $\mu\text{m}$  broad; prostrate system poorly developed with long multicellular rhizoids, arising from basal cells; erect system sparsely and dichotomously branched, ending sharply pointed; branches loose, elongated and not fasciculate; chloroplast parietal confined to upper part of cells; cells, 16.24-20.38  $\mu\text{m}$  long, 4.36-5.42  $\mu\text{m}$  broad; pyrenoid 1.

*Phenology* : August - September.

Attached to submerged old leaves and stem of Angiosperms at Asan, associated with *Spirogyra* sp. (93122).

2. ***Chaetophora elegans*** (Roth) C.A. Agardh, Dispositio algarum Succicae 42. 1812; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 22. 1962; Anand, Ind. freshwater microalgae 46. fig. 148. 1998.

Pl. 22, Fig. 2a-b

Colonies gelatinous, subglobose to flattened, 438.65-456.42  $\mu\text{m}$  broad; filaments radiating from common centre; branches loose dichotomous fasciculate at top; apical cell cylindrical, abruptly ending into acuminate apices; cells, 16.53-22.35  $\mu\text{m}$  long, 6.78-8.17  $\mu\text{m}$  broad; chloroplast parietal; pyrenoid 1; nucleus 1.

*Phenology* : August - September.

Attached to submerged grass in shallow water puddle at Asan, associated with certain cyanobacteria (93108).

## 2. STIGEOCLONIUM Kütz.

Thallus differentiated into irregularly branched or pseudoparenchymatous prostrate and sparsely branched erect portion; branches ending bluntly pointed or setiferous; gelatinous sheath absent; cells cylindrical or slightly swollen; chloroplast parietal; uninucleate; pyrenoids one to several; rhizoids present or absent; reproduction by aplanospores or akinetes, sexuality isogamous.

## KEY TO THE SPECIES

- |  |                    |
|--|--------------------|
| 1a. Branch opposite, apices tapering to setae      | 2. <i>S. tenue</i> |
| 1b. Branch alternate, apices not tapering to setae | 1. <i>S. nanum</i> |

1. *Stigeoclonium nanum* Kütz. Species algarum 354, 1849; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 27. 1962.

Pl. 22, Fig. 3

Thallus erect; prostrate portion pseudoparenchymatous; branch alternate; apices not tapering to setae; main axis, 5.18-19.37  $\mu\text{m}$  long, 8.23-11.16  $\mu\text{m}$  broad; cells cylindrical, 12.48-16.38  $\mu\text{m}$  long, 6.25-7.86  $\mu\text{m}$  broad; chloroplast parietal; pyrenoids 3-7.

*Phenology* : January.

Epiphytic on submerged twig in a slowly flowing water at Asan, associated with diatoms (93178).

2. *Stigeoclonium tenue* (C.A. Ag.) Kütz. Phycologia generalis 253, 1843; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 25. 1962; Printz in Hydrobiologia 24: 146. fig. 6. 1964; Anand, Ind. freshwater microalgae 46. fig. 149. 1998; Kant & Gupta, Algal Fl. Ladakh 109. pl. 39. fig. 5. pl. 108. fig. 3. 1998.

Pl. 23, Fig. 1

Thallus heterotrichous, prostrate and erect system well developed; erect filaments sparingly diffuse; prostrate filaments anchors the thallus; branch opposite with pointed end; gelatinous sheath absent; rhizoids absent; apices tapering to setae; hairs multicellular; main axis, 14.48-17.48  $\mu\text{m}$  long, 7.86-8.17  $\mu\text{m}$  broad; cells cylindrical slightly swollen, constricted at cross wall, 13.97-17.28  $\mu\text{m}$  long, 7.24-9.78  $\mu\text{m}$  broad; chloroplast parietal; pyrenoids 4-7.

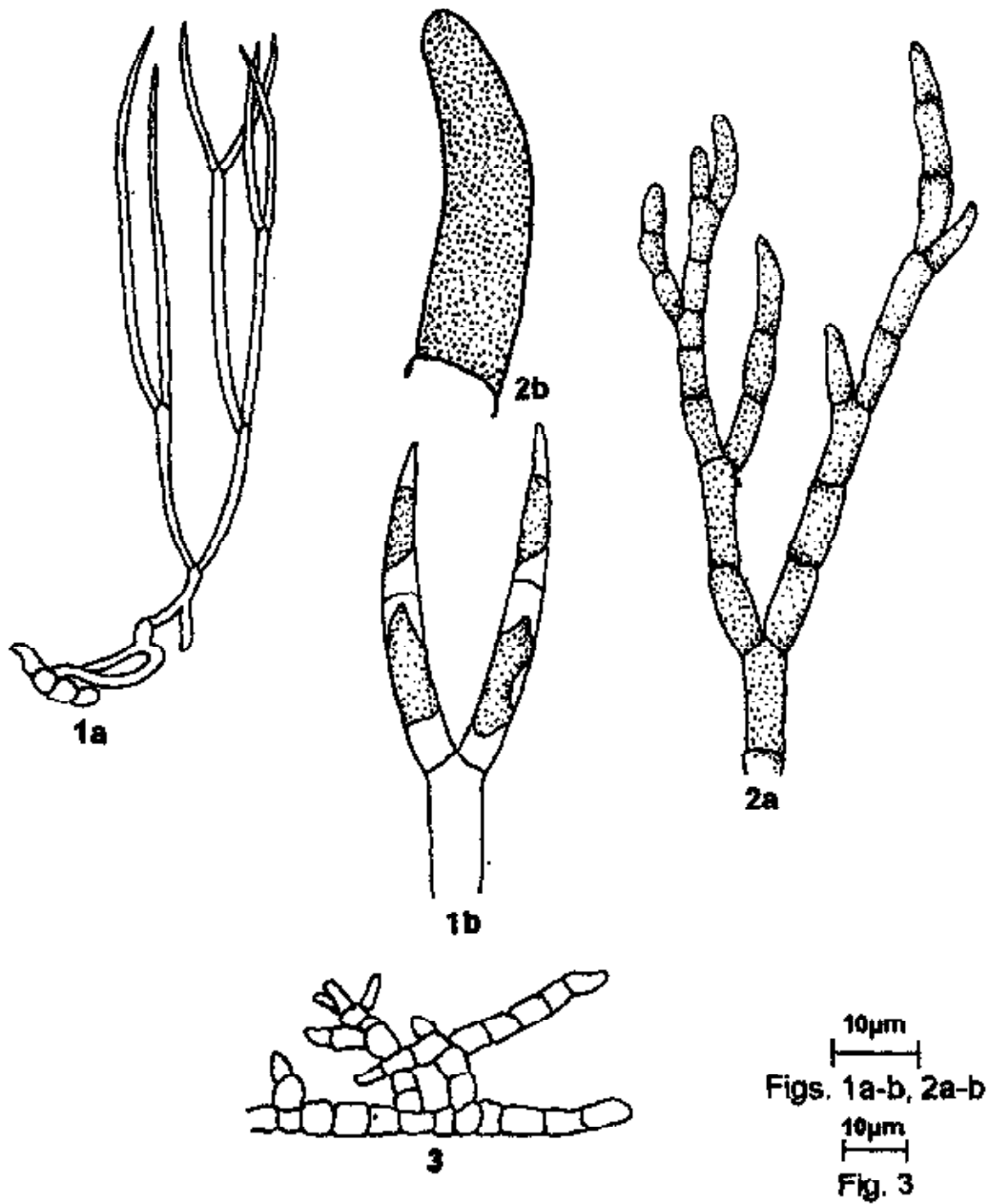


Plate - 22 : Figs. 1-3 : 1a. *Chaetophora attenuata*, 1b. Apical cells; 2a-b. *Chaetophora elegans*; 3. *Stigeoclonium nanum*.

*Phenology* : December-January.

Epiphytic on submerged aquatic plants in a slowly flowing water at Sahiya (94846).

### 3. *Aphanochaete* A. Br.

Thallus irregularly branched, prostrate and creeping on filamentous algae; cells cylindrical or inflated, bearing one or more setae with bulbous base; sheath absent; chloroplast, parietal, laminate; pyrenoids one or more; reproduction by zoospores or aplanospores, sexuality anisogamous.

#### KEY TO THE SPECIES

- |                          |                         |
|--------------------------|-------------------------|
| 1a. Cells with 2-6 setae | 1. <i>A. polychaete</i> |
| b. Cells with 1 setae    | 2. <i>A. repens</i>     |

1. *Aphanochaete polychaete* (Hansg.) Fritsch in Ann. Bot. 16: 410. 1902; Kant & Gupta, Algal Fl. Ladakh III. pl. 41. fig. 1. 1998.

Pl. 23, Fig. 3

Thallus sparsely branched, creeping; cells rounded or oblong-rectangular, 10.25-13.64  $\mu\text{m}$  broad; setae 2-6, arising from dorsal wall of each cell, 13.26-18.23  $\mu\text{m}$  long, 2.24-3.12  $\mu\text{m}$  broad; chloroplast parietal covering whole cells; pyrenoids 2-5.

*Phenology* : May-June.

Epiphytic on old filaments of *Oedogonium* sp. in a shallow water at Robber's cave, intermingled with *Gloeocapsa* sp. (96221).

2. *Aphanochaete repens* A. Br. Betrachtungen über die Erscheinung der Verjüngung in der Natur 196. 1851; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 16. 1962; Anand, Ind. freshwater microalgae 44. figs. 145. 1998; Kant & Gupta, Algal Fl. Ladakh. III. pl. 41. fig. 3. 1998.

Pl. 23, Fig. 2

Filaments branched, creeping; cells subcylindric to irregularly inflated, 9.47-12.55  $\mu\text{m}$  long, 6.85-8.13  $\mu\text{m}$  broad; setae 1, on dorsal surface, 7.43-9.28  $\mu\text{m}$  long, 2.54-3.17  $\mu\text{m}$  broad; chloroplast parietal; pyrenoid 5-7.

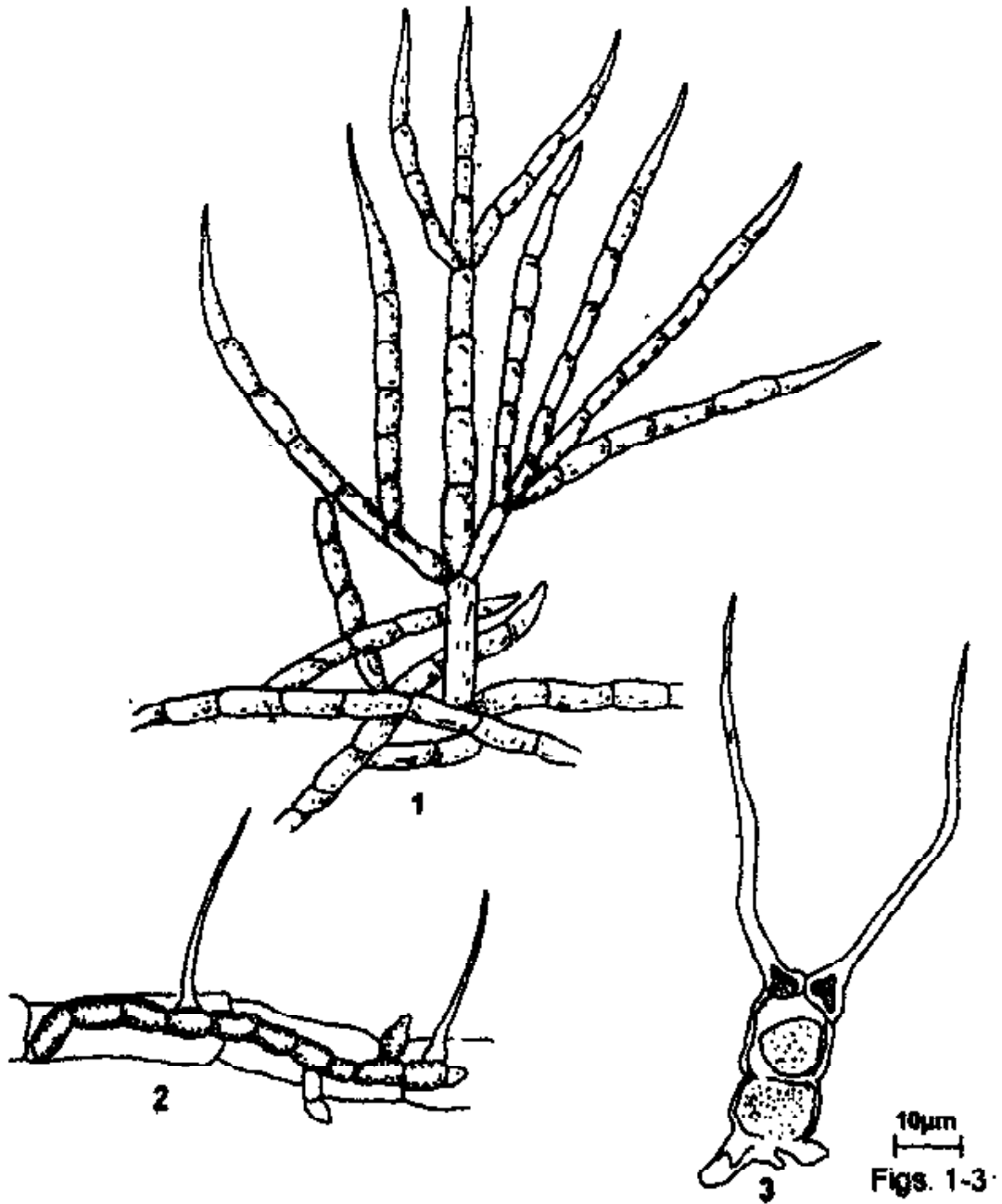


Plate - 23 : Figs. 1-3 : 1. *Stigeoclonium tenue*; 2. *Aphanochaete repens*; 3. *Aphanochaete polychaete*.

*Phenology* : August-October.

Epiphytic on old filaments of *Spirogyra* sp. in a shallow water puddle at Sahiya (96244).

#### 4. PROTODERMA Kütz.

Filaments irregularly branched; margin not free, semi-radiate; attached; wall thin; chloroplast parietal disc; pyrenoids several reproduction by fragmentation or zoospores.

1. *Protoderma viride* Kütz. *Phycologia generalis*, 295. 1843. Kant & Gupta. *Algal Fl. Ladakh* 111. pl. 41. fig. 7. 1998.

Pl. 24, Fig. 1

Thallus Pseudoparenchymatous; erect system completely suppressed; prostrate margin irregular branched, compactly arranged; terminal cells, slightly narrow; cells quadrate, 10.56-13.38  $\mu\text{m}$  long, 3.72-6.23  $\mu\text{m}$  broad; cell wall thin; chloroplast parietal; pyrenoids 7-9.

*Phenology* : December.

Attached on stone under shady condition at Sahiya (94847).

## 2. TRENTEPOHLIACEAE

### KEY TO THE GENERA

- |  |                 |
|--|-----------------|
| 1a. Thallus epiphytic; yellow or brick red | 2. TRENTEPOHLIA |
| b. Thallus parasite; grey-green            | 1. CEPHALEUROS  |

#### 1. CEPHALEUROS Kunze

Thallus parasitic, grows subcuticular or intercellular with erect branches bearing sporangia; hairs present; chloroplast discoid; pyrenoids absent; reproduction by zoospores, sexuality isogamous; commonly known as red-rust of tea.

1. *Cephaleuros virescens* Kunze, Weigelt *Surinam exsicc.* 65. 1827; Saxena in *Bull. Nat. Bot. Gard., Lucknow* 57: 41. 1962, *Mycoidea parasitica* Cunningham 1879, *Cephaleuros mycoidea* Karsten 1891.

Pl. 24, Figs. 2a-c

Thallus circular to irregular, spot slightly elevated grey-green, 2-3 mm broad; texture velvety pseudoparenchymatous; interwoven threads branched, 9.23-12.38  $\mu\text{m}$  broad; stratum compact grows under leaf epidermis of host plant, with erect branches bearing sporangia; stalk, 7.48-10.12  $\mu\text{m}$  long, 3.48-5.15  $\mu\text{m}$  broad; sporangia globose or slightly subglobose, 4.23-7.86  $\mu\text{m}$  broad; hairs present; rhizoids scattered in host tissue; chloroplast discoid, 4-6; pyrenoids absent.

*Phenology* : Throughout the year.

Parasitic on dorsal surface of leaves and young shoots of *Thea sinensis* (Theaceae) at tea garden near Vikashnagar (93185).

## 2. TRENTEPOHLIA Martius

Thallus cushion shaped; filament irregularly branched; prostrate and erect system developed or not well developed; erect branch alternate, opposite or unilateral; haematochrome present; hairs or setae absent; uninucleate; cells cylindrical or slightly swollen; wall thick; chloroplast one to several; pyrenoids absent; reproduction by fragmentation, akinetes, aplanospores or zoospores, sexuality isogamous.

### KEY TO THE SPECIES

- |   |                       |
|---|-----------------------|
| 1a. Prostrate and erect system well developed | 1. <i>T. aurea</i>    |
| b. Only erect system well developed           | 2. <i>T. iolithus</i> |

1. **Trentepohlia aurea** (L.) Martius, Flora cryptogamica Erlangensis 351. 1817; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 36. 1962; Printz in Hydrobiologia. 24: 304. figs. 7-13. 1964; *Chroolepus aureum* Wolle 1887.

**Pl. 24, Fig. 3**

Thallus orange yellowish; prostrate and erect branch well developed; branch opposite; cells cylindrical or barrel shaped, 15.58-23.46  $\mu\text{m}$  long, 12.48-19.16  $\mu\text{m}$  broad; chloroplast discoid 4-6; pyrenoids absent; wall parallel smooth; multinucleate; cap cell present; gametangia globular, lateral or terminal, 22.36-32.57  $\mu\text{m}$  broad; sporangia sessile, terminal, 23.87-30.53  $\mu\text{m}$  broad.

*Phenology* : December-January.



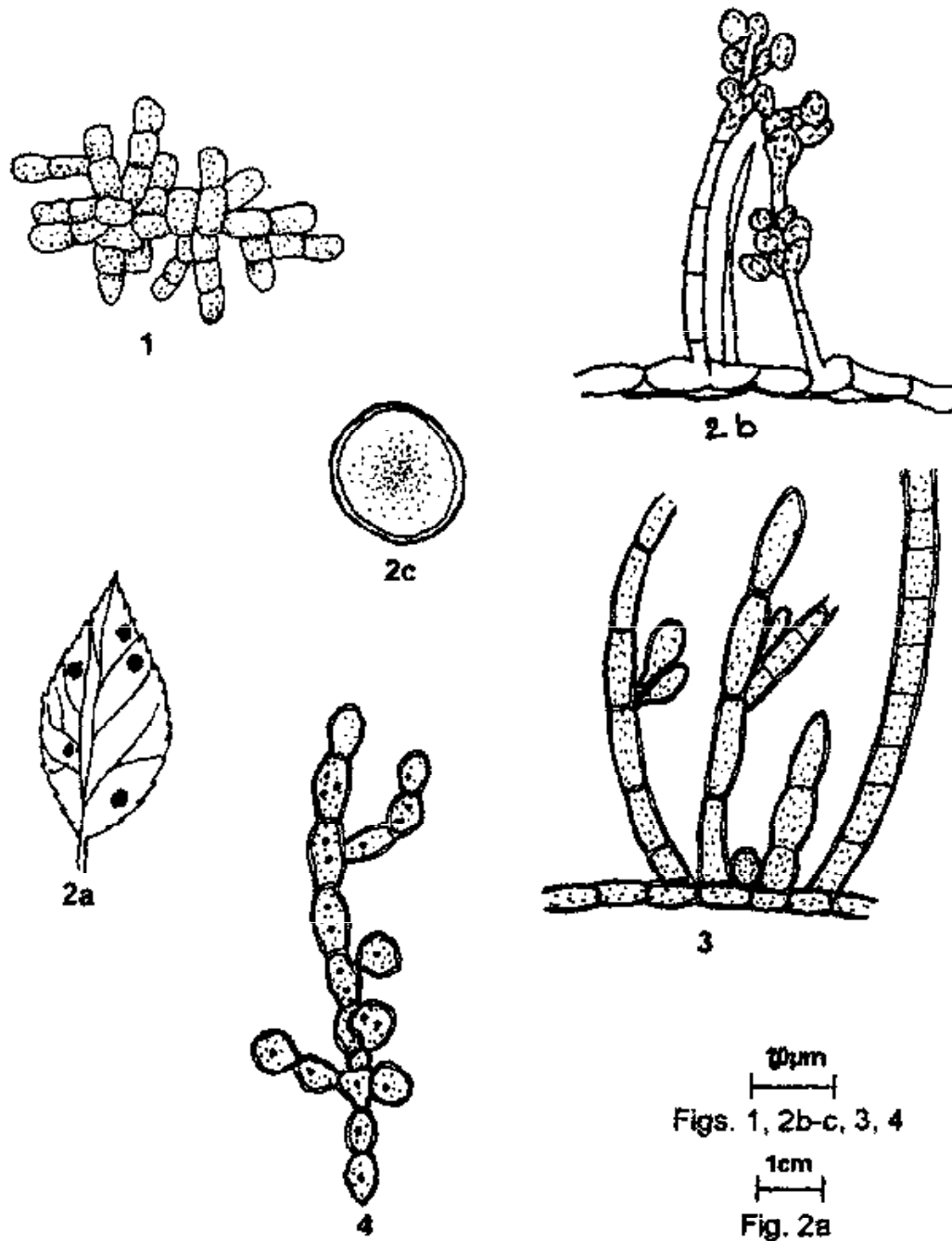


Plate 24 : Figs. 1-4 : 1. *Protoderma viride*; 2a. Parasitic patch on dorsal surface of *Thea sinensis* (Theaceae) leaf, 2b. *Cephaleuros virescens*, T.s. showing sporangia and interwoven threads, 2c. Single spore; 3. *Trentepohlia aurea*; 4. *Trentepohlia iolithus*.

Attached on damp tree trunk at Sahiya (94848).

2. *Trentepohlia lolithus* (L.) Wallroth, Flora cryptogamica germanicae 151. 1833; Brühl & Biswas in J. Dept. Sci. Calcutta University 5: 21. pl. 7. figs. 25a-f. 1923; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 35. 1962; Collins, The green algae of North America 319. figs. 9-12. 1970. *Chroolepus lolithus* Wolle 1887.

Pl. 24, Fig. 4

Thallus soft cushion, yellowish-green to dark orange; erect system well developed; filaments torulose, branched, constricted at cross-wall; cells ellipsoid, 23.45-26.38  $\mu\text{m}$  long, 13.38-15.65  $\mu\text{m}$  broad; cell wall thin, smooth; chloroplast discoid 3-5; pyrenoids absent; sporangia spherical, lateral or terminal, 23.14-25.32  $\mu\text{m}$  long, 16.21-19.85  $\mu\text{m}$  broad.

*Phenology* : March-April.

Attached on rock at Mussoorie, associated with lichens. (93180).

### 3. COLEOCHAETACEAE

#### 1. COLEOCHAETE de Brebisson

Thallus epiphytic, irregularly branched, erect and prostrate or entirely prostrate or monostromatic, parenchymatous disc; seta delicate; uninucleate; chloroplast parietal laminate; pyrenoid one; reproduction by zoospore or aplanospores, sexuality oogamous.

#### KEY TO THE SPECIES

- |   |                          |
|---|--------------------------|
| 1a. Branches radiating from a common centre | 2. <i>C. soluta</i>      |
| b. Branches spreading irregularly           | 1. <i>C. irregularis</i> |

1. *Coleochaete irregularis* Pringsh. in Jahrb. Wiss. Bot. 2: 11. 1860.

Pl. 25, Fig. 1

Thallus discoidal, monostromatic; margin circular disc; branch spread irregularly, free or adjoined laterally; cells quadrangular, 16.28-19.64  $\mu\text{m}$  broad; chloroplast 1 parietal laminate; pyrenoid 1; oogonia globose, 42.56-48.23  $\mu\text{m}$  broad.

*Phenology* : December January.

Epiphytic on the leaves and stem of free floating hydrophytes in a puddle at Kaunwala, Hardwar road (93166).

2. *Coleochaete soluta* Pringsh. in Jahrb. Wiss. Bot. 2: 6. 1860; Saxena in Bull. Nat. Bot. Gard., Lucknow 57: 46. 1962; Kant & Gupta, Algal Fl. Ladakh 13. pl. 44. fig. 2. 1998.

**Pl. 25, Figs. 2a-b**

Thallus monostromatic; branches radiating from common centre, loosely spreading; filaments slightly tapering; cells cylindric, 16.38-19.25  $\mu\text{m}$  long, 9.12-11.48  $\mu\text{m}$  broad; apical cells with bluntly rounded end; setae sheathed; chloroplast parietal; pyrenoid 1; oogonia globose, corticated, 112.87-118.58  $\mu\text{m}$  broad; antheridia flask-shaped, 13.28-15.36  $\mu\text{m}$  broad.

*Phenology* : December February.

Epiphytic on *Chara* sp. at Gullar ghati (93161).

#### 4. PLEUROCOCCACEAE

##### 1. PLEUROCOCCUS Menegh.

Thallus unicellular, globose to ellipsoidal; cell wall smooth thick; gelatinous envelope absent; uninucleate; chloroplast parietal; reproduction by cell division, occur in three directions.

1. *Pleurococcus vulgaris* Menegh. Monographia nostochinearum Italicarum 38. pl. 5. fig. 1. 1842; Kant & Gupta. Algal Fl. Ladakh 114. pl. 44. fig. 5. 1998.

**Pl. 25, Figs. 3a-b**

Thallus unicellular, globose to ellipsoidal, 18.34-23.62  $\mu\text{m}$  broad; chloroplast 1, parietal curved, lobed at margins; pyrenoids absent; cell wall thick smooth; nucleus 1, centrally located; gelatinous envelope absent.

*Phenology* : Throughout the year.

Attached on moist soil and stones forming green films at Sahiya, associated with few diatoms (94849).

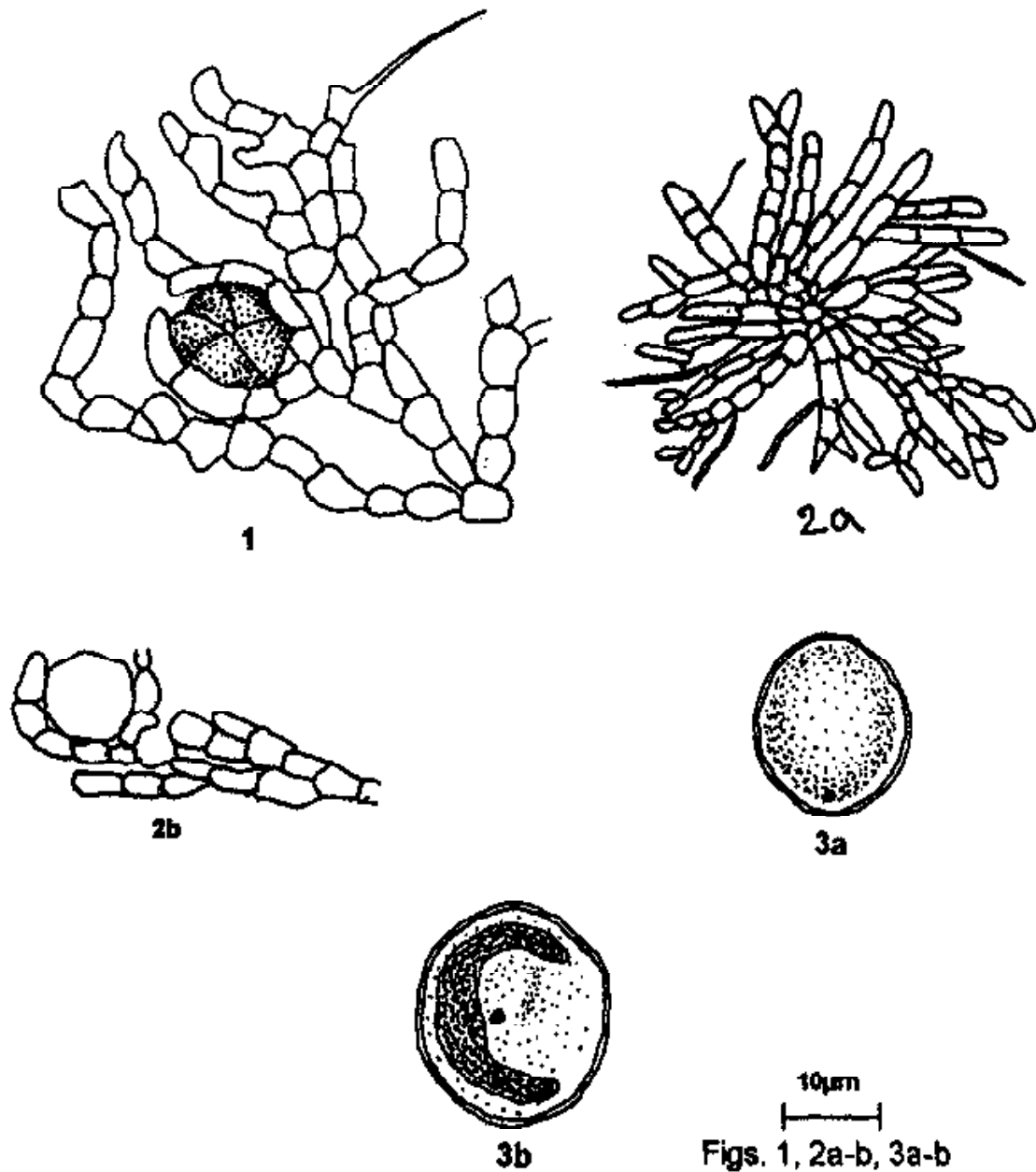


Plate - 25 : Figs. 1-3 : 1. *Coleochaete irregularis*; 2a. *Coleochaete soluta*,  
2b. Single oogonia; 3a. *Pleurococcus vulgaris*, 3b. Chloroplast parietal curved.

## 6. Order : Oedogoniales

Thallus unbranched or branched; monoecious or dioecious; macrandrous or nannandrous; free floating or attached; holdfast or rhizoid present; cells cylindric or slightly swollen or capitellate; terminal cell rounded or acute; cell wall smooth three layers, rigid and homogeneous; chloroplast parietal reticulate; uninucleate; pyrenoids one or several; setae present or absent; cap cells present; reproduction by fragmentation, zoospores, aplanospores or akinetes, sexuality oogamous.

### OEDOGONIACEAE

#### KEY TO THE GENERA

- |                          |                |
|--------------------------|----------------|
| 1a. Filaments unbranched | 1. OEDOGONIUM  |
| b. Filaments branched    | 2              |
| 2a. Setae present        | 2. BULBOCHAETE |
| b. Setae absent          | 3. OEDOCLADIUM |

#### 1. OEDOGONIUM Link

Filaments unbranched, monoecious or dioecious; attached or free floating; cells cylindric or slightly capitellate; cell wall smooth; chloroplast parietal, reticulate; uninucleate; pyrenoids many; terminal cell rounded or acute; cap cell present; reproduction by zoospores or aplanospores, sexuality oogamous.

#### KEY TO THE SPECIES

- |   |                          |
|---|--------------------------|
| 1a. Filaments macrandrous homothallic         | 2                        |
| b. Filaments macrandrous heterothallic        | 4                        |
| 2a. Oogonia oblong or sub-ellipsoid           | 5. <i>O. kurzii</i>      |
| b. Oogonia globose                            | 3                        |
| 3a. Antheridial cells 5 seriate               | 4. <i>O. globosum</i>    |
| b. Antheridial cells 3 seriate                | 3. <i>O. fragile</i>     |
| 4a. Oogonia operculate                        | 2. <i>O. epiphyticum</i> |
| b. Oogonia poriferous                         | 5                        |
| 5a. Oospore completely filling the oogonia    | 6. <i>O. sociale</i>     |
| b. Oospore not completely filling the oogonia | 1. <i>O. cardiacum</i>   |

1. *Oedogonium cardiacum* (Hass.) Wittr. in Öfvers Vetensk Akad. Förh. Stockh. 27: 135. 1870; Hirn. in Acta. Soc. Sci. fenn. 27: 85.

pl. 3. fig. 19. 1900; Gonzalves, *Oedogoniales* 260. figs. 9. 141 a, b 1981. *Vesiculifera cardiaca* Hass. 1845, *Pringsheimia inaequalis* Wood 1874, *Oedogonium lautumniarum* Wittr. 1896.

Pl. 26, Fig. 5

Thallus macrandrous, heterothallic; unbranched; cells cylindrical, 56.36-188.37  $\mu\text{m}$  long, 17.42-28.18  $\mu\text{m}$  broad; chloroplast parietal; nucleus 1; pyrenoids 8-12; dwarf male plant absent; basal cell elongate; terminal cell obtuse; oogonia solitary, globose or subcordiform-globose, with poriferous suprmedian pore, 52.78-70.15  $\mu\text{m}$  long, 52.32-67.14  $\mu\text{m}$  broad; oospore globose, not filling the oogonia, 44.74-58.17  $\mu\text{m}$  broad; spore wall thick, smooth; antheridia 1, 12.22-13.84  $\mu\text{m}$  long, 16.34-18.58  $\mu\text{m}$  broad.

*Phenology* : October-December.

Free floating and form pale yellow green cottony masses in a ditch at Sahasradhara, under expose condition, associated with members of Ulotrichales (93140); free floating in a ditch at Mohand near bridge, associated with certain desmids (94824, 94828).

2. *Oedogonium epiphyticum* Trans. & Tiff. in Ohio J. Sci. 34: 325. 1934; Gonzalves, *Oedogoniales*, 338. fig. 9. 221. 1981. *Oedogonium pisanum* var. *gracilis* Trans. & Tiff. 1919.

Pl. 26,

Fig. 1

Thallus macrandrous, heterothallic; unbranched; cells cylindrical, slightly capitellate, 26.28-38.63  $\mu\text{m}$  long, 7.47-8.54  $\mu\text{m}$  broad; chloroplast parietal; nucleus 1; pyrenoids, 8-9; basal cell elongate; cell wall smooth; dwarf male absent; oogonia solitary, ellipsoid, operculate, superior, 22.42-28.57  $\mu\text{m}$  long, 17.93-19.33  $\mu\text{m}$  broad; oospores ellipsoid, filling the oogonia, 20.18-27.82  $\mu\text{m}$  long, 15.36-17.49  $\mu\text{m}$  broad; spore wall smooth; antheridia 1, 6.58-8.25  $\mu\text{m}$  long, 5.56-7.88  $\mu\text{m}$  broad.

*Phenology* : August-December.

Attached on submerged stone at Asan, associated with certain cyanobacteria and diatoms (93114); attached in a small ditch at Mohand under shady condition (94838).

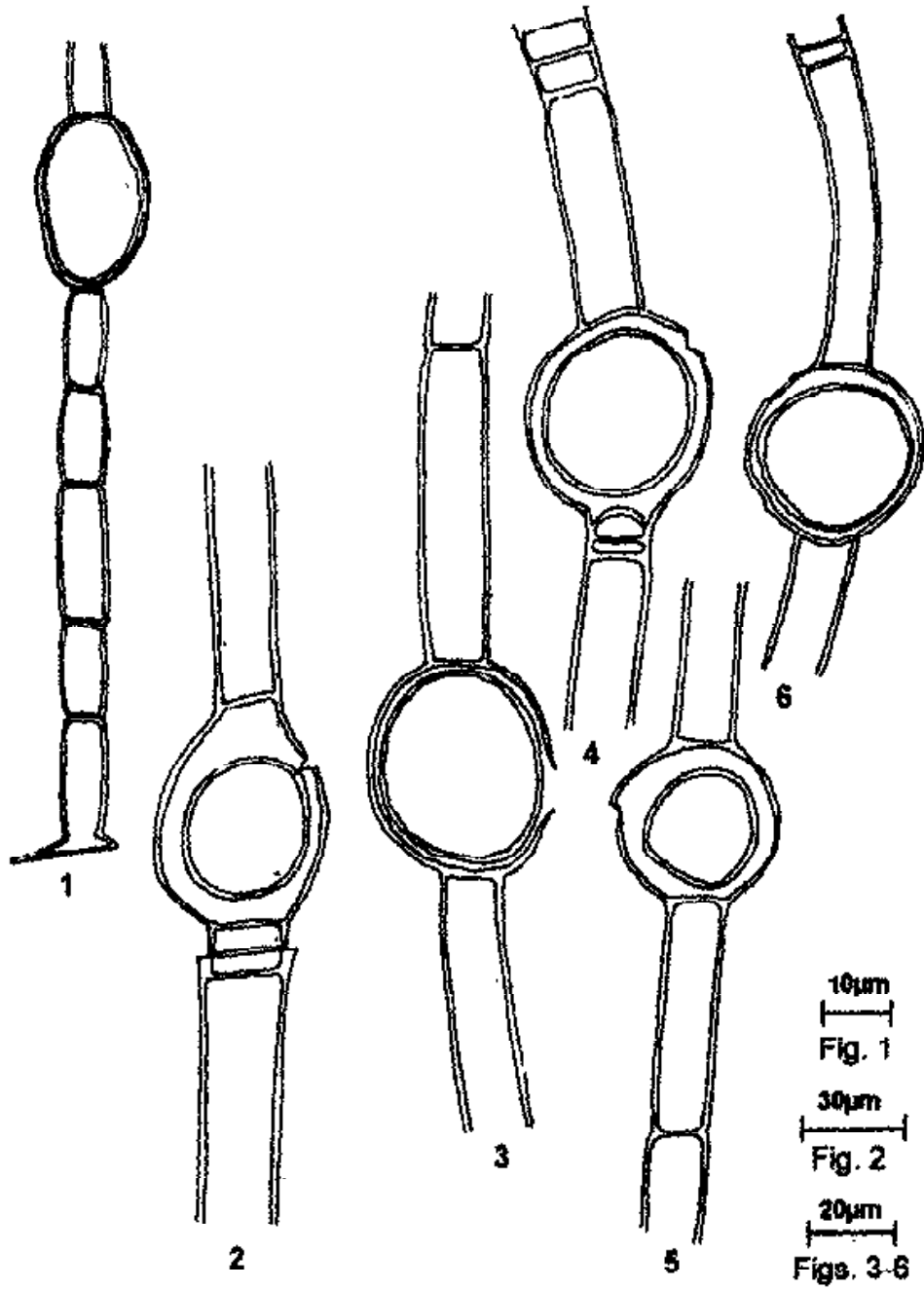


Plate 26 : Figs. 1-6 : 1. *Oedogonium epiphyticum*; 2. *Oedogonium kurzii*;  
3. *Oedogonium sociale*; 4. *Oedogonium fragile*; 5. *Oedogonium cardiacum*;  
6. *Oedogonium globosum*.

3. *Oedogonium fragile* Witttr. in Öfvers. VetenskAkad. Förh. Stockh. 27: 120. 1870; Hirn. in Acta. Soc. Sci. fenn. 27: 96. pl. 5. fig. 33. 1900; Gonzalves, Oedogoniales 164. fig. 9. 27a. 1981. *Oedogonium candollei* (Le cl.) Breb. 1884.

Pl. 26, Fig. 4

Thallus macrandrous, homothallic; unbranched; cells cylindrical, 51.82-115.35  $\mu\text{m}$  long, 14.48-18.53  $\mu\text{m}$  broad; chloroplast parietal; nucleus 1; pyrenoids 4-7; basal cell elongate; cell wall smooth; oogonia solitary, globose, opening by poriferous, superior pore, 44.50-52.25  $\mu\text{m}$  long, 43.48-52.34  $\mu\text{m}$  broad; oospore globose, completely filling the oogonia, 40.27-51.98  $\mu\text{m}$  long, 42.22  $\mu\text{m}$  broad; spore wall smooth; antheridia 3-seriate, subepigynous, 4.28-9.66  $\mu\text{m}$  long, 15.19-18.23  $\mu\text{m}$  broad.

*Phenology* : November-December.

Attached on submerged wood at Gullar ghati, associated with species of *Spirogyra* and *Fragilaria* (93162); free floating on stagnant water at Mohand, associated with *Rhizoclonium* sp. (94842, 94843).

4. *Oedogonium globosum* Nordstedt in Minneskr. Fys. Sällsk. Lund. 7: 20. pl. 2. fig. 16. 1878; Hirn. in Acta. Soc. Sci. fenn. 27: 94. pl. 5. fig. 30. 1900; Gonzalves, Oedogoniales 166. fig. 9. 29 a. 1981; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 69. pl. 11. fig. 12. 1992.

Pl. 26, Fig. 6

Thallus macrandrous homothallic; unbranched; cells cylindrical, 46.75-82.57  $\mu\text{m}$  long, 10.8-12.92  $\mu\text{m}$  broad; chloroplast parietal; nucleus, 1; pyrenoids 4-8; basal cell elongate; terminal cell setiform; cell wall smooth; oogonia solitary, globose, opening by poriferous superior pore, 36.28-42.64  $\mu\text{m}$  long, 36.21-40.23  $\mu\text{m}$  broad; oospore globose, smooth, filling the oogonia, 28.27-40.13  $\mu\text{m}$  long, 30.23-37.14  $\mu\text{m}$  broad; spore wall thick; antheridia 5-seriate, sub-epigynous, 4.45-7.38  $\mu\text{m}$  long, 10.22-11.18  $\mu\text{m}$  broad.

*Phenology* : Throughout the year.

Free floating and form yellowish green floating mats in a ditch at Gullar ghati, associated with diatoms mixture (93160).

5. *Oedogonium kurzii* Zeller in J. Asiat. Soc. Beng. 42: 189. 1873;



Hirn. in Acta. Soc. Sci. fenn. 27: 135. pl. 16. fig. 93. 1900; Gonzalves, Oedogoniales 171. fig. 9. 32a. 1981. *Oedogonium boyanum* Class. 1961.

**Pl. 26, Fig. 2**

Thallus macrandrous, homothallic; unbranched; cells cylindrical or slightly capitellate, 98.25-238.49  $\mu\text{m}$  long, 48.52-50.84  $\mu\text{m}$  broad; chloroplast parietal; nucleus 1; pyrenoids 4-6; apical cell obtuse; cell wall smooth; oogonia solitary, oblong or subellipsoid, opening by poriferous superior pore, 114.18-120.52  $\mu\text{m}$  long, 78.95-90.35  $\mu\text{m}$  broad; oospore sub-globose or ellipsoid, not filling the oogonia, 88.93-96.24  $\mu\text{m}$  long, 68.28-82.89  $\mu\text{m}$  broad; spore wall smooth, thick; anteridia 2-15 in series, 8.23-10.12  $\mu\text{m}$  long, 40.74-43.72  $\mu\text{m}$  broad.

*Phenology* : August-September.

Epiphytic on submerged hydrophytic angiosperm twigs and leaves at Asan, associated with *Spirogyra* sp. (93118).

**6. *Oedogonium sociale*** Wittr. in Alg. exs. 401. 1882; Hirn. in Acta. Soc. Sci. fenn. 27: 79. pl. 2. fig. 12. 1900; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 180. 1907. Gonzalves, Oedogoniales 295. fig. 9.173a. 1981. *Oedogonium ochroleucum* Kütz. 1862.

**Pl. 26, Fig. 3**

Thallus macrandrous, heterothallic; unbranched; cells cylindrical, 38.52-124.74  $\mu\text{m}$  long, 12.34-15.87  $\mu\text{m}$  broad; chloroplast parietal; nucleus, 1; pyrenoids 3-12; oogonia solitary, subglobose or ellipsoid globose, opening by poriferous median pore, 38.41-40.98  $\mu\text{m}$  long, 36.37-37.53  $\mu\text{m}$  broad; oospore globose or ellipsoid globose, filling the oogonia, 32.28-36.72  $\mu\text{m}$  long, 30.29-32.35  $\mu\text{m}$  broad; spore wall smooth; antheridia, 9.14-11.38  $\mu\text{m}$  long, 12.79-13.23  $\mu\text{m}$  broad.

*Phenology* : February-August.

Attached on aquatic angiosperms and free floating on sluggish water at Asan, associated with desmids and diatoms (93126).

**2. BULBOCHAETE C.A. Agardh**

Filaments unilaterally branched; attached; cells widening upwards with bulbous based setae; cells cylindrical broader at upper ends; cell

wall smooth, punctate or granulate; chloroplast parietal reticulate; uninucleate; pyrenoids many; reproduction by fragmentation, or zoospores, sexuality oogamous.

#### KEY TO THE SPECIES

- |                                 |                          |
|---------------------------------|--------------------------|
| 1a. Dwarf male on oogonia       | 2. <i>B. gigantea</i>    |
| b. Dwarf male below the oogonia | 1. <i>B. brebissonii</i> |

**1. *Bulbochaete brebissonii*** Kütz. in Tab. Phyc. 4: 19. pl. 86. figs. B, f, 1854; Hirn. in Acta Soc. Sci. fenn. 27: 323. pl. 51. fig. 330. 1900; Gonzalves, Oedogoniales 637. fig. 10.59. 1981; Kant & Gupta, Algal Fl. Ladakh 115. pl. 38. fig. 1, pl. 106. fig. 8. 1998. *Bulbochaete tumida* Wittr. 1870.

**Pl. 27, Fig. 1**

Thallus nannandrous, gynandrosporous; branches unilaterally; cells 50.12-54.38  $\mu\text{m}$  long, 17.28-19.47  $\mu\text{m}$  broad; chloroplast parietal reticulate; nucleus 1; pyrenoids 6-8; oogonia depressed subquadrangular globose, 36.75-40.54  $\mu\text{m}$  long, 38.23-43.62  $\mu\text{m}$  broad; oospores depressed globose, 26.78-32.43  $\mu\text{m}$  long, 10.13-12.84  $\mu\text{m}$  broad; wall coarsely scrobiculate; dwarf male just below the oogonia.

*Phenology* : April-May.

Attached on *Chara* growing in marshy area at Sahasradhara, associated with certain cyanobacteria (93127).

**2. *Bulbochaete gigantea*** Pringsh. in Jb. wiss Bot. 1: 71. pl. 6. fig. 1. 1858; Hirn in Acta Soc. Sci. fenn. 27: 347. pl. 57. fig. 359. 1900; Gonzalves, Oedogoniales 660. figs. 10.88. 1981; Kant & Gupta, Algal Fl. Ladakh 115. pl. 38. fig. 3. 1998.

**Pl. 27, Fig. 2**

Thallus nannandrous, idioandrosporous; branches unilaterally; cells 45.53-48.72  $\mu\text{m}$  long, 20.38-26.47  $\mu\text{m}$  broad; chloroplast parietal reticulate; nucleus 1; pyrenoids 4-6; oogonia subdepressed globose, 52.83-56.65  $\mu\text{m}$  long, 54.38-58.34  $\mu\text{m}$  broad; oospores depressed globose, 24.18-26.29  $\mu\text{m}$  long, 7.54-11.37  $\mu\text{m}$  broad; wall reticulate, scrobiculate; dwarf males on oogonia; antheridia, 24.27-28.56  $\mu\text{m}$  long, 13.18-15.23  $\mu\text{m}$  broad.

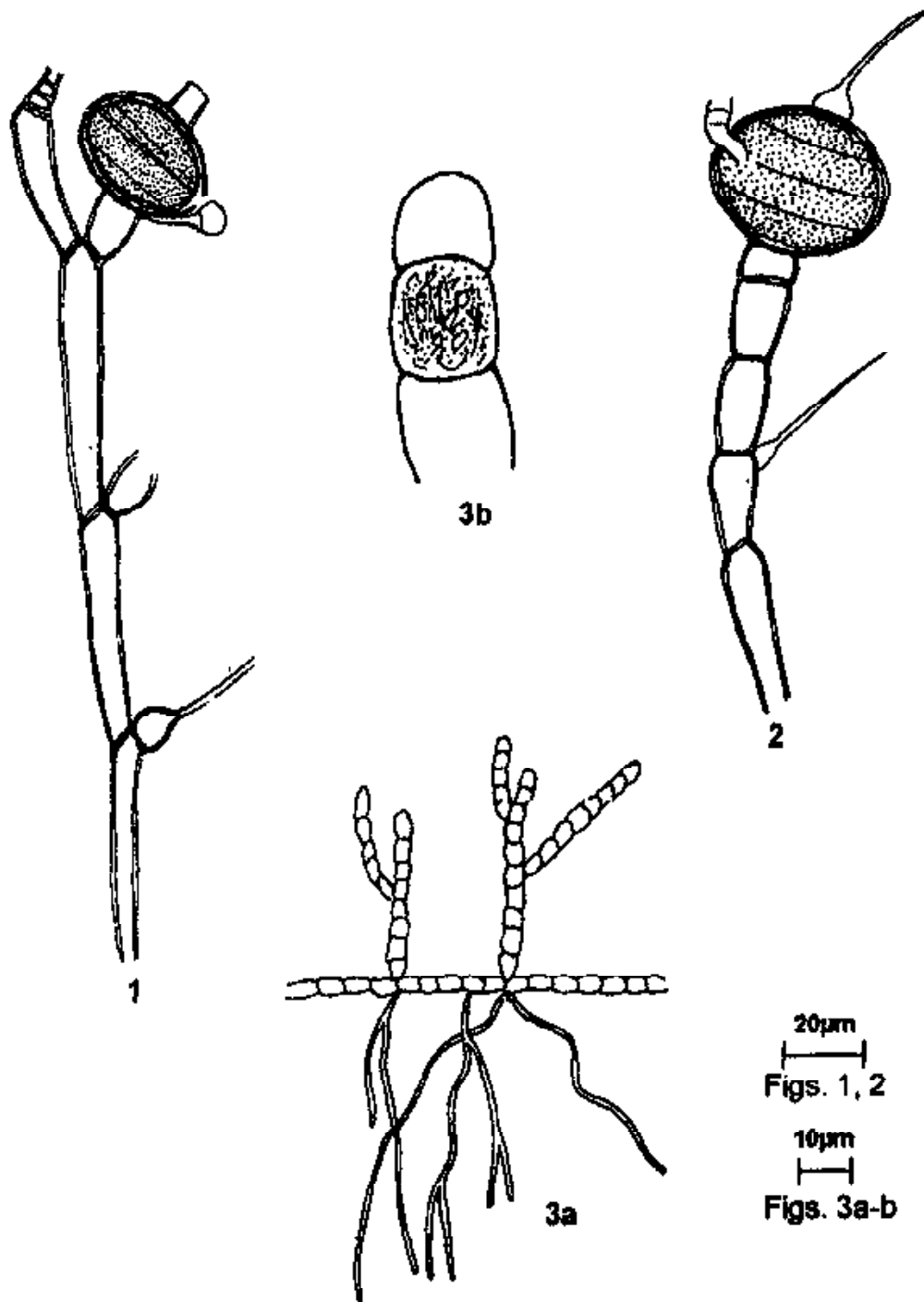


Plate - 27 : Figs. 1-3 : 1. *Bulbochaete brebissonii*; 2. *Bulbochaete gigantea*; 3a. *Oedocladium protonema*. 3b. Internal structure of cell.

*Phenology* : May-August.

Attached on old leaves of aquatic angiosperms in a puddle at Sahasradhara, associated with mixture of diatoms (93131).

### 3. OEDOCLADIUM Stahl

Thallus branched, with erect or prostrate system; terrestrial; setae absent; rhizoids colourless; cells cylindrical; chloroplast reticulate; uninucleate; pyrenoids present; reproduction by zoospores or akinetes, sexuality oogamous.

1. *Oedocladium protonema* Stahl in Jb. wiss. Bot. 23: 347. pl. 16. figs. 1-6, pl. 17. figs. 1-12. 1891; Hirn. in Acta Soc. Sci. Fenn. 27: 374. pl. 64. fig. 396. 1900; Gonzalves, Oedogoniales 678. fig. 11.3. 1981; Kant & Gutpa, Algal Fl. Ladakh 115. pl. 38. fig. 2. 1998.

Pl. 27, Figs. 3a-b

Thallus macrandrous homothallic; branched; cells, 14.78-16.38  $\mu\text{m}$  long, 3.16-5.28  $\mu\text{m}$  broad; chloroplast reticulate; nucleus 1; pyrenoid 3-5; rhizoidal cells, 218.58-236.86  $\mu\text{m}$  long, 2.17-3.12  $\mu\text{m}$  broad; oogonia 1, subglobose, poriferous, 60.67-64.83  $\mu\text{m}$  long, 54.23-62.87  $\mu\text{m}$  broad, oospore globose smooth, 13.47-161.18  $\mu\text{m}$  broad.

*Phenology* : December-January.

Growing on moist soil at Chakrata, intermingled with young mosses (94867).

### 7. Order : Conjugales

Thallus unicellular, colonial, or unbranched filaments; exclusively freshwater; filamentous conjugalean forms slimy, called 'pond scums'; motile cells complete absent; cell wall smooth or ornamented, consists of 1-3 layers; chloroplast bar-shaped, asteroid, spiral ribbon-shaped, axial plate-shaped, or stellate; uninucleate; pyrenoids present or absent; reproduction by fragmentation, aplanospore or akinetes, sexuality scalariform or lateral conjugation.

## KEY TO THE FAMILIES

- |  |                   |
|--|-------------------|
| 1a. Thallus unbranched filaments             | 2                 |
| b. Thallus unicellular                       | 3                 |
| 2a. Chloroplast stellate or spirally twisted | 2. ZYGNEMACEAE    |
| b. Chloroplast axial plate                   | 3. MOUGEOTIACEAE  |
| 3a. Cells without median constriction        | 1. MESOTAENIACEAE |
| b. Cells with median constriction            | 4. DESMIDIACEAE   |

## 1. MESOTAENIACEAE (Saccoderm Desmids)

## KEY TO THE GENERA

- |                              |                   |
|------------------------------|-------------------|
| 1a. Chloroplast single axial | 2. MESOTAENIUM    |
| b. Chloroplast double axial  | 1. CYLINDROCYSTIS |

## 1. CYLINDROCYSTIS Menegh.

Cells unicellular; cylindrical; poles rounded; cell wall smooth, homogeneous; chloroplasts two stellate; pyrenoids spherical or rod shaped; nucleus single; reproduction by transverse division, sexuality conjugation.

## KEY TO THE SPECIES

- |                        |                            |
|------------------------|----------------------------|
| 1a. Apices rounded     | 1. <i>C. brebissonii</i>   |
| b. Apices subpyramidal | 2. <i>C. subpyramidata</i> |

1. *Cylindrocystis brebissonii* Menegh., Organogr. 5. fig. 26. 1838; West & West, A monograph of the British Desmidiaceae 58. pl. 4. figs. 23-32, pl. 5, fig. 10. 1904; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 182. 1907; Anand, Ind. freshwater microalgae 55. fig. 172. 1998; Kant & Gupta, Algal Fl. Ladakh 138. pl. 64. fig. 2. 1998. *Penium brebissonii* Ralfs 1848.

Pl. 28, Fig. 3

Cells unicellular, cylindrical, middle portion not constricted, 38.25-43.67  $\mu\text{m}$  long, 19.12-22.34  $\mu\text{m}$  broad; poles rounded; cell wall smooth; chloroplast stellate, 2; nucleus 1; pyrenoids 2.

*Phenology* : December-January.

Planktonic in a paddy field at Sahiya, associated with *Closterium* sp. (94851).

2. *Cylindrocystis subpyramidata* W. & G.S. West, Freshw. Chloronhy. Koh Chang 162. pl. 2. figs. 8-11. 1901; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 189. 1907; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 89. pl. 15. fig. 11. 1992.

Pl. 28, Fig. 4

Cells unicellular, cylindrical, slightly constricted in equatorial portion, 29.38-33.47  $\mu\text{m}$  long, 18.42-21.15  $\mu\text{m}$  broad; cell wall smooth; apices subpyramidal with rounded ends; chloroplast substellate 2; nucleus 1; pyrenoid 2.

*Phenology* : December-January.

Planktonic in a paddy field at Sahiya, associated with diatoms mixture (94851).

## 2. MESOTAENIUM Näg.

Cells unicellular, cylindrical to subcylindrical; poles rounded; cell wall smooth; pores absent; chloroplast parietal, single axial; nucleus single; pyrenoids one or several; reproduction by transverse division, sexuality conjugation.

### KEY TO THE SPECIES

- |  |                          |
|--|--------------------------|
| 1a. Cells cylindrical, slightly curved | 2. <i>M. giganteum</i>   |
| b. Cells oblong, straight              | 1. <i>M. caldariorum</i> |

1. *Mesotaenium caldariorum* (Lagerh.) Hansg., Prod. Alg. Boehm. 174. 1888; Turner, The freshwater algae East India 15. 1892; West & West, A monograph of the British Desmidiaceae 53. pl. 4. figs. 15-17. 1904; Biswas in Rec. Bot. Surv. India 15(2): 85. 1949. *Mesotaenium endllicherianum* var. *caldariorum* Lagerh. 1886.

Pl. 28, Figs. 1a-b

Cells straight, oblong, unicellular, end portion slightly conical, 36.47-41.73  $\mu\text{m}$  long, 14.28-17.92  $\mu\text{m}$  broad; cell wall smooth; chloroplast 1, axial plate shape; nucleus 1; pyrenoids 4-6.

*Phenology* : December-January.

Free floating in a paddy fields at Sahiya, associated with *Oscillatoria* sp. (94850).

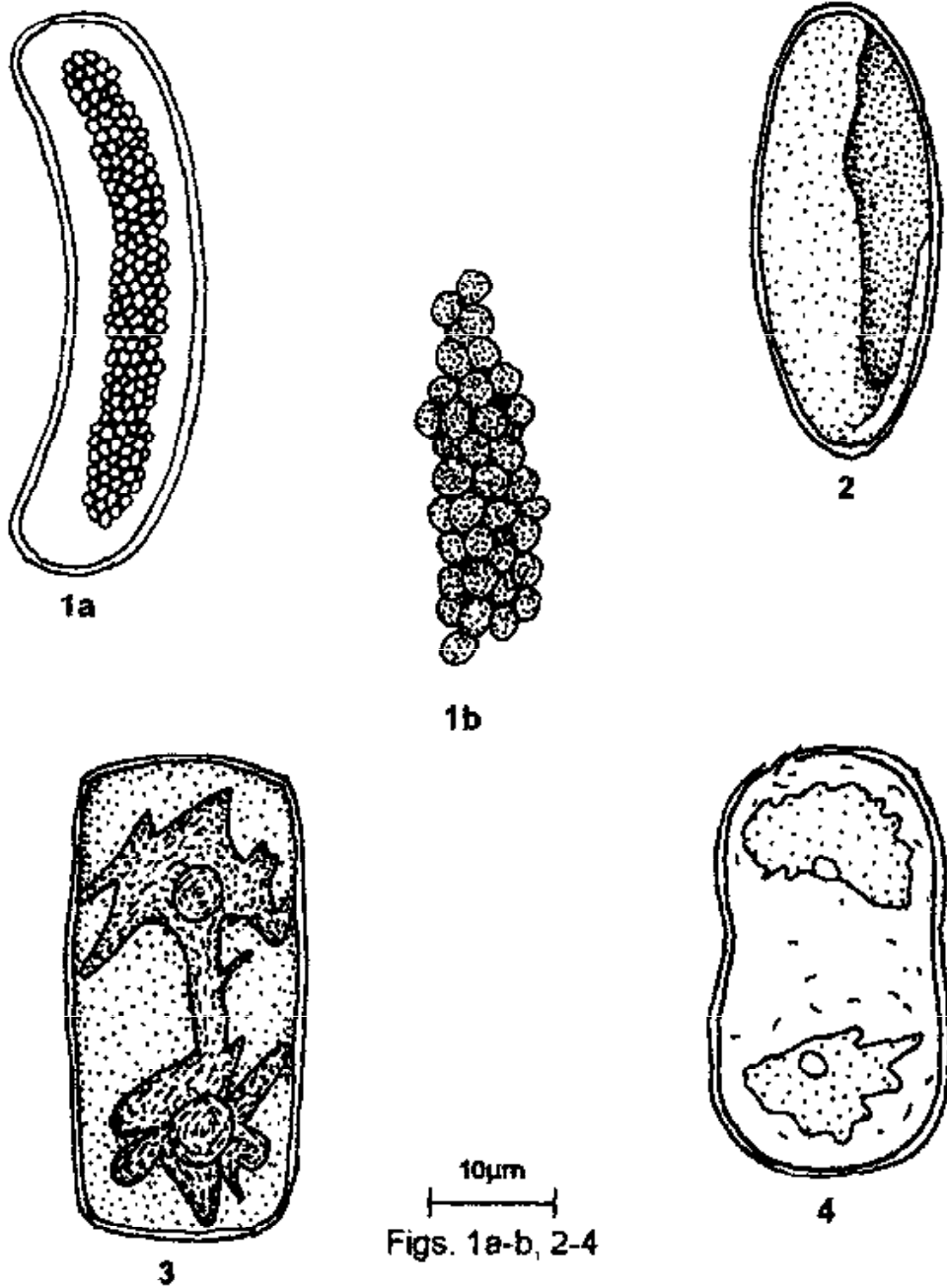


Plate 28 : Figs. 1-4 : 1a-b. *Mesotaenium caldariorum*; 2. *Mesotaenium giganteum*; 3. *Cylindrocystis brebissonii*; 4. *Cylindrocystis subpyramidata*.

2. *Mesotaenium giganteum* Turner, The freshwater algae East India 15. 1892; Biswas in Rec. Bot. Surv. India 15(2): 85. 1949.

Pl. 28, Fig. 2

Cells unicellular, cylindrical, slightly curved, 52.68-56.17  $\mu\text{m}$  long, 12.32-19.82  $\mu\text{m}$  broad; ends rounded; cell wall smooth; chloroplast 1 axial parietal; nucleus 1; pyrenoids 5-7.

*Phenology* : December-January.

Free floating in the paddy fields at Sahiya, associated with *Oscillatoria* sp. (94850).

## 2. ZYGNEMACEAE

### KEY TO THE GENERA

- |                                      |              |
|--------------------------------------|--------------|
| 1a. Chloroplasts 1-16, spiral shaped | 1. SPIROGYRA |
| b. Chloroplasts 2, stellate          | 2. ZYGNEMA   |

### 1. SPIROGYRA Link

Thallus unbranched; cells cylindrical, longer than broad; septa plane, colligate or replicate; nucleus one centrally situated; vacuole present; chloroplasts 1-16 loosely or tightly spirally coiled; pyrenoids numerous in linear series; reproduction by fragmentation, aplanospores, parthenospores or akinetes, sexuality scalariform or lateral conjugation; zygospores ellipsoid, ovate, sub-globose, lenticular or oblong.

### KEY TO THE SPECIES

- |   |                          |
|---|--------------------------|
| 1a. Chloroplast one in each cell                          | 2                        |
| b. Chloroplast more than one in each cell                 | 5                        |
| 2a. Zygospore ellipsoid                                   | 3                        |
| b. Zygospore oval to ovoid                                | 4                        |
| 3a. Gametangia inflated                                   | 5. <i>S. gracilis</i>    |
| b. Gametangia cylindric                                   | 2. <i>S. communis</i>    |
| 4a. Cells 40.00-47.5 $\mu\text{m}$ broad; septa plane     | 3. <i>S. condensata</i>  |
| b. Cells 26.00-31.00 $\mu\text{m}$ broad; septa replicate | 9. <i>S. semitorhata</i> |
| 5a. Gametangia cylindric                                  | 6                        |
| b. Gametangia swollen                                     | 8                        |
| 6a. Chloroplast three in each cell                        | 8. <i>S. rivularis</i>   |



- b. Chloroplast more than three in each cell 7  
 7a. Cells 135.0-140.0  $\mu\text{m}$  broad; zygospore lenticular  
     6. *S. maxima*  
 b. Cells 125.0-130.0  $\mu\text{m}$  broad; zygospore ellipsoid  
     4. *S. ellipsozona*  
 8a. Cells 57.0-60.5  $\mu\text{m}$  broad 1. *S. bichromatophora*  
 b. Cells 53.0-55.0  $\mu\text{m}$  broad 7. *S. paradoxa*

1. *Spirogyra bichromatophora* (Randhawa) Transeau in Ohio Jour. Sci. 44: 243. 1944; Randhawa, Zygnemaceae 328. fig. 315. 1959; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 78. pl. 14. figs. 16, 17. 1992; Kant & Gupta, Algal Fl. Ladakh 126. pl. 51. fig. 6, pl. 111. fig. 2. 1998. *Spirogyra gallica* var. *bichromatophora* Randhawa 1938.

**Pl. 29, Figs. 1a-d**

Filaments of vegetative cells cylindrical, 153.64-160.93  $\mu\text{m}$  long, 57.12-60.56  $\mu\text{m}$  broad; septa plane; chloroplasts 2 in each cell with 4-5 turns; conjugation scalariform; conjugation tube formed by both gametangia; fertile cells cylindrical, 154.87-162.84  $\mu\text{m}$  long, 58.18-61.36  $\mu\text{m}$  broad; zygospores ellipsoid, 70.78-73.43  $\mu\text{m}$  long, 47.54-58.52  $\mu\text{m}$  broad; mesospore wall smooth, brown.

*Phenology* : August-December.

Free floating in Yamuna at Asan, along with other members of Conjugales (93106); free floating in a drain water at Gullar ghati, associated with *Closterium* sp. (93162).

2. *Spirogyra communis* (Hassal) Kütz., Species Algarum 439. 1849; Randhawa, Zygnemaceae 293. fig. 247. 1959; Kant & Gupta, Algal Fl. Ladakh 123. pl. 49. fig. 5, pl. 109. fig. 7. 1998.

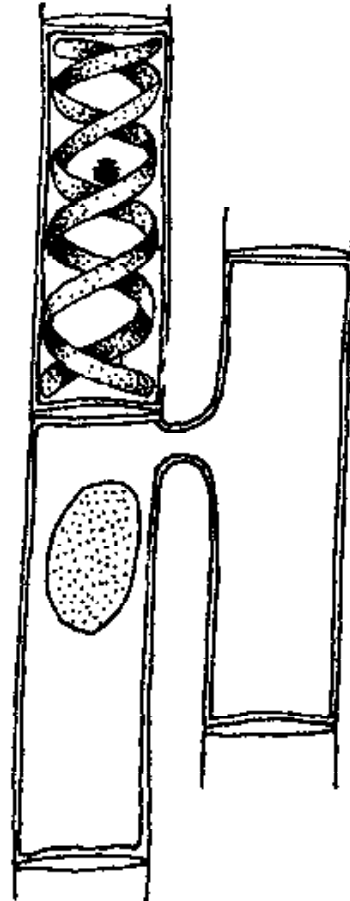
**Pl. 30, Figs. 1a-d**

Filaments of vegetative cells cylindrical, 87.18-91.43  $\mu\text{m}$  long, 19.5-21.94  $\mu\text{m}$  broad; septa plane; chloroplast 1 with 2-3 turns; conjugation scalariform; conjugation tube formed by both gametangia; fertile cells cylindrical, 89.23-92.79  $\mu\text{m}$  long, 20.32-22.79  $\mu\text{m}$  broad; zygospores ellipsoid with narrow rounded end, 38.39-45.98  $\mu\text{m}$  long, 19.0-20.38  $\mu\text{m}$  broad; mesospore wall smooth, yellowish.

*Phenology* : March-December.



1a

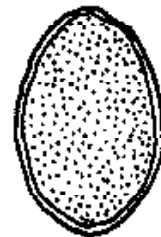


1b



1c

20µm  
Figs. 1a-d



1d

Plate 29 : Fig. 1: 1a. *Spirogyra bichromatophora*, 1b. *Scalariform conjugation*, 1c. *Septa*, 1d. *Zygospore*.

Free floating in Yamuna at Asan (93101); free floating in a puddle at Sahasradhara, intermingled with *Rhizoclonium* sp. (93154); free floating in a drain water at Gullar ghati, associated with members of Ulotrichales (93160); free floating in a small puddle at Mussoorie (93180); free floating in a ditch at Rajajee National Park near Ramgarh (93192).

3. *Spirogyra condensata* (Vaucher) Kütz., *Phycologia Generalis* 279. 1843; Randhawa, *Zygnemaceae* 291. figs. 245, a-c. 1959; Prasad & Misra, *Freshwater algal Fl. Andaman and Nicobar Islands*, 78. pl. 13. figs. 11, 12. 1992; Kant & Gupta, *Algal Fl. Ladakh* 124. pl. 45. fig. 12, pl. 48. fig. 5. 1998.

**Pl. 30, Figs. 2a-d**

Filaments of vegetative cells cylindrical, 86.47-96.25  $\mu\text{m}$  long, 40.12-47.5  $\mu\text{m}$  broad; septa plane; chloroplast 1 in each cell with 3-4 turns; conjugation scalariform; conjugation canal formed by both gametangia; fertile cell cylindrical, 88.24-89.54  $\mu\text{m}$  long, 42.48-43.64  $\mu\text{m}$  broad; zygospores ellipsoid, 49.23-52.19  $\mu\text{m}$  long, 34.86-38.16  $\mu\text{m}$  broad; mesospore wall smooth, yellowish brown.

*Phenology* : August-October.

Free floating in Asan reservoir, along with other *Spirogyra* sp. (93102).

4. *Spirogyra ellipsospora* Transeau in *Amer Journ. Bot.* 1: 294. 1914; Randhawa, *Zygnemaceae* 323. fig. 304. 1959. *Spirogyra setiformis* var. *maior* Biswas 1930, *Spirogyra ellipsospora* f. *tenuis* Singh 1945.

**Pl. 31, Figs. 1a-d**

Filaments of vegetative cells cylindrical, 398.66-424.27  $\mu\text{m}$  long, 58.52-95.19  $\mu\text{m}$  broad; septa plane; chloroplasts 3-5 with 4-5 turns; conjugation scalariform, tubes formed by both gametangia; fertile cells cylindrical, 402.48-406.68  $\mu\text{m}$  long, 59.84-64.19  $\mu\text{m}$  broad; zygospores ellipsoid with pointed end, 175.56-203.82  $\mu\text{m}$  long, 43.89-73.15  $\mu\text{m}$  broad; mesospore wall smooth, yellowish brown.

*Phenology* : August December.

Free floating in a puddle at Dhalipur, associated with *Cosmarium* sp. (93111, 93116).

5. *Spirogyra gracilis* (Hassall) Kütz., *Species Algarum* 438. 1849; West & West in *Ann. Roy. Bot. Gard. Cal.* 6(2): 185. 1907. Randhawa,

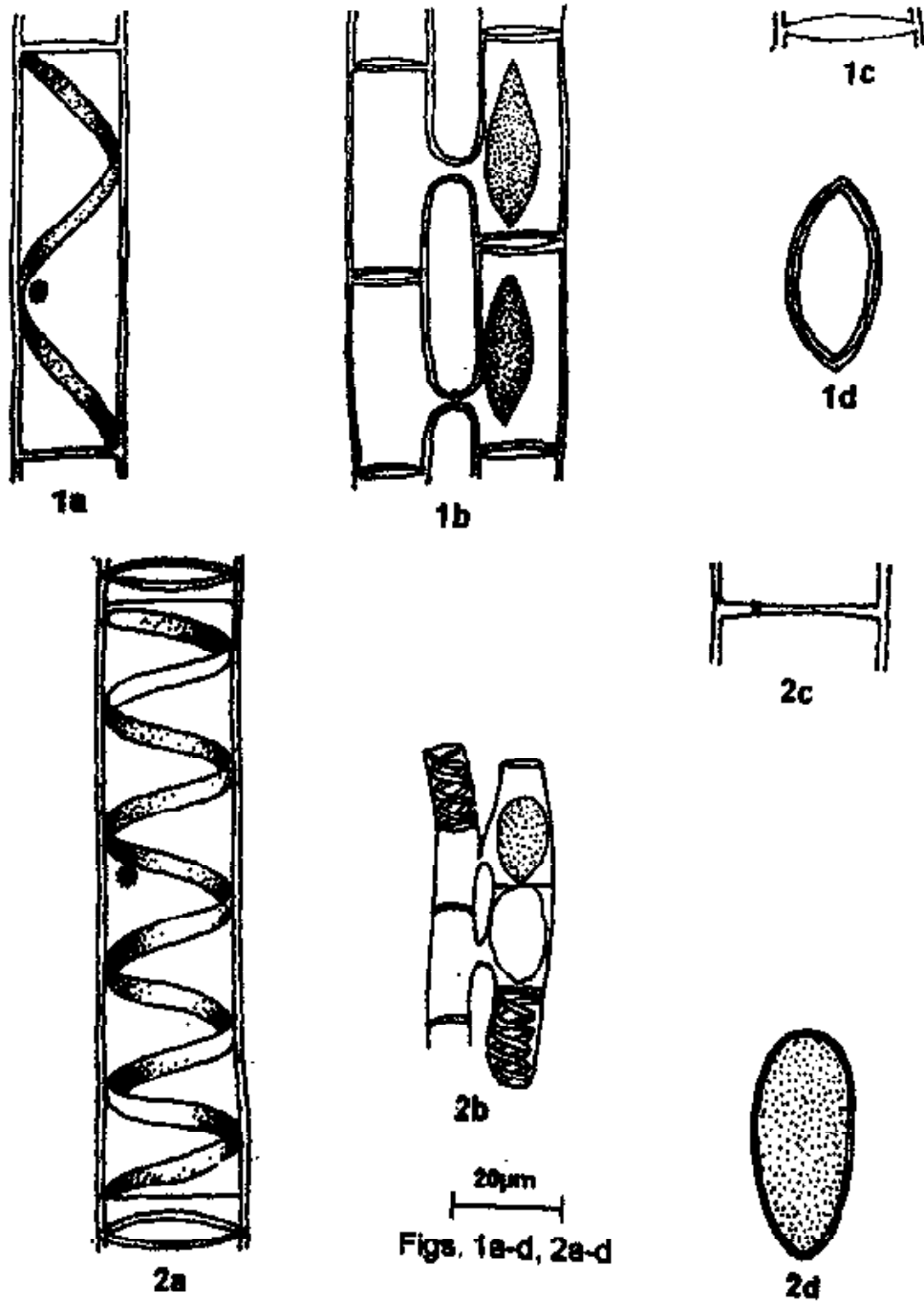


Plate - 30 ; Figs. 1-2 : 1a. *Spirogyra communis*, 1b. Scalariform conjugation, 1c. Septa, 1d. Zygospore; 2a. *Spirogyra condensata*; 2b. Scalariform conjugation, 2c. Septa, 2d. Zygospore.

Zygnemaceae 296. figs. 253, a-c. 1959; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 83. pl. 14. figs. 2, 3. 1992.

**Pl. 31, Figs. 2a-d**

Filaments of vegetative cells cylindrical, 62.36-71.68  $\mu\text{m}$  long, 16.19-17.51  $\mu\text{m}$  broad; septa plane; chloroplast 1 in each cell with 4-5 turns; conjugation scalariform, tube formed by both gametangia; fertile cells inflated, 64.18-67.37  $\mu\text{m}$  long, 17.69-18.22  $\mu\text{m}$  broad; zygospores ellipsoid, with rounded apex, 43.48-45.16  $\mu\text{m}$  long, 20.56-23.77  $\mu\text{m}$  broad; mesospore wall smooth, yellowish brown.

*Phenology* : August-December.

Free floating in a ditch at Gullar ghati, associated with other species of *Spirogyra* (93101, 93102, 93104, 93121, 93122, 93124); free floating in a ditch at Sahasradhara, associated with *Oedogonium* sp. and diatoms mixture (93136); free floating in a drain water at Gullar ghati, associated with certain diatoms (93156).

6. *Spirogyra maxima* (Hassall) Wittr. in Bot. Notiser 57. 1868; West & West in Ann. Roy. Bot. Gard. Cal., 6(2): 187. 1907; Biswas in Rec. Bot. Surv. India 15(1): 82. pl. 6. figs. 61a-b. 1949.

**Pl. 32, Figs. 1a-d**

Filaments of vegetative cells cylindrical, 191.19-234.18  $\mu\text{m}$  long, 120.69-131.67  $\mu\text{m}$  broad; septa plane; chloroplasts 6-7 in each cell with 1-2 turns; conjugation scalariform, tubes formed by both gametangia; fertile cells cylindrical, 192.27-197.48 long, 124.57-126.23  $\mu\text{m}$  broad; zygospores lenticular, 73.15-91.43  $\mu\text{m}$  long, 102.41-117.04  $\mu\text{m}$  broad; mesospore wall reticulate, golden brown.

*Phenology* : Throughout the year.

Free floating in Asan reservoir (93103); free floating in a ditch at Asan reservoir near bridge alongwith other species of *Spirogyra* (93115); free floating in a rain water puddle at Sahasradhara, along with *Gomphonema* sp. (93128, 93151); free floating in a puddle at Dhanaulti near temple (94812).

7. *Spirogyra paradoxa* Rao in J. Indian Bot. Soc. 16: 281. fig. 5. e, 1937; Randhawa, Zygnemaceae 326. fig. 313. 1959; Prasad &

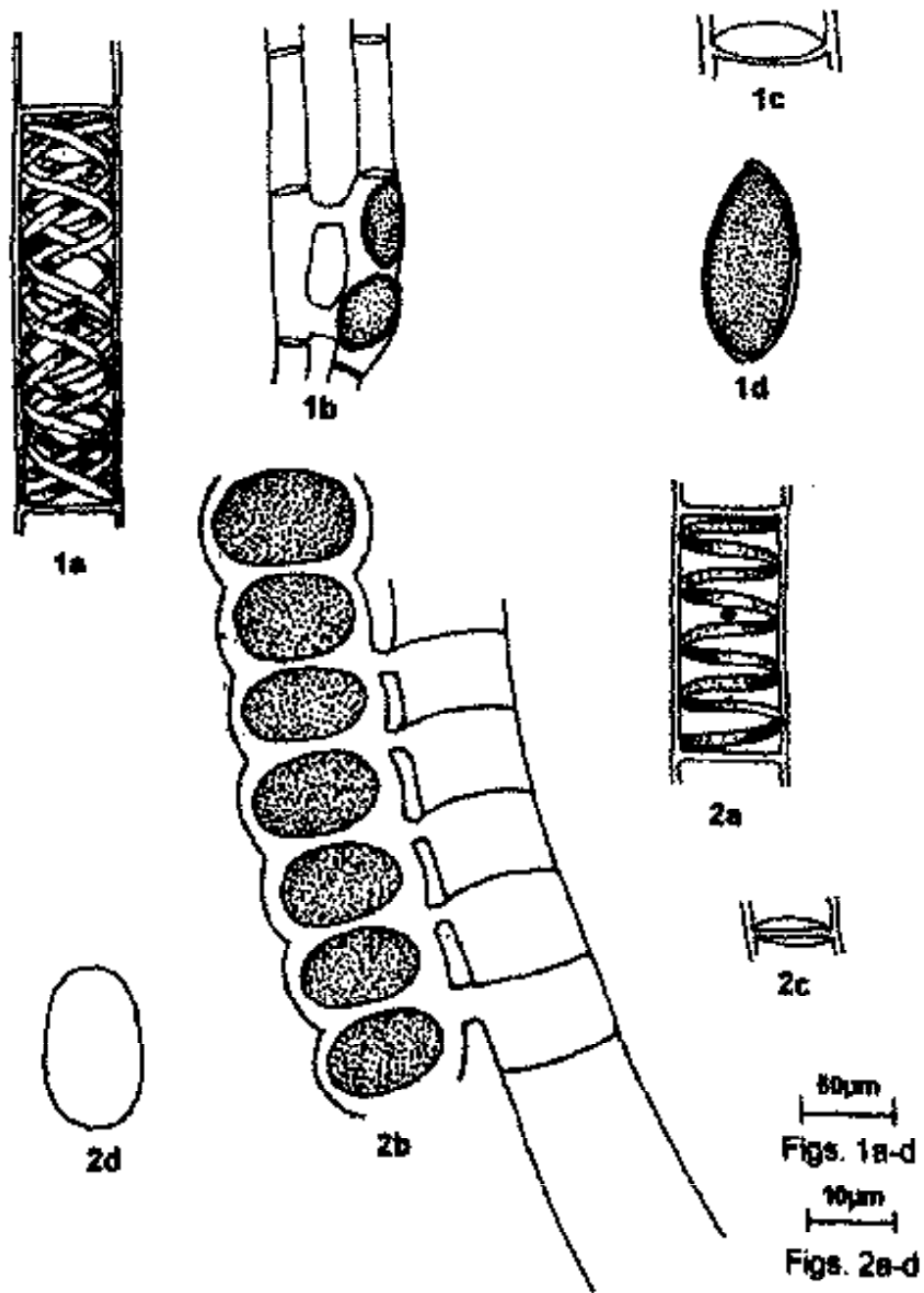


Plate - 31 : Figs. 1-2 : 1a. *Spirogyra elliptospora*, 1b. Scalariform conjugation, 1c. Septa, 1d. Zygospore; 2a. *Spirogyra gracilis*, 2b. Scalariform conjugation, 2c. Septa, 2d. Zygospore.

Misra, Freshwater algal Fl. Andaman and Nicobar Islands, 85. pl. 13. figs. 8, 10. 1992.

**Pl. 32, Figs. 2a-d**

Filaments of vegetative cells cylindrical, 62.18-65.69  $\mu\text{m}$  long, 53.12-54.56  $\mu\text{m}$  broad; septa plane; chloroplasts 3 in each cell with 2-3 turns; conjugation scalariform; tubes formed by both gametangia; fertile cells swollen, 63.37-67.87  $\mu\text{m}$  long, 54.97-56.23  $\mu\text{m}$  broad; zygospores ellipsoid, 56.13-58.73  $\mu\text{m}$  long, 60.46-63.03  $\mu\text{m}$  broad; mesospore wall smooth, brown.

*Phenology* : May-November.

Free floating in a ditch at Asan reservoir near bridge along with other species of *Spirogyra* (93115); free floating in a ditch at Chandrabani near temple, (94804, 94805).

**8. *Spirogyra rivularis* (Hassall) Rabenh., Flora Europaea Algarum 3: 243, 1868; Randhawa, Zygnemaceae 317. figs. 292, a-c. 1959; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 88. pl. 14. figs. 4, 6. 1992.**

**Pl. 33, Figs. 1a-d**

Filaments of vegetative cells cylindrical, 192.49-245.68  $\mu\text{m}$  long, 43.47-45.52  $\mu\text{m}$  broad; septa plane; chloroplasts 3 in each cell with 2-3 turns; conjugation scalariform; tubes formed by both gametangia; fertile cells cylindrical, 197.28-212.35  $\mu\text{m}$  long, 34.58-46.74  $\mu\text{m}$  broad; zygospores ellipsoid, 78.36-80.25  $\mu\text{m}$  long, 40.56-42.18  $\mu\text{m}$  broad; mesospore wall smooth, yellowish brown.

*Phenology* : May-December.

Free floating in a drain at Gullar ghati, associated with *Microspora* sp. (93157); free floating in a Vrubala pond (93200); free floating in a ditch at Chandrabani near temple, associated with certain desmids (94803); free floating in a slowly flowing water at Mohand (94839).

**9. *Spirogyra semiorhata* Jao in Sinensia 6: 604. pl. 9. figs. 97-98. 1935; Randhawa, Zygnemaceae 358. figs. 376, a-b. 1959.**

**Pl. 34, Figs. 1a-d**

Filaments of vegetative cells cylindrical, 204.82-235.9  $\mu\text{m}$  long, 29.26-31.18  $\mu\text{m}$  broad; septa replicate; chloroplast 1 with 3-6 turns;

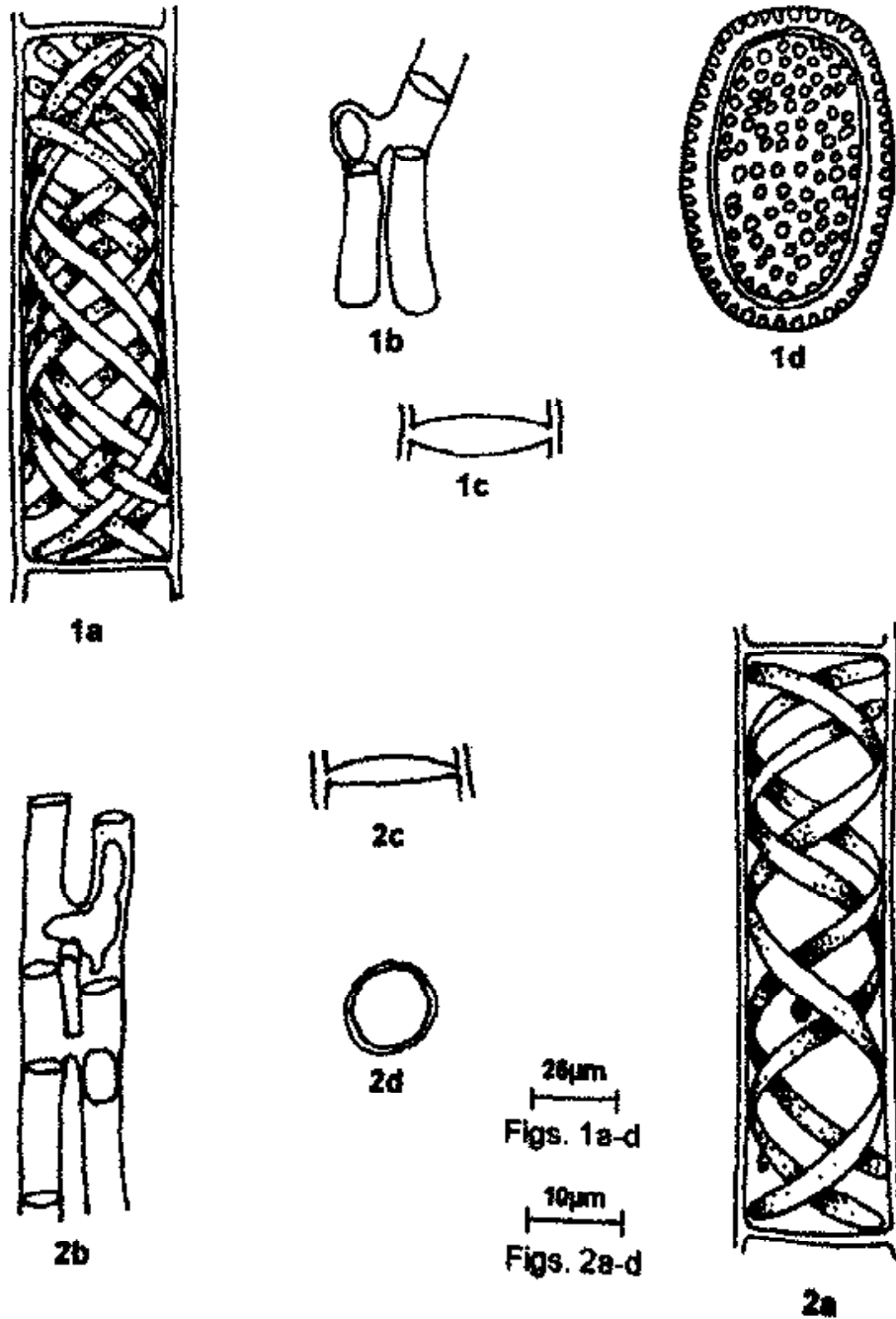


Plate - 32 : Figs. 1-2 : 1a. *Spirogyra maxima*, 1b. Scalariform conjugation, 1c. Septa, 1d. Zygospore; 2a. *Spirogyra paradoxa*, 2b. Scalariform conjugation, 2c. Septa, 2d. Zygospore.



pyrenoids 6-8; conjugation scalariform; tubes formed by both gametangia; fertile cells cylindrical, 209.56-239.55  $\mu\text{m}$  long, 30.38-37.78  $\mu\text{m}$  broad; zygospores ovoid, 60.34-62.17  $\mu\text{m}$  long, 34.25-36.79  $\mu\text{m}$  broad; mesospore wall smooth yellowish brown.

*Phenology* : November-January.

Free floating a small ditch at Asan, associated with certain desmids (93174); free floating in a puddle at Nayanbagh near tehri bridge, associated with diatoms mixture (94820); free floating in a ditch at Mohand near bridge, associated with *Rhizoclonium*, sp. (94826); free floating in a cultivated land at Sahiya (94857, 94858); free floating in a small ditch at Chakrata, associated with diatoms mixture (94862).

## 2. ZYGNEMA C.A. Agardh

Thallus unbranched; cells cylindrical longer than broad; cell wall smooth; chloroplast two stellate, connected by cytoplasmic isthmus containing one centrally situated nucleus; pyrenoids two; reproduction by fragmentation, aplanospores, or akinetes, sexuality scalariform or lateral conjugation; zygospores formed either in conjugation canal or in gametangia vary morphologically.

### KEY TO THE SPECIES

- 1a. Vegetative cells 30-32  $\mu\text{m}$  broad; zygospores formed in gametangia 1. *Z. cyaneum*
- b. Vegetative cells 20-22  $\mu\text{m}$  broad; zygospores formed in conjugation canal 2. *Z. cyanosporum*

1. *Zygnema cyaneum* Czurda, Süßwasserflora Mitteleuropa 9: 127. fig. 132. 1932; Randhawa, Zygnemaceae 246. figs. 205 a-b. 1959. *Zygnema melanosporum* f. *dalense* Misra 1937.

**Pl. 35, Figs. 2a-b**

Filaments unbranched; vegetative cells cylindrical, 47.62-51.84  $\mu\text{m}$  long, 31.14-31.74  $\mu\text{m}$  broad; cell wall smooth; chloroplast 2 stellate; pyrenoid 2; nucleus 1 centrally located; conjugation scalariform; zygospores globose, formed in one gametangia, 30.38-32.45  $\mu\text{m}$  broad; median spore wall thick, smooth, blue.

*Phenology* : February-March.

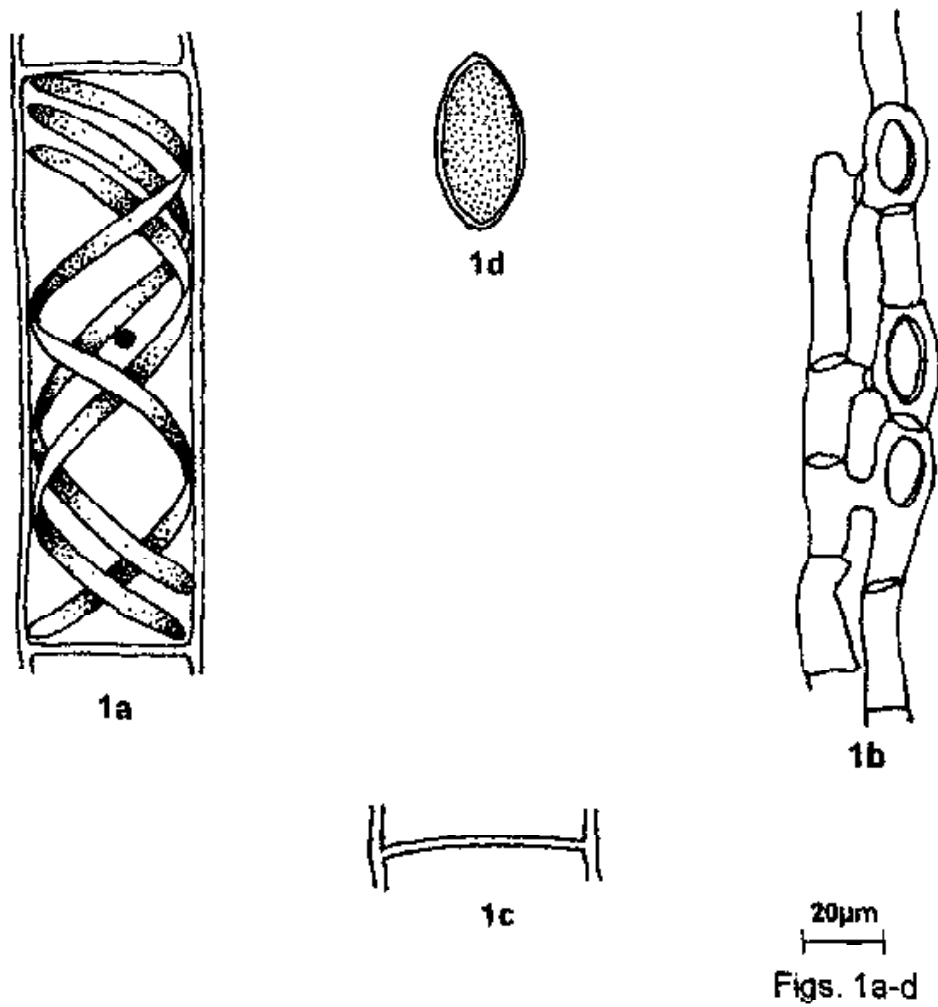


Plate 33 : Fig. 1: 1a. *Spirogyra rivularis*, 1b. Scalariform conjugation, 1c. Septa, 1d. Zygospore.

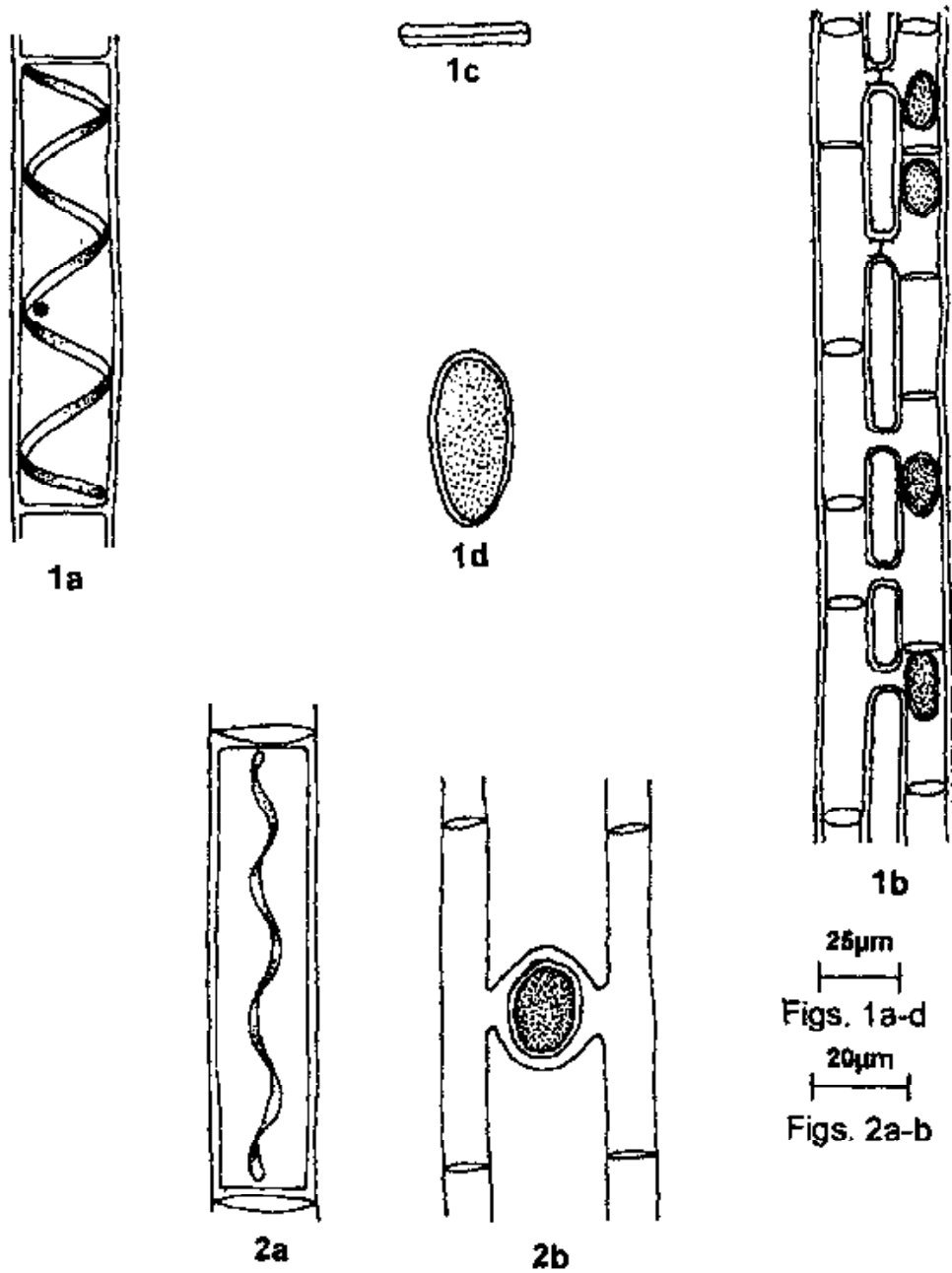


Plate 34 : Figs. 1-2 : 1a. *Spirogyra semiornata*, 1b. Scalariform conjugation, 1c. Septa, 1d. Zygospore; 2a. *Mougeotia recurva*, 2b. Scalariform conjugation.

Free floating in a slowly flowing water at Lachiwala, associated with *Spirogyra* sp. (94872).

2. **Zygnema cyanosporum** Cleve in Nova. Acta. Reg. Soc. Sci. Upsali 6: 28. pl. 8. figs. 6-8. 1868; Randhawa, Zygnemaceae 225. fig. 159. 1959.

Pl. 35, Figs. 1a-b

Filaments unbranched; vegetative cells cylindrical, 62.38-64.67  $\mu\text{m}$  long, 20.23-22.12  $\mu\text{m}$  broad; cell wall smooth; chloroplasts 2 stellate; pyrenoids 2; nucleus 1 centrally located; conjugation scalariform; zygospores globose, formed in conjugation canal, with 2 layers wall, 27.18-29.24  $\mu\text{m}$  broad; mesospore smooth, blue.

*Phenology* : February-March.

Free floating in a ditch at Lachiwala, associated with diatoms mixture (94874, 94875).

### 3. MOUGEOTIACEAE

#### 1. MOUGEOTIA C.A. Agardh

Filaments unbranched; cells cylindrical, longer than broad; cell wall thin; septa plane; chloroplast flat axial plate; nucleus one; pyrenoids several, linear; reproduction by fragmentation or aplanospore, sexuality scalariform or lateral conjugation; zygospores globose, spheroid or quadrate-ovoid.

#### KEY TO THE SPECIES

- |   |                           |
|---|---------------------------|
| 1a. Vegetative cells 6.0-8.0 $\mu\text{m}$ broad zygospores quadrate              | 3. <i>M. viridis</i>      |
| b. Vegetative cells 12.0-25.0 $\mu\text{m}$ broad; zygospores not quadrate        | 2                         |
| 2a. Vegetative cells 12.0-18.0 $\mu\text{m}$ broad; zygospores globose            | 1. <i>M. recurva</i>      |
| b. Vegetative cells 20.5-24.0 $\mu\text{m}$ broad; zygospores ovoid to subglobose | 2. <i>M. sphaerocarpa</i> |

1. **Mougeotia recurva** (Hassall) De Toni, Sylloge Algarum 1: 714. 1889; Randhawa, Zygnemaceae 127. fig. 17. 1959. Kant & Gupta, Algal Fl. Ladakh 120. pl. 53. figs. 4a, 4b. 1998.

Pl. 34, Figs. 2a-b

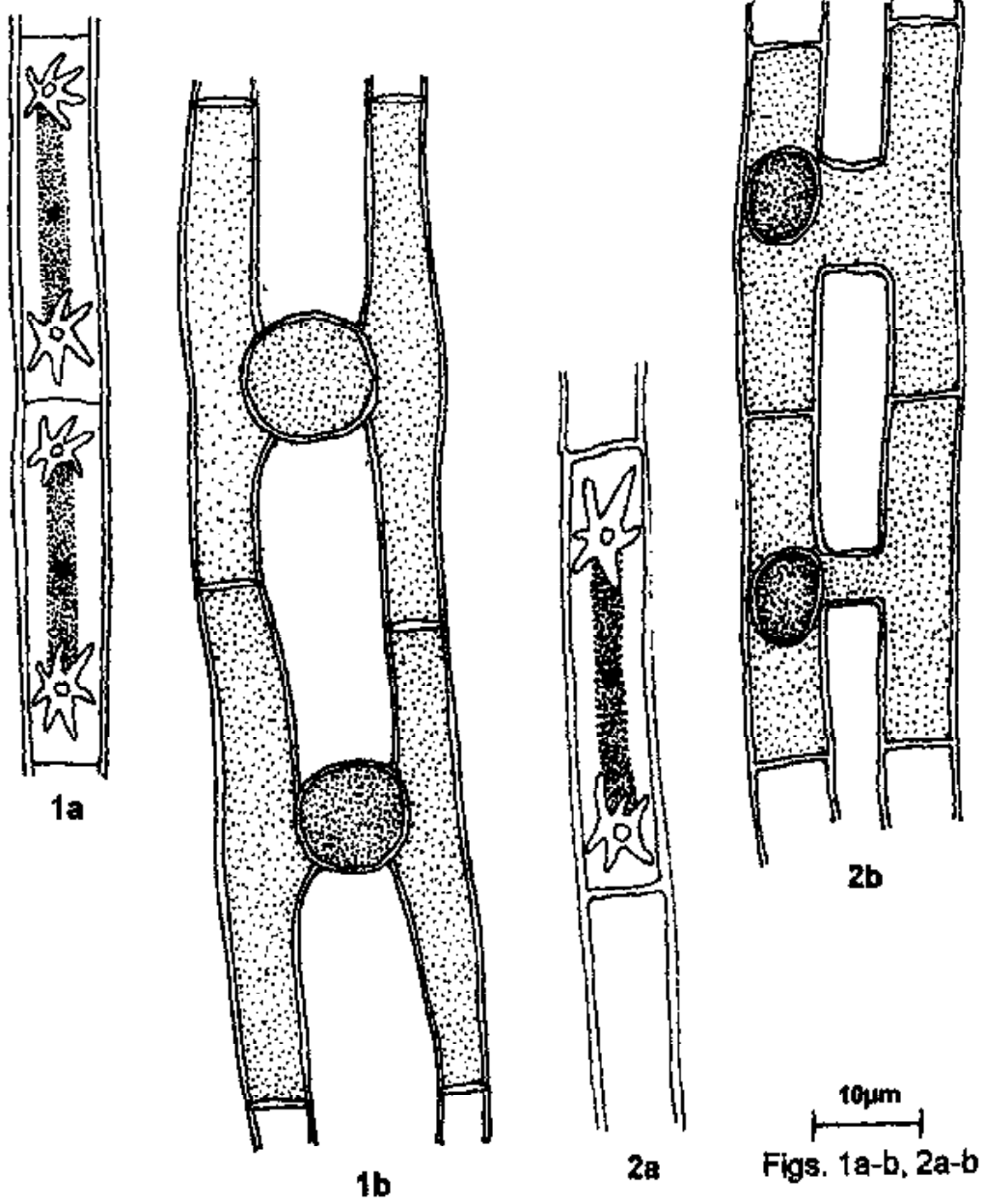


Plate 35 : Figs. 1-2. : 1a. *Zygnema cyanosporum*, 1b. Scalariform conjugation; 2a. *Zygnema cyaneum*, 2b. Scalariform conjugation.

Filaments of vegetative cells cylindrical, 151.17-179.21  $\mu\text{m}$  long, 14.63-17.28  $\mu\text{m}$  broad; chloroplast 1, axial plate; nucleus 1; pyrenoids 5-7, arranged in series; conjugation scalariform; zygospores globose, formed in conjugation tube, 27.94-29.26  $\mu\text{m}$  broad; mesospore wall smooth brown; aplanospores globose, 25.15-29.26  $\mu\text{m}$  broad.

*Phenology* : May-November.

Free floating in a Asan reservoir along with *Spirogyra* sp. (93116); free floating in a Varubala pond, associated with other members of Conjugales (93199); free floating in a slowly flowing water at Mohand, associated with *Rhizoclonium* sp. (94840, 94841).

2. *Mougeotia sphaerocarpa* Wolle, Freshwater algae of the United States 227. pl. 146. figs. 1-2. 1887; Randhawa, Zygnemaceae 29. figs. 21 a-c. 1959. Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 75. pl. 12. figs. 6-8. 1992; Kants & Gupta, Algal Fl. Ladakh 120. pl. 53. fig. 7, pl. 54. fig. 3, pl. 113. fig. 2. 1998.

Pl. 36, Figs. 1a-b

Filaments of vegetative cells cylindrical, 97.47-18.27  $\mu\text{m}$  long, 20.5-24.0  $\mu\text{m}$  broad; chloroplast 1, axale plate; nucleus 1, pyrenoids 5-8; conjugation scalariform, tubes formed by both gametangia; zygospores ovoid, 40.56-42.89  $\mu\text{m}$  long, 37.14-40.23  $\mu\text{m}$  broad; mesospore wall smooth, brown.

*Phenology* : August-November.

Free floating in a puddle under expose condition along with other members of Conjugales at Asan near bridge (93111, 93112, 93116, 93123); free floating in a ditch at Sahasradhara, intermingled with *Rhizoclonium* sp. (93129); free floating in a ditch at Mohand under exposed condition (94836).

3. *Mougeotia viridis* (Kütz.) Wittr. in Bih. Kgl. Svensk. Vetensk. Akad. Handl. 1: 39. 1872; Randhawa, Zygnemaceae 158. figs. 83a-b. 1959; Kant & Gupta, Algal Fl. Ladakh 120. pl. 54. figs. 1, 4, pl. 113. fig. 1. 1998.

Pl. 36, Figs. 2a-c

Filaments of vegetative cells cylindrical, 55.89-112.36  $\mu\text{m}$  long, 6.23-8.47  $\mu\text{m}$  broad; chloroplast 1, axial plate; pyrenoids 3-5 in one

row; conjugation scalariform; zygospores quadrate with retuse end, 23.26-30.57  $\mu\text{m}$  broad; mesospore wall smooth, colourless.

*Phenology* : August-September.

Free floating in a puddle at Asan reservoir near bridge along with other members of Conjugales and certain diatoms (93111, 93113).

#### 4. DESMIDIACEAE (Placoderm Desmids)

##### KEY TO THE GENERA

- |  |                  |
|--|------------------|
| 1a. Cells elongated                                  | 2                |
| b. Cells compressed                                  | 3                |
| 2a. Cells curved, attenuated toward each end         | 1. CLOSTERIUM    |
| b. Cells straight, plane toward each end or truncate | 4. PLEUROTAENIUM |
| 3a. Semicells radiate                                | 5. STAUSTRUM     |
| b. Semicells not radiate                             | 4                |
| 4a. Apical and lateral incision lobed margin         | 3. EUASTRUM      |
| b. Apical and lateral incision without lobed margin  | 2. COSMARIUM     |

##### 1. CLOSTERIUM Nitzsch

Cell elongate, curved, without median constriction; poles attenuated; cell wall smooth or striated; chloroplasts entire or with longitudinal ridges; pyrenoids many arranged in axial row or irregularly scattered; nucleus one; reproduction by transverse division, sexuality conjugation.

##### KEY TO THE SPECIES

- |                              |                          |
|------------------------------|--------------------------|
| 1a. Cells strongly curved    | 2                        |
| b. Cells slightly curved     | 5                        |
| 2a. Inner margin not tumid   | 3                        |
| b. Inner margin tumid        | 4                        |
| 3a. Apices obtusely rounded  | 3. <i>C. diana</i>       |
| b. Apices acutely rounded    | 7. <i>C. parvulum</i>    |
| 4a. Outer margin 90-110° arc | 4. <i>C. ehrerbergii</i> |
| b. Outer margin 120-130° arc | 6. <i>C. moniliferum</i> |
| 5a. Cell wall smooth         | 6                        |
| b. Cell wall striated        | 7                        |
| 6a. Inner margin straight    | 1. <i>C. acerosum</i>    |

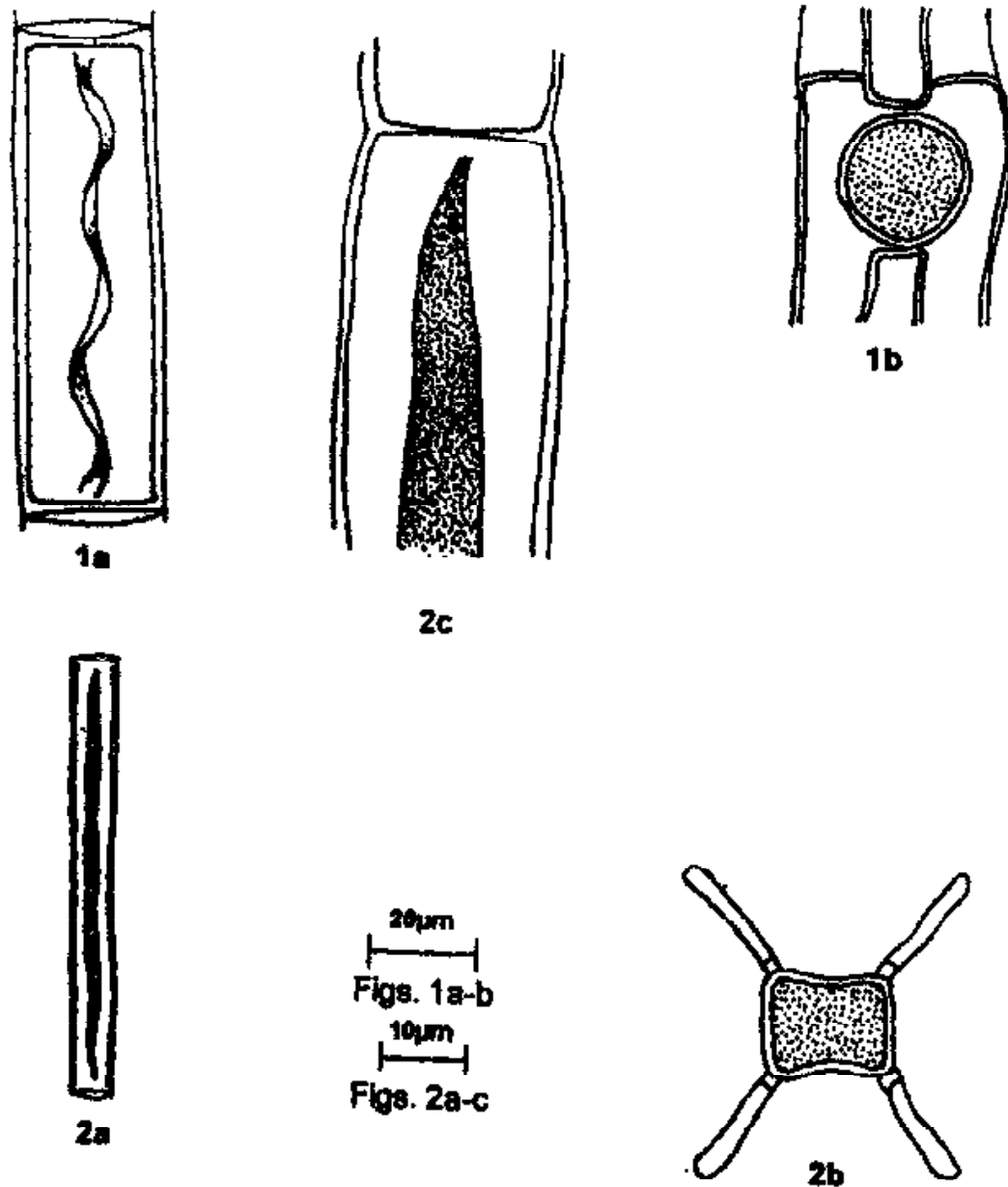


Plate - 36 : Figs. 1-2 : 1a. *Mougeotia sphaerocarpa*, 1b. Scalariform conjugation; 2a. *Mougeotia viridis*, 2b. Scalariform conjugation, 2c. Apical portion of chloroplast.



- |                                     |                       |
|-------------------------------------|-----------------------|
| b. Inner margin not straight        | 8. <i>C. venus</i>    |
| 7a. Median portion of cells tumid   | 5. <i>C. lineatum</i> |
| b. Median portion of cells straight | 2. <i>C. decorum</i>  |

1. *Closterium acerosum* (Schrank) Ehr. Abhl. 34. 1831; Turner, The freshwater algae East India 18. fig. 15. 1892; West & West, A monograph of the British Desmidiaceae 146. pl. 18. figs. 2-5. 1904; Biswas in Rec. Bot. Surv. India 15(2): 55. 1949; Prescott in Phykos 5(1&2): 4. pl. 1. figs. 1-2. 1966; Agarkar in Phykos 8(1&2): 1. fig. 4. 1969; Patel in J. Bombay nat. Hist. Soc. 66(3): 415. 1969; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 97. pl. 16. fig. 15. 1992; Anand, Ind. freshwater microalgae 55. figs. 175. 1998; Kant & Gupta, Algal Fl. Ladakh 130. pl. 57. figs. 2, 11, pl. 58. figs. 3, 10, pl. 59. fig. 17. pl. 118. fig. 7, pl. 119. fig. 9, pl. 120. fig. 1. 1998. *Vibrio acerosus* Schrank 1803.

Cells slightly curved in middle, narrowly fusiform, 422.15-497.57  $\mu\text{m}$  long, 40.62-42.48  $\mu\text{m}$  broad; outer margin curved with 30-35° arc; inner margin straight; semicells gradually tapering to rounded-truncate or subacute apices; wall smooth; chloroplasts 3-4, ridged; nucleus 1; pyrenoids 5-6, arranged in row.

*Phenology* : August-December.

Planktonic in a ditch near Asan bridge, associated with diatoms mixture (93121); planktonic in a ditch at Gullar ghati, associated with *Spirogyra* sp. (93162).

2. *Closterium decorum* Breb., Liste Desm. 151. pl. 2. fig. 39. 1856; West & West, A monograph of the British Desmidiaceae 184. pl. 17. figs. 7, 8, pl. 28. figs. 1-3. 1904; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 193. pl. 13. fig. 20, 1907; Biswas in Rec. Bot. Surv. India 15(2): 55. 1949; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 104. pl. 16. figs. 11, 12. 1992. *Closterium crassum* Delp. 1877, *Closterium delpontei* Wolle 1885.

Pl. 37, Fig. 2

Cells gradually attenuated towards pole, 440.32-472.18  $\mu\text{m}$  long, 25.13-26.47  $\mu\text{m}$  broad; apices rounded, 4.9-5.17  $\mu\text{m}$  broad; outer margin slightly curved with 50-55° arc; median portion tumid; wall striated; chloroplasts 2-3, ridged; pyrenoids 12-18.

*Phenology* : August-November.

Planktonic in a ditch near Asan bridge, associated with diatoms mixture (93125).

**3. *Closterium diana*** Ehr. in Infus. 92. pl. 5. figs. 17, 1-6. 1838; West & West, A monograph of the British Desmidiaceae 130. pl. 15. figs. 1-6. 1904. West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 191. 1907; Iyengar & Bai in J. Indian bot. Soc. 20: 77. figs. 9, 14, 15. 1941; Gonzalves & Joshi in J. Bombay nat. Hist. Soc. 46(1): 174. pl. 111. fig. 8. 1946; Biswas in Rec. Bot. Surv. India 15(2): 55. 1949; Agarkar in Phykos 8(1 & 2): 3. fig. 11. 1969; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 105. pl. 16. fig. 7. 1992; Kant & Gupta, Algal Fl. Ladakh 130. pl. 57. figs. 12, pl. 119. fig. 7. 1998. *Closterium acuminatum* Rabenh. 1868.

Pl. 38, Fig. 3

Cells sickle-shaped, gradually attenuated at pole, 159.26-246.56  $\mu\text{m}$  long, 16.37-23.47  $\mu\text{m}$  broad; apices rounded, 5.23-7.57  $\mu\text{m}$  broad; outer margin curved with 110-125° arc; inner margin scarcely tumid; wall smooth; chloroplasts 3-5, ridged; pyrenoids 7-10, arranged in single row.

*Phenology* : December.

Planktonic in a ditch at Gullar ghati, associated with *Spirogyra* sp. (93162).

**4. *Closterium ehrenbergii*** Menegh., Synops. 232. 1841; Turner, The freshwater algae East India 19. fig. 16. 1892; West & West, A monograph of the British Desmidiaceae 143. pl. 17. figs. 1-4. 1904; Biswas in Rec. Bot. Surv. India 15(2): 56. 1949; Prescott in Phykos 5(1 & 2): 5. pl. 1. figs. 6, 7. 1966; Suxena & Venkateswarlu in J. Indian bot. Soc. 47(1 & 2): 24. figs. 3a, b. 1968; Agarkar in Phykos. 8(1 & 2): 3. fig. 14. 1969; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 106. pl. 17. figs. 1, 2. 1992; Anand, Ind. freshwater microalgae 55. fig. 176. 1998; Kant & Gupta, Algal Fl. Ladakh 130. pl. 57. fig. 10. 1998. *Closterium lunula* Ehr. 1838.

Pl. 37, Fig. 4

Cells moderately curved, gradually attenuated towards pole, 492.48-512.16  $\mu\text{m}$  long, 70.19-78.59  $\mu\text{m}$  broad; apices rounded, 10.89-11.34  $\mu\text{m}$  broad; outer margin 90-110° arc; inner margin concave but inflated in middle portion; wall smooth; chloroplasts 5-6, band shape; pyrenoids 8-12, scattered.

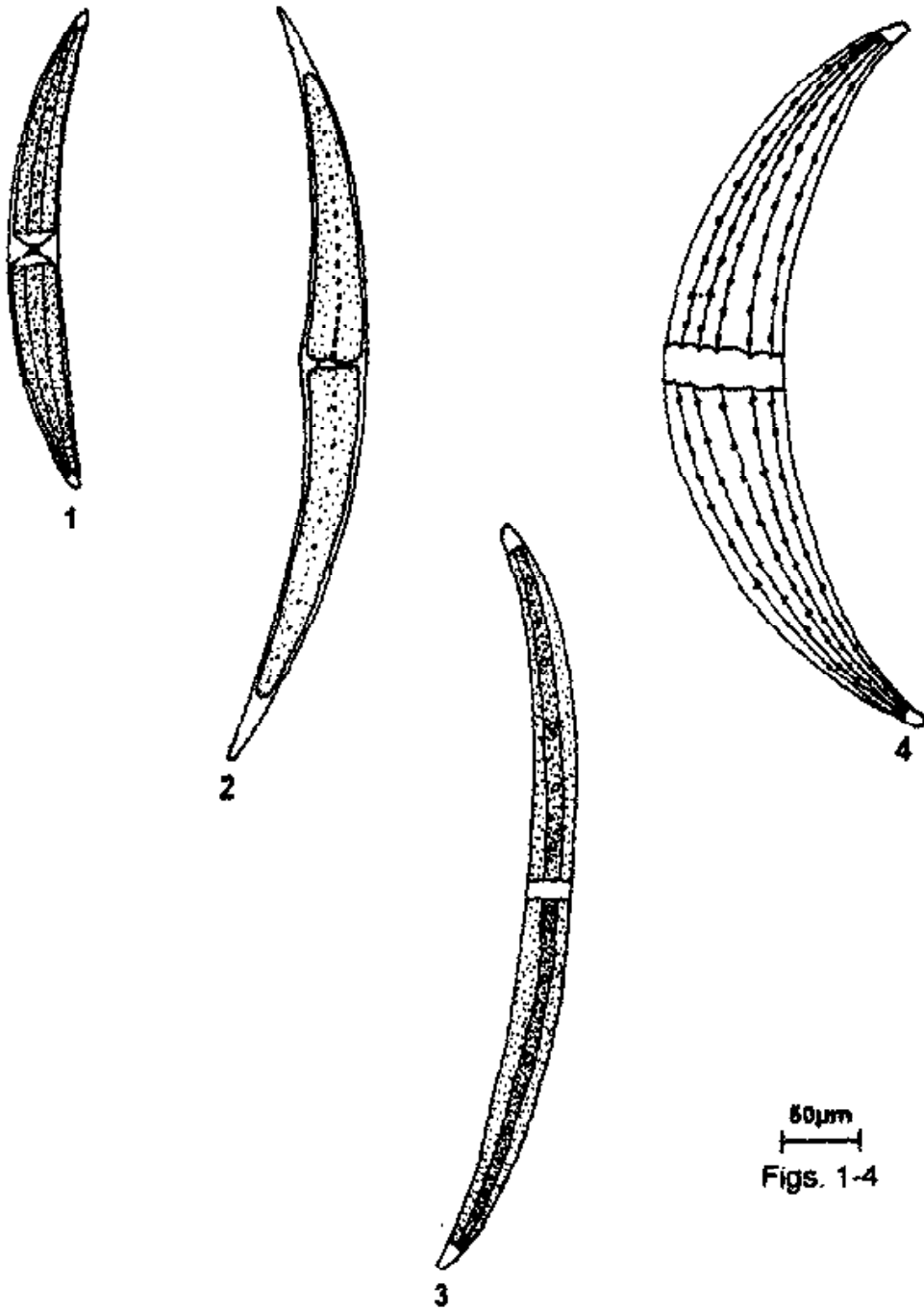


Plate -37 : Figs. 1-4 : 1. *Closterium acerosum*; 2. *Closterium decorum*; 3. *Closterium lineatum*; 4. *Closterium ehrenbergii*.

*Phenology* : Throughout the year.

Planktonic in a puddle at Gullar ghati, associated with *Hydrodictyon reticulatum* (93163); planktonic in a ditch at Sahiya, associated with certain diatoms (94851).

**5. *Closterium lineatum*** Ehr. Berl. Abhandl. 238. 1833; Turner, The freshwater algae East India 20. 1892; West & West, A monograph of the British Desmidiaceae 181. pl. 24. figs. 1-5. 1904; Biswas in Rec. Bot. Surv. India 15(2): 57. 1949; Prescott in Phykos 5(1 & 2): 6. pl. 11. figs. 17, 18. 1966; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 110. pl. 17. fig. 15. 1992; Kant & Gupta, Algal Fl. Ladakh 131. pl. 118. fig. 2. 1998.

**Pl. 37, Fig. 3**

Cells curved, gradually attenuated towards poles, middle portion almost straight, 515.38-532.87  $\mu\text{m}$  long, 19.52-21.44  $\mu\text{m}$  broad; outer margin moderately curved, 35-40° arc; inner margin parallel and tumid in middle; apices truncately rounded, 5.43-7.72  $\mu\text{m}$  broad; wall striated; chloroplasts 5-6 ridges; pyrenoids 9-10.

*Phenology* : August-December.

Planktonic in a ditch at Asan, along with certain cyanobacteria (93113); free floating in a puddle at Chakrata near temple, associated with *Rhizoclonium* sp. (94863).

**6. *Closterium moniliferum*** (Bory.) Ehr., Desm. Preuss. 10. fig. 4. 1838; West & West, A monograph of the British Desmidiaceae 142. pl. 16. figs. 15, 16. 1904; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 192. 1907; Biswas in Rec. Bot. Surv. India 15(2): 57. 1949; Prescott in Phykos 5(1 & 2): 7. pl. 11. figs. 6, 7. 1966; Agarkar in Phykos 8(1 & 2): 1. 1969; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 113. pl. 17. fig. 5. 1992; Kant & Gupta, Algal Fl. Ladakh 130. pl. 57. figs. 13, pl. 58. fig. 2. 1998. *Lunulina monilifera* Bory 1824.

**Pl. 38, Fig. 4**

Cells slightly curved with swelling in middle, gradually attenuated to poles, 215.29-223.59  $\mu\text{m}$  long, 34.52-36.73  $\mu\text{m}$  broad; apices rounded, 7.25-8.47  $\mu\text{m}$  broad; outer margin 120-130° arc inner margin inflated in middle portion; wall smooth; chloroplasts 4-5 ridges; pyrenoids 8-10 arranged in median series.

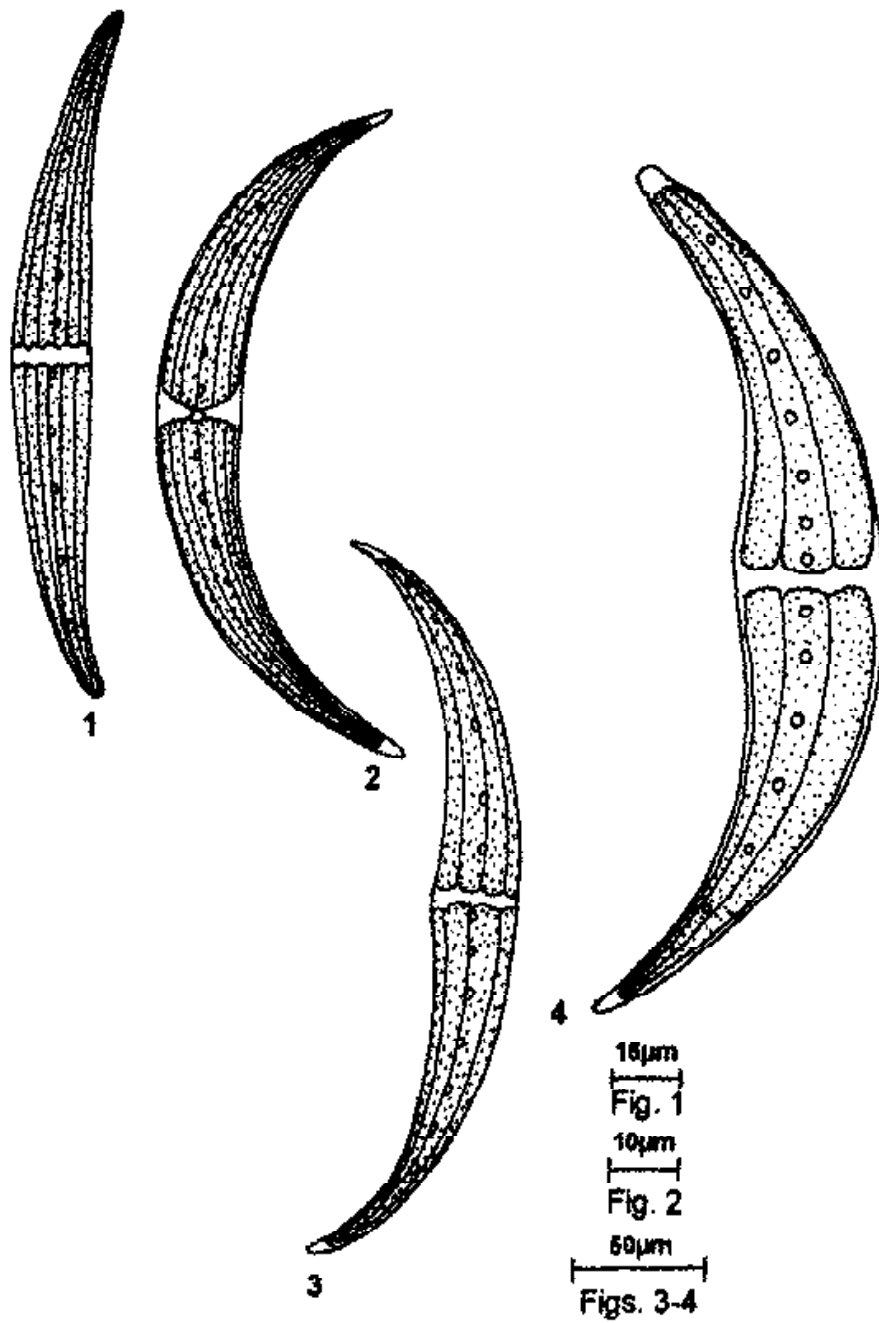


Plate 38 : Figs. 1-4 : 1. *Closterium venus*; 2. *Closterium rostratum*;  
3. *Closterium diana*; 4. *Closterium moniliferum*.

*Phenology* : August-December.

Planktonic in a ditch at Asan, along with certain cyanobacteria (93123); planktonic in a ditch at Gullar ghati, associated with *Spirogyra* sp. (93162); planktonic in a puddle at Mohand, intermingled with *Ulothrix* sp. (94843).

7. *Closterium rostratum* Ehr. in Abhandl. der Akademie d. wissensch. zu. 67. 1831; West & West, A monograph of the British Desmidiaceae 188. pl. 26. figs. 1-5. 1904; Biswas in Rec. Bot. Surv. India 15(2): 57. 1949; Prescott in Phykos 5(1 & 2): 7. 1966; Agarkar in Phykos 8(1 & 2): 1. fig. 3. 1969; Ralfs, The British Desmidiaceae 175. 1972; Kamat in J. Bombay nat. Hist. Soc. 72: 616. 1974; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 114. pl. 16. fig. 17. 1992; Kant & Gupta, Algal Fl. Ladakh 131. pl. 58. fig. 7, pl. 119. fig. 5. 1998.

Pl. 38, Fig. 2

Cells sickle shaped, strongly curved, 120.9-126.18  $\mu\text{m}$  long, 13.15-21.00  $\mu\text{m}$  broad; apices bluntly pointed, 2.5-3.79  $\mu\text{m}$  broad; outer margin 125-130° arc, middle portion not tumid; wall smooth; chloroplasts 5-6 ridges; pyrenoids 7-8, in axial row.

*Phenology* : March-November.

Planktonic in a puddle at Mussoorie, along with *Rhizoclonium* sp. (93182); planktonic in a ditch at Mohand, associated with algal mixture (94828).

8. *Closterium venus* Kütz., Phyc. germ. 130. 1845; West & West, A monograph of the British Desmidiaceae 137. pl. 15. figs. 15-20. 1904; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 191. 1907; Biswas in Rec. Bot. Surv. India 15(2): 59. 1949; Prescott in Phykos 5(1 & 2): 8. pl. 1. fig. 13. 1966; Agarkar in Phykos 8(1 & 2): 1. fig. 6. 1969; Patel in J. Bombay nat. Hist. Soc. 66(3): 415. 1969; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 119. pl. 16. fig. 18. 1992.

Pl. 38, Fig. 1

Cells strongly curved, gradually attenuated at poles, 146.56-149.45  $\mu\text{m}$  long, 16.81-19.41  $\mu\text{m}$  broad; apices rounded, 4.89-5.68  $\mu\text{m}$  broad; outer margin 155-170° arc, inner margin curved; wall smooth; chloroplast 6-8, ridges; pyrenoids 2-3, arranged in row.

*Phenology* : August-November.

Planktonic in a ditch at Asan, along with certain cyanobacteria (93111); planktonic in a ditch at Mohand, near bridge, associated with *Rhizoclonium* sp. (94834).

## 2. *Cosmarium* Corda

Cells compressed symmetrical, constricted in the median isthmus to form sinus; apex rounded, truncate or sub-truncate; margin entire, undulate or crenate; wall smooth or decorated; chloroplast axial one in each semicell; pyrenoids one or two; reproduction by cell division, sexuality by conjugation.

### KEY TO THE SPECIES

1a. Cell wall smooth	2
b. Cell wall rough	5
2a. Margin entire	3
b. Margin undulate	4
3a. Sinus widely open	5. <i>C. moniliforme</i>
b. Sinus linear	7. <i>C. tenue</i>
4a. Semicell ovate or elliptic	2. <i>C. dispersum</i>
b. Semicell rectangular oblong	6. <i>C. quadrilaterum</i>
5a. Isthmus 2 lipped	4. <i>C. miscellum</i>
b. Isthmus 1 lipped	6
6a. Cell wall punctate	3. <i>C. granatum</i>
b. Cell wall scrobiculate	1. <i>C. contractum</i>

1. *Cosmarium contractum* Kirchn., Alg. Schles. 147, 1878; Turner, The freshwater algae East India. 48. pl. 7. figs. 19, 33, 34. 1892; West & West, A monograph of the British Desmidiaceae 170. pl. 61. figs. 23-25, 34. 1905; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 202. pl. 14. fig. 1. 1907; Biswas in Rec. Bot. Surv. India 15(1): 61. 1949; Kant & Gupta, Algal Fl. Ladakh 134. pl. 61. fig. 13. 1998. *Colpopelta deplanata* Corda 1839.

Pl. 39, Fig. 4

Cells compressed, 76.32-97.56  $\mu\text{m}$  long, 48.47-75.63  $\mu\text{m}$  broad; sinus widely open; margin entire; isthmus, 43.29-52.56  $\mu\text{m}$  broad; semicells elliptic or sub-elliptic; wall scrobiculate; chloroplasts axile; pyrenoid 1.

*Phenology* : August-September.

Planktonic in a ditch near Yamuna, associated with *Spirogyra* sp. (93104).

**2. *Cosmarium dispersum*** Johnson, Rare. Desm. U.S. 297. pl. 240. fig. 19. 1895; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 202. 1907; Biswas in Rec. Bot. Surv. India 15(2): 63. 1949.

**Pl. 39, Fig. 9**

Cells compressed, margin undulate, 26.63-28.48  $\mu\text{m}$  long, 23.17-24.56  $\mu\text{m}$  broad; semicells ovate or elliptic; isthmus, 6.47-8.15  $\mu\text{m}$  broad; wall smooth; chloroplasts axile; pyrenoid 1.

*Phenology* : October-December.

Planktonic in a rocky ditch at Sahasradhara, associated with *Gomphonema* sp. (93145); planktonic in a ditch at Mohand near bridge, associated with algal mixture (94828).

**3. *Cosmarium granatum*** Breb in Ralfs Brit. Desm. 96. pl. 32. figs. 6. 1848; Turner, The freshwater algae East India 71. 1892; West & West, A monograph of the British Desmidiaceae 186. pl. 63. figs. 1-3. 1905; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 203. 1907; Gonzalves & Joshi in J. Bombay nat. Hist. Soc. 46(1): 175. pl. 4. figs. 5. 1946; Biswas in Rec. Bot. Surv. India 15(2): 64. 1949; Prescott in Phykos 5(1 & 2): 15. pl. 3. fig. 30, pl. 8. figs. 46-48. 1966; Agarkar in Phykos 8(1 & 2): 3. fig. 16. 1969; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 160. pl. 21. figs. 20. 1992. Anand, Ind. freshwater microalgae 58. fig. 192. 1998.

**Pl. 39, figs. 6**

Cells rhomboid to elliptic, margin entire, 25.56-53.48  $\mu\text{m}$  long, 17.34-32.74  $\mu\text{m}$  broad; semicells pyramidal with rounded angles; isthmus, 8.18-12.16  $\mu\text{m}$  broad; sinus narrow and closed; wall punctate; chloroplasts axile; pyrenoid 1.

*Phenology* : Throughout the year.

Planktonic in a ditch at Asan, associated with filamentous conjugalian algae (93111).

**4. *Cosmarium miscellum*** Skuja in Nova Acta Reg. Soc. Sci. Upsala 18(3): 222. pl. 39. fig. 11. 1964; Prasad & Misra, Freshwater algal



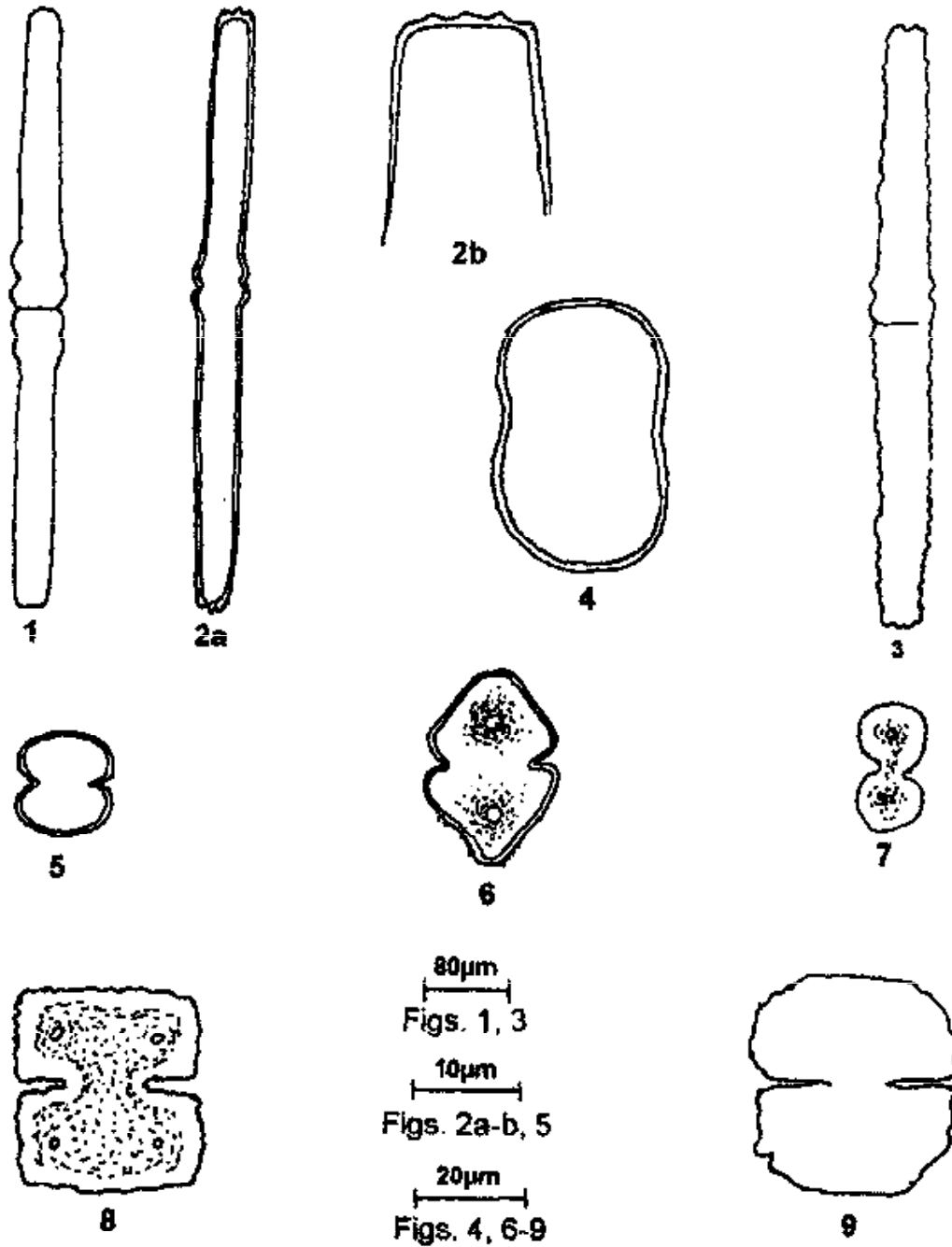


Plate 39 : Figs. 1-9 : 1. *Pleurotaenium trabecula*; 2a. *Pleurotaenium ehrenbergii*, 2b. Apex portion; 3. *Pleurotaenium ehrenbergii* var. *undulatum*; 4. *Cosmarium contractum*; 5. *Cosmarium tenue*; 6. *Cosmarium granatum*; 7. *Cosmarium moniliforme*; 8. *Cosmarium quadrilaterum*; 9. *Cosmarium dispersum*.

Fl. Andaman and Nicobar Islands 167. pl. 24. fig. 5. 1992.

Pl. 40, Figs. 1a-b

Cells 72.48-76.26  $\mu\text{m}$  long, 54.34-59.36  $\mu\text{m}$  broad; semicells circular with marginal crenulations furnished with pair of granules; apical angles sub-acute, basal angles rounded; isthmus bilipped, linear, 16.85-18.15  $\mu\text{m}$  broad; chloroplasts 2 axile in each semicells; pyrenoids 2.

*Phenology* : June-July.

Attached on the exposed hill-slope, under continuously dripping of water, at Dhanaulti near Surkunda Devi temple, associated with *Nostoc* sp. (94808).

**5. *Cosmarium moniliforme*** (Turp.) Ralfs, Br. Desm. 107. pl. 17. fig. 6. 1835; Turner, The freshwater algae East India 66. pl. 9. figs. 44, 45. 1892; West & West, A monograph of the British Desmidiaceae 20. pl. 67. figs. 1-3. 1908; Biswas in Rec. Bot. Surv. India 15(2): 66, 1949; Prescott in Phycos 5(1 & 2): 18. pl. 5. fig. 11. 1966; Suxena & Venkateswarlu in J. Indian bot. Soc. 47 (1 & 2): 35. figs. 33a, b. 1968. *Tessarthonia moniliforme* Turp. 1832.

Pl. 39, Fig. 7

Cells, 23.25-35.68  $\mu\text{m}$  long, 13.27-20.56  $\mu\text{m}$  broad; margin entire; semicell circular or subcircular; isthmus, 7.36-9.47  $\mu\text{m}$  broad; constriction deep; sinus open; wall smooth; chloroplasts axile, in each semicell; pyrenoids 2.

*Phenology* : Throughout the year.

Planktonic in a ditch at Sahasradhara, associated with certain diatoms (93146); planktonic in a puddle at Chakrata near temple, associated with *Rhizoclonium* sp. (94863).

**6. *Cosmarium quadrilaterum*** Brühl & Biswas in Mem. Asiat. Soc. Beng. 8(5): 298. pl. 11. figs. 111a-c, pl. 13. fig. 143. 1926; Biswas in Rec. Bot. Surv. India 15(2): 69. 1949.

Pl. 39, Fig. 8

Cells, 52.35-53.47  $\mu\text{m}$  long, 43.23-46.38  $\mu\text{m}$  broad; semicells rectangular, oblong; isthmus, 12.48-14.58  $\mu\text{m}$  broad; margin undulate; sinus linear; poles rounded; middle portion slightly inflated; chloroplasts axile; pyrenoid 1.

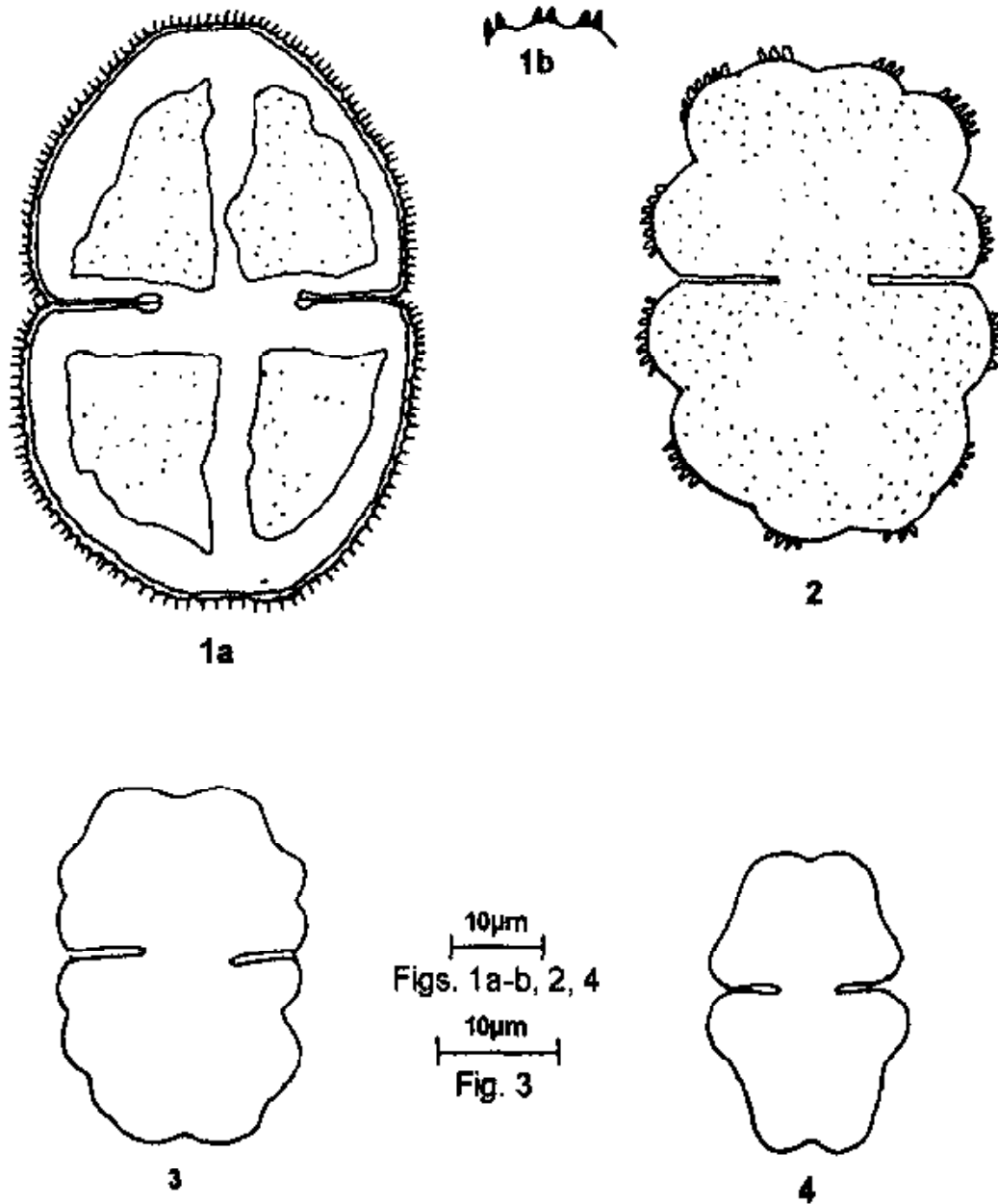


Plate 40 : Figs. 1-4 : 1a. *Cosmarium miscellum*, 1b. Marginal crenulations; 2. *Euastrum spinulosum*; 3. *Euastrum dubium* var. *triatum*; 4. *Euastrum anglolense* var. *brasiliense*.

*Phenology* : March-April.

Attached on cemented tank at Jharipani, associated with the members of Chlorococcales (93183).

7. *Cosmarium tenue* Arch. in J. Fed. Malay. St. Muse. 14(3 & 4): 422. pl. 12. fig. 40. 1829; West & West, A monograph of the British Desmidiaceae 167. pl. 61. figs. 12-15. 1905; Biswas in Rec. Bot. Surv. India 15(2): 72. 1949; Suxena & Venkateswarlu in J. Indian bot. Soc. 47 (1 & 2): 40. figs. 45a, b. 1968.

Pl. 39, Fig. 5

Cells, 14.78-17.49  $\mu\text{m}$  long, 12.23-15.28  $\mu\text{m}$  broad; margin entire; constriction deep; isthmus, 3.56-4.47  $\mu\text{m}$  broad; sinus linear; wall smooth; chloroplasts axile; pyrenoids 2.

*Phenology* : August-November.

Planktonic in a ditch at Asan, associated with *Spirogyra* sp. (93125); planktonic in a ditch at Mohand, near bridge (94835).

### 3. EUASTRUM Ehr.

Cells compressed, deeply constricted; sinus linear; semicells truncate-pyramidate; apex shallow or deep notch; margins entire, lobed; wall smooth, punctate or granulate; chloroplast one in each semicell; pyrenoids one or many; reproduction by cell division, sexuality by conjugation.

1. *Euastrum spinulosum* Delp., Desm. sub-alp. 85. pl. 6. figs. 17, 18. 1889; Turner, The freshwater algae East India 87. 1892; West & West, A monograph of the British Desmidiaceae 38. pl. 37. figs. 14-15. 1905; Biswas in Rec. Bot. Surv. India 15(2): 83. 1949; Patel in J. Bombay nat. Hist. Soc. 66(3): 417. 1969; Kamat in J. Bombay nat. Hist. Soc. 72: 618. 1974; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 136. pl. 19. fig. 10. 1992; Anand, Ind. freshwater microalgae, 58. fig. 186. 1998.

Pl. 40, Fig. 2

Cells compressed, 58.53-61.26  $\mu\text{m}$  long, 45.17-46.34  $\mu\text{m}$  broad; isthmus deeply constricted, 10.5-11.38  $\mu\text{m}$  broad; sinus narrow and linear; semicells 5 lobed; lateral lobes rounded with 4-5 spines; polar lobes truncate with 2-3 spines; wall granulated; chloroplasts axial; pyrenoids 2-8.

*Phenology* : December-January.

Attached on *Chara zeylanica* at Asan (94844).

#### KEY TO THE VARIETY

- |                       |   |
|-----------------------|---|
| 1a. Semicells 2-lobed | 1. <i>E. anglolense</i> var. <i>brasiliense</i> |
| b. Semicells 5-lobed  | 2. <i>E. dubium</i> var. <i>triatum</i>         |

1. ***Euastrum anglolense* var. *brasiliense*** Krieger in Hydrobiol. 3: 35. fig. 35. 1950; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands. 133. pl. 19. fig. 5. 1992.

**Pl. 40, Fig. 4**

Cells compressed, 23.48-25.18  $\mu\text{m}$  long, 14.87-16.56  $\mu\text{m}$  broad; isthmus deeply constricted, 4.57-5.36  $\mu\text{m}$  broad; sinus narrow linear; semicells bilobed; apical notch prominent with quadrangular rounded angles; apex with median incision; spine absent; wall smooth; chloroplasts axial; pyrenoids 3-6.

*Phenology* : December-January.

Attached on *Chara zeylanica* at Asan (94844).

2. ***Euastrum dubium* var. *triatum*** West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 198. pl. 14. fig. 6. 1907; Biswas in Rec. Bot. Surv. India 15(2): 79. 1949; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 135. pl. 19. figs. 3. 1992.

**Pl. 40, Fig. 3**

Cells compressed, 21.23-24.57  $\mu\text{m}$  long, 12.68-15.79  $\mu\text{m}$  broad; isthmus deeply constricted, 2.75-3.32  $\mu\text{m}$  broad; sinus narrow linear; semicells 5 lobed; apical notch shallow; spine absent; wall smooth; chloroplasts axial; pyrenoids 2-8.

*Phenology* : October-December.

Free floating in a ditch at Asan, associated with blue green algae (94848).

#### 4. PLEUROTAENIUM Nägeli

Cells cylindrical, elongated; median constriction, present; wall smooth or punctate; semicells parallel, slightly attenuated towards poles; semicells

base inflated; truncate; chloroplasts numerous straight to undulate, band-shaped; pyrenoids several; reproduction by cell division, sexuality by conjugation.

#### KEY TO THE SPECIES

- |                         |                          |
|-------------------------|--------------------------|
| 1a. Apices tubercles    | 1. <i>P. ehrenbergii</i> |
| b. Apices not tubercles | 2. <i>P. trabecula</i>   |

1. ***Pleurotaenium ehrenbergii*** (Breb.) de Bary, Spec. Desm. subalp. 228. pl. 20. figs. 1-7. 1873; West & West, A monograph of the British Desmidiaceae 205. pl. 29. figs. 9-11, pl. 30. fig. 1. 1904; Biswas in Rec. Bot. Surv. India 15(2): 92. 1949; Agarkar in Phykos 10(1 & 2): 56. figs. 20. 197; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 124. pl. 18. figs. 9. 10. 1992; Anand, Ind. freshwater microalgae 55. figs. 179. 1998; Kant & Gupta, Algal Fl. Ladakh 136. pl. 63. figs. 7. 1998. *Closterium trabecula* Ehr. 1830, *Docidium ehrenbergii* Breb. 1844.

Pl. 39, Figs. 2a-b.

Cells cylindrical slightly constricted at base, 345.38-450.56  $\mu\text{m}$  long, 22.48-30.37  $\mu\text{m}$  broad; apex, 19.21-20.63  $\mu\text{m}$  broad; semicells cylindrical, gently attenuated from base towards apex; median constriction present; lateral margins without undulation; apex portion with ring of 7-10 tubercles; wall minutely punctate; chloroplasts slightly undulate; pyrenoids 8-12.

*Phenology* : August-December.

Planktonic in a ditch at Asan, associated with members of cyanobacteria and euglenoids (93125).

1.1. ***Pleurotaenium ehrenbergii* var. *undulatum*** Schaarsch., Magyar. Desm. 278. pl. 1. fig. 21. 1883; West & West, A monograph of the British Desmidiaceae 207. pl. 30. fig. 4. 1904; Biswas in Rec. Bot. Surv. India 15(2): 92. 1949; Prescott in Phykos 5(1 & 2): 9. pl. 12. fig. 2. 1966; Prasad & Misra, Freshwater algal Fl. Andaman and Nicobar Islands 125. pl. 18. figs. 8. 1992.

Pl. 39, Fig. 3

Cells cylindrical slightly constricted at base, 615.85-618.32  $\mu\text{m}$

long, 32.48-34.69  $\mu\text{m}$  broad; apex portion, 22.56-23.42  $\mu\text{m}$  broad; semicells cylindrical gently attenuated from base towards apex; median constriction present; lateral margins throughout undulate; apex portion with ring of 6-8 tubercles; wall punctate; chloroplasts slightly undulate; pyrenoids 6-8.

*Phenology* : May-October.

Attached on floating clumps of algae at Chandrabani, associated with other desmids (94803).

**2. *Pleurotaenium trabecula* (Ehr.) Näg.** Einz. Alg. 104. pl. 6a. 1849; West & West, A monograph of the British Desmidiaceae 209. pl. 30. figs. 11-13. 1904; West & West in Ann. Roy. Bot. Gard. Cal, 6(2): 196. 1907; Iyengar & Bai in J. Indian bot. Soc, 20: 79. Figs. 13, 20, 21. 1941; Biswas in Rec. Bot. Surv. India 15(2): 93. 1949; Prescott in Phytos 5(1&2): 11. pl. 12. fig. 6, 1966; Agarkar in Phytos 8(1&2): 3. fig. 5. 1969; Anand, Ind. freshwater microalgae 55. fig. 180. 1998; Kant & Gupta, Algal Fl. Ladakh 136. pl. 63. figs. 1, 5, 15, pl. 120. fig. 4. 1998. *Closterium trabecula* Ehr. 1830.

### Pl. 39, Fig. 1

Cells cylindrical, gradually attenuated towards apex, 468.17-556.75  $\mu\text{m}$  long, 20.0-25.6  $\mu\text{m}$  broad; apex, 14.12-20.16  $\mu\text{m}$  broad; semicells with one basal inflation; lateral margins straight; apices rounded; tubercles absent; wall punctate; chloroplasts band-shaped; pyrenoids 15-18.

*Phenology* : August October.

Planktonic in a ditch at Asan, along with certain cyanobacteria and euglenoids (93111, 93126).

### 5. STAUSTRUM Meyen

Cells radially symmetrical; median constriction deep; sinus acute; isthmus narrow; semicells cylindrical, ellipsoid, triangular, hexagonal, campanulate or trapeziform; wall smooth, punctate; spines scrobiculate, granulate, denticulate, or combination of these ornamentations; chloroplast axial; pyrenoids one or several; reproduction by cell division, sexuality by conjugation.

## KEY TO THE SPECIES

- |                                   |                               |
|-----------------------------------|-------------------------------|
| 1a. Semicells fusiform            | 3. <i>S. recurvatum</i>       |
| b. Semicells triangular           | 2                             |
| 2a. Apices with undulate margin   | 1. <i>S. gracile</i>          |
| b. Apices without undulate margin | 2. <i>S. pseudotetracerum</i> |

**1. *Staurastrum gracile*** Ralfs, Brit. Desm. 136. pl. 22. fig. 12. 1848; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 221. 1907; Iyengar & Bai in J. Indian bot. Soc. 20: 96. figs. 64, 65, 66. 1941; Biswas in Rec. Bot. Surv. India 15(2): 104. 1949; Prescott in Phycos 5 (1 & 2): 35. 1966; Agarkar in Phycos 8(1 & 2): 7. fig. 48. 1969; Kamat in J. Bombay nat. Hist. Soc. 72: 618. 1974.

Pl. 41, Fig. 2

Cells radially symmetrical, 21.26-24.45  $\mu\text{m}$  long, 27.85-29.32  $\mu\text{m}$  broad; isthmus, 4.57-6.28  $\mu\text{m}$  broad; notch acute; semicells triangular; apices undulate slightly convex; spines 2-3; chloroplasts axial; pyrenoid 1.

*Phenology* : May-June.

Planktonic in a cemented tank at Mahabkendra, Mohabewala, associated with other desmids (93195).

**2. *Staurastrum pseudotetracerum*** (Nordst.) West & West in Trans. Linn. Soc. Bot. 5(2): 79. pl. 8. fig. 39. 1895; Biswas in Rec. Bot. Surv. India 15(2): 109. 1949; Prasad & Misra Freshwater algal Fl. Andaman and Nicobar Islands 199. pl. 25. figs. 12, 16. 1992.

Pl. 41, Fig. 1

Cells radially symmetrical, 24.17-26.63  $\mu\text{m}$  long, 18.86-20.52  $\mu\text{m}$  broad; isthmus, 13.46-15.35  $\mu\text{m}$  broad; notch acute; semicells triangular; sinus open; apices without undulate margin; spines 3; chloroplasts axial; pyrenoid 1.

*Phenology* : May-June.

Planktonic in a cemented tank at Mahabkendra, Mohabewala, associated with other desmids (93195).



3. *Staurastrum recurvatum* Turner, The freshwater algae of East India 128. pl. 16. fig. 16. 1892; Biswas in Rec. Bot. Surv. India 15(2): 109. 1949.

Fig. 41, Figs. 3a-c

Cells radially symmetrical, 20.57-22.43  $\mu\text{m}$  long, 29.32-31.52  $\mu\text{m}$  broad; isthmus deep, 5.47-6.15  $\mu\text{m}$  broad; sinus open; semicells fusiform with dorsal margin undulate and ventral tumid; apices recurved with 3-4 spines; chloroplasts axile; pyrenoid 1.

*Phenology* : May- June.

Planktonic in a cemented tank at Mahabkendra, Mohabewala, associated with other desmids (93195).

### 8. Order : Siphonales

Thallus filamentous or vesicular, coenocytic unseptate more or less branched; cross wall absent, except during reproduction; chloroplast discoid or ovate peripherally arranged along filaments wall; vacuole present; pyrenoids present or absent; starch or oil present; reproduction by akinetes, aplanospores or multiciliate zoospores, sexuality isogamous, anisogamous or oogamous.

### KEY TO THE FAMILIES

- |                                |                     |
|--------------------------------|---------------------|
| 1a. Thallus sparingly branched | 2. VAUCHERiaceae    |
| b. Thallus tubular unbranched  | 1. PROTOSIPHONACEAE |

### 1. PROTOSIPHONACEAE

#### 1. PROTOSIPHON Klebs

Thallus coenocytic; terrestrial; aerial portion spherical; rhizoid unbranched, colourless; chloroplast discoid; multinucleate; pyrenoids numerous; reproduction by fragmentation, aplanospores, sexuality isogamous.

1. *Protosiphon botryoides* (Kütz.) Klebs, Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen 48. 1896; Moewns in Arch. Protistenk. 80: 469. 1933.

Pl. 42, Fig. 3

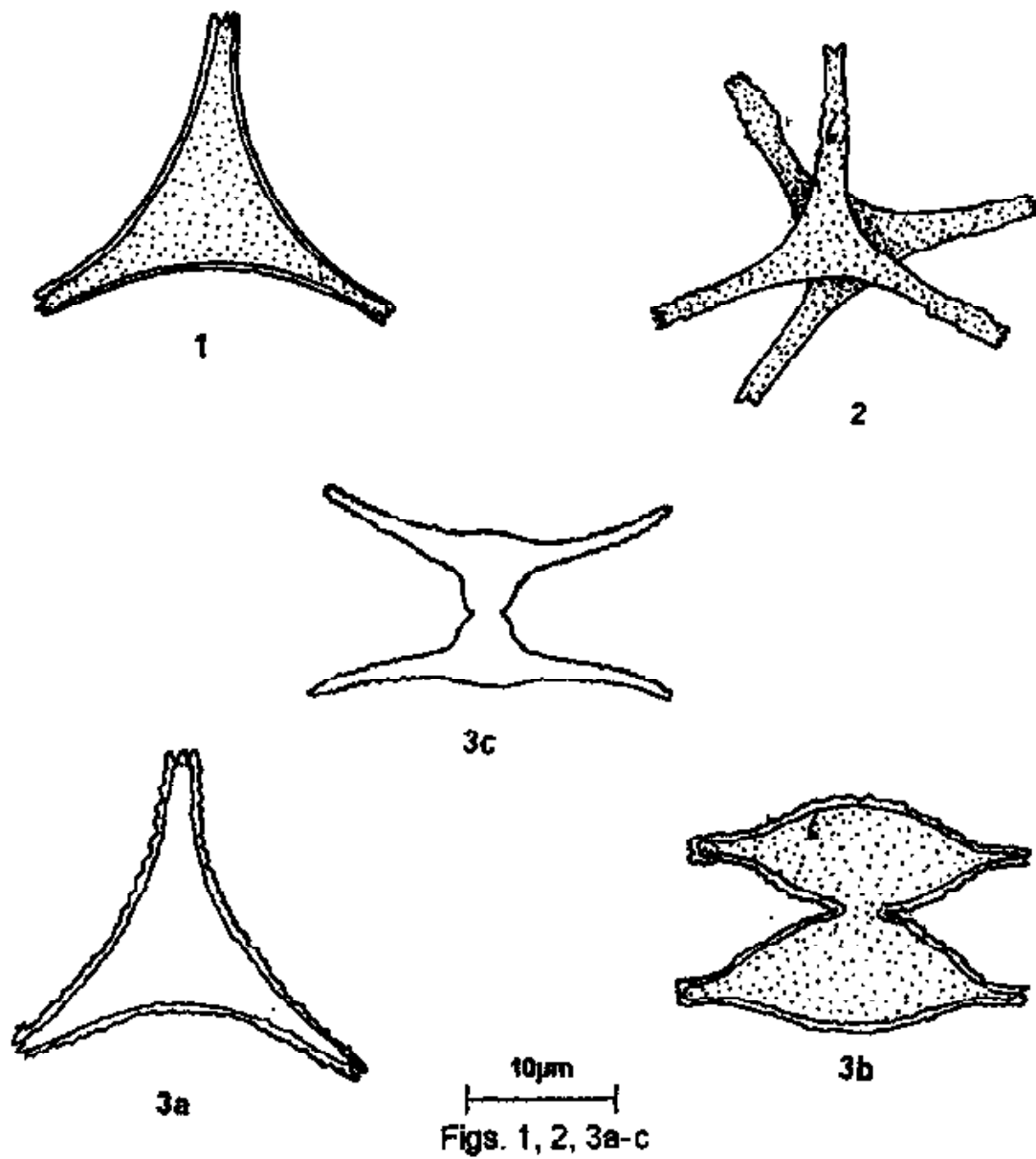


Plate 41 : Figs. 1-3 : 1. *Staurastrum pseudotetracerum*; 2. *Staurastrum gracile*; 3a. *Staurastrum recurvatum*, 3b-c. Lateral view.

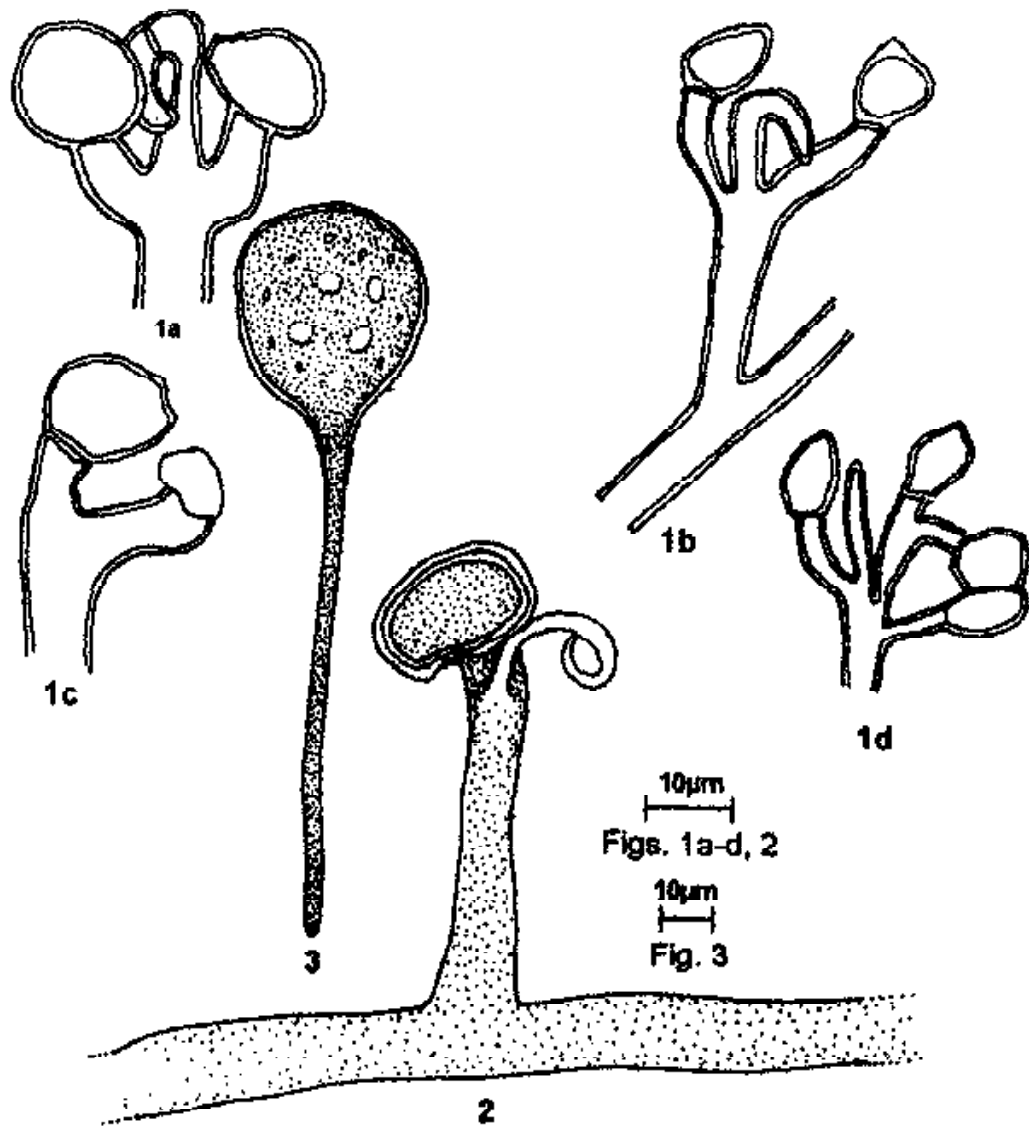


Plate - 42 : Figs. 1-3 : 1a. *Vaucheria amphibia*, 1b. Fruiting branches with two oogonia and one antheridia, 1c. Fruiting branches with one oogonia and a developing oogonia, 1d. Fruiting branches bearing many oogonia and one antheridia; 2. *Vaucheria hamata*; 3. *Protosiphon botryoides*.

Thallus coenocytic; aerial vesicle green spherical, 13.16-17.38  $\mu\text{m}$  long, 11.27-15.46  $\mu\text{m}$  broad; rhizoids subterranean, colourless, 98.75-123.28  $\mu\text{m}$  long 2.17-3.52  $\mu\text{m}$  broad; chloroplast single parietal; pyrenoids 10-15; nucleus 5-7; starch present; aplanospores spherical, 4.15-7.12  $\mu\text{m}$  broad.

*Phenology* : January February.

Growing on damp soil around the edges of puddle and intermingled with *Botrydium granulatum* (93168).

## 2. VAUCHERIACEAE

### KEY TO THE GENERA

- 1a. Filaments dichotomously branched;  
starch present 1. DICHOTOMOSIPHON
- b. Filaments not dichotomously branched;  
oil present 2. VAUCHERIA

#### 1. DICHOTOMOSIPHON Ernst

Thallus dense, entangled tufts or mats; filaments coenocytic dichotomously branched, constricted; chloroplasts numerous disc-shaped; multinucleate; starch present; pyrenoid absent; reproduction by akinetes, sexuality oogamous.

**1. *Dichotomosiphon tuberosus*** (A. Br.) Ernst in Beih. Bot. Centralbl. 13: 115. 1902; Heering in Süßwasser-Flora 7: 96. figs. 93, 94. 1921; Brown in Trans. Amer. mic. Soc. 48: 102. pl. 20. figs. 38, 39. 1929; Randhawa in J. Indian bot. Soc. 21: 265. fig. 4. 1942; Venkataraman, Vaucheriaceae 38. figs. 18a-f. 1961. *Vaucheria tuberosa* A. Br. 1856.

#### Pl. 43, Figs. 1a-d

Filaments dichotomously branched, 73.15-307.23  $\mu\text{m}$  long, 73.15-80.46  $\mu\text{m}$  broad; constrictions, 58.52-65.83  $\mu\text{m}$  broad; oogonia globose, 277.97-279.79  $\mu\text{m}$  broad; oospore globose, deep green, 252.53-265.83  $\mu\text{m}$  broad; antheridia cylindrical or clavate, arising from ultimate and penultimate branches, 131.67-193.84  $\mu\text{m}$  long, 58.52-60.34  $\mu\text{m}$  broad.

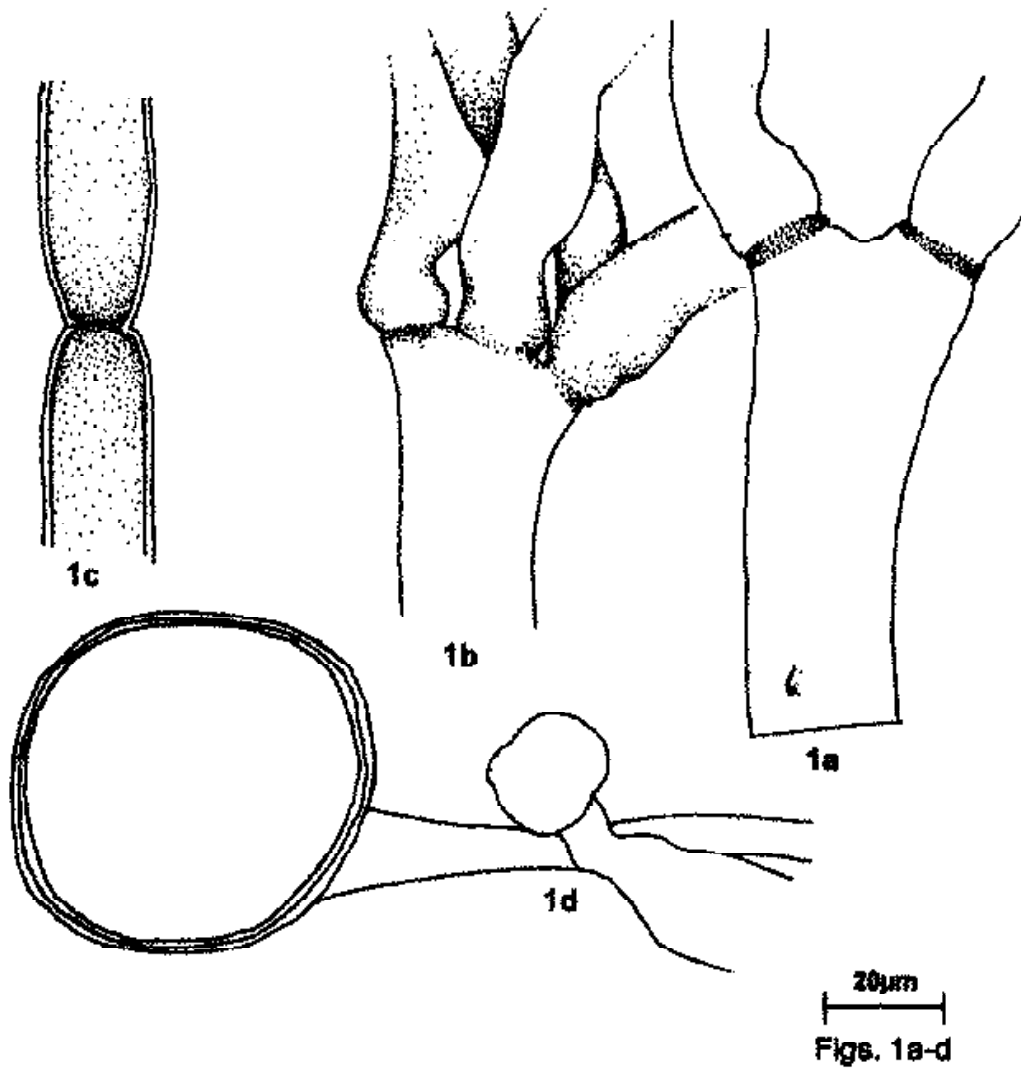


Plate - 43 : Fig. 1 : 1a. *Dichotomosiphon tuberosus*, 1b. Upper portion of filaments, 1c. Constricted filament, 1d. Oogonia.

*Phenology* : March-December.

Free floating in a shallow water of Yamuna river as well as Asan reservoir, alongwith several diatoms (93107, 93119, 93120, 93186); on moist rock at Sahasradhara (93132, 93134, 93137, 93139, 93140, 93147, 93148); free floating in a Varubala pond (94801, 94802); free floating in a puddle along with *Fragilaria* sp. at Gullar ghati (93159, 93160).

## 2. VAUCHERIA DC.

Thallus dark green, velvety mats, compactly interwoven on damp soil; filaments irregularly branched, coenocytic; cross wall absent, except during reproduction; rhizoids colourless; tip rounded; chloroplasts numerous disc shaped; pyrenoids absent; reproduction by multiflagellate zoospores, akinetes or aplanospores, sexuality oogamous.

### KEY TO THE SPECIES

- |   |                         |
|---|-------------------------|
| 1a. Oogonia sessile, beak oblique                     | 4. <i>V. sessilis</i>   |
| b. Oogonia pedicellate, beak not oblique              | 2                       |
| 2a. Oogonia spherical to pear shaped                  | 1. <i>V. amphibia</i>   |
| b. Oogonia not spherical                              | 3                       |
| 3a. Vegetative filaments undulate; oogonia subovoid   | 3. <i>V. longata</i>    |
| b. Vegetative filaments not undulate; oogonia globose | 4                       |
| 4a. Oogonia below the antheridia                      | 5. <i>V. terrestris</i> |
| b. Oogonia above the antheridia                       | 2. <i>V. hamata</i>     |

1. *Vaucheria amphibia* Randhawa in Arch. f. protistenk 92: 541. fig. 4. 1939; Venkataraman, Vaucheriaceae 73. figs. 49 a-c. 1961; Sarma & Rattan in Nova Hedwigia 51 (3 & 4): 491. figs. 10-14. 1990. Kant & Gupta, Algal Fl. Ladakh 117. pl. 65. fig. 3, pl. 113. fig. 8. 1998.

### Pl. 42, Figs. 1a-d

Filaments monoecious, 58.24-64.93  $\mu\text{m}$  broad; chloroplasts ovoid towards exterior end; pyrenoid absent; oogonia 2 globose to pear-shaped, 75.92-108.9  $\mu\text{m}$  long, 75.9-97.12  $\mu\text{m}$  broad; pedicellate; beak not oblique; oospores deep brown, completely filling the oogonium, 71.23-84.38  $\mu\text{m}$  long, 66.29-82.51  $\mu\text{m}$  broad; antheridia terminal or lateral, slightly curved, 56.1-58.41  $\mu\text{m}$  long, 26.4-36.2  $\mu\text{m}$  broad.

*Phenology* : June-December.

Attached on the edge of moist puddle at Nayan bagh, near Tehri bridge (94815); attached on rock under exposed conditions at Mohand, associated with *Uronema* sp. (94843).

**2. *Vaucheria hamata*** Walz in Pringsh. Jahrb. 5: 148. 1866; Randhawa in Arch. f. protistenk. 92: 542. 1939; Venkataraman, Vaucheriaceae 85. fig. 62. 1961; Sarma & Rattan in Nova Hedwigia 51 (3&4): 501. 1990; Kant & Gupta, Algal Fl. Ladakh 117. pl. 67. figs. 2a, b, pl. 113. fig. 6. 1998.

**Pl. 42, Fig. 2**

Filaments monoecious, 43.89-54.52  $\mu\text{m}$  broad; chloroplasts ovoid towards exterior end; pyrenoid absent; oogonia 2, ovoid, above the associated antheridia, 62.84-68.32  $\mu\text{m}$  long, 45.38-47.26  $\mu\text{m}$  broad; pedicellate; oospore deep greyish, completely filling the oogonium, 58.52-75.15  $\mu\text{m}$  long, 43.89-51.2  $\mu\text{m}$  broad; wall 2 layer; antheridium 1, plane, 22.63-26.93  $\mu\text{m}$  long, 14.63-18.28  $\mu\text{m}$  broad.

*Phenology* : March-April.

Attached on moist wall at Mussoorie, along with moss and diatoms (93179).

**3. *Vaucheria longata*** Blume in Bull. Torrey bot. Club 80: 492. figs. 15, 32-38. 1953; Venkataraman, Vaucheriaceae 74. fig. 50 a-f. 1961; Sarma & Rattan in Nova Hedwigia, 51(3 & 4): 492. 1990.

**Pl. 44, Figs. 1a-e**

Filaments undulate, monoecious, 28.12-61.34  $\mu\text{m}$  broad; chloroplast ovoid towards exterior end; pyrenoid absent; oogonia ovoid, 62.73-82.59  $\mu\text{m}$  long, 49.56-72.63  $\mu\text{m}$  broad; pedicellate; oospores brown, subglobose; wall 2-layered, outer thinner and inner thicker, 56.54-76.72  $\mu\text{m}$  long, 49.58- 59.21  $\mu\text{m}$  broad; antheridia circinate with single terminal pore. 13.27-23.12  $\mu\text{m}$  broad.

*Phenology* : March-August.

Attached on the edge of exposed moist soil at Asan (93187).

**4. *Vaucheria sessilis*** (Vauch) DC., Flore Francaise 2: 63. 1805; Randhawa in Arch. f. Protistenk 92: 538. fig. 1. 1939; Venkataraman, Vaucheriaceae 68. fig. 46a. 1961; Kant & Gupta, Algal Fl. Ladakh 117. pl. 65. figs. 2a, b. 1998. *Vaucheria caespitosa* Vauch 1805.

**Pl. 44, Figs. 2a-b**

Filaments monoecious, 453.53-497.42  $\mu\text{m}$  long, 58.03-68.13  $\mu\text{m}$  broad; chloroplasts ovoid towards exterior end; pyrenoids absent; antheridia between two oogonia, hooked to circinate, 63.56-94.84  $\mu\text{m}$  long, 32.28-32.67  $\mu\text{m}$  broad; oogonia 2 ovate sessile, slightly oblique, 83.27-90.84  $\mu\text{m}$  long, 62.56-65.6  $\mu\text{m}$  broad; beak oblique; oospores dark green, completely filling the oogonium, 75.76-94.62  $\mu\text{m}$  long, 52.97-65.68  $\mu\text{m}$  broad; wall three layered.

*Phenology* : Throughout the year.

Attached on moist Nala wall at Raipur along with moss (93155); attached on moist soil at Kaunwala, Hardwar road (93107); attached on moist soil at Gullar ghati, associated with certain diatoms (93158).

**5. *Vaucheria terrestris*** Lyngbye emend. Walz in Pringsh. Jahrb. 5: 149. 1866; Randhawa in J. Indian bot. Soc. 21: 264. fig. 3. 1942; Venkataraman, Vaucheriaceae 76. fig. 53. 1961; Sarma & Rattan in Nova Hedwigia 51(3 & 4): 501. 1990; Kant & Gupta, Algal Fl. Ladakh 117. pl. 65. fig. 4. 1998. *Vaucheria pendula* Reinsch 1887.

**Pl. 44, Fig. 3**

Filaments monoecious, 56.85-79.14  $\mu\text{m}$  broad; chloroplast ovoid towards exterior end; pyrenoid absent; oogonia 1 subglobose with slightly bent stalk; pore directed downward, 110.37-118.24  $\mu\text{m}$  long, 92.84-96.68  $\mu\text{m}$  broad; pedicellate, oospore globose black, completely filling the oogonium, 89.29-91.47  $\mu\text{m}$  broad; wall thick 4 layer; antheridia circinate, 108.92-125.39  $\mu\text{m}$  long, 17.24-19.39  $\mu\text{m}$  broad.

*Phenology* : November-January.



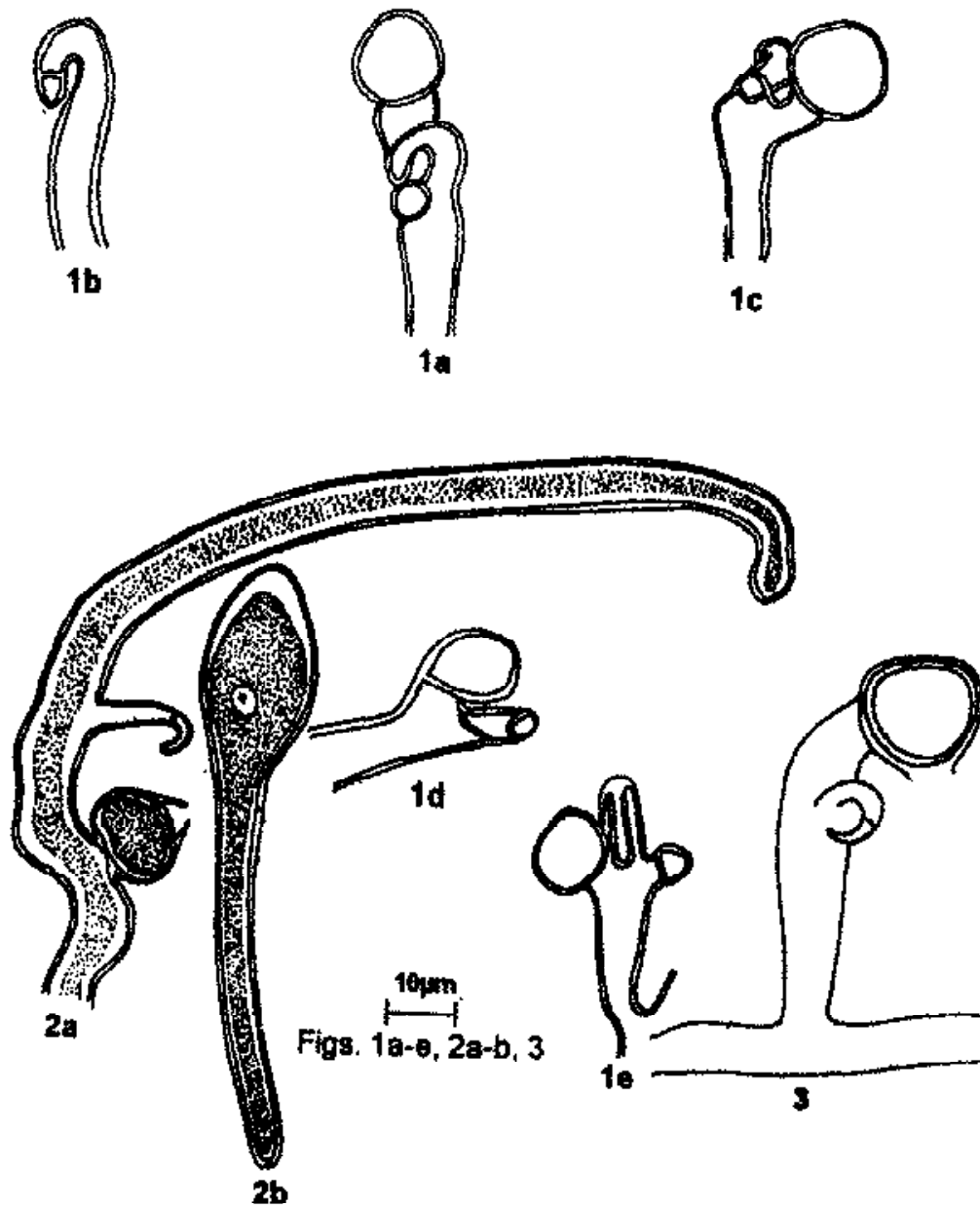


Plate 44 : Figs. 1-3 : 1a. *Vaucheria longata*, 1b. Developing antheridia, 1c-1e. Fruiting branches bearing oogonia and antheridia; 2a. *Vaucheria sessilis*, 2b. Germinating oospore; 3. *Vaucheria terrestris*.

Attached on moist soil at Yamuna, along with *Microspora* and certain diatoms (93177, 93178).

### 9. Order : Charales

Thallus popularly known as stoneworts, monoecious or dioecious, macroscopic, erect, branched dimorphic, highly elaborately organised; rhizoids multicellular; chloroplasts numerous, discoid; uninucleate; pyrenoid absent; node and internodes present; whorls of laterals present at each node; internode corticated or ecorticated; stipulodes present; sex organs complex, enclosed by sterile sheath; oogonia large, ovoid or subglobose, containing single egg; oospore colourless or pale yellow to black; antheridia small globose; antherozoids biflagellate spiral shaped; reproduction by amylum stars, bulbils, amorphous bulbils or secondary protonemata, sexuality oogamous.

#### 1. CHARACEAE

##### KEY TO THE GENERA

- |                                  |            |
|----------------------------------|------------|
| 1a. Antheridia below the oogonia | 2. CHARA   |
| b. Antheridia above the oogonia  | 1. NITELLA |

#### 1. NITELLA Agardh

Plant macroscopic, erect; stem and branchlets entirely ecorticate; antheridia terminal; oogonia lateral; coronula cells ten in two tiers; reproduction by bulbils; sexuality oogamous.

##### KEY TO THE SPECIES

- |                                |                      |
|--------------------------------|----------------------|
| 1a. Branchlets 6 in each whorl | 1. <i>N. furcata</i> |
| b. Branchlets 3 in each whorl  | 2. <i>N. hyalina</i> |

1. *Nitella furcata* (Roxb. *apud* Bruzelius) Agardh, Syst. Alg. 124. 1824; Pal in J. Burma Res. Soc. 18: 113. 1929; Pal, Kundu, Sundaralingam & Venkataraman, Charophyta 62, figs. 76-79. 1962.

Pl. 45, Figs. 1a-e

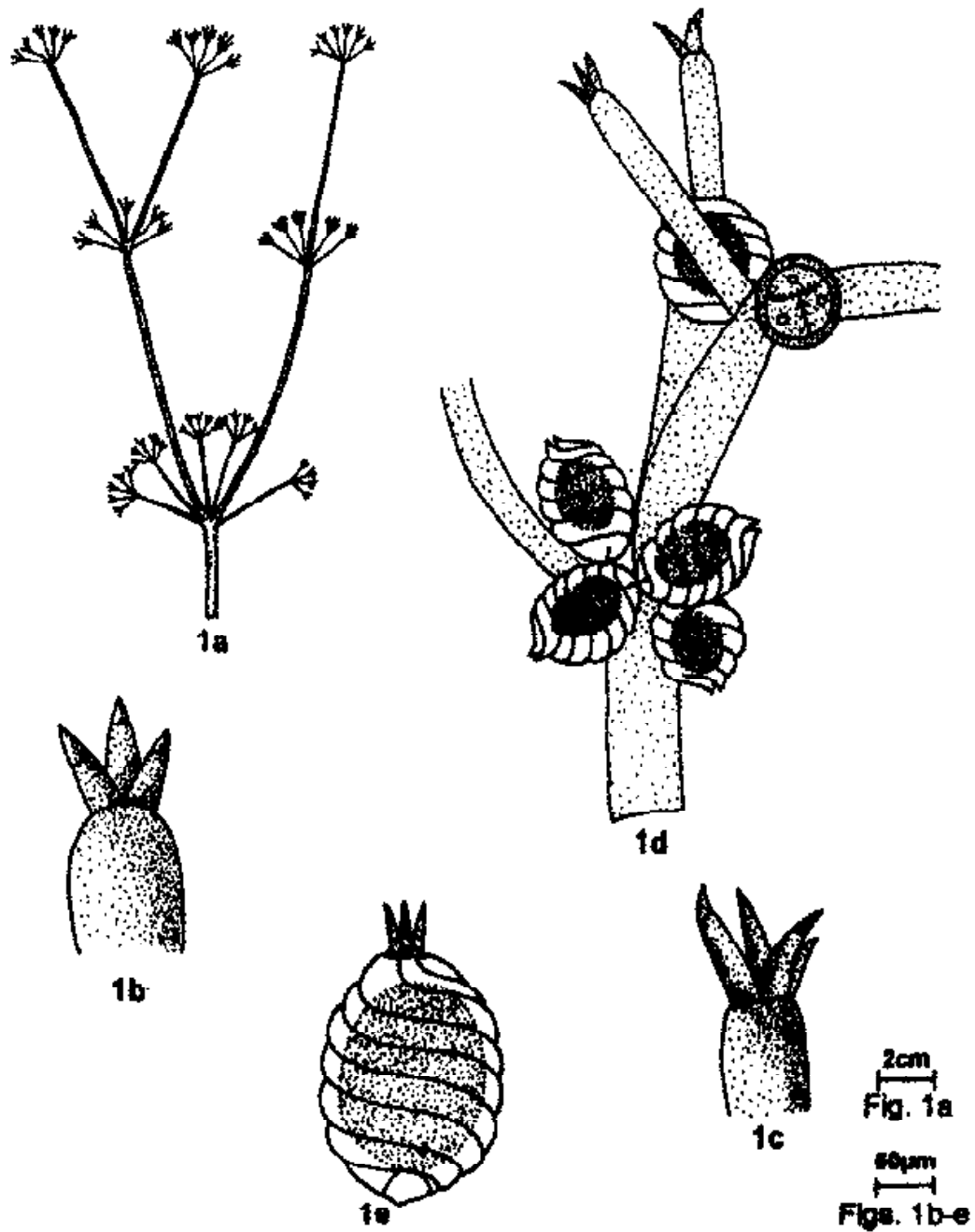


Plate 45 : Fig. 1: 1a. *Nitella furcata*, 1b-c. Dactyls, 1d. Branchlet node with game-tangia, 1e. Oogonium.

Plant erect, monoecious, 23-26 cm long; stem slender, 410.26-415.38  $\mu\text{m}$  broad; internodes, 672.85-692.64  $\mu\text{m}$  long, 378.52-396.46  $\mu\text{m}$  broad; branchlets 6 in single row of each whorl, furcate; dactyls 1-3, divergent; gametangia at free nodes; antheridia solitary, terminal, 223.38-227.56  $\mu\text{m}$  broad; oogonia 2-4, 242.74-246.35  $\mu\text{m}$  long, 223.24-238.84  $\mu\text{m}$  broad; convolutions 8-9; coronula, 62.12-65.22  $\mu\text{m}$  long, 70.18-72.35  $\mu\text{m}$  broad; oospores brown, 192.37-197.14  $\mu\text{m}$  long, 184.27-188.48  $\mu\text{m}$  broad; membrane reticulate.

*Phenology* : November-December.

Growing on a shallow marshy swamp at Lachiwala, associated with *Oscillatoria* sp. (94856).

2. *Nitella hyalina* (DC.) Agardh, Syst. Alg. 126. 1824; Pal, Kundu, Sundaralingam & Venkataraman, Charophyta, 72. figs. 133-142. 1962; Moore, Charophytes Great Britain and Ireland 104. figs. 22 a-d, 1986. *Chara condensata* Ruprecht. 1845, *Chara interrupta* Ruprecht. 1845.

**Pl. 46, Figs. 1a-d**

Plant erect, monoecious, 28-32 cm long; stem, 425.18-432.78  $\mu\text{m}$  broad; internodes, 638.28-652.36  $\mu\text{m}$  long, 410.16-418.65  $\mu\text{m}$  broad; branchlets 7-8, more than one row in each whorl; dactyls 2 cells, lower cell tapering towards the base, upper cell conical; gametangia at furcation of branchlets; antheridia, 275.56-284.78  $\mu\text{m}$  broad; oogonia, 361.87-368.37  $\mu\text{m}$  long, 293.58-298.53  $\mu\text{m}$  broad; convolutions 8-9; coronula cell, 29.24-34.36  $\mu\text{m}$  long, 25.34-31.17  $\mu\text{m}$  broad; oospores dark brown, 331.65-334.58  $\mu\text{m}$  long, 274.43-278.83  $\mu\text{m}$  broad.

*Phenology* : September-January.

Growing on an edge of shallow water puddle, under exposed conditions at Kaunwala, associated with diatoms mixture (94860).

**2. CHARA L.**

Plant macroscopic; monoecious or dioecious; stem and branchlets corticate or ecorticate; stipulodes present, sometimes rudimentary; branchlets four or more segments; bract cell four or more at node; oogonia and

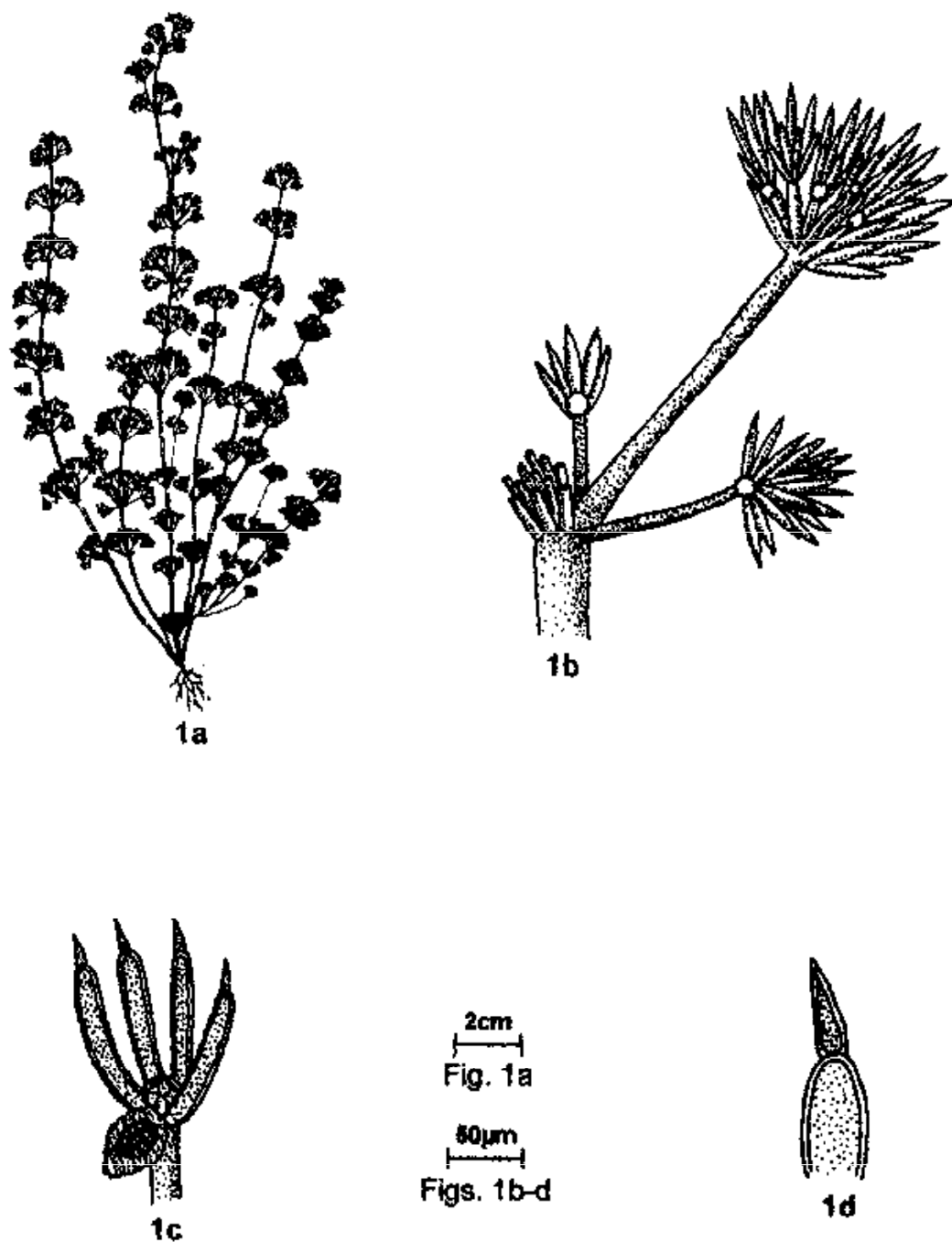


Plate 46 : Fig. I : 1a. *Nitella hyalina*, 1b. Stem node with one primary and two accessory branchlets, 1c. Branchlet node with gametangia, 1d. Dactyls.

antheridia produced one above the other from periphery of branchlet nodes; antheridium below the oogonium; oospores terete; reproduction by bulbils or amylum stars, sexuality oogamous.

#### KEY TO THE SPECIES

- 1a. Stipulodes 2 ring; lowest branchlet ecorticate 3. *C. zeylanica*  
 b. Stipulodes 1 ring; entire branchlet ecorticate  
 or corticate 2  
 2a. Gametangia produced at base of whorls;  
 stipulodes rudimentary 2. *C. corallina*  
 b. Gametangia produced at first, second or third  
 whorls; stipulodes well developed 1. *C. braunii*

1. *Chara braunii* Gmelin Flor. Badens. Alsat. 646. 1826; Groves & Bullock-webster, Brit. Charophyta 1: 11. pl. 26. 1924; Pal, Kundu, Sundaralingam & Venkataraman, Charophyta 89. figs. 200-203. 1962; Moore, Charophytes Great Britain and Ireland 80. figs. 12, a-d, 1986. *Chara involucrata* Roxb., *Chara coronata* Ziz., *Chara coronata* var. *coromandelina* Br., *Chara coronata* var. *braunii* Br.

Pl. 47, Figs. 1a-d

Plants erect, monoecious, encrusted with lime, 10-17.5 cm long; stem, 430.36-510.94  $\mu\text{m}$  broad; internodes 2-3 cm long; stem and branchlets ecorticate; stipulodes well developed, acute, 278.87-286.34  $\mu\text{m}$  long, 75.93-112.48  $\mu\text{m}$  broad; branchlets 8-10, with corona-like termination; bract cells 3-4 acute, 121.49-124.58  $\mu\text{m}$  long, 58.47-61.62  $\mu\text{m}$  broad; spine cell absent; gametangia conjoined at 1-3 lowest branchlet node; antheridia globose, 230.36-375.78  $\mu\text{m}$  broad; oogonia ovoid, 452.22-546.38  $\mu\text{m}$  long, 347.18-392.56  $\mu\text{m}$  broad; coronula cells, 118.22-125.32  $\mu\text{m}$  long, 128.63-178.52  $\mu\text{m}$  broad; spiral cells, 8-12 turns; oospores black 436.48-498.76  $\mu\text{m}$  long, 338.48-378  $\mu\text{m}$  broad.

*Phenology* : June-December.

Growing on marshy shallow puddle at Bander Koat near Mussoorie band (94819); growing on marshy soil at Sahiya (94856).

2. *Chara corallina* Willdenow in Mem. Ac. Roy. Berlin 83. pl. 2. fig. 2. 1803; Pal, Kundu, Sundaralingam & Venkataraman, Charophyta 87. figs. 194-198, 1962.

Pl. 47, Fig. 2

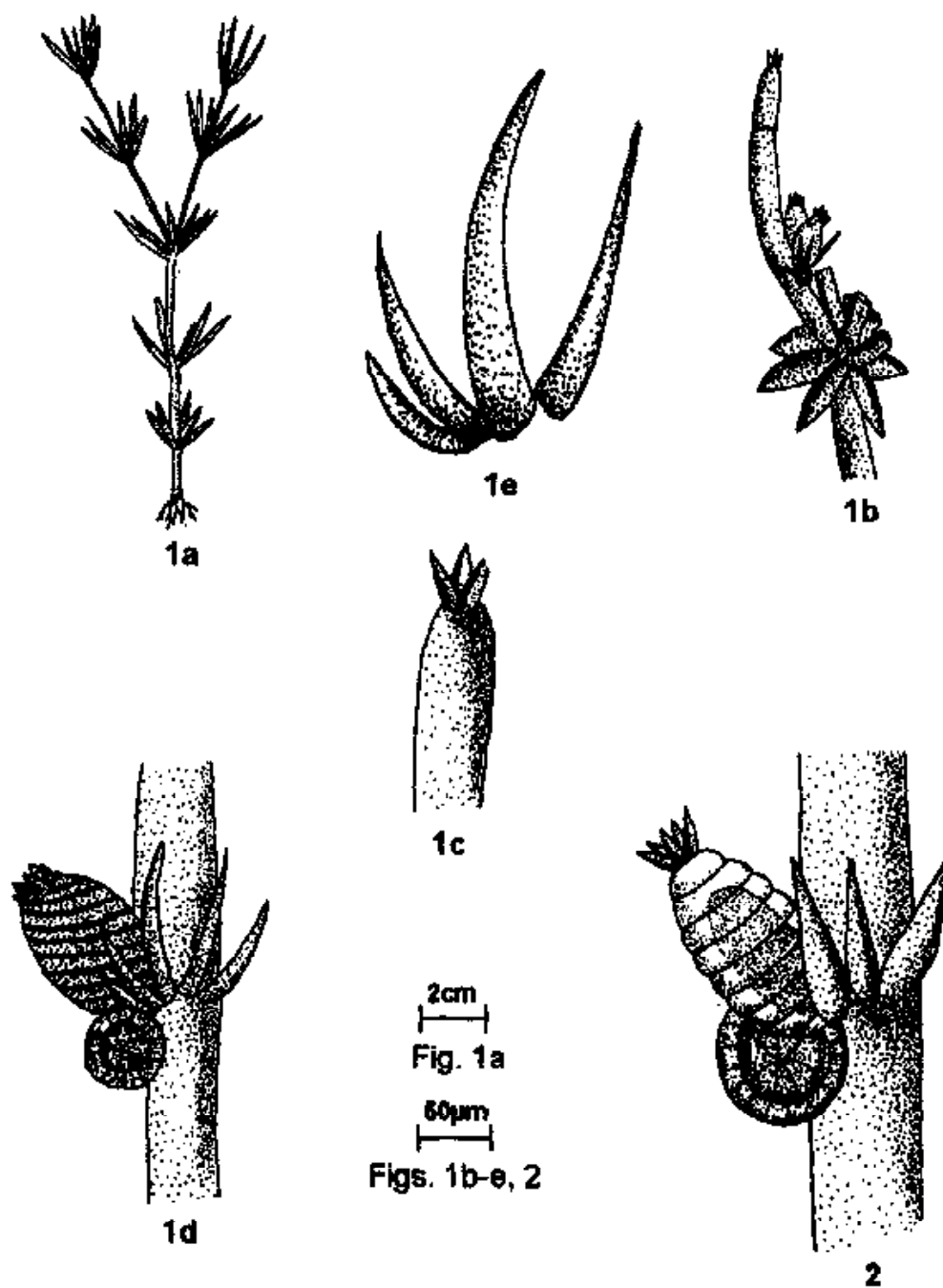


Plate 47 : Figs. 1-2: 1a. *Chara braunii*, 1b. Portion of axis with branchlet whorl, 1c. Branchlet apex, 1d. Branchlet node with gametangia, 1e. Stipulodes; 2. *Chara corallina*.

Plants erect, monoecious, 15-20 cm long; stem, 755.84-762.34  $\mu\text{m}$  broad; internodes 3-7 cm long; stem and branchlets ecorticate; stipulodes 1 whorl, rudimentary, acute, 195.56-205.31  $\mu\text{m}$  long, 135.46-142.82  $\mu\text{m}$  broad; branchlets 6-8 whorl; antheridia and oogonia produced at base of branchlet; antheridia globose, 535.38-567.42  $\mu\text{m}$  broad; oogonia elongate, 946.24-949.47  $\mu\text{m}$  long, 605.56-692.48  $\mu\text{m}$  broad; spiral cells 7-9; coronula cells, 98.65-112.78  $\mu\text{m}$  long, 185.42-214.98  $\mu\text{m}$  broad; oospores dark black, 657.38-678.45  $\mu\text{m}$  long, 536.17-588.78  $\mu\text{m}$  broad.

*Phenology* : December-March.

Growing on marshy shallow puddle, under exposed conditions at Asan (94845).

3. *Chara zeylanica* Willdenow in Mem. Ac. Roy. Berlin 86. pl. 2. fig. 1. 1805; Biswas in Rec. Bot. Surv. India 15(1): 94. pl. 10. fig. 105. 1949; Pal, Kundu, Sundaralingam & Venkataraman, Charophyta 105. figs. 253-255. 1962. *Chara verticillata* Roxb., *Chara gymnopus* var. *macilenata* Br., *Chara gymnopus* var. *ceylonica* Br., *Chara polyphylla* var. *ceylonica* Br.

Pl. 48, Fig. 2

Plants erect, monoecious, 8-17 cm long; stem, 710.68-765.83  $\mu\text{m}$  broad; internodes, 2-3 cm long; stipulodes acute, double whorl; cortex triplostichous; spine cells elongate, acute, solitary; whorls 11-12; lowest branchlet segment ecorticate; bract cells 7-8; antheridium globose, 427.38-432.49  $\mu\text{m}$  broad; oogonia elongate, 785.45-796.49  $\mu\text{m}$  long, 438.21-456.48  $\mu\text{m}$  broad; spiral cells 14-15; coronula cells, 112.20-118.23  $\mu\text{m}$  long, 205.85-245.56  $\mu\text{m}$  broad; oospores, 651.83-658.28  $\mu\text{m}$  long, 335.19-327.29  $\mu\text{m}$  broad.

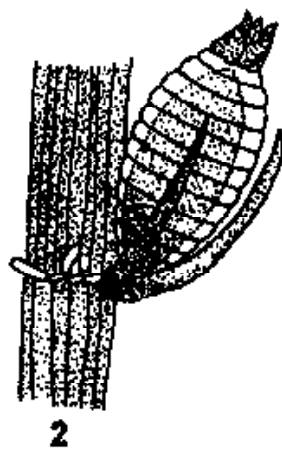
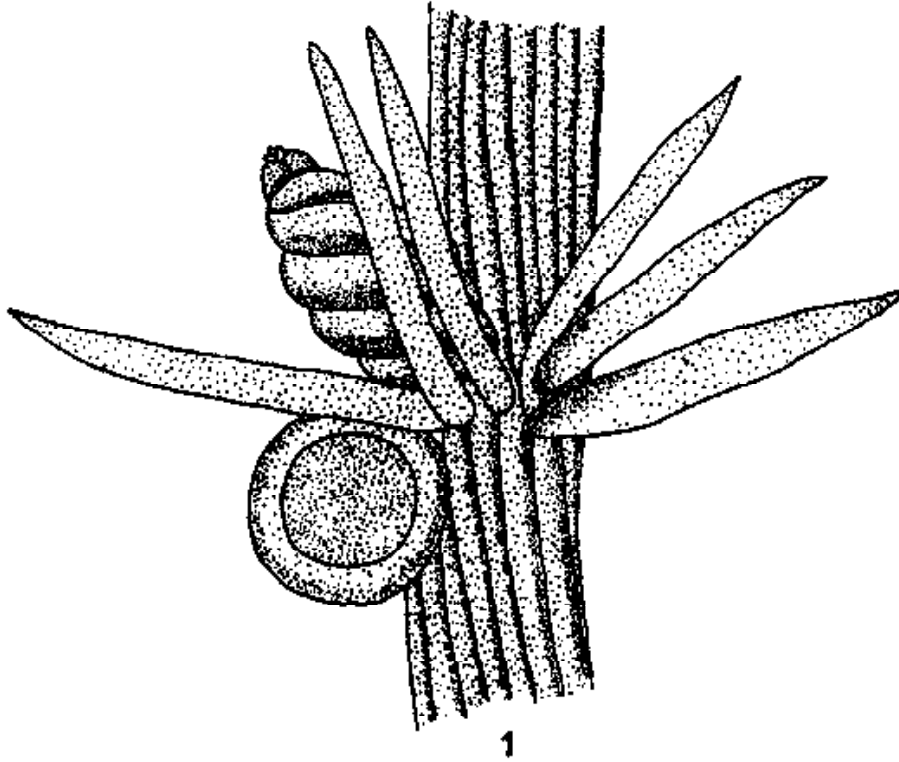
*Phenology* : December April.

Growing on an edge of marshy ditch at Yamuna, under exposed condition (94844).

1. *Chara fibrosa* f. *hydrophytis* RDW. Wood & Imahori, Monograph of the Characeae, 304. icon 146. 1965; Khan in Phytos 24:55. 1985.

Pl. 48, Fig. 1





50µm  
Figs. 1, 2

Plate 48 : Figs. 1-2 : 1. *Chara fibrosa* f. *hydrophytis*; 2. *Chara zeylanica*.

Plants erect, monoecious, 20-25 cm long; stem, 382.38-409.64  $\mu\text{m}$  broad; internodes, 4-7 cm long; stipulodes in single whorl, acute; cortex diplostichous; spine cells solitary; branchlets 5-6, partially corticate, but lower most segments ecorticate; bract cells 8, acute; oogonia and antheridia produced at lowest nodes; antheridium globose, 198.19-204.82  $\mu\text{m}$  broad; oogonia ellipsoid 438.94-453.53  $\mu\text{m}$  long, 307.23-321.86  $\mu\text{m}$  broad; spiral cells, 13-14; coronula cells, 43.89-58.52  $\mu\text{m}$  long, 87.78-102.41  $\mu\text{m}$  broad; oospores black, 378.27-383.49  $\mu\text{m}$  long, 249.15-277.68  $\mu\text{m}$  broad.

*Phenology* : October-November.

Growing on shallow marshy puddle, under shady condition, densely associated with *Oscillatoria princeps* at Sahasradhara (93127).

## 2. CLASS : XANTHOPHYCEAE

Thallus unicellular, colonial, filamentous or coenocytic vesicles; yellow green; flagella two, heterokontae; chloroplast parietal plate or disc shaped; uninucleate; pyrenoids absent; leucosin or oil present not responding to iodine test; cell wall two halves, overlaps each other; H-shaped pieces present in filamentous forms; reproduction by fragmentation, autospores, aplanospores, zoospores or resting spores, sexuality isogamous or anisogamous.

## KEY TO THE ORDER

- |                                       |                      |
|---------------------------------------|----------------------|
| 1a. Thallus filamentous               | 3. HETEROTRICHALES   |
| b. Thallus not filamentous            | 2                    |
| 2a. Thallus macroscopic, siphonous    | 4. HETEROSIPHONALES  |
| b. Thallus microscopic, not siphonous | 3                    |
| 3a. Thallus unicellular, motile       | 1. HETEROCHLORIDALES |
| b. Thallus coccoid, non-motile        | 2. HETEROCOCCALES    |

## 1. Order : Heterochloridales

Thallus unicellular, motile; periplast present; flagella heterokontae; chloroplasts discoid or band shaped; uninucleate; reserve food oil; reproduction by longitudinal cell division or autospores, sexuality anisogamous.

## 1. HETEROCAPSACEAE

## 1. BOTRYOCOCCUS Kütz.

Colonies various shapes; cells arranged densely, radial, connected by delicate stands; cells ovoid, ellipsoid or cuneate; uninucleate; chloroplast single parietal, laminate, discoid or reticulate; pyrenoids present or absent; reproduction by fragmentation or autospores.

1. *Botryococcus braunii* Kütz. *Species Algarum* 892. 1849; Turner, *The freshwater algae of East India* 157. 1892; Biswas in *Rec. Bot. Surv. India* 15(2): 121. 1949; Philipose, *Chlorococcales* 195. fig. 108. 1967. *Thallogesmium wallichianum* Turner 1892, *Ineffigiata neglecta* West & West 1897.

Pl. 49. Fig. 4

Colonies spherical to various shapes, united in aggregates by delicate mucilaginous, 46.67-52.16  $\mu\text{m}$  broad; cells ovoid to ellipsoid, radially arranged, 3.53-7.28  $\mu\text{m}$  long, 4.23-5.12  $\mu\text{m}$  broad, completely enclosed in brown gelatinous membrane with irregular wrinkles at margin; chloroplasts parietal cup-shaped; pyrenoid 1.

*Phenology* : December-January.

Free floating in a ditch at Mothranowala, associated with *Oscillatoria* sp. (96253).

## 2. Order : Heterococcales

Thallus coccoid, non-motile; chloroplasts numerous discoid; uninucleate or multinucleate; food reserve oil; flagella unequal; reproduction by zoospores, aplanospores or autospores.

### 1. HALOSPHAERACEAE

#### 1. BOTRYDIOPSIS Borzi

Cells solitary, spherical; cell wall thin and overlapping; chloroplasts numerous disc-shaped; oil globules scattered; reproduction by zoospores, aplanospores or autospores.

1. *Botrydiopsis arhiza* Borzi in Bull. Soc. Bot. Ital. 6: 170, 1895; Ettl, Xanthophyceae Band 3. Teil 1. 249. figs. 303 a-d, 1978.

#### Pl. 49, Figs. 2a-b

Cells solitary spherical, 56.48-60.32  $\mu\text{m}$  broad; cell wall smooth thin; gelatinous investment absent; chloroplasts 8-14, disc-shaped; oil globules scattered; autospores 4-7, spherical, 23.93-27.85  $\mu\text{m}$  broad.

*Phenology* : January-February.

On moist soil at Raiwala, associated with *Botrydium granulatum* (93168).

## 3. Order : Heterotrichales

Thallus filamentous unbranched; cells cylindrical or barrel shaped;

chloroplasts parietal, discoid; pyrenoid absent; reserve food oil; cell wall overlapped; nucleus one or many; reproduction by fragmentation, zoospores or aplanospores, sexuality isogamous.

### 1. TRIBONEMACEAE

#### KEY TO THE GENERA

- |   |               |
|---|---------------|
| 1a. Cell wall thick, H-pieces clearly visible   | 2. TRIBONEMA  |
| b. Cell wall thin, H-pieces not clearly visible | 1. BUMILLERIA |

#### 1. BUMILLERIA Borzi

Filaments unbranched; cells cylindrical; wall thin, smooth; H-shaped structure not clear; chloroplasts parietal discoid; oil drop present; reproduction by fragmentation, zoospores or aplanospores.

1. *Bumilleria sicula* Borzi, Studi. Algologici, Fasc. 2. 186. 1896; Ettl, Xanthophyceae Band 3 Teil 1. 438. fig. 539. 1978.

Pl. 49, Figs. 1a-b

Filaments unbranched; cells cylindrical, slightly constricted at ends, 33.74-36.18  $\mu\text{m}$  long, 21.68-24.27  $\mu\text{m}$  broad; cell wall smooth, with 2 halves; chloroplasts discoid 3-4; nucleus 1; oil globules 5-7.

*Phenology* : August-October.

Free floating in a puddles at Mussoorie, associated with certain zooplanktons (93181).

#### 2. TRIBONEMA Derbes & Solier

Thallus filamentous; cells elongate cylindrical; wall constricted of two sections, overlapping in midregion of cell; H-shaped pieces clearly visible; chloroplasts many disc-shaped; pyrenoid absent; reproduction by fragmentation, aplanospores or zoospores, sexuality isogamous.

1. *Tribonema bombycinum* (Ag.) Derbes & Solier in Mem. Sur. Physiol. Alg. 18. pl. 4. figs. 16-21. 1856; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 232. 1907. *Conferva bombycina* Ag. 1817.

Pl. 49, Fig. 3

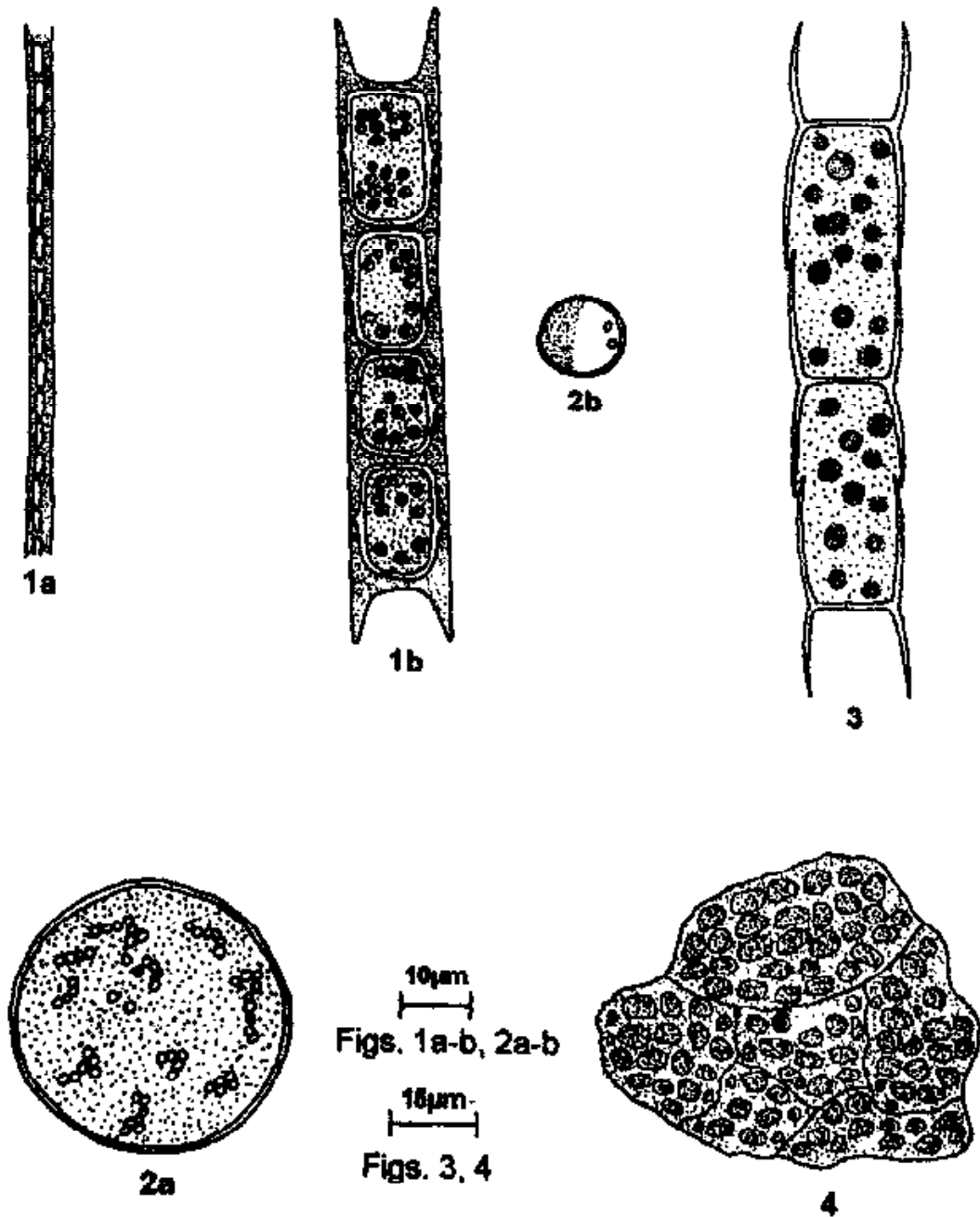


Plate 49 : Figs. 1-4 : 1a-b. *Bumilleria sicula*; 2a-b. *Botrydiopsis arhiza*; 3. *Tribonema bombycinum*; 4. *Botryococcus braunii*.

Filaments unbranched, grayish-yellow; cells cylindrical or slightly constricted at cross wall, 43.89-48.76  $\mu\text{m}$  long, 10.39-12.63  $\mu\text{m}$  broad; wall overlapping in midregion; H-pieces clearly visible; chloroplasts 4-6 disc shaped; pyrenoid absent.

*Phenology* : December-January.

Free floating on edge of Yamuna river, associated with an old thallus of *Cladophora* (93156); free floating in a ditch at Gullar ghati, associated with *Spirogyra* and *Fragilaria* sp. (93156).

#### 4. Order : Heterosiphonales

Thallus macroscopic; terrestrial; coenocytis, siphonous; chloroplasts numerous disc-shaped; multinucleate; vacuole present; reserve food oil; rhizoids dichotomously branched, colourless; reproduction by zoospores or aplanospores, sexuality isogamous or anisogamous.

### 1. BOTRYDIACEAE

#### 1. BOTRYDIUM Wallroth 1815

Thallus terrestrial, macroscopic, acellular, coenocytic; aerial portion globose, narrowed below to form subterranean colourless rhizoidal branches; chloroplasts numerous yellow green, disc-shaped, arranged peripheral portion of aerial globose; oil and leucosin present; reproduction by zoospores, sexuality isogamous or anisogamous.

1. *Botrydium granulatum* Greville, *Algae britannicae* 196. 1830; Ettl, *Xanthophyceae* Band 3. Teil 1. 509, figs. 627, 628. 1978; Kant & Gupta, *Algal Fl. Ladakh* 174. pl. 81. fig. 15. 1998. *Botrydium argillaceum* Wallroth, *Botrydium rupestre* Opiz, *Ulva granulata* Linne, *Ulva radicata* Retzius, *Tremella globosa* Weiss, *Linckia granulata* Wiggers, *Vaucheria radicata* Ag., *Vaucheria granulata* Lyngby, *Hydrogastrum granulatum* Desvaux.

Pl. 50, Figs. 1a-d

Thallus deep yellow-green, balloon-shaped; vesicles coenocytic; aerial portion globose, 512.35-541.31  $\mu\text{m}$  long, 292.6-321.86  $\mu\text{m}$  broad; rhizoidal portion colourless, dichotomously branched, rooted in moist

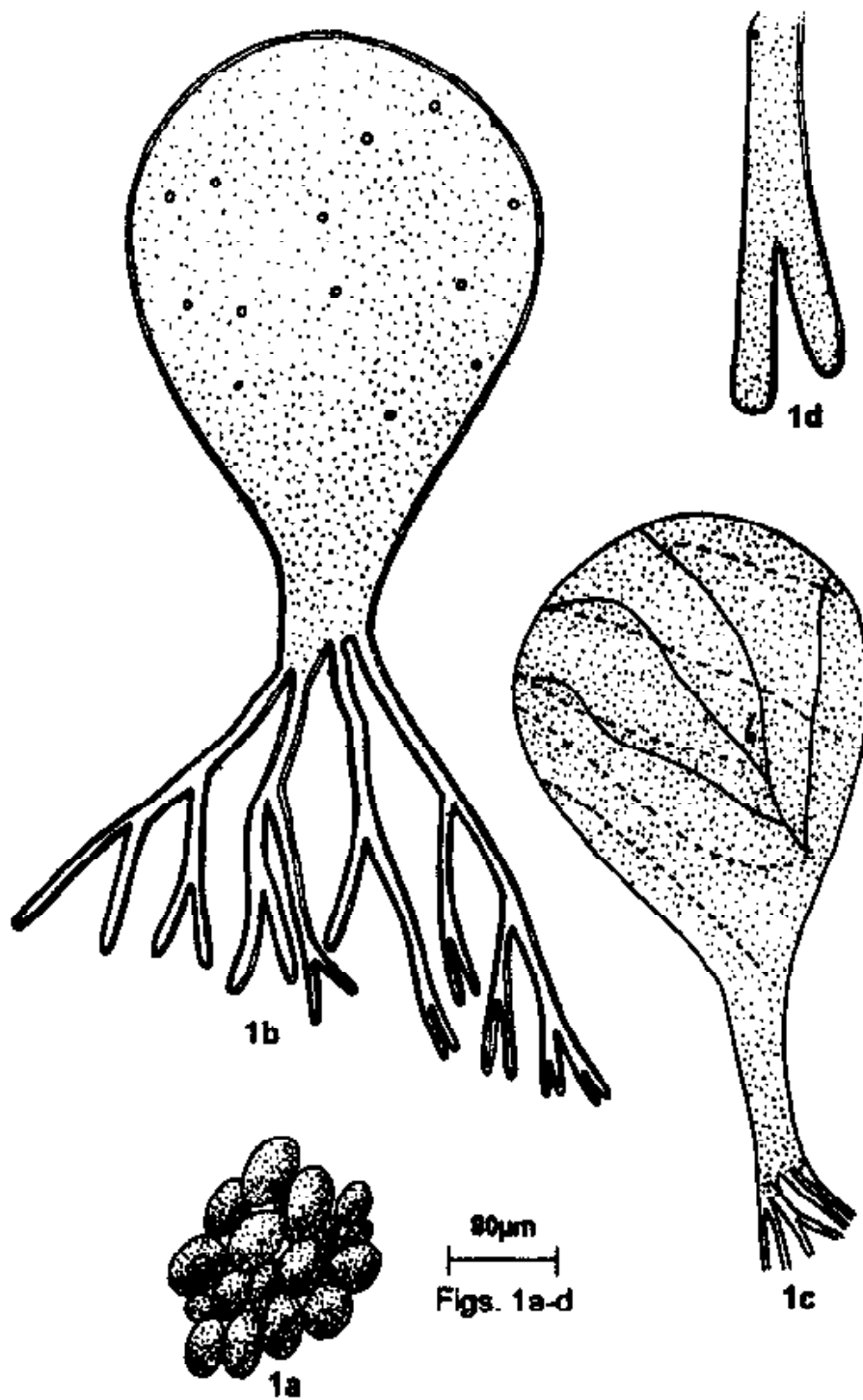


Plate - 50 : Fig. 1: 1a-c. *Botrydium granulosum*, 1d. Portion of dichotomously branched rhizoids.



soil, 175.56-219.45  $\mu\text{m}$  long, 12.26-23.39  $\mu\text{m}$  broad; chloroplasts disc-shaped, 2.13-3.15  $\mu\text{m}$  long, 1.82-2.97  $\mu\text{m}$  broad, arranged in peripheral portion of upper vesicles; nucleus 6-8; oil drops scattered throughout vesicle.

*Phenology* : January-February.

Growing on moist soil under exposed conditions at Raiwala, associated with *Botrydiopsis arhiza* (93168).

## 3. CLASS : BACILLARIOPHYCEAE

Thallus unicellular, colonial or loose chains; cells constituted by epitheca and hypotheca; striae present or absent; cell wall impregnated with silica; polar nodules and vacuole present; food reserve oil; uninucleate; chloroplasts disc or stellate; pyrenoids one or several; reproduction by cell division, auxospores, microspores or statospores, sexuality isogamous, anisogamous or oogamous.

Members of Bacillariophyceae (golden-brown) commonly known as diatoms, occur wide range of ecological habitats and play an important role, especially in aquatic vegetation.

## KEY TO THE ORDER

- |                                |                     |
|--------------------------------|---------------------|
| 1a. Valves circular            | <b>1. Centrales</b> |
| b. Valves elliptical or oblong | <b>2. Pennales</b>  |

## 1. Order : Centrales

Valves circular or filamentous; raphe present or absent; striae present or absent; chloroplasts discoid; pyrenoid present; reproduction by auxospores formed without conjugation.

## 1. COSCINODISCACEAE

## KEY TO THE GENERA

- |                            |                         |
|----------------------------|-------------------------|
| 1a. Valves filamentous     | <b>3. MELOSIRA</b>      |
| b. Valves circular         | <b>2</b>                |
| 2a. Valves areolate        | <b>1. COSCINODISCUS</b> |
| b. Valves without areolate | <b>2. CYCLOTELLA</b>    |

## 1. COSCINODISCUS Ehr.

Valves circular; areolate radial tangential or irregularly arranged; chloroplasts rounded, numerous, irregularly arranged; pyrenoids present; reproduction by auxospores.

**1. *Coscinodiscus sublineatus*** Grunow, Denkschr. Akad. Wissensch. Wien. 48 : 85. pl. d. figs. 21, 22. 1884; Hustedt, Kryptogamen-Flora Teil 1. 394. fig. 205. 1930.

**Pl. 51, Fig. 7**

Frustules discoid, radially symmetrical, 9.38-12.47  $\mu\text{m}$  broad; valves surface areolated hexagonal, arranged tangential series, 11-12 in 10  $\mu\text{m}$ ; margin striated; striae thin short radiating towards centre, 14-15 in 10  $\mu\text{m}$ .

*Phenology* : April-May.

Free floating in a puddle, associated with *Cladophora* sp. (96201).

## 2. CYCLOTELLA Kütz.

Cells solitary, colonial or united; valves circular or elliptical, ornamented in two concentric regions; outer zone radially striated or punctate, inner zone smooth or irregularly arranged striae; girdle view straight or undulate; reproduction by auxospores.

### KEY TO THE SPECIES

- |                                    |                           |
|------------------------------------|---------------------------|
| 1a. Central zone without punctate  | 1. <i>C. glomerata</i>    |
| b. Central zone punctate           | 2                         |
| 2a. Central zone finely punctate   | 2. <i>C. meneghiniana</i> |
| b. Central zone star like punctate | 3. <i>C. stelligera</i>   |

1. *Cyclotella glomerata* Bachmann, *Phytopl. d. Sübwassers* 131. figs. 106-108. 1911; Hustedt, *Kryptogamen-Flora Teil I.* 362. fig. 189. 1930; Hustedt, *Bacillariophyta* 105. fig. 81. 1930. *Cyclotella socialis* var. *minima* Bachmann 1906, *Cyclotella luzernensis* Bachmann 1911, *Cyclotella bachmanni* Meister 1912.

**Pl. 51, Fig. 8**

Frustules rectangular; valves discoid, radially symmetrical, 8.56-11.32  $\mu\text{m}$  broad; marginal striae fine lineate; central zone without punctate; striae 8-10 in 10  $\mu\text{m}$ .

*Phenology* : March June.

Free floating in a small ditch at Mohand near Asharori, associated with *Microspora* sp. (96207).

2. *Cyclotella meneghiniana* Kütz., *Bac.* 50. pl. 30. fig. 68. 1844; Hustedt, *Kryptogamen-flora Teil I.* 341. fig. 174. 1930; Hustedt, *Bacillariophyta* 100. fig. 67. 1930; Foged, *Freshwater diatoms in Ireland*

37. pl. 2. figs. 17, 18. 1977; Kant & Gupta, Algal Fl. Ladakh. 143. pl. 80. figs. 1. 1998. *Surirella melosiroides* Menegh., *Cyclotella melosiroides* Menegh. 1897, *Cyclotella salina* Marsson 1901, *Cyclotella meneghiniana* var. *vogesiaca* Grunow 1881, *Cyclotella rectangula* Brebisson 1861, *Cyclotella meneghiniana* var. *rectangulata* Grunow 1881, *Cyclotella meneghiniana* var. *binotata* Grunow 1881, *Cyclotella meneghiniana* var. *maior* Kütz. 1849, *Cyclotella laevissima* van Goor 1920, *Cyclotella meneghiniana* var. *tenera* Kolbe 1926.

Pl. 51, Fig. 9

Frustules rectangular in girdle view; valves discoid, 12.42-16.73  $\mu\text{m}$  broad; central zone finely punctate; striae 8-10 in 10  $\mu\text{m}$ .

*Phenology* : June-July.

Free floating in a puddle at Sahasradhara, associated with *Dichotomosiphon tuberosus* (96212).

3. *Cyclotella stelligera* Cleve & Grunow, V.H. Syn. pl. 94. figs. 22-27. 1881; Hustedt, Kryptogamen-Flora Teil 1, 339. fig. 172. 1930; Hustedt, Bacillariophyta 100. fig. 65. 1930; Foged, Freshwater diatoms in Ireland 37. pl. 2. fig. 14. 1977. *Cyclotella meneghiniana* var. *stelligera* Cleve & Grunow 1881, *Cyclotella meneghiniana* var. *stellifera* Grunow 1881.

Pl. 51, Fig. 10

Frustules discoid; valves radially symmetrical, 7.18-9.67  $\mu\text{m}$  broad; central zone punctate, surrounded by thick radiating lines forming star like structure; striae 12-14 in 10  $\mu\text{m}$ .

*Phenology* : June - September.

Free floating in a slowly flowing water at Robber's cave, associated with *Oscillatoria* sp. (96219).

### 3. MELOSIRA Agardh

Cells cylindrical, united to form long chains; valves circular with or without marginal teeth; girdles with or without sulcus; chloroplast numerous small discoid, frequently crowded around cell wall; reproduction by auxospore.

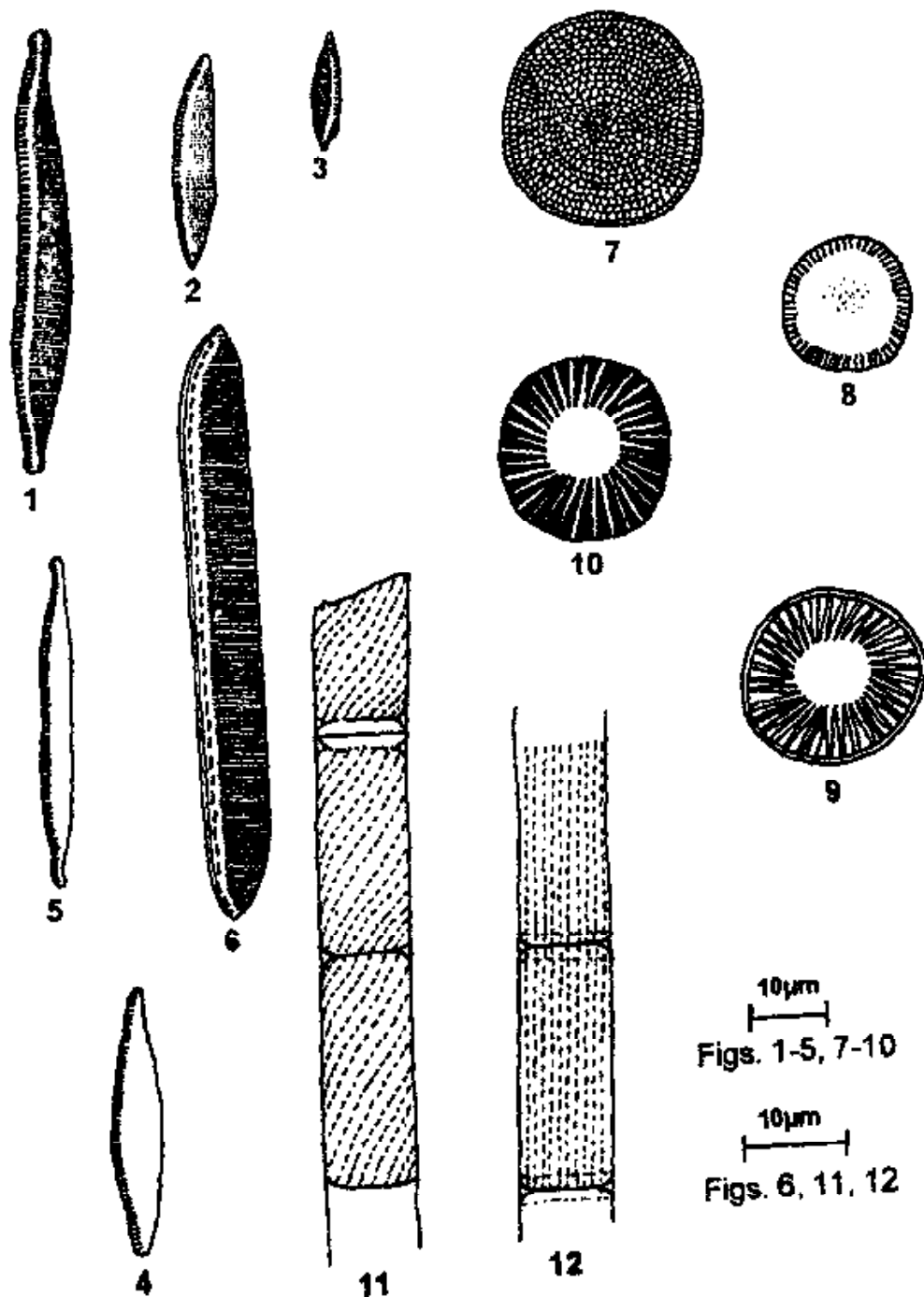


Plate - 51 : Figs. 1-12 : 1. *Hantzschia linearis*; 2. *Nitzschia amphibia*; 3. *Nitzschia frustulum*; 4. *Nitzschia palea*; 5. *Nitzschia interrupta*; 6. *Nitzschia obtusa*; 7. *Coscinodiscus sublineatus*; 8. *Cyclotella glomerata*; 9. *Cyclotella meneghiniana*; 10. *Cyclotella stelligera*; 11. *Melosira granulata*; 12. *Melosira islandica*.

## KEY TO THE SPECIES

- 1a. Rows of areoles spiral 1. *M. granulata*  
 b. Rows of areoles straight 2. *M. islandica*

1. ***Melosira granulata*** (Ehr.) Ralfs. in Pritchard Infus. 820. 1861; Hustedt, Kryptogamen-Flora Teil 1. 248. fig. 104. 1930; Hustedt, Bacillariophyta 87. fig. 44. 1930; Foged, Freshwater diatoms in Ireland 74. pl. 1. figs. 5-9. 1977; Kant & Gupta, Algal Fl. Ladakh 142. pl. 80. figs. 6. 1998. *Gaillonella granulata* Ehr. 1843, *Gaillonella decussata* Ehr. 1843, *Melosira decussata* Kütz. 1844, *Melosira decussata* var. *ordinata* Kütz., *Melosira granulata* var. *maxima* Ehr. 1853, *Orthosira punctata* W. Smith 1856, *Melosira granulata* var. *decussata* Grunow 1881, *Melosira granulata* var. *jeremiae* Grunow 1881, *Melosira granulata* var. *johensis* Grunow 1881, *Melosira lineolata* Grunow, *Melosira punctata* Juhlin-Dannfelt 1882, *Melosira granulata* var. *boryana* Pantocsek 1892, *Melosira granulata* var. *attenuata* Pantocsek, *Melosira granulata* var. *spinosa* Balachoncow 1902.

Pl. 51, Fig. 11

Frustules robust, cylindrical, united to form chains, 5.68-7.82  $\mu\text{m}$  broad; mantle cylindrical, punctate, arranged parallel or slightly spiral appearance; semicells, 7.18-12.52  $\mu\text{m}$  long; end cells with spines; areoles rows spiral, 10-14 in 10  $\mu\text{m}$ .

*Phenology* : August-October.

Free floating in a puddle at Raiwala, along with diatoms mixture (96236).

2. ***Melosira islandica*** O. Müller in Jahrb. f. wissenschaft. Bot. 43: 56. pl. 1. figs. 3-6. 1906; Hustedt, Kryptogamen-Flora Teil 1. 252. fig. 106a, 1930; Hustedt, Bacillariophyta 88. 1930; Foged, Freshwater diatoms in Ireland 74. pl. 1. fig. 13. 1977. *Melosira transsilvanica* Pantocsek 1892, *Melosira granulata* var. *hungarica* Pantocsek.

Pl. 51, Fig. 12

Frustules cylindrical, united to form chains, 6.53-7.38  $\mu\text{m}$  broad; semicells, 8.47-14.29  $\mu\text{m}$  long; areoles rows straight, 10-12 in 10  $\mu\text{m}$ .

*Phenology* : August-October.

Free floating in a small ditch at Raiwala, associated with other species of diatoms (96240); free floating in a slowly flowing waterlets at Sahasradhara (93127).

## 2. Order : Pennales

Valves isobilateral; valve-view boat or needle-shaped; chloroplasts laminate; pyrenoids present; reproduction by auxospores formed by conjugation.

### KEY TO THE FAMILIES

- |                                    |                   |
|------------------------------------|-------------------|
| 1a. Pseudoraphe present            | 1. FRAGILARIACEAE |
| b. Pseudoraphe absent              | 2                 |
| 2a. Raphe rudimentary              | 2. EUNOTIACEAE    |
| b. Raphe well developed            | 3                 |
| 3a. Raphe present on one valve     | 3. ACHNANTHACEAE  |
| b. Raphe present on both valve     | 4                 |
| 4a. Raphe occupying apical axis    | 4. NAVICULACEAE   |
| b. Raphe not occupying apical axis | 5                 |
| 5a. Valves with lateral wing       | 6. SURIRELLACEAE  |
| b. Valves without lateral wing     | 5. NITZSCHIACEAE  |

### 1. FRAGILARIACEAE

### KEY TO THE GENERA

- |   |               |
|---|---------------|
| 1a. Frustules arranged zig-zag                      | 3. TABELLARIA |
| b. Frustules not arranged zig-zag                   | 2             |
| 2a. Frustules attached side by side to form ribbons | 1. FRAGILARIA |
| b. Frustules single, needle shaped                  | 2. SYNEDRA    |

### 1. FRAGILARIA Lyngbye

Frustules quadrate or rectangular in girdle view, attached side by side to form ribbons; septa and costae absent; valves linear to fusiform, bilaterally symmetric, attenuated towards poles or capitate; striae fine or coarse; pseudoraphe narrow; chloroplasts discoid or plate-like; pyrenoids present: reproduction by auxospores.

## KEY TO THE SPECIES

- |                              |                           |
|------------------------------|---------------------------|
| 1a. Striae marginal          | 1. <i>F. brevistriata</i> |
| b. Striae not marginal       | 2                         |
| 2a. Valve linear rectangular | 3. <i>F. intermedia</i>   |
| b. Valve linear              | 3                         |
| 3a. Central area present     | 4. <i>F. vaucheriae</i>   |
| b. Central area absent       | 2. <i>F. capucina</i>     |

1. *Fragilaria brevistriata* Grunow, V.H. Syn. pl. 45. figs. 32, 34. 1881; Hustedt, Bacillariophyta 145. fig. 151. 1930; Hustedt, Kryptogamen-Flora Teil 2. 168. figs. 676a-e. 1959; Foged, Freshwater diatoms in Ireland 60. pl. 6. fig. 15. 1977; Hustedt & Jensen, The pennate diatoms. 157. figs. 676a-e. 1985. *Fragilaria acuta* Ehr., *Fragilaria rostrata* Pantocsek 1912, *Fragilaria brevistriata* var. *linearis* A. Mayer 1919.

## Pl. 52, Figs. 4a-b

Frustules rectangular, attached together to form chain; valves linear elliptic, tapering towards ends, 15.63-16.17  $\mu\text{m}$  long, 4.54-6.42  $\mu\text{m}$  broad; pseudoraphe elliptic, lanceolate; striae, marginal, 14-15 in 10  $\mu\text{m}$ .

*Phenology* : August-February.

Free floating in a puddle at Raiwala, associated with members of blue green algae (96242).

2. *Fragilaria capucina* Desmazieres, Crypt. de France. edit. I. 453. 1825; Hustedt, Bacillariophyta 138. fig. 126. 1930; Hustedt, Kryptogamen-Flora Teil 2. 144. figs. 659a-e. 1959; Foged, Freshwater diatoms in Ireland. 60. pl. 6., fig. 5. 1977; Hustedt & Jensen, The Pennate diatoms 134. figs. 659a-e. 1985; Nautiyal, Nautiyal & Singh in Phytos 35(1 & 2): 59. 1996; Kant & Gupta, Algal Fl. Ladakh. 146. pl. 73. fig. 8. 1998. *Conferva pectinalis* Müller 1779, *Bacillaria multipunctata* Ehr. 1817, *Bacillaria pectinalis* Nitzsch 1817, *Diatoma pectinalis* Agardh 1817, *Fragilaria pectinalis* Lynghye 1819, *Fragilaria tenuis* Agardh 1832. *Fragilaria ventriculus* Ehr. 1843, *Fragilaria corrugata* Kütz. 1844, *Diatomosira pectinalis* Trevisan 1848, *Fragilaria pusilla* Kütz., 1849, *Fragilaria sepes* Ehr. 1854, *Fragilaria aequalis* Heiberg 1863, *Stauroneis capucina* Borszczow 1873, *Fragilaria balatonis* Pantocsek 1902.

## Pl. 52, Figs. 1a-b



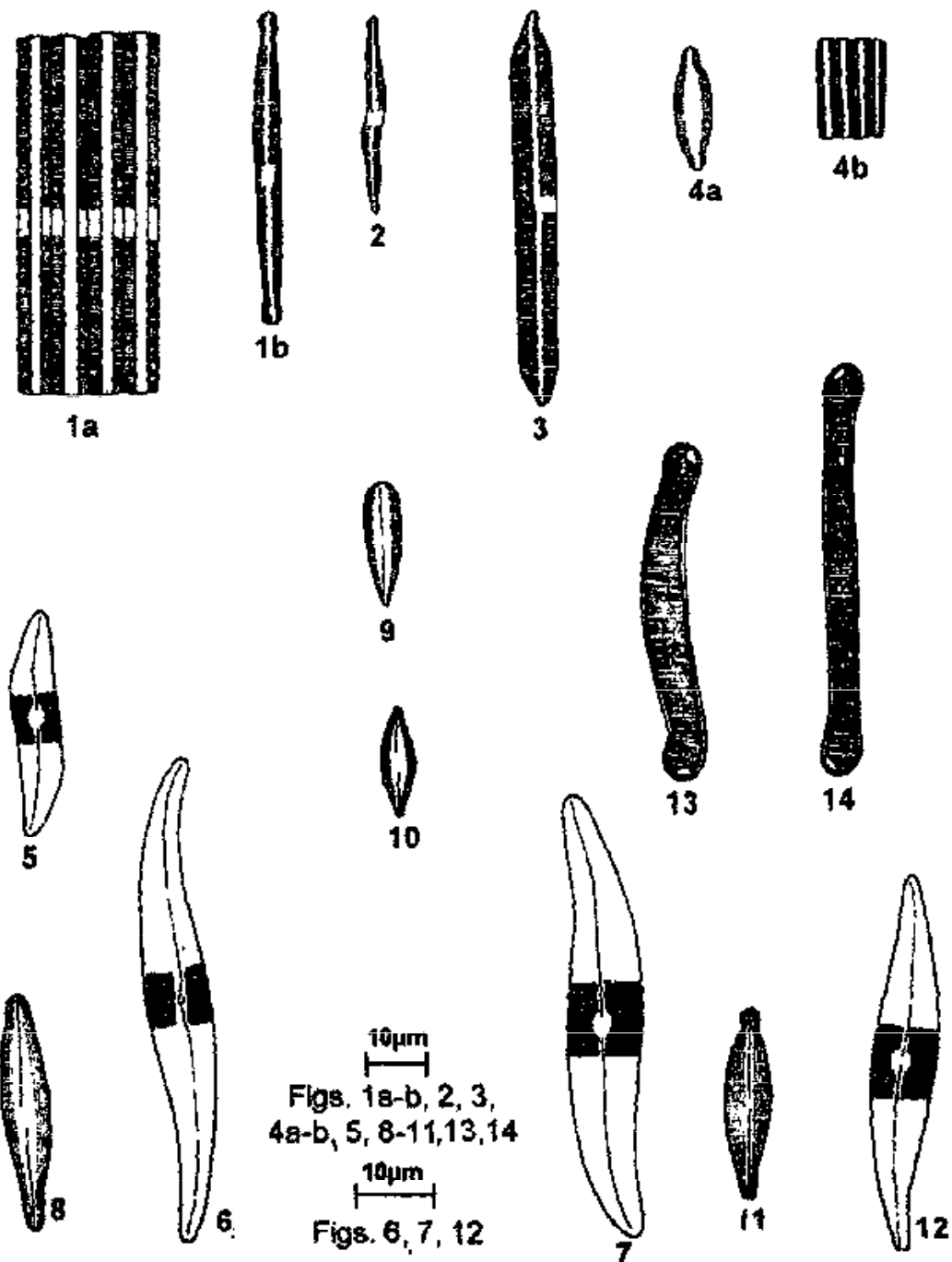


Plate 52 : Figs. 1-14 : 1a-b. *Fragilaria capucina*; 2. *Fragilaria vaucheriae*; 3. *Fragilaria intermedia*; 4a-b. *Fragilaria brevistriata*; 5. *Gyrosigma spencerii*; 6. *Gyrosigma attenuatum*; 7. *Gyrosigma kuetzingii*; 8. *Gomphonema lanceolatum*; 9. *Gomphonema olivaceum*; 10. *Gomphonema parvulum*; 11. *Gomphonema subclavatum*; 12. *Pleurosigma salinarum*; 13. *Eunotia arcus*; 14. *Eunotia gracilis*.

Frustules rectangular, attached together to form chain; valves linear, narrow towards ends, 18.26-129.47  $\mu\text{m}$  long, 3.13-4.27  $\mu\text{m}$  broad; ends slightly constricted; pseudoraphe linear lanceolate; central area not formed; striae 16-18 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating in a puddle at Asan, along with other diatoms (93110); Free floating in Yamuna river (93173); attached on *Cladophora glomerata* at Yamuna (93176); free floating in a ditch at Mussoorie, along with *Ulothrix* sp. (93189); free floating in a ditch at Gular ghati (93101, 93164).

**3. *Fragilaria intermedia*** Grunow, V.H. Syn. pl. 45. figs. 9-11. 1881; Hustedt, Bacillariophyta 139. fig. 130. 1930; Hustedt, Kryptogamen-Flora Teil 2. 152. fig. 666. 1959; Foged, Freshwater diatoms in Ireland 62. pl. 6. fig. 11. 1977; Hustedt & Jensen, The Pennate diatoms 142. fig. 666. 1985; Nautiyal, Nautiyal & Singh in Phykos 35(1 & 2): 59. 1996. *Staurosira intermedia* Grunow, *Fragilaria mutabilis* var. *intermedia* Grunow 1862, *Odontidium mutabile* var. *intermedia* De Toni 1892,

Pl. 52, Fig. 3

Frustules attached together to form chain; valves linear, rectangular, 75.48-78.31  $\mu\text{m}$  long, 3.13-5.57  $\mu\text{m}$  broad; ends slightly capitate, gradually tapering, rounded; axial area narrow, linear; striae 12-14 in 10  $\mu\text{m}$ .

*Phenology* : December-January.

Free floating in a ditch at Chakrata, associated with *Spirogyra* sp. (96248).

**4. *Fragilaria vaucheriae*** (Kütz.) Petersen in Bot. Not. 3: 167. figs. 1c-g. 1938; *Synedra vaucheriae* Kütz. 1844.

Pl. 52, Fig. 2

Frustules attached together to form chain, bent or twisted in middle; valves linear, 32.28-36.47  $\mu\text{m}$  long, 3.16-4.63  $\mu\text{m}$  broad; ends narrow, capitate; pseudoraphe linear and narrow; striae 16-18 in 10  $\mu\text{m}$ .

*Phenology* : December.

Free floating in a puddle at Chakrata, associated with species of *Oscillatoria* and diatoms mixture (96253).

## 2. SYNEDRA Ehr.

Valves solitary or in colonies, free floating or epiphytic; frustules elongate with truncate apices in girdle view; valves linear to linear lanceolate, straight or curved; central area present or absent; transverse striations lateral to conspicuous and narrow pseudoraphe; chloroplasts plate shaped; pyrenoids many; reproduction by auxospores.

### KEY TO THE SPECIES

- |  |                        |
|--|------------------------|
| 1a. Pseudoraphe broad                  | 3. <i>S. tabulata</i>  |
| b. Pseudoraphe narrow                  | 2                      |
| 2a. Frustules 40-50 $\mu\text{m}$ long | 2. <i>S. minuscula</i> |
| b. Frustules 60-120 $\mu\text{m}$ long | 3                      |
| 3a. Striae coarse                      | 4. <i>S. ulna</i>      |
| b. Striae fine                         | 1. <i>S. acus</i>      |

1. *Synedra acus* Kütz., Bacill. 68. pl. 15. fig. 7. 1844; Hustedt, Bacillariophyta 155. fig. 170. 1930; Hustedt, Kryptogamen-Flora, Teil 2. 201. fig. 693a. 1959; Foged, Freshwater diatoms in Ireland 112. 1977; Hustedt & Jensen, The pennate diatoms 188. fig. 693. 1985; Nautiyal, Nautiyal & Singh in Phycos 35(1 & 2): 60. 1996; Kant & Gupta, Algal Fl. Ladakh 147. pl. 80. fig. 14, pl. 127. fig. 9. 1998. *Synedra acula* Kütz., *Synedra tenuis* Kütz., *Synedra acus* var. *genuina* A. Mayer 1913.

Pl. 53, Fig. 2

Frustules linear in girdle view; valves narrow, linear to lanceolate, middle portion gradually tapering towards ends, 87.78-91.43  $\mu\text{m}$  long, 3.57-4.23  $\mu\text{m}$  broad; ends obtuse; pseudoraphe narrow, linear; central area without striae; striae fine 14-15 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating in a ditch near Yamuna river, along with *Microspora* and *Ulothrix* sp. (93177).

2. *Synedra minuscula* Grunow, V.H. Syn. pl. 39. fig. 13. 1881; Hustedt, Bacillariophyta 158. fig. 180. 1930; Hustedt, Kryptogamen-

Flora Teil 2. 210. fig. 700. 1959; Foged, Freshwater diatoms in Ireland 112. pl. 7. fig. 14. 1977; Hustedt & Jensen, The pennate diatoms 195. fig. 700. 1985; Kant & Gupta, Algal Fl. Ladakh 146. pl. 76. fig. 1, pl. 122. fig. 8, pl. 127. fig. 3. 1998. *Synedra minuscula* var. *latestriata* Østrup 1920, *Synedra minuscula* var. *undulata* Peragallo 1920, *Synedra delicatula* A. Mayer 1919.

**Pl. 53, Fig. 4**

Frustules linear, elongate in girdle view; valves linear lanceolate with narrow, rounded ends, 18.25-21.63  $\mu\text{m}$  long, 3.16-4.12  $\mu\text{m}$  broad; axial area narrow, linear lanceolate; central area slightly widened; striae 14-15 in 10  $\mu\text{m}$ .

*Phenology* : January-May.

Free floating in a ditch at Yamuna, along with other species of *Synedra* (93177); free floating in a puddle at Rajajee National Park, associated with diatoms mixture (94165).

**3. *Synedra tabulata* (Ag.) Kütz.** Bacill. 68. pl. 15. figs. 1-3, 10. 1844; Hustedt, Kryptogamen-Flora Teil 2. 218. figs. 710a-d. 1959; Foged, Freshwater diatoms in Ireland 113. 1977; Hustedt & Jensen, The pennate diatoms 201. figs. 710a-d. 1985; Nautiyal, Nautiyal & Singh in Phykos, 35 (1 & 2) 61. 1996. *Diatoma tabulatum* Agardh 1832, *Exilaria fasciculata-minor* Agardh, *Frustulia subtilis* Kütz. 1834, *Navicula acus* Ehr. 1838, *Synedra subtilis* Kütz. 1844, *Synedra tenuis* Kütz., *Synedra affinis* Kütz., *Synedra gracilis* Kütz., *Synedra affinis* var. *delicatula* Grunow 1880, *Synedra tabulata* var. *affinis* Marsson 1901, *Synedra affinis* var. *lanceolata* Østrup 1910, *Synedra affinis* f. *anomala* Østrup 1920, *Synedra affinis* var. *thermalis* Peragallo.

**Pl. 53, Fig. 1**

Frustules linear in girdle view; valves linear, narrow with tapering rounded ends, 46.87-53.96  $\mu\text{m}$  long, 3.25-3.89  $\mu\text{m}$  broad; pseudoraphe broad; central area absent; striae 12-14 in 10  $\mu\text{m}$

*Phenology* : January-March.

Attached on *Microspora* sp. at Yamuna (93177).

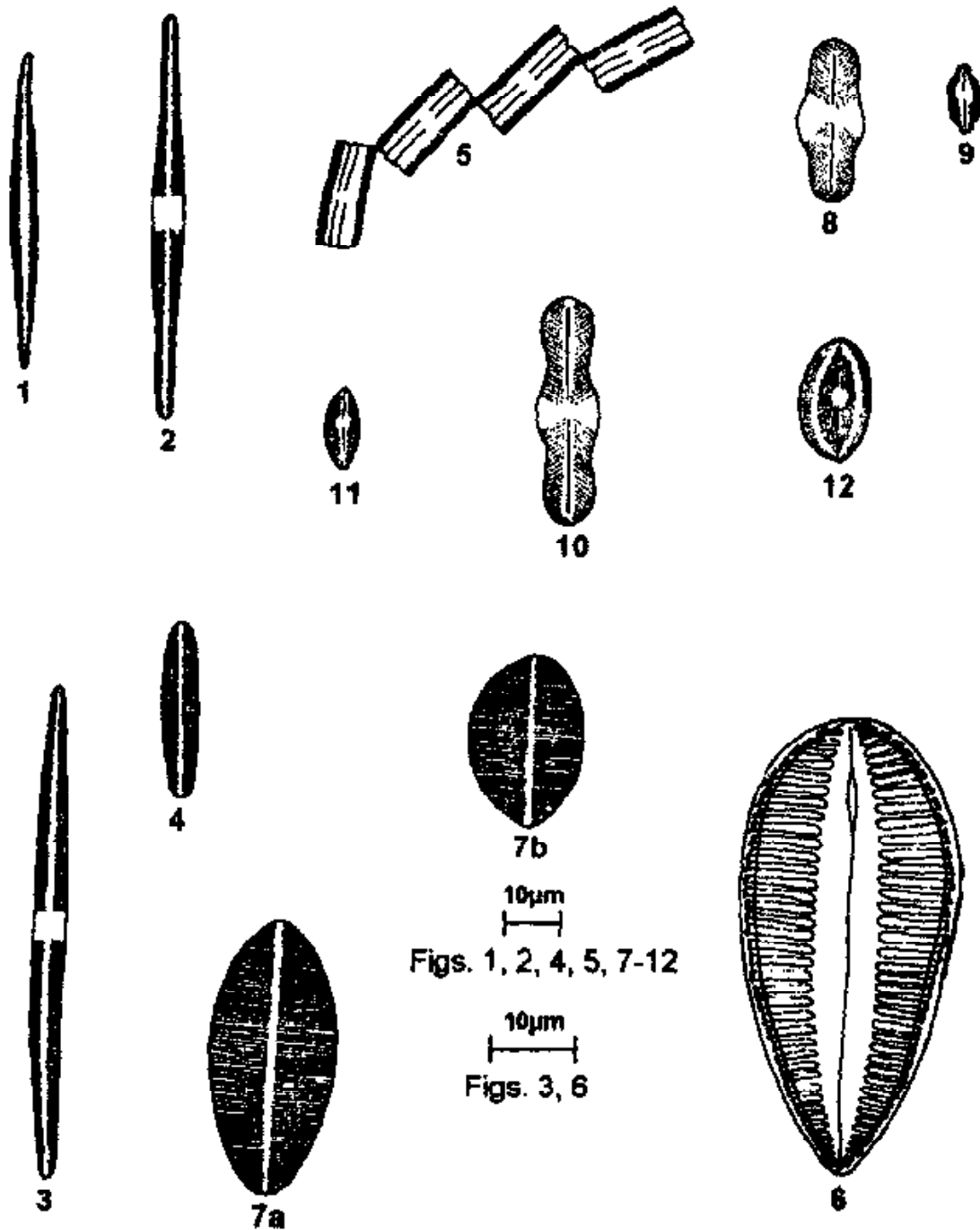


Plate - 53 : Figs. 1-12 : 1. *Synedra tabulata*; 2. *Synedra acus*; 3. *Synedra ulna*; 4. *Synedra minuscula*; 5. *Tabellaria binalis*; 6. *Surirella capronioides*; 7a-b. *Surirella ovata*; 8. *Achnanthes elata*; 9. *Achnanthes exigua*; 10. *Achnanthes inflata*; 11. *Achnanthes subsalsa*; 12. *Cocconeis placentula*.

4. *Synedra ulna* (Nitzsch) Ehr. Infus. 211. pl. 17. fig. 1. 1838; Hustedt, Bacillariophyta 151. figs. 158-159. 1930; Hustedt, Kryptogamenflora Teil 2. 195. figs. 691A, a-c; 1959. Foged, Freshwater diatoms in Ireland 113. pl. 7. figs. 1, 2. 1977. Hustedt & Jensen, The pennate diatoms 181. fig. 691A, a-c. 1985; Nautiyal, Nautiyal & Singh in 35(1 & 2): 61. 1996; Kant & Gupta, Algal Fl. Ladakh 146. pl. 77. fig. 12; pl. 121. fig. 7, pl. 124. fig. 3. 1998. *Bacillaria ulna* Nitzsch 1817, *Echinella vitrea* Bory, *Bacillaria vitrea* Bory 1824, *Frustulia splendens* Kütz. 1834, *Synedra lanceolata* Kütz. 1844, *Synedra splendens* Kütz., *Synedra vitrea* Kütz., *Synedra mesolepta* Kütz., *Synedra aequalis* Kütz., *Frustulia aequalis* Kütz. 1834, *Synedra mesocampa* Brebisson 1849, *Synedra radians* W. Smith, *Synedra salina* W. Smith, *Synedra interrupta* Auerswald, *Synedra bicurvata* Biene, 1881. *Synedra subaequalis* Pantocsek 1902, *Synedra subaequalis* f. *curvata* pantocsek, *Synedra ulna* var. *intermedia* Mereschkowsky 1906; *Synedra vitrea* var. *distorta* Meister 1912, *Synedra lanceolata* var. *abbreviata* Pantocsek 1913. *Synedra ulna* var. *crassa* Pantocsek, *Synedra ulna* var. *curta* A. Mayer, *Synedra ulna* var. *robusta* Peragallo 1920.

### Pl. 53, Figs. 3

Frustules linear in girdle view; valves linear to linear lanceolate, tapering at ends, 117.14-131.67  $\mu\text{m}$  long, 5.47-6.25  $\mu\text{m}$  broad; ends rounded; pseudoraphe narrow, linear; central area absent or present; striae coarse 9-11 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating in a ditch at Yamuna along with species of *Microspora* and *Ulothrix* (93177); free floating in a ditch at Rajajee National Park near Ramgarh (93191).

### 3. TABELLARIA Ehr.

Frustules united in zig-zag chains; gelatinous cushions at corners; free floating; transverse line punctate; pseudoraphe faint; chloroplasts discoid; reproduction by auxospores.

1. *Tabellaria binalis* (Ehr.) Grunow, V.H. Syn. pl. 44. fig. 23. 1880; Hustedt, Bacillariophyta. 124. fig. 102. 1930; Hustedt, Kryptogamen-Flora Teil 2. 30. fig. 559. 1959; Foged, Freshwater diatoms in Ireland 114. pl.

4. figs. 11-13. 1977; Hustedt & Jensen, The pennate diatoms 28. fig. 559. 1985. *Fragilaria binalis* Ehr. 1854, *Tetracyclus lewisianus* Östrup 1910.

**Pl. 53, Fig. 5**

Frustules attached in zig-zag chains; valves, 9.17-13.42  $\mu\text{m}$  long, 3.23-4.78  $\mu\text{m}$  broad; septa longitudinal straight; pseudoraphe faint linear; striae punctate, 10-11 in 10  $\mu\text{m}$ .

*Phenology* : March April.

Free floating in Yamuna river, associated with *Cladophora glomerata* (93189).

**2. EUNOTIACEAE**

**1. EUNOTIA Ehr.**

Frustules rectangular or cuneate, linear with intercalary band; free floating or epiphytic, solitary or united into chains; valves arcuate, asymmetric, undulate; pseudoraphe asymmetrically; central nodules absent; transverse striation punctate; reproduction by auxospores.

**KEY TO THE SPECIES**

- |                          |                       |
|--------------------------|-----------------------|
| 1a. Ends capitate        | 1. <i>E. arcus</i>    |
| b. Ends without capitate | 2. <i>E. gracilis</i> |

**1. *Eunotia arcus* Ehr.** Infus. 191. pl. 21. fig. 22. 1838; Hustedt, Bacillariophyta 175. fig. 216. 1930; Hustedt, Kryptogamen-Flora, Teil 2. 282, figs. 748a-c. 1959; Foged, Freshwater diatoms in Ireland 53. pl. 9. fig. 13. 1977; Hustedt & Jensen, The pennate diatoms 255. figs. 748a-c. 1985. *Himantidium arcus* Ehr. 1840, *Himantidium arcus* var. *curta* Grunow 1862, *Eunotia arcus* var. *minor* Grunow 1881, *Eunotia arcus* var. *plicata* Bruns & Heribaud 1893, *Eunotia paludosa* A. Mayer 1916, *Eunotia arcus* var. *subalpina* Fontell 1917.

**Pl. 52, Fig. 13**

Frustules linear; valves dorsal margin arcuate, ventral margin slightly concave and constricted at ends, 42.28-46.72  $\mu\text{m}$  long, 6.43-7.18  $\mu\text{m}$  broad; ends smooth rounded and capitate; nodules present; striae coarse 9-11 in 10  $\mu\text{m}$ .

*Phenology* : December-March.

Free floating in a puddle at Chakrata, associated with *Fragilaria* sp. (93464).

2. *Eunotia gracilis* (Ehr.) Rabenh. Fl. Eur. Alg. 72. 1864; Hustedt, Bacillariophyta 185. fig. 253. 1930; Hustedt, Kryptogamen-flora Teil 2. 305. fig. 771. 1959; Foged Freshwater diatoms in Ireland 55. 1977; Hustedt & Jensen, The pennate diatoms 275. fig. 771. 1985. *Himantidium gracile* Ehr. 1843, *Eunotia gracilis* var. *fossilis* Pantocsek 1892, *Eunotia gracilis* var. *capitata* Peragallo & Heribaud 1902, *Eunotia gracilis* f. *minor* Dippel 1904, *Eunotia glacialis* Meister 1912, *Eunotia major* var. *genuina* A. Mayer, 1913.

Pl. 52, Fig. 14

Frustules linear; valves slightly arcuate, linear with swollen rounded ends, 84.53-87.67  $\mu\text{m}$  long, 5.16-5.37  $\mu\text{m}$  broad; polar nodules present; ends without capitate; striae fine 13-14 in 10  $\mu\text{m}$ .

*Phenology* : December-August.

Free floating in a ditch at Chakrata, associated with *Closterium* sp. (96293).

### 3. ACHNANTHACEAE

#### KEY TO THE GENERA

- |                                    |               |
|------------------------------------|---------------|
| 1a. Transverse axis of cells bent  | 2. COCCONEIS  |
| b. Longitudinal axis of cells bent | 1. ACHNANTHES |

#### 1. ACHNANTHES Bory

Frustules longitudinally curved in girdle view; free floating or attached by gelatinous stalks or sessile and united into bundles; valves linear lanceolate or elliptic; hypotheca concave; epitheca convex with pseudoraphe; central nodule present; transverse striation punctate; chloroplasts discoid; reproduction by auxospores.



## KEY TO THE SPECIES

- 1a. Valve with unilateral pseudoraphe 2
- b. Valve with central pseudoraphe 3
- 2a. Valves fusiform with subcuneate rounded ends 1. *A. elata*
- b. Valves linear with rounded or cuneately rounded ends 3. *A. inflata*
- 3a. Valves rectangular 2. *A. exigua*
- b. Valves elliptic lanceolate 4. *A. subsalsa*

1. *Achnanthes elata* (Leud-Fort) Gandhi in J. roy. microsc. soc. 79: 82. figs. 3-7, 10. 1960; Sarode & Kamat, Freshwater diatoms of Maharashtra 53. pl. 5. fig. 107. 1984.

Pl. 53, Fig. 8

Frustules rectangular curved; valves fusiform, linear lanceolate, 30.57-32.76  $\mu\text{m}$  long, 12.43-13.12  $\mu\text{m}$  broad; middle margin tumid with subcuneate rounded ends; raphe thin and straight; axial area wide; pseudoraphe central; striae radial punctate 10-11 in 10  $\mu\text{m}$ .

*Phenology* : October-December.

Epiphyte on *Rhizoclonium* sp. at Sahasradhara (93140).

2. *Achnanthes exigua* Grunow in K. Sv. Vet. Akad. Handl. 17(2): 21. 1880; Hustedt, Bacillariophyta 201. fig. 286. 1930; Hustedt, Kryptogamen-Flora Teil 2. 386, figs. 832. a-b. 1959; Foged, Freshwater diatoms in Ireland 23. 1977; Hustedt & Jensen, The pennate diatoms 336. figs. 832 a-b. 1985. *Stauroneis exilis* Kütz. 1844, *Stauroneis quadrata* (Morren) Kütz. 1903, *Stauroneis tylophora* Reichelt 1903, *Microneis exigua* Cleve, *Cocconeis exigua* Torika, 1909.

Pl. 53, Fig. 9

Frustules rectangular, curved; valves elliptical in middle portion, 13.28-15.72  $\mu\text{m}$  long, 5.26-6.15  $\mu\text{m}$  broad; ends rostrate; raphe thin, straight; axial area narrow; striae slightly radial 18-21 in 10  $\mu\text{m}$ .

*Phenology* : December-March.

Free floating in a slowly flowing water at Chakrata, associated with *Cladophora* sp. (96286).

3. *Achnanthes inflata* (Kütz.) Grunow in K. Sv. Vet. Akad. Handl. 17(2): 19. 1880; Hustedt, Bacillariophyta 209. fig. 307. 1930; Hustedt, Kryptogamen-Flora Teil 2. 421. fig. 873. 1959; Hustedt & Jensen. The Pennate diatoms 365. fig. 873. 1985; Kant & Gupta, Algal Fl. Ladakh 150. pl. 76. fig. 10; pl. 124. fig. 6, pl. 128. fig. 11. 1998. *Stauroneis inflata* Kütz. 1844, *Achnanthes ventricosa* Ehr. 1854, *Monogramma ventricosa* Ehr., *Navicula elata* Leudiger-Fortmorel, *Achnanthes brevipes* var. *tumidula* Grunow, *Achnanthes hormanii* Gutwinsky 1899.

Pl. 53, Fig. 10

Frustules linear; valves elliptical, 45.64-49.15  $\mu\text{m}$  long, 12.33-15.67  $\mu\text{m}$  broad; ends rounded; raphe thin and straight; axil area narrow; central area stauroid; rapheless valve with narrow, unilaterally disposed pseudoraphe; striae radial and punctate 11-12 in 10  $\mu\text{m}$ .

*Phenology* : December-March.

Free floating in a ditch at Chakrata, associated with *Gomphonema* sp. (96287).

4. *Achnanthes subsalsa* Petersen in Bot. of Iceland 2: 379. fig. 4. 1928; Hustedt, Kryptogamen-Flora, Teil 2. 401. fig. 853. 1959; Hustedt & Jensen, The pennate diatoms 348. fig. 853. 1985.

Pl. 53, Fig. 11

Frustules rectangular, curved; valves elliptic lanceolate, 9.37-13.43  $\mu\text{m}$  long, 4.28-5.13  $\mu\text{m}$  broad; raphe valve with narrow axial area; central area quadrangular; rapheless valve with narrow, lanceolate; central area; absent; striae fine radial 24-27 in 10  $\mu\text{m}$ .

*Phenology* : December-April.

Free floating in a slowly flowing water at Chakrata, associated with other species of diatoms (96299).

## 2. COCCONEIS Ehr.

Cells transversely curved in girdle view; intercalary bands absent; valves elliptic; epitheca with axial pseudoraphe; hypotheca with median

raphe; nodules present; striae punctate; chloroplasts discoid; pyrenoid one or two; reproduction by auxospores.

1. *Cocconeis placentula* Ehr. Infus. 194. 1838; Hustedt, Bacillariophyta 189. fig. 260. 1930; Hustedt, Kryptogamen-Flora, Teil 2, 347. figs. 802a-b. 1959; Foged, Freshwater diatoms in Ireland 34. pl. 15. fig. 2. pl. 14. figs. 20-22. 1977; Hustedt & Jensen, The pennate diatoms 306. figs. 802a-b. 1985. *Cocconeis punctata* Schumann 1867, *Cocconeis reichelti* A. Schmidt 1894, *Cocconeis producta* A. Schmidt, *Cocconeis grovei* Østrup, *Cocconeis placentula* var. *genuina* A. Mayer 1913, *Cocconeis østrupii* Heribaud 1920, *Cocconeis grosli* Heribaud  
**Pl. 53, Fig. 12**

Valves elliptical, 29.26-37.18  $\mu\text{m}$  long, 14.63-25.59  $\mu\text{m}$  broad; axial area very narrow; raphe valve with thin and straight raphe; striae punctate 25-26 in 10  $\mu\text{m}$ ; rapheless valve with narrow linear, pseudoraphe; striae 25-26 in 10  $\mu\text{m}$ .

*Phenology* : March-April.

Growing on moist wall at Mussoorie, associated with *Vaucheria* sp. (93179).

#### 4. NAVICULACEAE

##### KEY TO THE GENERA

- |                                     |                |
|-------------------------------------|----------------|
| 1a. Valves symmetrical              | 2              |
| b. Valves asymmetrical              | 5              |
| 2a. Valves view sigmoid             | 3              |
| b. Valves view not sigmoid          | 4              |
| 3a. Striae in two series            | 4. GYROSIGMA   |
| b. Striae in three series           | 7. PLEUROSIGMA |
| 4a. Valves with transverse striae   | 5. NAVICULA    |
| b. Valves with transverse costae    | 6. PINNULARIA  |
| 5a. Valves transversely asymmetric  | 3. GOMPHONEMA  |
| b. Valves longitudinally asymmetric | 6              |
| 6a. Valves flat                     | 2. CYMBELLA    |
| b. Valves convex                    | 1. AMPHORA     |

## 1. AMPHORA Ehr.

Cells solitary, free floating or attached at ends of gelatinous stalks or gelatinous mucous; valves asymmetric, convex with truncate ends; axial area excentric; raphe gibbous with central nodules close to concave margin; chloroplasts discoid; reproduction by auxospores.

## KEY TO THE SPECIES

- |                                    |                          |
|------------------------------------|--------------------------|
| 1a. Valves not constricted at ends | 3. <i>A. veneta</i>      |
| b. Valves constricted at ends      | 2                        |
| 2a. Ventral margin convex          | 1. <i>A. acutiuscula</i> |
| b. Ventral margin straight         | 2. <i>A. bongrainii</i>  |

**1. *Amphora acutiuscula* Kütz., Species Algarum 95. 1849; Sarode & Kamat, Freshwater diatoms of Maharashtra 160. pl. 19. fig. 42a. 1984.**

**Pl. 54, Fig. 8**

Frustules elliptic; valves semi-lanceolate with convex ventral margin, 25.68-28.13  $\mu\text{m}$  long, 13.17-14.27  $\mu\text{m}$  broad; ends capitate; raphe thin straight; axial area narrow; striae punctate, 14-16 in 10  $\mu\text{m}$ .

*Phenology* : January-March.

Free floating on Yamuna river along with *Cladophora glomerata* and other species of diatoms (93173).

**2. *Amphora bongrainii* Peragallo, Deux. Exp. Ant. Fr. 60. pl. 2. fig. 22. 1921; Sarode & Kamat, Freshwater diatoms of Maharashtra 160. pl. 19. fig. 431. 1984.**

**Pl. 54, Fig. 10**

Frustules linear elliptical; valve arcuate on dorsal margin and straight ventral margin, 23.21-25.74  $\mu\text{m}$  long, 6.12-6.42  $\mu\text{m}$  broad; ends capitate; raphe thin, straight; striae coarsely punctate 14-15 in 10  $\mu\text{m}$ .

*Phenology* : January-July.

Free floating on Yamuna river, associated with *Cladophora glomerata* and other diatoms species (43173).

3. *Amphora veneta* Kütz., Species Algarum 94. 1849; Hustedt, Bacillariophyta 345. fig. 631. 1930; Foged, Freshwater diatoms in Ireland 29. pl. 34. fig. 13. 1977; Hustedt & Jensen, The pennate diatoms 797. fig. 631. 1985; Nautiyal, Nautiyal & Singh in Phykos, 35 (1 & 2): 70. 1996; Kant & Gupta, Algal Fl. Ladakh 164. pl. 74. fig. 11, pl. 127. fig. 7. 1998.

**Pl. 54, Fig. 9**

Frustules elliptic with subtruncate ends; valves convex on dorsal side and slightly concave on ventral side with bent rounded ends, 16.37-18.58  $\mu\text{m}$  long, 4.22-4.78  $\mu\text{m}$  broad; raphe thin; striae punctate 22-23 in 10  $\mu\text{m}$ .

*Phenology* : September-October.

Free floating in a puddle at Asan reservoir, associated with diatoms mixture (93105).

**2. CYMBELLA Agardh**

Cells solitary, free floating or attached at ends of gelatinous stalks; valves asymmetrical, lunate, elliptic, rhombic, naviculoid, dorsally convex, ventrally concave; axial field wide or narrow; central area with or without dots; raphe curved with nodules; transverse striations radiate; chloroplasts discoid; reproduction by auxospores.

**KEY TO THE SPECIES**

- |  |                         |
|--|-------------------------|
| 1a. Dorsal and ventral margins bent in opposite directions | 1. <i>C. affinis</i>    |
| b. Dorsal and ventral margins bent in same direction       | 2                       |
| 1a. Ends rounded   | 3. <i>C. turgida</i>    |
| b. Ends acute  | 2. <i>C. lanceolata</i> |

1. *Cymbella affinis* Kütz., Species Algarum 58. 1849; Hustedt, Bacillariophyta 362. fig. 671. 1930; Foged, Freshwater diatoms in Ireland. 39. 1977; Hustedt & Jensen, The pennate diatoms 814. fig. 671. 1985; Nautiyal, Nautiyal & Singh in Phykos 35(1 & 2): 71. 1996. Kant & Gupta, Algal Fl. Ladakh 163. pl. 70. fig. 2, pl. 127. fig. 1. 1998.

**Pl. 54, Fig. 11**

Valves asymmetrical, 18.76-22.56  $\mu\text{m}$  long, 8.24-10.72  $\mu\text{m}$  broad; dorsal margin convex and ventral margin concave; ends rostrate to subcapitate; raphe thick, arcuate; axial area sublinear; central area widened with stigma on ventral side; striae radial, lineate 10-12 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating in a ditch at Mussoorie, associated with *Cosmarium* sp. (93179).

2. *Cymbella lanceolata* (Ehr.) v.H., Consp. Crit. Diat. 1: 9. 1830; Hustedt, Bacillariophyta 364. fig. 679. 1930; Foged, Freshwater diatoms in Ireland 43. pl. 37. fig. 2. 1977; Hustedt & Jensen, The pennate diatoms 816. fig. 679. 1985.

Pl. 54, Fig. 13

Valves asymmetrical, 158.48-161.73  $\mu\text{m}$  long, 31.23-33.28  $\mu\text{m}$  broad; dorsal margin convex, ventral margin straight; ends acute; raphe thick, slightly excentric; axial area, linear; striae coarsely punctate 9-10 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating in a small puddle at Sahasradhara, associated with *Oscillatoria* sp. (93132).

3. *Cymbella turgida* (Greg.) Cleve in Quart. J. Microscop. Sci. 4: 5. pl. 1. fig. 18. 1856; Hustedt, Bacillariophyta 358. fig. 660. 1930; Foged, Freshwater diatoms in Ireland 46. pl. 36. fig. 6. 1977; Hustedt & Jensen, The pennate diatoms 811. fig. 660. 1985; Nautiya, Nautiyal & Singh in Phykos 35(1 & 2): 73. 1996; Kant & Gupta, Algal Fl. Ladakh 163. pl. 72. fig. 10. 1998. *Encyonema turgidum* Greg. 1875.

Pl. 54, Fig. 12

Valves lunate with convex dorsal and straight ventral margin, 24.58-27.59  $\mu\text{m}$  long, 8.15-12.46  $\mu\text{m}$  broad; ends rounded; raphe excentric; axial area linear; central area elliptical; striae lineate, radial 8-9 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating at Asan reservoir, associated with certain desmids (93125).

## 3. GOMPHONEMA Agardh 1824

Cells free floating or epiphytic, transversely asymmetric; valves clavate, lanceolate or straight; raphe straight and conspicuous; central and polar nodules present; striations transverse or radial; chloroplasts ellipsoid; pyrenoid present; reproduction by auxospores.

## KEY TO THE SPECIES

- |                                   |                          |
|-----------------------------------|--------------------------|
| 1a. Central area without punctate | 2. <i>G. olivaceum</i>   |
| b. Central area with punctate     | 2                        |
| 2a. Valves ovate-clavate          | 4. <i>G. subclavatum</i> |
| b. Valves lanceolate              | 3                        |
| 3a. Raphe thin                    | 3. <i>G. parvulum</i>    |
| b. Raphe thick                    | 1. <i>G. lanceolatum</i> |

1. *Gomphonema lanceolatum* Ehr. in Species Algarum 67. 1849; Hustedt, Bacillariophyta 376. fig. 700. 1930; Foged, Freshwater diatoms in Ireland. 68. pl. 40. fig. 23. 1977; Hustedt & Jensen, The pennate diatoms 829. fig. 700. 1985; Nautiyal, Nautiyal & Singh in Phycos 35. (1 & 2); 74. 1996.

Pl. 52, Fig. 8

Valves lanceolate with rounded apex and base, 47.13-52.87  $\mu\text{m}$  long, 9.16-11.37  $\mu\text{m}$  broad; raphe thick and straight; axial area narrow, linear; central area unilateral with isolated stigma on opposite sides; striae radial, lineate. 11-12 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Epiphytic on *Rhizoclonium* sp. at Sahasradhara (93152).

2. *Gomphonema olivaceum* (Lyng.) Kütz, Species Algarum 64. 1849; Hustedt, Bacillariophyta 378. figs. 719a-c. 1930; Foged, Freshwater diatoms in Ireland 69. pl. 41. figs. 12, 20. 1977; Hustedt & Jensen, The Pennate Diatoms 831. fig. 719. 1985; Nautiyal, Nautiyal & Singh in Phycos 35(1&2): 74. 1996.

Pl. 52, Fig. 9

Valves linear ovoid, 21.14-23.27  $\mu\text{m}$  long, 6.24-7.16  $\mu\text{m}$  broad, linear, ovoid with broadly rounded apex and gradually attenuated rounded base;

raphe thin and straight; axial area narrow; central area without punctate; striae radial 10-14 in 10  $\mu\text{m}$ .

*Phenology* : October-November.

Free floating in a ditch at Sahasradhara, associated with member of blue green algae (93132).

**3. *Gomphonema parvulum* (Kütz.) Grunow** in Kütz. Species Algarum 65. 1849; Hustedt, Bacillariophyta 372. fig. 713. 1930; Foged, Freshwater diatoms in Ireland 69. pl. 42. fig. 4. 1977; Hustedt & Jensen, The pennate diatoms 825. fig. 713a. 1985; Nautiyal; Nautiyal & Singh in Phytos, 35 (1 & 2): 75. 1996. Kant & Gupta, Algal Fl. Ladkha 160. pl. 73. fig. 2, pl. 76. fig. 15. 1998.

**Pl. 52, Fig. 10**

Valves lanceolate, clavate with constricted rounded ends, 12.65-18.92  $\mu\text{m}$  long, 4.15-5.87  $\mu\text{m}$  broad; raphe thin and straight; axial area narrow; central area unilateral with stigma on opposite side; striae radial 11-13 in 10  $\mu\text{m}$ .

*Phenology* : October-January.

Free floating in a ditch at Sahasradhara, associated with *Rhizoclonium* sp. (93145).

**4. *Gomphonema subclavatum* (Grunow) Grunow** in van Heurok Syn. Diat. Belgiae, 23. figs. 38-41. 1880; Hustedt, Bacillariophyta 372. fig. 695. 1930; Foged, Freshwater diatoms in Ireland 70. 1977; Hustedt & Jensen, The pennate diatoms 825. fig. 695. 1985; Nautiyal, Nautiyal & Singh in Phytos 35 (1 & 2): 75. 1996. *Gomphonema longiceps* var. *subclavatum* Grunow 1885.

**Pl. 52, Fig. 11**

Valves ovate-clavate with constricted truncate apex and capitate base, 23.49-25.17  $\mu\text{m}$  long, 5.82-6.73  $\mu\text{m}$  broad; raphe thin and straight; central area unilateral with isolated stigma on opposite side; striae radial, punctate 14-18 in 10  $\mu\text{m}$ .

*Phenology* : October-February.



Free floating in a puddle at Sahasradhara, intermingled with *Microspora* sp. (93140).

#### 4. GYROSIGMA Hassall

Cells solitary, free floating, elliptic, lanceolate in girdle view; intercalary band and septa absent; valves sigmoid, gradually attenuated towards acute or rounded poles; raphe sigmoid; axial area narrow; central area rounded; chloroplasts two discoid; pyrenoids many; reproduction by auxospores.

#### KEY TO THE SPECIES

- |                               |                         |
|-------------------------------|-------------------------|
| 1a. Transverse striae fine    | 1. <i>G. attenuatum</i> |
| b. Transverse striae coarser  | 2                       |
| 2a. Valves sigmoid lanceolate | 2. <i>G. kuetzingii</i> |
| b. Valves sigmoid linear      | 3. <i>G. spencerii</i>  |

1. *Gyrosigma attenuatum* (Kuetz.) Rabenh. Süsw. Diat. 47. pl. 5. fig. 2, 1853; Hustedt, Bacillariophyta 222. fig. 329. 1930; Foged, Freshwater diatoms in Ireland 71. pl. 19. fig. 5. 1977; Hustedt & Jensen, The pennate diatoms 783. fig. 330. 1985.

**Pl. 52, Fig. 6**

Valves sigmoid, lanceolate, gradually tapering from middle towards ends, 102.77-104.48  $\mu\text{m}$  long, 11.17-12.38  $\mu\text{m}$  broad; ends rounded; raphe sigmoid; axial area narrow; central area elliptical; striae fine 17-18 in 10  $\mu\text{m}$ .

*Phenology* : October-December.

Free floating in a puddle near Asan reservoir, associated with members of blue green algae (93119).

2. *Gyrosigma kuetzingii* (Grun) Cleve in Kongl. Svenska vetenska Psakad. Handl. 26(2): 115. 1894; Hustedt, Bacillariophyta 224. fig. 333. 1930; Foged, Freshwater diatoms in Ireland. 71. 1977; Hustedt & Jensen, The pennate diatoms 783. fig. 333. 1985.

**Pl. 52, Fig. 7**

Valves sigmoid, lanceolate with rounded ends, 86.29-88.37  $\mu\text{m}$  long, 12.78-14.25  $\mu\text{m}$  broad; raphe sigmoid; axial area narrow, linear; central area rounded; transverse striae coarse 23-24 in 10  $\mu\text{m}$ ; longitudinal striae

fine 25-26 in 10  $\mu\text{m}$ .

*Phenology* : October-February.

Free floating in a ditch at Sahasradhara, intermingled with green algae (93137).

3. *Gyrosigma spencerii* (Quekett) Griffith & Henfrey, Microgr. Dict. 303. pl. 11. fig. 17. 1856; Hustedt, Bacillariophyta 226. fig. 338. 1930; Foged, Freshwater diatoms in Ireland 71. pl. 20. fig. 1, 1977; Hustedt & Jensen, The pennate diatoms 785. fig. 338. 1985; Nautiyal, Nautiyal & Singh in Phytos, 35 (1 & 2): 66. 1996.

Pl. 52, Fig. 5

Valves sigmoid linear and slightly attenuated towards ends, 47.18-53.26  $\mu\text{m}$  long, 6.52-8.12  $\mu\text{m}$  broad; ends obliquely rounded; raphe sigmoid; axial area narrow; transverse striae 22-24 in 10  $\mu\text{m}$ ; longitudinal striae 27-30 in 10  $\mu\text{m}$ .

*Phenology* : December-January.

Free floating in a shallow water at Gular ghati, associated with *Hydrodictyon raticulatum* (93163).

### 5. NAVICULA Bory

Cells solitary, free floating; frustules symmetrical, rectangular in girdle view; valves elongate, attenuated towards poles with capitate rounded or rostrate ends; raphe axial, straight; polar nodules present; axial area narrow; central area rounded, elliptical or rectangular; striae perpendicular or radiate in middle and convergent at ends; chloroplasts many; reproduction by auxospores.

### KEY TO THE SPECIES

- |                                    |                            |
|------------------------------------|----------------------------|
| 1a. Valves elliptical              | 3. <i>N. pygmaea</i>       |
| b. valves linear lanceolate        | 2                          |
| 2a. Striae perpendicular in middle | 2. <i>N. cuspidata</i>     |
| b. Striae radial in middle         | 3                          |
| 3a. Ends rounded                   | 4. <i>N. radiosa</i>       |
| b. Ends capitate                   | 1. <i>N. cryptocephala</i> |

1. *Navicula cryptocephala* Kütz., Species Algarum 75. 1849; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 236. 1907; Hustedt, Bacillariophyta 295. fig. 496. 1930; Foged, Freshwater diatoms in Ireland 77. 1977.

Pl. 54, Fig. 5

Valves linear lanceolate with capitate ends, 23.17-27.58  $\mu\text{m}$  long 8.53-9.12  $\mu\text{m}$  broad; raphe thin and straight; axial area narrow; central area small; striae radial in middle and slightly convergent at ends 10-12 in 10  $\mu\text{m}$ .

*Phenology* : September-March.

Epiphytic on *Cladophora glomerata* at Yamuna (93173).

2. *Navicula cuspidata* Kütz., Species Algarum 74. 1849; Hustedt, Bacillariophyta 268. fig. 433. 1930; Foged, Freshwater diatoms in Ireland 78. pl. 24. figs. 3, 8. 1977.

Pl. 54, Fig. 6

Valves linear lanceolate with rounded end, 72.68-76.28  $\mu\text{m}$  long, 14.84-16.68  $\mu\text{m}$  broad; raphe thin and straight with hook; axial area narrow, linear; central area rounded; striae perpendicular in middle 14-16 in 10  $\mu\text{m}$ .

*Phenology* : October-April.

Free floating in a slowly flowing water at Sahasradhara, associated with members of Chlorophyceae (93132, 93148).

3. *Navicula pygmaea* Kütz., Species Algarum 77. 1849; Hustedt, Bacillariophyta 312. fig. 561. 1930; Foged, Freshwater diatoms in Ireland. 87. pl. 30. fig. 4. 1977.

Pl. 54, Fig. 7

Valves elliptical with rounded ends, 19.13-22.18  $\mu\text{m}$  long, 8.37-10.56  $\mu\text{m}$  broad; raphe thin and straight; axial area narrow; central area rectangular; striae radial 27-28 in 10  $\mu\text{m}$ .

*Phenology* : September-April.

Free floating in a ditch at Mothranowala, associated with algal mixture (97929).

4. *Navicula radiosa* Kütz., Bacill. 91. pl. 4, fig. 23. 1844; Kütz., Species Algarum 69. 1849; Hustedt, Bacillariophyta 299. fig. 513. 1930; Foged, Freshwater diatoms in Ireland 87. 1977; Nautiyal, Nautiyal & Singh in Phytos, 35(1 & 2): 69. 1996.

Pl. 54, Fig. 4

Valves linear lanceolate with gradually tapering rounded ends, 63.68-72.17  $\mu\text{m}$  long, 8.22-10.12  $\mu\text{m}$  broad; raphe thin and straight; axial area narrow lanceolate with gradually tapering rounded ends; central area rhomboidal; raphe thin and straight; striae radial in middle 13-14 in 10  $\mu\text{m}$ .

*Phenology* : September.

Free floating in a slowly flowing water at Mothranowala, associated with algal mixture (97927).

#### 6. PINNULARIA Eht.

Cells solitary, free floating, symmetric, rectangular in girdle view; intercalary bands absent; valves with straight margins with smooth rounded ends; axial area broad; raphe sigmoid; costae smooth, radial or transverse; chloroplasts laminate; pyrenoids many; reproduction by auxospores.

#### KEY TO THE SPECIES

- |   |                           |
|---|---------------------------|
| 1a. Central area reaching up to margin    | 2. <i>P. interrupta</i>   |
| b. Central area not reaching up to margin | 2                         |
| 2a. Valves linear-elliptic                | 3. <i>P. viridis</i>      |
| b. Valves linear                          | 1. <i>P. acrosphaeria</i> |

1. *Pinnularia acrosphaeria* (Breb.) W. Smith, Syn. Brit. Diat. 58. pl. 19. fig. 183. 1853; Hustedt, Bacillariophyta 330. fig. 610. 1930; Foged, Freshwater diatoms in Ireland 99. pl. 31. figs. 3, 4. 1977; Hustedt & Jensen, The pennate diatoms 734. fig. 610. 1985. *Pinnularia acrosphaeria* var. *genuina* Breb.

Pl. 54, Fig. 1

Valves linear, slightly inflated in middle and ends, 46.28-52.61  $\mu\text{m}$  long, 9.12-11.37  $\mu\text{m}$  broad; raphe thin and straight; axial area very rhomboid; striae 12-14 in 10  $\mu\text{m}$ .

*Phenology* : September-November.

Free floating in a drain at Gullar ghati, associated with *Euglena* sp. (93105).

**2. *Pinnularia interrupta*** W. Smith, Syn. Brit. Diat. 59. pl. 19. fig. 184. 1853; Hustedt, Bacillariophyta 317. fig. 573. 1930; Foged, Freshwater diatoms in Ireland 102. 1977. Hustedt & Jensen, The pennate diatoms 723. fig. 573. 1985.

**Pl. 54, Fig. 2**

Valves linear with narrowed, constricted, subcapitate rounded ends, 36.17-38.12  $\mu\text{m}$  long, 5.28-6.75  $\mu\text{m}$  broad; raphe thin and straight; axial area narrow, sublinear; central area, rhomboid and reach up to margin; striae coarse radial in middle and convergent at ends, 10-12 in 10  $\mu\text{m}$ .

*Phenology* : October-December.

Free floating in a stream at Sahasradhara along with *Amphora* Sp. (93137).

**3. *Pinnularia viridis*** (Nitz.) Ehr., Abh. Königl. Akad. Wiss. Berlin 305. pl. 1(1). fig. 7, pl. 1(3), fig. 3, pl. 1(4) fig. 3, pl. 2(1). fig. 22, pl. 2(3). fig. 1; pl. 2(5). fig. 2, pl. 2(6). fig. 21. pl. 3(1). figs. 1-2. 1843; Hustedt, Bacillariophyta 334. fig. 617a. 1930; Foged, Freshwater diatoms in Ireland 105. pl. 32. fig. 3, pl. 34. fig. 1. 1977; Hustedt & Jensen, The pennate diatoms 739. fig. 617a. 1985; Kant & Gupta, Algal Fl. Ladakh 157. pl. 74. fig. 3, 1998. *Pinnularia viridis* var. *genuina* A. Cl. 1832, *Navicula viridis* Nitz. 1838.

**Pl. 54, Fig. 3**

Valves linear elliptic with tapering rounded ends, 94.15-97.95  $\mu\text{m}$  long, 17.23-21.62  $\mu\text{m}$  broad; raphe thick; axial area narrow, linear; central area rhomboid; striae slightly radial in middle and convergent at ends 10-12 in 10  $\mu\text{m}$ .

*Phenology* : Throughout the year.

Free floating in a stream at Sahasradhara, associated with species of *Oedogonium* and *Spirogyra* (93136).

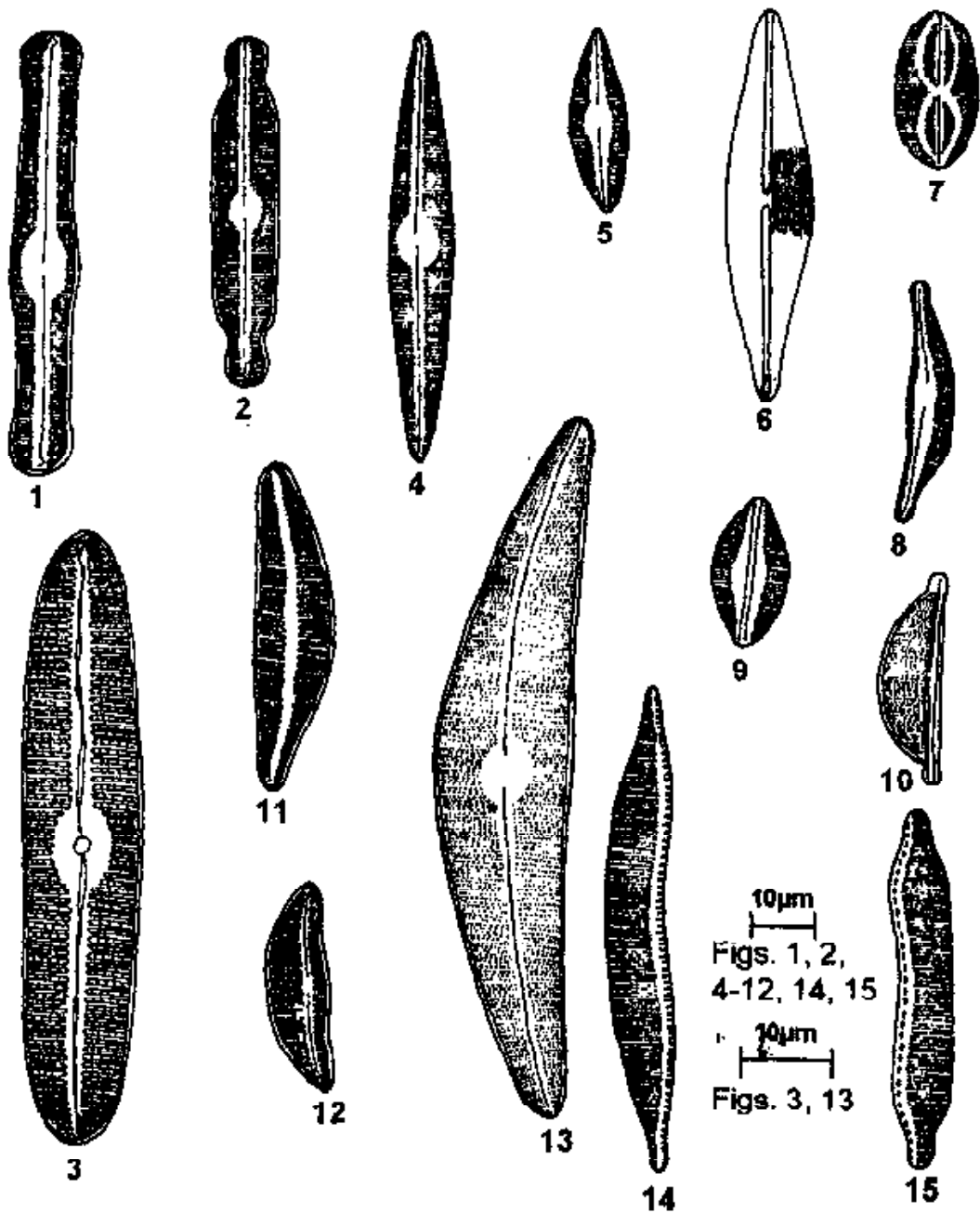


Plate 54 : Figs. 1-15 : 1. *Pinnularia acrosphaeria*; 2. *Pinnularia interrupta*; 3. *Pinnularia viridis*; 4. *Navicula radiosa*; 5. *Navicula cryptocephala*; 6. *Navicula cuspidata*; 7. *Navicula pygmaea*; 8. *Amphora acutiuscula*; 9. *Amphora veneta*; 10. *Amphora bongrainii*; 11. *Cymbella affinis*; 12. *Cymbella turgida*; 13. *Cymbella lanceolata*; 14. *Hantzschia voigtii*; 15. *Hantzschia amphioxys*.

## 7. PLEUROSIGMA W. Smith

Cells solitary, elliptic, lanceolate in girdle view; intercalary bands and septa absent; valves sigmoid, gradually tapering to subacute or rounded ends; raphe sigmoid with small polar nodules; axial area narrow; central area rounded; striae lie in three series, one parallel, other two oblique; chloroplasts discoid; reproduction by auxospores.

1. *Pleurosigma salinarum* Grunow, Kongl. Svenska vetenskapskad. Handl. N.F. 17(2): 54. 1880. Hustedt, Bacillariophyta 228. fig. 344. 1930; Hustedt & Jensen, The pennate diatoms 787 fig. 344. 1985.

Pl. 52, Fig. 12

Valves linear, lanceolate, 76.38-120.78  $\mu\text{m}$  long, 13.76-14.15  $\mu\text{m}$  broad; poles rounded; raphe excentric, sigmoid; axial area narrow; central area elliptical; transverse striae 25-27 in 10  $\mu\text{m}$ , oblique striae 30-33 in 10  $\mu\text{m}$ .

*Phenology* : December.

Free floating in a drain at Mussoorie, associated with *Euglena* sp. (97914).

## 5. NITZSCHIACEAE

## KEY TO THE GENERA

- |  |               |
|--|---------------|
| 1a. Valves with raphes diagonally opposite | 2. NITZSCHIA  |
| b. Valves with raphes opposite each other  | 1. HANTZSCHIA |

## 1. HANTZSCHIA Grunow

Frustules rectangular; valves straight or sigmoid; apices capitate or attenuated; keel margins opposite; striae transverse or punctae; chloroplasts discoid; reproduction by auxospores.

## KEY TO THE SPECIES

- |                                  |                        |
|----------------------------------|------------------------|
| 1a. Ventral margin without notch | 2. <i>H. linearis</i>  |
| b. Ventral margin with notch     | 2                      |
| 2a. Ends not constricted         | 3. <i>H. volgtii</i>   |
| b. Ends constricted              | 1. <i>H. amphioxys</i> |

**1. *Hantzschia amphioxys* (Ehr.) Grunow, Kongl. Svenska. Vetenskapsakad. Handl. 17(2): 103. 1880; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 239. 1907. Hustedt, Bacillariophyta 394. fig. 747. 1930; Foged, Freshwater diatoms in Ireland 71. pl. 43. fig. 9. 1977; Hustedt & Jensen, The pennate diatoms 847. fig. 747. 1985; Krammer & Lange-Bertalot, Bacillariophyceae Teil 2. 128, pl. 88. figs. 1-7. 1988. *Eunotia amphioxys* Ehr. 1843.**

**Pl. 54, Fig. 15**

Valves slightly arcuate, linear, 58.32-61.67  $\mu\text{m}$  long, 8.17-9.38  $\mu\text{m}$  broad; dorsal side convex; ventral side concave, despressed in middle; ends constricted; keel excentric, punctate 8-9 in 10  $\mu\text{m}$ ; striae 18-20 in 10  $\mu\text{m}$ .

*Phenology* : October.

Free floating in a puddle at Sahasradhara, associated with *Rhizoclonium* sp. (93143).

**2. *Hantzschia linearis* (O. Muell.) A. Cl. in V.K. Svenska Vetens Akad. Handl. Fjurde 51. figs. 1921a-d. 1952; Foged, Freshwater diatoms in Ireland 71. 1977.**

**Pl. 51, Fig. 1**

Valves without notch, arcuate, linear, 122.18-127.48  $\mu\text{m}$  long, 10.58-12.26  $\mu\text{m}$  broad; dorsal margin uniformly convex; ventral margin concave; ends narrowed, subcapitate; keel excentric, punctate 7-8 in 10  $\mu\text{m}$ ; striae 14-15 in 10  $\mu\text{m}$ .

*Phenology* : December-March.

Free floating in a ditch at Chakrata, associated with diatoms mixture (96261).

**3. *Hantzschia voigtii* Gandhi in J. Sci. (Biol.) 2: 110. fig. 31. 1959; Sarode & Kamat, Freshwater diatoms of Maharashtra 210. pl. 25. fig. 576. 1984.**

**Pl. 54, Fig. 14**

Valves linear, arcuate, 83.27-86.22  $\mu\text{m}$  long, 9.51-10.42  $\mu\text{m}$  broad;



dorsal margin slightly convex; ventral margin concave with notch at middle; ends not constricted; keel excentric 8-10 in 10  $\mu\text{m}$ ; striae punctate 18-20 in 10  $\mu\text{m}$ .

*Phenology* : March-June.

Free floating in a puddle at Mohand, associated with diatoms mixture (96201).

## 2. NITZSCHIA Hassall

Cells solitary or clustered, elongate, rectangular or sigmoid in girdle view; free floating; valves asymmetric, straight, sigmoid or linear elliptic; poles acute or capitate; keel present or absent, chloroplasts axial; reproduction by auxospores.

### KEY TO THE SPECIES

- |                                       |                         |
|---------------------------------------|-------------------------|
| 1a. Valves linear with convex margin  | 2                       |
| b. Valves linear with parallel margin | 3                       |
| 2a. Striae 18-20 in 10 $\mu\text{m}$  | 1. <i>N. amphibia</i>   |
| b. Striae 30-35 in 10 $\mu\text{m}$   | 5. <i>N. palea</i>      |
| 3a. Valves with keel punctae          | 3. <i>N. interrupta</i> |
| b. Valves with carinal dots           | 4                       |
| 4a. Ends rounded                      | 2. <i>M. frustulum</i>  |
| b. Ends oblique                       | 4. <i>N. obtusa</i>     |

1. *Nitzschia amphibia* Grunow, Kongl. Svenska. Vetenskapsakad Handl. 17(2): 98. 1860; Hustedt, Bacillariophyta 414. fig. 793. 1930; Foged, Freshwater diatoms in Ireland 93. pl. 45. figs. 5-7. 1977; Hustedt & Jensen, The pennate diatoms 867. fig. 793. 1985; Krammer & Lange-Bertalot, Bacillariophyceae Teil 2. 108. pl. 78. figs. 13-26. 1988.

### Pl. 51, Fig. 2

Valves linear to linear lanceolate with convex margin, 23.47-28.26  $\mu\text{m}$  long, 3.54-5.13  $\mu\text{m}$  broad; ends rounded; keel excentric; striae 19-20 in 10  $\mu\text{m}$ .

*Phenology* : December-January.

Free floating in a ditch at Tiuni, associated with other species of diatoms (97902).

**2. *Nitzschia frustulum* (Kütz.) Grunow**, Kongl. Svenska. Vetenskapsakad, Handl. 17(2): 98, 1880; Hustedt, Bacillariophyta 414. fig. 795. 1930; Foged, Freshwater diatoms in Ireland 95. 1977; Hustedt & Jensen, The pennate diatoms, 868. fig. 795. 1985; Krammer & Lange-Bertalot, Bacillariophyceae Teil 2. 94. pl. 68. figs. 1-19. 1988.

Pl. 51, Fig. 3

Valves linear, margin convex, lanceolate with carinal dots, 18.24-21.63  $\mu\text{m}$  long, 3.78-4.25  $\mu\text{m}$  broad; ends rounded; keel excentric; striae 20-22 in 10  $\mu\text{m}$ .

*Phenology* : December-March.

Free floating in a ditch at on way Chakrata to Mussoorie, along with algal mixture (97914).

**3. *Nitzschia interrupta* (Reichelt) Hustedt** in Arch. Hydrobiol. 18: 168. 1927; Hantzsch, Die Diatomeen von Schweden und Finnland 86. figs. 1495a. 1952; Krammer & Lange-Bertalot, Bacillariophyceae Teil 2. 87. pl. 61. figs. 1-10. 1988.

Pl. 51, Fig. 5

Valves linear lanceolate with parallel margin, 89.28-92.57  $\mu\text{m}$  long, 6.38-7.13  $\mu\text{m}$  broad; ends, subcapitate; keel punctate, excentric; striae 23-25  $\mu\text{m}$  in 10  $\mu\text{m}$ .

*Phenology* : September-January.

Free floating in a ditch at Mothranowala, associated with blue green algae mixture (97930).

**4. *Nitzschia obtusa* W. Smith** in Syn. Brit. Diat. 1: 39. pl. 13. fig. 109. 1853; West & West in Ann. Roy. Bot. Gard. Cal. 6(2): 239, 1907; Hustedt, Bacillariophyta 422. fig. 817a. 1930; Hendeey, Bacillariophyta 282. 1964; Hustedt & Jensen, The pennate diatoms 876. fig. 817a. 1985; Krammer & Lange-Bertalot, Bacillariophyceae. Teil 2. 25. pl. 17, figs. 1, 2, pl. 18. fig. 1. 1988.

Pl. 51, Fig. 6

Valves linear, margin parallel with carinal dots, 73.48-79.65  $\mu\text{m}$  long, 7.32-8.55  $\mu\text{m}$  broad; ends oblique; keel excentric with notch at middle; keel punctate; striae 28-30 in 10  $\mu\text{m}$ .

*Phenology* : March-April.

Free floating in a puddle at Tiuni, associated with algal mixture (97909).

5. *Nitzschia palea* (Kütz.) W. Smith in Syn. Brit. Diat. 89. 1856; West & West in Ann. Roy. Bot. Gard. Cal. 6(2):-239. 1907; Hustedt, Bacillariophyta 416. fig. 801. 1930; Foged, Freshwater diatoms in Ireland 96. 1977; Hustedt & Jenson, The pennate diatoms 870. fig. 801. 1985; Krammer & Lange-Bertalot, Bacillariophyceae Teil 2. 85. pl. 59. figs. 1-24. pl. 60. fig. 1-7. 1988; Kant & Gupta, Algal Fl. Ladakh 167. pl. 79. fig. 17. 1998.

Pl. 51, Fig. 4

Valves linear, sub lanceolate with convex margin, 23.52-24.87  $\mu\text{m}$  long, 3.63-4.15  $\mu\text{m}$  broad; ends capitate; keel punctate, excentric; striae 30-35 in 10  $\mu\text{m}$ .

*Phenology* : November-April.

Free floating in a slowly flowing water at Kaunwala, associated with diatoms mixture (97921).

## 6. SURIRELLACEAE

### 1. SURIRELLA Turpin

Valves linear, elliptic, ovate or spirally twisted, solitary, rectangular, naviculoid, cuneate or sigmoid in girdle view; keel present; costae parallel; pseudoraphe present; chloroplasts plate shape; reproduction by auxospores.

#### KEY TO THE SPECIES

- |                              |                           |
|------------------------------|---------------------------|
| 1a. Valves with cuneate base | 1. <i>S. capronioides</i> |
| b. Valves with narrow base   | 2. <i>S. ovata</i>        |

1. *Surirella capronioides* Gandhi in J. Indian bot. Soc. 38: 328. fig. 52. 1959; Gandhi in Nova Hedwigia 3(4): 491. fig. 80. 1962; Sarode &

Kamat, Freshwater diatoms of Maharashtra 231. pl. 27. fig. 642. 1984.

**Pl. 53, Fig. 6**

Valves ovate with cuneate base, 82.18-89.62  $\mu\text{m}$  long, 43.23-45.47  $\mu\text{m}$  broad; axial area lanceolate with middle line throughout interrupted; heteropolar present; spines present at both ends; flap margin projected; costae 22-25 in 100  $\mu\text{m}$ ; striae 18-20 in 10  $\mu\text{m}$ .

*Phenology* : December-January.

Free floating in a ditch at Kaunwala, Hardwar road, associated with diatoms mixture (93166).

2. *Surirella ovata* Kütz., Bacill. 62. pl. 7. figs. 1-3. 1844; Hustedt, Bacillariophyta 442. figs. 863, 864. 1930; Hendey, Bacillariophyta 287. pl. 40. 1962; Foged, Freshwater diatoms in Ireland 111, pl. 47. figs. 5, 7. 1977; Hustedt & Jensen, The pennate diatoms 895. figs. 863, 864. 1985.

**Pl. 53, Figs. 7a-b**

Valves ovate to ovate lanceolate with narrow base, 32.15-54.36  $\mu\text{m}$  long, 22.17-31.34  $\mu\text{m}$  broad heteropolar present; costae 40-55 in 100  $\mu\text{m}$ ; striae 16-20 in 10  $\mu\text{m}$ .

*Phenology* : December-January.

Free floating in a ditch at Kaunwala, Hardwar road, associated with diatoms mixture (93166).

#### 4. CLASS : DINOPHYCEAE

Cells solitary unicellular, dorsiventrally flattened, mostly marine, although a few genera occur in fresh water, terrestrial and brackish condition; flagella two of equal length, one located at transversely aligned groove and other encircles the cell longitudinally; pellicle thick; chloroplasts disc, parietal, or rod shaped; pyrenoids present; nucleus large moniliform; epitheca and hypotheca present; thecal plates or horny projection present; starch and oil present; reproduction by longitudinal cell division, aplanospore, autospores or zoospores, sexuality isogamous.

##### 1. Order : Dinoflagellata

Cells solitary, subcircular, ovoid or pyramidal; biflagellate, composed of definite number of plates, arranged in specific manner; reproduction by longitudinal cell division, zoospores, sexuality isogamous.

##### 1. PERIDINIACEAE

##### 1. PERIDINIUM Ehr.

Cells globose, oval, egg shaped, dorsiventrally flattened, rounded at poles or produced to form apiculations or horns; pellicle thick; transverse furrow infra-median; pore present; flagella two, one winding the cell transversely furrow, other trailing; epitheca with apical, intercalary, and precingular plates; hypotheca with postcingular and antapical plates; chloroplasts disc shaped; pyrenoids present; reproduction by longitudinal cell division, zoospores; sexuality isogamous.

##### KEY TO THE SPECIES

- |                                   |                           |
|-----------------------------------|---------------------------|
| 1a. Posterior pole with 2-3 teeth | 1. <i>P. inconspicuum</i> |
| b. Posterior pole without teeth   | 2. <i>P. pusillum</i>     |

1. *Peridinium inconspicuum* Lemm. in Abh. Natur. Ver. Bremen 16: 350. 1900; Gupta & Srivastava in Res. J.Pl. Environ 8(1 & 2): 38. 1992; Gupta & Srivastava in J. Econ. Tax. Bot. 18(3): 516. 1994.

Pl. 55, Figs. 3

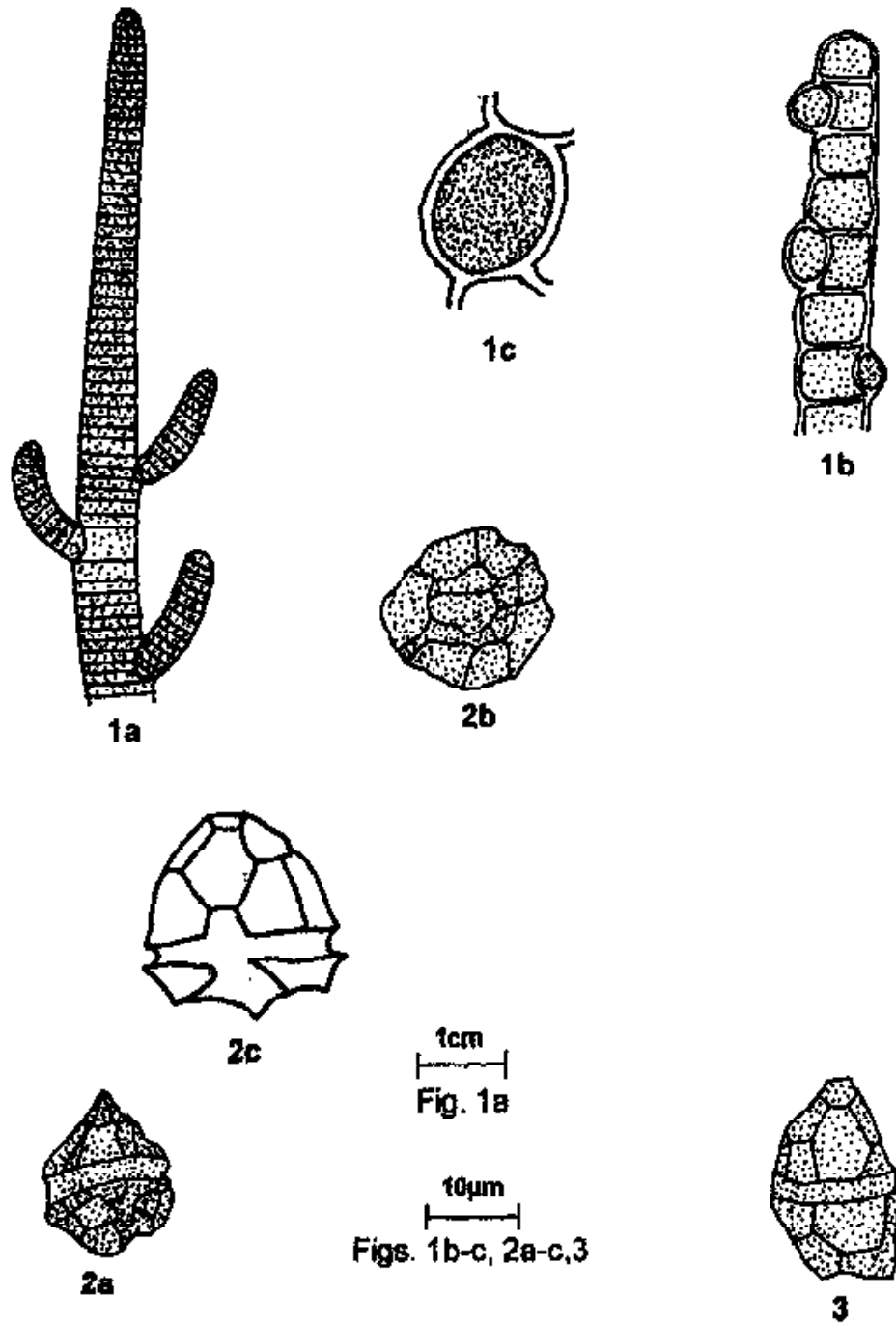


Plate 55 : Figs. 1-3 : 1a. *Compsopogon coeruleus*, 1b. Thallus with sporangia, 1c. Single sporangia; 2a-b. *Peridinium pusillum*; 3. *Peridinium inconspicuum*.

Vegetative cells ovoid, dorsiventrally flattened, 22.58-26.96  $\mu\text{m}$  long, 16.15-18.63  $\mu\text{m}$  broad; chloroplasts disc-shaped; pyrenoids present; anterior pole pointed; posterior pole rounded with 2 or 3 sharp, horn-like projections; transverse furrow without marginal ridge, dividing the cells into epicone and hypocone; longitudinal furrow in hypocone extending from posterior pole; epitheca with 6 precingular and 7 apical plates; hypotheca with 6 postcingular and 2 antapical plates.

*Phenology* : April-May.

Planktonic in a cemented tank at Manabkendra, associated with *Staurastrum* sp. (93196).

2. *Peridinium pusillum* (Penard) Lemm. in Forsch. Biol. Stat. Plön. 8: 65. 1901; Gupta & Srivastava in Res. J.Pl. Environ 8(1 & 2): 38. 1992; Gupta & Srivastava in J. Econ. Tax. Bot. 18(3): 516. 1994.

**Pl. 55, Figs. 2a-c**

Vegetative cell ovoid, flattened dorsiventrally, 20.94-23.67  $\mu\text{m}$  long, 14.38-19.52  $\mu\text{m}$  broad; chloroplasts disc shaped; epicone larger than hypocone; transverse furrow inframedian; epitheca with 7 precingular and 6 apical plates; hypotheca with 5 postcingular and 2 antapical plates.

*Phenology* : April-May.

Planktonic in a cemented tank at Manabkendra, associated with *Staurastrum* sp. (93195).

## 5. CLASS : EUGLENINEAE

Cells unicellular or arbuscular colony; flagella one or two arise from gullet; chloroplasts different shape; pellicle present; cell wall absent; pyrenoids present; nucleus single; reserve food paramylon of diverse shape, negative to iodine test; reproduction by longitudinal cell division.

## 1. Order : Euglenales

Flagella two at anterior end of cells, only one emerges from reservoir and canal; paramylon various shape; reproduction by longitudinal cell division.

## KEY TO THE FAMILIES

- |                                      |                |
|--------------------------------------|----------------|
| 1a. Chloroplast and eye spot present | 1. EUGLENACEAE |
| b. Chloroplast and eye spot absent   | 2. ASTASIACEAE |

## 1. EUGLENACEAE

## KEY TO THE GENERA

- |                                   |                  |
|-----------------------------------|------------------|
| 1a. Cells epizoic                 | 1. COLACIUM      |
| b. Cells not epizoic              | 2                |
| 2a. Cells enclosed in lorica      | 4. TRACHELOMONAS |
| b. Cells never enclosed in lorica | 3                |
| 3a. Cells metabolic               | 2. EUGLENA       |
| b. Cells never metabolic          | 3. PHACUS        |

## 1. COLACIUM Ehr.

Thallus epizoic; cells solitary or arbuscular colonies, surrounded by gelatinous sheath; attached; anterior pole downward by stalks; flagella present or absent; chloroplasts many ovoid discs; pyrenoids present or absent; multinucleate; reproduction by longitudinal cell division.

## KEY TO THE SPECIES

- |                                  |                          |
|----------------------------------|--------------------------|
| 1a. Cells in plume-like colonies | 1. <i>C. arbuscula</i>   |
| b. Cells solitary                | 2. <i>C. vesiculosum</i> |



1. *Colacium arbuscula* Stein, Der Organismus der Infusionstiere 1.1878; Waghodekar & Patel in Geophytology 18(1): 109. fig. 3. 1988.

Pl. 56, Fig. 2

Colonies plume-like, arbuscular; cells fusiform, 12.63-16.42  $\mu\text{m}$  long, 8.12-11.27  $\mu\text{m}$  broad; highly metabolic; anterior end truncated; posterior end attenuated into caudus like process; pellicle smooth; chloroplasts 5-6 ovoid; pyrenoids absent; paramylon scattered rod shape; flagella present; stigma oval, brown-red; nucleus posterior.

*Phenology* : December-January:

Attached on the members of freshwater zooplanktons at Tiuni (97901).

2. *Colacium vesiculosum* Ehr. in Phys. Abh. Königl. Akad. Wiss. Berlin 1831: 115. 1833; Huber-Pestalozzi, Das phytoplankton de Süßwassers 127. figs. Abb. 112. 1955; Waghodekar & Patel Geophytology in 18(1): 109. fig. 1. 1988.

Pl. 56, Fig. 1

Cells solitary, pyriform, 23.82-25.23  $\mu\text{m}$  long, 8.62-14.36  $\mu\text{m}$  broad; cuticle finely striated; chloroplasts 4-7 ovoid discs; pyrenoid absent; paramylon rod shaped; stigma oval; nucleus 7-8 posterior to middle of cells.

*Phenology* : November-March.

Attached on rotifers, associated with other members of zooplankton at Mothranowala swamp (97930).

## 2. EUGLENA Ehr.

Cells fusiform, elongate, lanceolate, cylindrical or ovate; posterior end either rounded or pointed; anterior end narrowed or conspicuously two lipped; cell wall absent; periplast either firm or soft; gullet and reservoir at anterior end from which arises single flagellum; chloroplasts numerous ovoid, discs or ribbon-like bands; paramylon present; reproduction by longitudinal cell division.

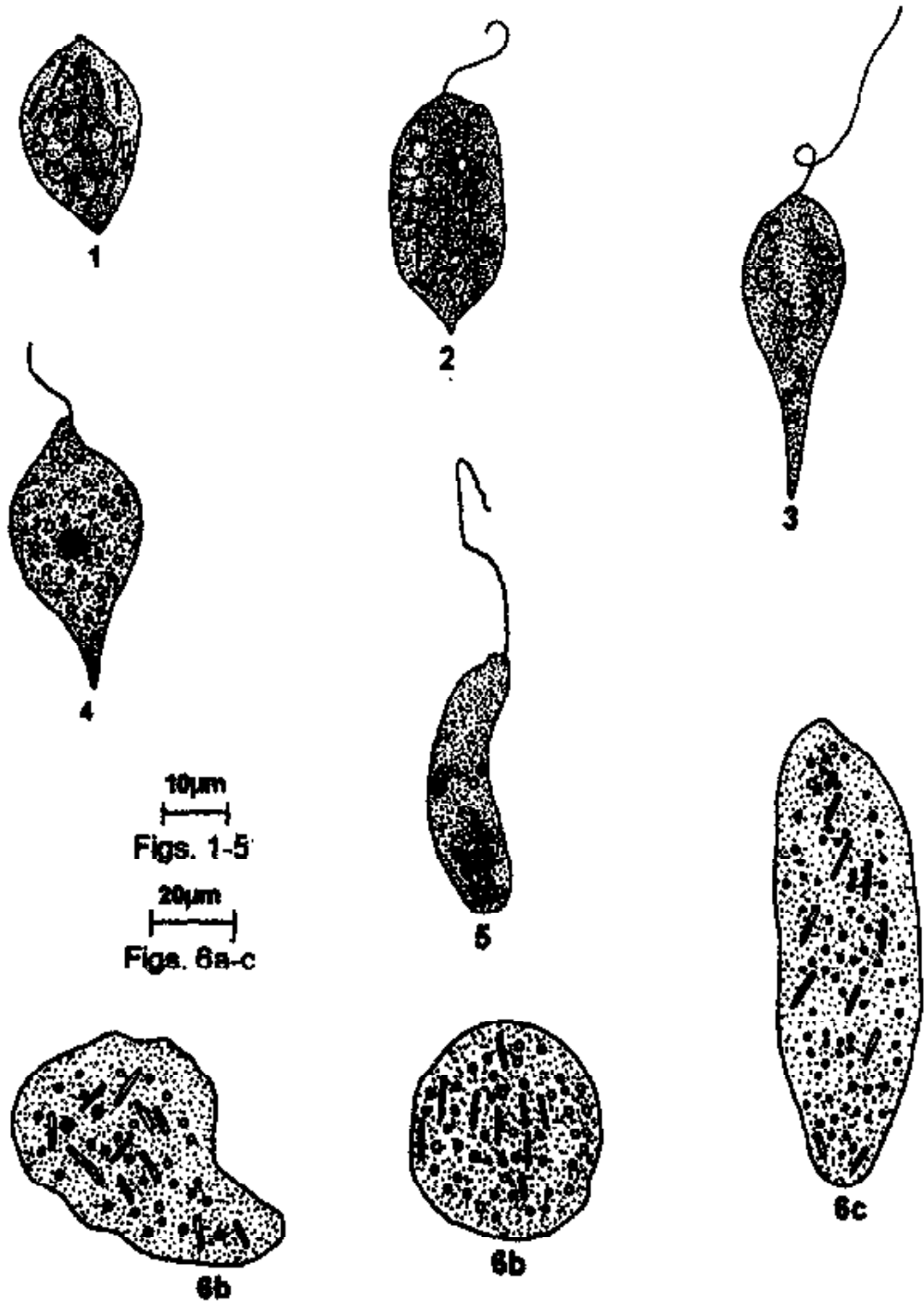


Plate - 56 : Figs. 1-6 : 1. *Colacium vesiculosum*; 2. *Colacium arbuscula*; 3. *Astasia applanata*; 4. *Astasia braviciliata*; 5. *Astasia elongata*; 6a-c. *Euglena elastica*.

## KEY TO THE SPECIES

- |     |                                   |                         |
|-----|-----------------------------------|-------------------------|
| 1a. | Cells rigid                       | 1. <i>E. acus</i>       |
| b.  | Cells not rigid                   | 2                       |
| 2a. | Cells slightly metabolic          | 3                       |
| b.  | Cells highly metabolic            | 4                       |
| 3a. | Paramylon bodies two              | 6. <i>E. tripteris</i>  |
| b.  | Paramylon bodies numerous         | 4. <i>E. proxima</i>    |
| 4a. | Cells swollen in middle           | 2. <i>E. elastica</i>   |
| b.  | Cells not swollen in middle       | 5                       |
| 5a. | Chloroplasts disc shape           | 3. <i>E. polymorpha</i> |
| b.  | Chloroplasts band or ribbon shape | 5. <i>E. sanguinea</i>  |

**1. *Euglena acus* Ehr.** Die Infusionsthierchen als Vollkommene organismen 112. 1838; Huber-Pestalozzi Das phytoplankton des Süßwassers, 96. fig. Abb. 75. 1955; Pandey in Phykos 24: 125. 1985; Gupta & Srivastava in Geophytology 23(2): 277. 1994; Anand Ind. freshwater microalgae 63. fig. 210. 1998. *Euglena acus* var. *minor* Hansg., *Euglena acutissima* Lemm., *Phacus acutissimus* Bernard.

Pl. 57, Fig. 8

Vegetative cells elongate fusiform, posterior portion fine, tapering pointed, 175.56-177.38  $\mu\text{m}$  long, 10.98-12.81  $\mu\text{m}$  broad; pellicle firm, colourless without flexibility, no change of shape on stimulation; flagella 1; chloroplasts pale-green many, disc-shaped; paramylon bodies 7-10, rod-shaped, 4.87-7.31  $\mu\text{m}$  long, 2.18-3.59  $\mu\text{m}$  broad; uninucleate; eye spot red, ovoid.

*Phenology* : Throughout the year.

Planktonic near Asan barrage, associated with desmids (93110, 93125).

**2. *Euglena elastica* Prescott** in Farlowia 1: 365. 1944; Huber-Pestalozzi, Das phytoplankton des Süßwassers 118. Fig. Abb. 1066. 1955; Gupta & Srivastava in Geophytology 23(2): 277. 1994.

Pl. 56, Figs. 6a-c.

Vegetative cells highly metabolic, spindle-shaped but frequently much swollen in middle portion and narrowed anteriorly rounded posteriorly, 87.78-102.41  $\mu\text{m}$  long, 14.63-16.53  $\mu\text{m}$  broad; granules absent; periplast smooth;

flagella 1; chloroplasts many ovoid shape, arranged irregularly; paramylon bodies numerous rod shaped, 9.46-12.89  $\mu\text{m}$  long, 3.47-4.86  $\mu\text{m}$  broad, scattered throughout the body.

*Phenology* : May-June.

Planktonic under shade conditions and form bloom in a ditches at Rajajee National Park near Ramgarh, without other algal associates (93190).

3. *Euglena polymorpha* Dangeard in *Le Botaniste* 8: 175. 1902; Huber-Pestalozzi, *Das phytoplankton des Süßwassers* 85. fig. Abb. 62. 1955; Gupta & Srivastava in *J. Econ. Tax. Bot.* 18(3): 515. 1994.

Pl. 57, Figs. 12

Vegetative cells highly metabolic, subcylindric, narrowed posteriorly, tip blunt, 82.32-84.27  $\mu\text{m}$  long, 21.33-23.56  $\mu\text{m}$  broad; periplast with spiral striations; chloroplasts 12-15 disc shaped; flagella 1; paramylon bodies ovoid, 3.87-4.29  $\mu\text{m}$  broad.

*Phenology* : August-November.

Planktonic in a shallow ditch near Asan reservoir, associated with other *Euglena* sp. (93112); planktonic in a small ditch at Gullar ghati (93163).

4. *Euglena proxima* Dangeard in *Le Botaniste* 8. 154. 1902; Huber-Pestalozzi, *Das phytoplankton des Süßwassers* 86. fig. Abb. 64. 1955; Gupta & Srivastava in *Geophytology* 23(2): 277. 1994.

Pl. 57, Fig. 9

Vegetative cells slightly metabolic, spindle-shaped with truncated anterior end and bluntly pointed posterior end, 58.52-73.15  $\mu\text{m}$  long, 14.63-16.45  $\mu\text{m}$  broad; periplast spirally striated; chloroplasts 30-40, green ovoid scattered all over the body; paramylon bodies numerous rod shaped scattered throughout the body, 3.65-4.87  $\mu\text{m}$  long, 2.16-3.18  $\mu\text{m}$  broad.

*Phenology* : August-September.

Planktonic in a ditch near Asan bridge, associated with certain desmids (93105, 93125).

5. *Euglena sanguinea* Ehr. Die Infusion sthierchen als Vollkommene organismen, 105. 1838; Huber-Pestalozzi Das phytoplankton des Süßwassers 90. fig. 70. 1955; Pandey in Phykos 24: 125. 1985; Gupta & Srivastava in Geophytology 23(2): 278. 1994.

Pl. 57, Fig. 11

Vegetative cells highly metabolic, pyriform to subcylindric, tapering posteriorly to short blunt tail-piece, 17.04-118.86  $\mu\text{m}$  long, 29.26-31.8  $\mu\text{m}$  broad; periplast spirally striated; chloroplasts irregularly band or ribbons shaped; paramylon bodies ovoid, 6.69-7.31  $\mu\text{m}$  broad.

*Phenology* : March-August.

Planktonic in a ditch at Asan reservoir, associated with the members of Conjugales and other euglenoids (93111).

6. *Euglena tripteris* (Duj.) Klebs in Bot. Inst. 1: 306. 1883; Huber-Pestalozzi Das phytoplankton des Süßwassers 62. fig. 39. 1955; Pandey in Phykos 24: 126. 1985. Gupta & Srivastava in Bull. Bot. Surv. India 35(1-4): 4. fig. 15. 1993.

Pl. 57, Fig. 10

Vegetative cells slightly metabolic, elongate ribbon-shaped, spirally twisted with acute tail, 73.15-80.13  $\mu\text{m}$  long, 9.37-11.26  $\mu\text{m}$  broad; periplast faint longitudinally striate; flagella more or less half length of body; chloroplasts many, disc-shaped; paramylon 2, elongate rod-shaped, one anterior, other posterior to central nucleus, 5.47-7.31  $\mu\text{m}$  long, 2.91-3.72  $\mu\text{m}$  broad.

*Phenology* : August-September.

Epizoic in a Asan reservoir, associated with few members of Ulotrichales (93120).

### 3. PHACUS Dujardin

Cells ovate, pyriform or orbicular, never metabolic, flattened with longitudinal or spiral striations and terminating in short caudus; periplast rigid; gullet at anterior end; chloroplasts numerous ovoid disc; paramylon bodies circular plate or ring shape; reproduction by cell division.

## KEY TO THE SPECIES

- |   |                          |
|---|--------------------------|
| 1a. Cells orbicular; caudus curved          | 3. <i>P. orbicularis</i> |
| b. Cells ovoid to pyriform; caudus straight | 2                        |
| 2a. Caudus 10.0-15.0 $\mu\text{m}$ long     | 2. <i>P. longicauda</i>  |
| b. Caudus 5.5-8.0 $\mu\text{m}$ long        | 1. <i>P. caudatus</i>    |

1. ***Phacus caudatus*** Hübner, Euglenaceen-flora von stralsund, 5, 1886; Huber-Pestalozzi Das phytoplankton des Süßwassers 196. fig. Abb. 236. 1955; Barhate & Tarar in Phykos 24: 185. 1985; Gupta & Srivastava in Geophytology 23(2): 278. 1994.

Pl. 57, Fig. 2

Vegetative cells ovoid to pyriform, spirally twisted, 32.91-48.76  $\mu\text{m}$  long, 19.5-24.39  $\mu\text{m}$  broad; caudus straight sharp, 5.63-7.89  $\mu\text{m}$  long; anterior portion rounded; periplast longitudinally striated; chloroplasts 2, disc shaped; paramylon body 1 disc shaped, 7.31-8.52  $\mu\text{m}$  broad.

*Phenology* : July-September.

Planktonic in a small puddle near Asan reservoir, associated with members of Conjugales and few other euglenoids (93110, 93111, 93121).

2. ***Phacus longicauda*** (Ehr.) Dujardin, Histoire naturelle des zoophytes. 337. 1841; Huber-Pestalozzi, Das phytoplankton des Süßwassers 220. fig. Abb. 299. 1955; Barhate & Tarar in Phykos 24: 185. 1985; Pandey in Phykos 24: 126. 1985; Gupta & Srivastava in Geophytology 23(2); 278. 1994; Anand, Ind. freshwater microalgae, 63. fig. 214. 1998; Kant & Gupta, Algal Fl. Ladakh 181. pl. 83. fig. 6. pl. 121. fig. 3. 1998. *Euglena longicauda* Ehr. 1838, *Phacus longicaudus* (Ehr.) Böttchli 1889.

Pl. 57, Fig. 1

Vegetative cells flat ovoid to pyriform, 85.33-87.78  $\mu\text{m}$  long, 47.54-63.39  $\mu\text{m}$  broad; caudus straight sharp pointed, 9.39-13.47  $\mu\text{m}$  long; anterior portion rounded; periplast longitudinally striated; flagella not observed; chloroplasts 2 ovoid shaped; paramylon body 1 circular plate, 7.31-8.52  $\mu\text{m}$  broad.

*Phenology* : August-September.

Planktonic in a Asan reservoir, associated with members of desmids (93124, 93125).

3. *Phacus orbicularis* Hübner, Euglenaceen-flora von stralsund 5. 1886; Huber-Pestalozzi Das phytoplankton des Süßwassers 209, fig. Abb. 273. 1955; Gupta & Srivastava in Geophytology 23(2): 278. 1994. *Phacus ovoidea* Roll. 1925, *Phacus zingeri* Roll. 1925, *Phacus plenromectes* bei Lefevre 1931.

Pl. 57, Fig. 3

Vegetative cells orbicular, 87.78-91.43  $\mu\text{m}$  long, 36.57-43.84  $\mu\text{m}$  broad; caudus curved to right, 9.37-13.54  $\mu\text{m}$  long; anterior portion rounded; periplast longitudinally striated; chloroplasts 2, ovoid shaped; paramylon bodies 2 disc-shaped, 14.63-21.94  $\mu\text{m}$  broad.

*Phenology* : August-January.

Planktonic in a ditch near Asan reservoir, associated with diatoms mixture (93118); planktonic in a ditch under exposed condition at Mohand, associated with *Oscillatoria* sp. and diatoms mixture (94832).

#### 4. TRACHELOMONAS Ehr.

Cells globose, elliptic, oval or subspherical, enclosed in lorica, brown to colourless; flagellum aperture with or without collar; lorica smooth or spiny, wart, reticulate, punctate striate or combinations of these; flagella one; protoplast inside the lorica is highly metabolic; chloroplasts numerous ovoid disc shaped; pyrenoids present; reproduction by cell division.

#### KEY TO THE SPECIES

- |                           |                          |
|---------------------------|--------------------------|
| 1a. Lorica with spines    | 1. <i>T. armata</i>      |
| b. Lorica without spines  | 2                        |
| 2a. Lorica elliptic       | 3. <i>T. pulcherrima</i> |
| b. Lorica oval or globose | 3                        |
| 3a. Lorica yellow         | 4. <i>T. volvocina</i>   |
| b. Lorica brown           | 2. <i>T. intermedia</i>  |

1. *Trachelomonas armata* (Ehr.) Stein, Der organismus der Infusionthiere naheigenen Forschngen 22. fig. 37. 1883; Huber-Pestalozzi, Das phytoplankton des Süßwassers 308. fig. Abb. 582. 1955; Pandey in Phykos 24: 127. 1985; Gupta & Srivastava in J. Econ. Tax. Bot. 18(3): 515. 1994.

Pl. 57, Fig. 7

Lorica ovate, 38.24-39.94  $\mu\text{m}$  long, 23.59-25.62  $\mu\text{m}$  broad; flagellum aperture in collar; wall light brown; spines of anterior and mid portion straight sparsely scattered, 2.89-4.12  $\mu\text{m}$  long; spines of posterior part backward directed, 6.93-8.53  $\mu\text{m}$  long.

*Phenology* : September-November.

Planktonic in a roadside ditch at Asan, associated with other members of euglenoids and certain diatoms (93110).

2. *Trachelomonas intermedia* Dangeard in *Le Botaniste* 8: 231. 1902; Huber-Pestalozzi, *Das phytoplankton des Süßwassers* 280. fig. Abb. 467. 1955; Gupta & Srivastava in *J. Econ. Tax. Bot.* 18(3): 515. 1994.

Pl. 57, Fig. 4

Lorica oval, 21.94-29.26  $\mu\text{m}$  long, 16.05-18.28  $\mu\text{m}$  broad; flagellum aperture narrower, without a distinct collar around the flagellum aperture; wall brown smooth; spines absent.

*Phenology* : January-April.

Planktonic in a ditch on the way to Asan, associated with *Spirogyra* sp. and certain desmids (93104).

3. *Trachelomonas pulcherrima* Playfair in *Proc. Linn. Soc. N.S. Wales* 40: 13. 1916; Huber-Pestalozzi, *Das phytoplankton des Süßwassers* 289. fig. Abb. 497. 1955; Barhate & Tarar in *Phykos*, 24: 185. 1985.

Pl. 57, Fig. 5

Lorica elliptic, 21.32-26.81  $\mu\text{m}$  long, 14.63-15.8  $\mu\text{m}$  broad; flagellum aperture narrower without collar; wall yellow-brown, smooth; spines absent.

*Phenology* : January-February.

Planktonic in a small puddle near Dhalipur, Power house, associated with of *Spirogyra* and *Closterium* spp. (93111).

4. *Trachelomonas volvocina* Ehr. *Die Infusionsthierchen als vollkommene organismen* 48. 1838; Huber-Pestalozzi, *Das phytoplankton*



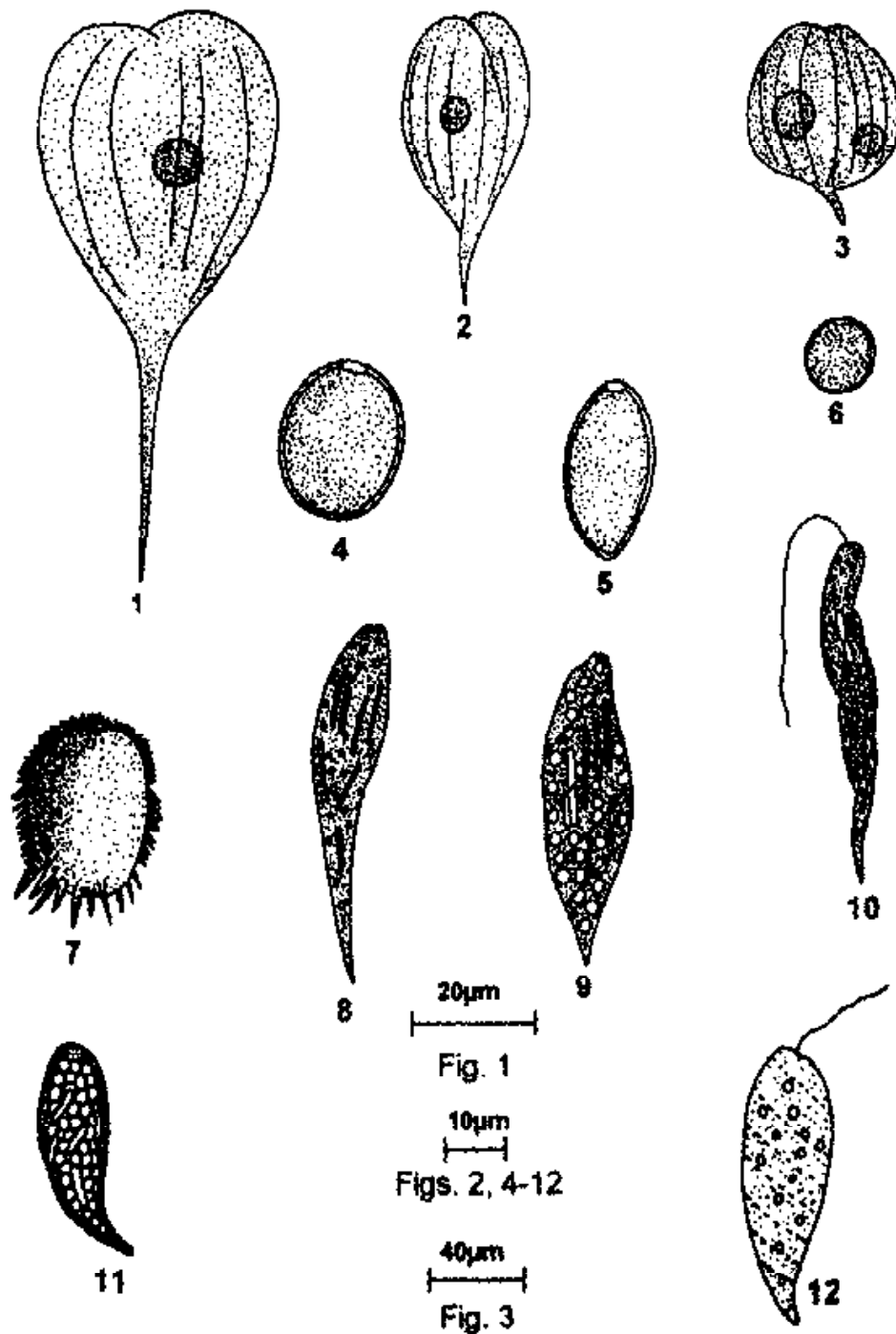


Plate - 57 : Figs. 1-12 : 1. *Phacus longicauda*; 2. *Phacus caudatus*; 3. *Phacus orbicularis*; 4. *Trachelomonas intermedia*; 5. *Trachelomonas pulcherrima*; 6. *Trachelomonas volvocina*; 7. *Trachelomonas armata*; 8. *Euglena acus*; 9. *Euglena proxima*; 10. *Euglena tripteris*; 11. *Euglena sanguinea*; 12. *Euglena polymorpha*.

des Süßwassers 251. fig. Abb. 349. 1955; Barhate & Tarar in *Phykos* 24: 185. 1985. Gupta & Srivastava in *J. Econ. Tax. Bot.* 18(3): 515. 1994; Anand, Ind. freshwater microalgae 63. fig. 207. 1998.

**Pl. 57, Fig. 6**

Lorica globose, 17.53-20.03  $\mu\text{m}$  broad; flagellum aperture narrower without a collar around flagellum aperture; wall thin, smooth, yellow; spines absent.

*Phenology* : Throughout the year.

Planktonic in a small ditch near Dhalipur, power house, associated with other euglenoids and few desmids (93125); planktonic in a ditch at Sahasradhara along with *Rhizoclonium* sp. (93127, 93145).

**2. ASTASIACEAE**

**1. ASTASIA Ehr.**

Cells oval to fusiform; uniflagellate; blepharoplast present; chloroplast absent; eye spot absent; uninucleate; pellicle striated; paramylon granules present; reproduction by longitudinal cell division.

**KEY TO THE SPECIES**

- |  |                           |
|--|---------------------------|
| 1a. Cells elongate, posterior end rounded    | 3. <i>A. elongata</i>     |
| b. Cells fusiform, posterior end not rounded | 2                         |
| 2a. Anterior portion with papilla            | 1. <i>A. applanata</i>    |
| b. Anterior portion without papilla          | 2. <i>A. braviciliata</i> |

1. *Astasia applanata* Pringsh. in *New phytol.* 41: 175. fig. 1. 1942; Huber-Pestalozzi, *Das phytoplankton des Süßwassers* 439. fig. Abb. 911. 1955; Waghodekar & Patel in *Geophytology* 18(1): 111, fig. 19. 1988.

**Pl. 56, Fig. 3**

Cells fusiform, 36.42-38.65  $\mu\text{m}$  long, 12.14-16.19  $\mu\text{m}$  broad; anterior portion with papilla-like projection; posterior portion with blunt tip; pellicle spirally striated; paramylon body 7-9 oval shaped; flagella 1, slightly longer than cells; nucleus 1 centrally located.

*Phenology* : December.

Free floating in a puddle at Mussoorie, associated with certain cyanobacteria and diatoms (97918).

2. *Astasia braviciliata* Matv. in Bot. Kharkov. 3: 31. 1938; Huber-Pestalozzi, Das phytoplankton des Süßwassers 428. fig. Abb. 885. 1955; Waghodekar & Patel in Geophytology 18(1): 111. fig. 16. 1988.

Pl. 56, Fig. 4

Cells fusiform, 38.74-41.38  $\mu\text{m}$  long, 22.32-25.46  $\mu\text{m}$  broad; anterior portion narrow; neck elongated; posterior end with short blunt caudus; pellicle smooth; paramylon body 4-7 oval shaped; flagella 1; nucleus 1 centrally located.

*Phenology* : November-December.

Free floating in a puddle at Mussoorie, associated with certain colonial cyanobacteria (97914).

3. *Astasia elongata* Skv. in Arch. Protistenk. 48: 182. 1924; Huber-Pestalozzi, Das phytoplankton des Süßwassers 428. fig. Abb. 886. 1955; Waghoderkar & Patel in Geophytology 18(1): 111. fig. 17. 1988.

Pl. 56, Fig. 5

Cells elongate, 26.84-29.15  $\mu\text{m}$  long, 5.18-8.25  $\mu\text{m}$  broad; posterior end rounded; anterior end slightly narrow and bilabiate; pellicle smooth; paramylon body 3-5 oval shaped; flagella 1; nucleus 1 located in posterior half of body.

*Phenology* : December-March.

Free floating in a ditch at Kaunwala, associated with *Fragilaria* sp. (97920, 97922).

## 6. CLASS : RHODOPHYCEAE

Thallus unicellular, filamentous or thalloid; attached; pit connections present or absent; food reserve floridean-starch, which is iodine negative; flagella absent; cell wall two layers; chloroplasts axial; pyrenoids present; reproduction by monospores, carospores or tetraspores, sexuality advanced oogamous.

Members of this group commonly known as red algae, mainly distributed marine communities, but few are freshwater; pigments red phycoerythrin and blue phycocyanin.

## KEY TO THE ORDER

- |                            |                 |
|----------------------------|-----------------|
| 1a. Pit-connections absent | 1. BANGIALES    |
| b. Pit-connections present | 2. NEMALIONALES |

## 1. Order : Bangiales

Thallus unicellular, colonial, filamentous or parenchymatous; uninucleate; chromatophores single, axile, stellate; pyrenoids present; pit connection absent; reproduction by fission or monospores.

## 1. ERYTHROTRICHIACEAE

## 1. COMPSOPOGON Montagne

Thallus branched bluish to violet-green; branch uniseriate; cells compactly polygonal; axial cell present; peripheral cells forms corticating tissue; chloroplasts numerous spherical; uninucleate; reproduction by monospores.

1. *Compsopogon coeruleus* (Balbis) Montagne, Flore d' Algerie 154. 1846; Thaxtar in Bot. Gaz., 29: 259. 1900; Brühl & Biswas in J. Dept. Sci. Calcutta Univ. 5: 1. pl. 8. figs. 1-4, pl. 9. figs. 5-9, pl. 10. figs. 10-23, pl. 11. figs. 24-28. 1923; Biswas in Rec. Bot. Surv. India 15(1): 102. pl. 9. figs. 98a-b. 1949; Misra & Dey in Vijnan Parishad Anusandhan Patrika 2: 123. figs. 1-4. 1959; Krishnamurthy in J. Linn. Soc. Bot. 53(372): 214. pl. 1. figs. 1-2. 1962; Desikachary, Krishnamurthy & Balakrishnan, Rhodophyta, Part II, 27. 1998.

Pl. 55, Figs. 1a-c

Thallus bluish-violet, coarse, erect; filaments profusely branched, 5-7 cm long; branches making an angle of 30-60° with subtending

axis; main axis multiseriate, 172.36-182.67  $\mu\text{m}$  broad, constituted by central cells, surrounded by corticating cells; central cells 26.53-45.26  $\mu\text{m}$  long, 45.36-68.87  $\mu\text{m}$  broad; corticating cells unilayered except in main axis, 15.23-25.58  $\mu\text{m}$  long, 11.33-24.65  $\mu\text{m}$  broad; uniseriate branches, 42.92-48.36  $\mu\text{m}$  broad; cells of branches, 6.62-22.58  $\mu\text{m}$  long, 18.36-48.74  $\mu\text{m}$  broad; lateral wall of uniseriate filaments thick and double layered, inner layered rigid and outer layered gelatinized; terminal cells of uniseriate branches with rounded apices; macrosporangia and microsporangia present.

*Phenology* : November-December.

Attached on submerged stone in a slow-moving water at Kaunwala, associated with *Fragilaria* sp. (97921).

## 2. Order : Nemalionales

Thallus heterotrichous with uniaxial or multiaxial; chromatophores one or many, discoid or rod shaped; gonimoblasts usually arising from carpogonium; chantransia stage present; reproduction by monospores, sexuality advances oogamous.

### 1. BATRACHOSPERMACEAE

#### 1. BATRACHOSPERMUM Roth

Thallus macroscopic, gray green, gelatinous, densely beaded vertical and lateral branches with central axis; chloroplasts discoid or elongate; pyrenoids present; reproduction by monospores restricted in chantransia stage; carpogonia, spermatangia present in same or separate thallus, sexuality advance oogamous.

1. *Batrachospermum moniliforme* Roth, Tentamen florae germanicae Bd. 3. 450. 1800; Sirodot, Les Batrachos Permes, 309. pl. 2. figs. 1-3, 5, pl. 3. figs. 1-9; pl. 6, figs. 1-8. 1884; Kylin in Bot. Ges., 35: 155. 1917; Chaturvedi, Bhatnagar & Pandey in Phycos, 18(1 & 2): 53. 1978; Pandey & Chaturvedi in Phycos 18(3): 42, 1979; Balakrishnan & Chaugule, Indian Batrachospermaceae. 236. 1980; Desikachary, Krishnamurthy & Balakrishnan, Rhodophyta. Part. II, 91. 1998.

Pl. 58, Figs. 1a-f

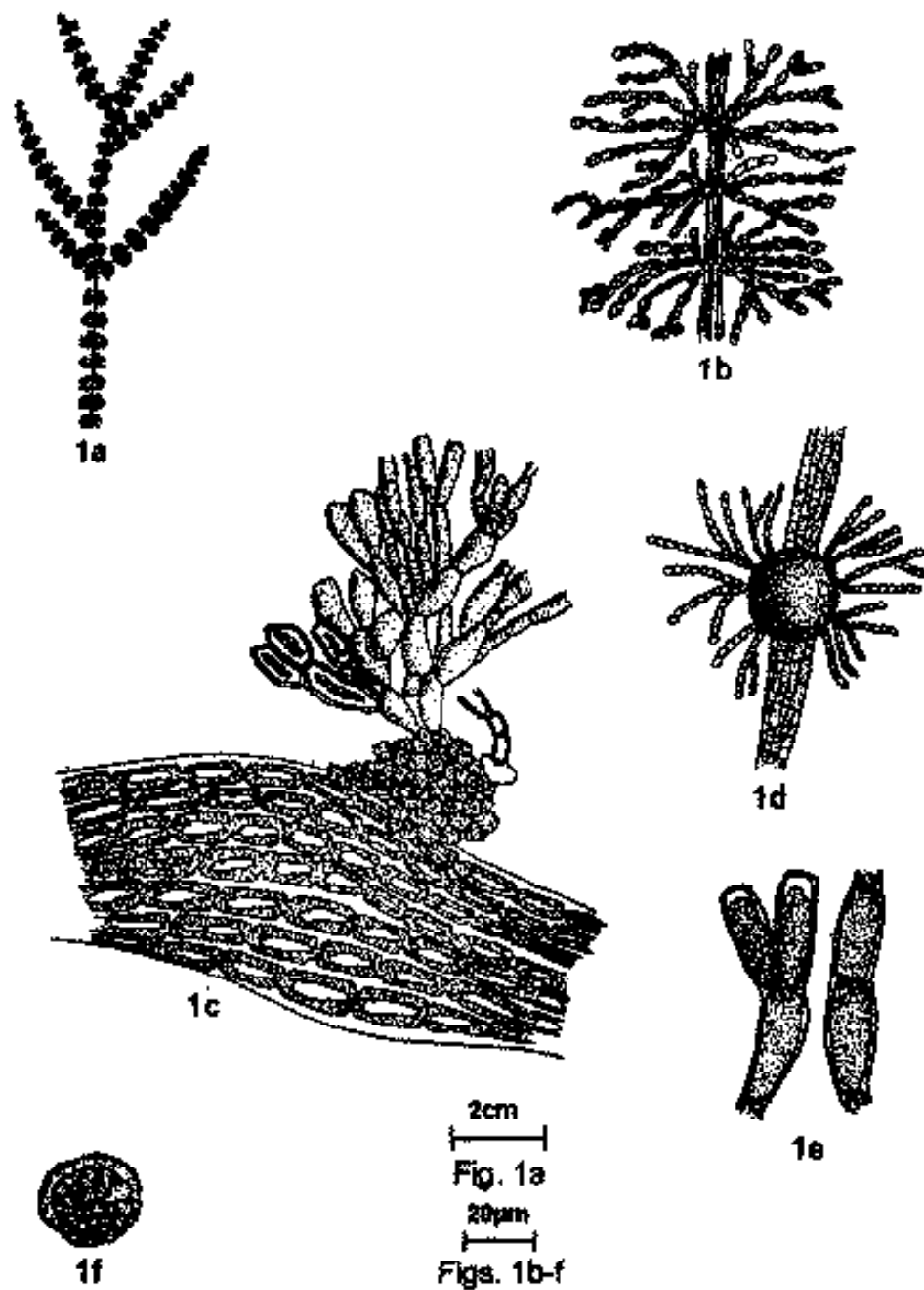


Plate - 58 : Fig. 1 : 1a-b. *Batrachospermum moniliforme*, 1c. Nodal portion with lateral branches, 1d. Single node with carpospore, 1e. Cells of lateral branches, 1f. Single carpospore.

Thallus uniaxial gray-green or violet 5-14 cm long, monoecious, soft-textured, lubricious, profuse branched with beaded appearance; lateral branchlets arise from angular nodal cells and extending halfway up and down the internodes, dichotomous with swollen base; cells, 17.83-21.47  $\mu\text{m}$  long, 6.18-8.57  $\mu\text{m}$  broad; wall 2 layered; chloroplasts laminate; central axis corticated, divisible into nodes and internodes; internodal cells elongated, parallel, non-chlorophyllous, inner cells connected by pit connections; carpogonia rounded yellowish gray, 10.36-13.49  $\mu\text{m}$  broad, developed in inner part of branch-whorls; carpospores dense, scattered throughout thallus; trichogyne clavate on terminal lateral branches.

*Phenology* : December.

Attached on a submerged stone with slowly flowing water at Kaunwala, Hardwar road (93165).

## 7. CLASS : MYXOPHYCEAE

Thallus unicellular, coccoid, filamentous or multicellular; cell wall thin or gelatinization very thick; procaryotic; flagella absent; food reserve glycogen and cyanophycin; chromatoplasm, centropiasm present; heterocysts present or absent; reproduction by fragmentation, hormogones, hormocysts, endospores, akinetes, exospore or planococci, sexuality absent.

Members of Myxophyceae commonly known as blue-green algae or cyanobacteria, occur wide range of ecological habitats .

## KEY TO THE ORDER

- |     |                                 |                     |
|-----|---------------------------------|---------------------|
| 1a. | Thallus with hormogones         | 2                   |
| b.  | Thallus without hormogones      | 3                   |
| 2a. | Thallus non heterotrichous      | 4. NOSTOCALES       |
| b.  | Thallus heterotrichous          | 5. STIGONEMATALES   |
| 3a. | Thallus pseudoparenchymatous    | 3. PLEUROCAPSALES   |
| b.  | Thallus unicellular or colonial | 4                   |
| 4a. | Thallus free floating           | 1. CHROOCOCCALES    |
| b.  | Thallus attached                | 2. CHAMAESIPHONALES |

## 1. Order : Chroococcales

Thallus free floating, sessile; unicellular or colonial; trichome absent; exospores absent; endospores not formed in sporangia; reproduction by cell division or nannocytes.

## KEY TO THE FAMILIES

- |     |                                     |                      |
|-----|-------------------------------------|----------------------|
| 1a. | Cells arranged in linear series     | 2. ENTOPHYSALIDACEAE |
| b.  | Cells not arranged in linear series | 1. CHROOCOCCACEAE    |

## 1. CHROOCOCCACEAE

## KEY TO THE GENERA

- |     |   |                  |
|-----|---|------------------|
| 1a. | Thallus unicellular or forming few aggregates | 2                |
| b.  | Thallus composed of many cells                | 4                |
| 2a. | Cells elongate without envelope               | 8. SYNECHOCOCCUS |
| b.  | Cells spherical with envelope                 | 3                |
| 3a. | Sheath vesicular                              | 5. GLOEOCAPSA    |



- |     |  |                   |
|-----|--|-------------------|
| b.  | Sheath not vesicular                   | 3. CHROOCOCCUS    |
| 4a. | Cells without any definite arrangement | 5                 |
| b.  | Cells with definite arrangement        | 7                 |
| 5a. | Cells densely arranged                 | 7. MICROCYSTIS    |
| b.  | Cells loosely arranged                 | 6                 |
| 6a. | Cells spherical                        | 1. APHANOCAPSA    |
| b.  | Cells ellipsoidal to cylindrical       | 2. APHANOTHECE    |
| 7a. | Colonies flat or curved plates         | 6. MERISMOPEDIA   |
| b.  | Colonies spherical                     | 4. COELOSPHAERIUM |

### 1. APHANOCAPSA Næg.

Thallus soft, amorphous, gelatinous, spherical, hemispherical or flattened forming hyaline, yellowish brown colonies; cells spherical, loosely arranged; mucilage matrix homogeneous; cell contents homogenous; reproduction by fragmentation or nannocytes.

### KEY TO THE SPECIES

- |     |                                   |                           |
|-----|-----------------------------------|---------------------------|
| 1a. | Thallus planktonic                | 2                         |
| b.  | Thallus attached                  | 3                         |
| 2a. | Cells 6.0-7.5 $\mu\text{m}$ broad | 4. <i>A. roeseana</i>     |
| b.  | Cells 3.5-4.5 $\mu\text{m}$ broad | 3. <i>A. pulchra</i>      |
| 3a. | Sheath colourless                 | 1. <i>A. banaresensis</i> |
| b.  | Sheath olive green                | 2. <i>A. bifformis</i>    |

1. *Aphanocapsa banaresensis* Bharadw. in Proc. Indian Acad. Sci. 2: 96. fig. 1b, 1935; Desikachary, Cyanophyta. 133. pl. 22. fig. 8. 1959; Kant & Gupta, Algal Fl. Ladakh 42. pl. 7. fig. 21. 1998.

### Pl. 61, Fig. 9

Thallus soft, spherical, hollow, irregularly hyaline; cells spherical, 4.17-6.12  $\mu\text{m}$  broad; sheath colourless, thick, unstratified, hyaline.

*Phenology* : December-January.

Attached on moist soil at Chakrata, associated with certain desmids (96300).

2. *Aphanocapsa bifformis* A. Br., Fl. Eur. Alg. 2: 246. 1865; Geitler, Kryptogamen-flora. 158. fig. 70. 1932; Desikachary, Cyanophyta. 134.

pl. 21. figs. 3, 4, 1959; Kant & Gupta, Algal Fl. Ladakh 42. pl. 7. fig. 23. 1998.

**Pl. 61, Fig. 8**

Thallus gelatinous; cells spherical, loosely arranged, 2-4 together in common mucilaginous envelope, 6.42-7.22  $\mu\text{m}$  broad; sheath olive green; nannocytes present.

*Phenology* : August-September.

Attached on moist rocks at Rispana, associated with certain diatoms (93110).

3. *Aphanocapsa pulchra* (Kütz.) Rabenh., Fl. Eur. Alg. 2: 49. 1865; Geitler, Kryptogamen-flora. 159. fig. 69 g. 1932; Desikachary, Cyanophyta 132. pl. 21. fig. 2, 1959.

**Pl. 59, Fig. 1**

Thallus gelatinous, homogeneous, ovate or globose; cells spherical, loosely and evenly dispersed within copious mucilage, 3.34-4.57  $\mu\text{m}$  broad; cell contents blue-green, finely granular; individual sheath not clear.

*Phenology* : December-March.

Free floating in a shallow water ditch at Chakrata, intermingled with *Spirogyra* sp. (96296).

4. *Aphanocapsa roeseana* de Bary in Hedwigia 9: 74, 1870; Geitler, Kryptogamen-flora 157. 1932; Desikachary, Cyanophyta 131, 1959.

**Pl. 61, Figs. 10a-b**

Thallus irregular, brownish-green, surrounded by thin gelatinous mucilage; cells oval, 6.47-7.15  $\mu\text{m}$  broad; individual envelope not distinct; cell contents pale blue-green; sheath homogeneous.

*Phenology* : August-October.

Free floating in a small pond at Raiwala, associated with *Oscillatoria* sp. (96242).

## 2. APHANOTHECE Näg.

Thallus spherical, hemispherical or expanded; mucilage firm homogeneous with or without lamellated; cells ellipsoidal to cylindrical with rounded ends; cell contents homogeneous; reproduction by nannocytes.

## KEY TO THE SPECIES

- |     |                                   |                        |
|-----|-----------------------------------|------------------------|
| 1a. | Cells with individual sheath      | 2. <i>A. conferta</i>  |
| b.  | Cells without individual sheath   | 2                      |
| 2a. | Cells 2-2.5 $\mu\text{m}$ broad   | 3. <i>A. saxicola</i>  |
| b.  | Cells 3.0-3.5 $\mu\text{m}$ broad | 1. <i>A. castagnei</i> |

1. *Aphanothece castagnei* (Breb.) Rabenh., Fl. Eur. Alg. 2: 64. 1865; Geitler, Kryptogamen-flora 171. 1932; Desikachary, Cyanophyta 140. pl. 21. fig. 8. 1959. *Anacystis marginata* Menegh. 1837.

Pl. 59, Fig. 2

Thallus bluish-green, gelatinous, amorphous, without definite shape; cells ellipsoidal to cylindrical, densely crowded, without individual envelope, 8.38-9.87  $\mu\text{m}$  long, 3.17-3.48  $\mu\text{m}$  broad; sheath diffluent, colourless.

*Phenology* : September-December.

Free floating and forming a scum on a puddle at Mothranowala, associated with *Oscillatoria* sp. (97931).

2. *Aphanothece conferta* Richter in Hauck & Richter Phyk. Univ. 10: 487, 1892; Forti in De Toni Sylloge Algarum 5: 84. 1907; Desikachary, Cyanophyta, 140. 1959.

Pl. 59, Fig. 3

Thallus olive brown, gelatinous, expanded; cells oblong, densely arranged with individual sheath, 4.57-5.96  $\mu\text{m}$  long, 2.53-2.98  $\mu\text{m}$  broad; cells contents granular, pale blue-green.

*Phenology* : September-November.

Free floating in a puddle at Mothranowala, associated with certain diatoms mixture (97929).

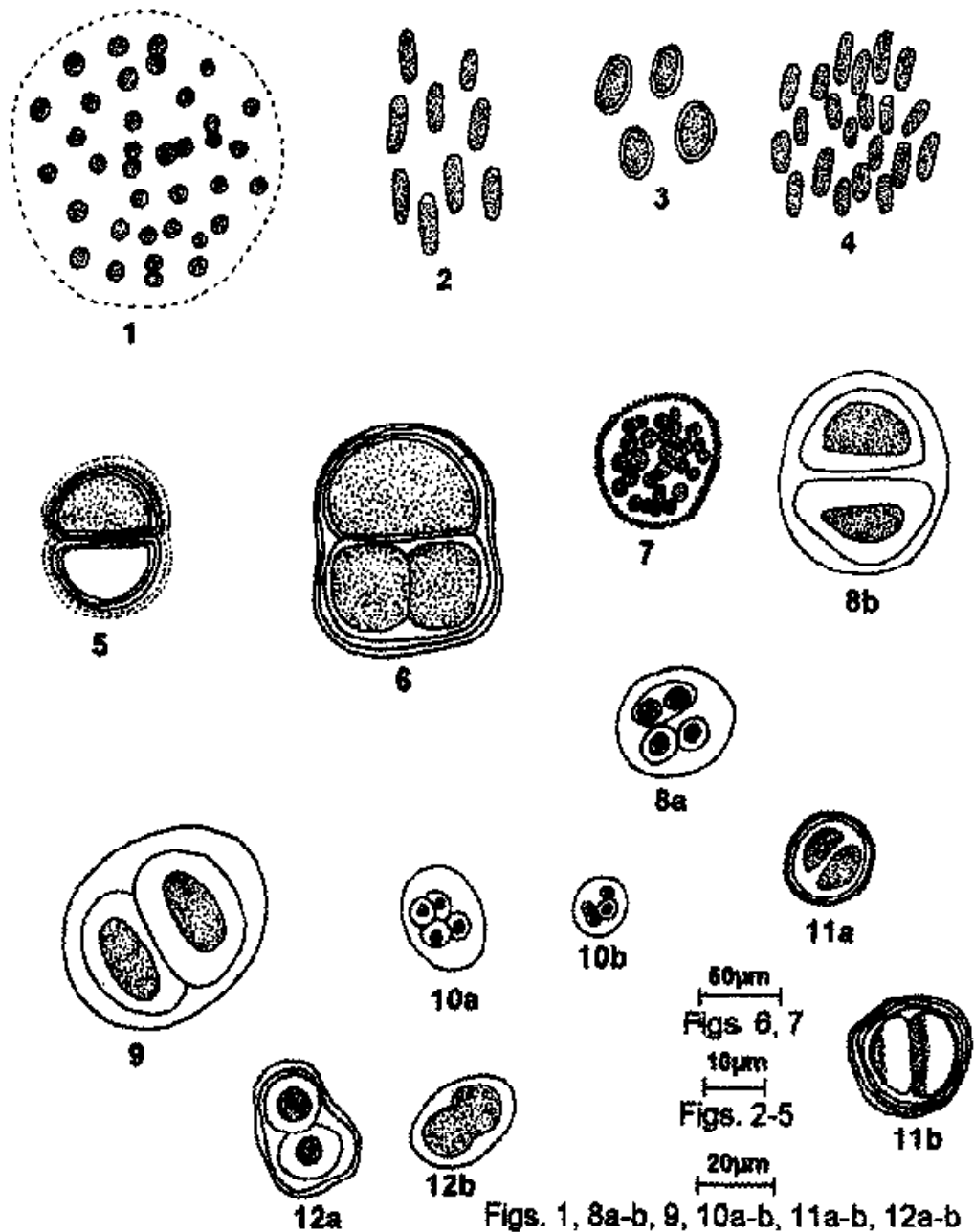


Plate - 59 ; Figs. 1-12 : 1. *Aphanocapsa pulchra*; 2. *Aphanothece castagnei*; 3. *Aphanothece conferta*; 4. *Aphanothece saxicola*; 5. *Chroococcus tenax*; 6. *Chroococcus turgidus*; 7. *Coelosphaerium dubium*; 8a-b. *Gloeocapsa atrata*; 9. *Gloeocapsa rupestris*; 10a-b. *Gloeocapsa sanguinea*; 11a-b. *Gloeocapsa polydermatica*; 12a-b. *Gloeocapsa kuetzingiana*.

3. *Aphanothece saxicola* Näg., Gatt. einzell. Algen 60. 1849; Geitler, Kryptogamen-flora 169. 1932; Desikachary, Cyanophyta, 138, pl. 22. fig. 11. 1959.

Pl. 59, Fig. 4

Thallus light blue-green, mucilaginous, without any definite shape; cells without individual sheath, cylindrical with rounded ends, loosely arranged within amorphous, homogeneous and colourless mucilage, 4.13-5.78  $\mu\text{m}$  long, 1.95-2.34  $\mu\text{m}$  broad; cell contents light blue-green, homogeneous.

*Phenology* : September-January.

Free floating in a drain at Mothranowala, associated with mixture of other blue green algae (97927).

### 3. CHROOCOCCUS Näg.

Cells spherical, subspherical or hemispherical in small groups of 2-4 individuals in a gelatinous or mucous matrix; sheath of individual cells lamellated; reproduction by fragmentation.

#### KEY TO THE SPECIES

- |                      |                       |
|----------------------|-----------------------|
| 1a. Sheath distinct  | 2. <i>C. turgidus</i> |
| b. Sheath indistinct | 1. <i>C. tenax</i>    |

1. *Chroococcus tenax* (Kirchn.) Hieron., Beitr. Biol. Pfl. 5: 483. pl. 17. fig. 11. 1892; Geitler, Kryptogamen-flora. 231. fig. 111a. 1932; Desikachary, Cyanophyta 103. pl. 26. figs. 7, 16. 1959.

Pl. 59, Fig. 5

Cells 2-4 in groups, blue-green, with sheath, 20.33-24.17  $\mu\text{m}$  broad, without sheath, 16.15-19.86  $\mu\text{m}$  broad; sheath colourless; lamellae indistinct.

*Phenology* : August-January.

Planktonic in a ditch at Asan reservoir along with member of euglenoids and diatoms (93110).

**2. *Chroococcus turgidus* (Kütz.) Näg., Gatt. einzell. Alg. 46. 1849; Geitler, Kryptogamen-flora 228. figs. 109 b, 110. 1932; Desikachary, Cyanophyta 101. pl. 26. fig. 6. 1959; Kant & Gupta, Algal Fl. Ladakh 40. pl. 85. fig. 4, pl. 91. fig. 11. 1998.**

**Pl. 59, Fig. 6**

Cells spherical or ellipsoidal, single or in groups of 2-4, with sheath, 28.21-31.29  $\mu\text{m}$  broad, without sheath 15.32-23.47  $\mu\text{m}$  broad; sheath colourless; lamellae distinct.

*Phenology* : May-June.

Planktonic in a cemented tank at Mahabkendra, associated with *Peridinium* and certain desmids.

#### 4. COELOSphaerium Näg.

Colonies spherical, ellipsoidal or reniform; mucilage homogeneous or heterogeneous, colourless; cells spherical, ovoid, ellipsoid or pyriform forming a hollow sac contain few cells; cell contents homogeneous; gas-vacuoles present or absent; reproduction by fragmentation.

#### KEY TO THE SPECIES

- |                                   |                            |
|-----------------------------------|----------------------------|
| 1a. Cells 5-7 $\mu\text{m}$ broad | 1. <i>C. dubium</i>        |
| b. Cells 2-4 $\mu\text{m}$ broad  | 2. <i>C. kuetzingianum</i> |

**1. *Coelosphaerium dubium* Grunow, Fl. Eur. Alg. 2: 55. 1865; Geitler, Kryptogamen-flora. 254. figs. 121f, 122 a. 1932; Desikachary, Cyanophyta. 147. pl. 28. figs. 10, 11, 14, 15. 1959.**

**Pl. 59, Fig. 7**

Colony spherical, 87.78-102.41  $\mu\text{m}$  broad; colonial mucilage firm, 4.87-7.31  $\mu\text{m}$  thick, not lamellate; cells spherical, closely arranged, 3.65-6.69  $\mu\text{m}$  broad; gas vacuoles present.

*Phenology* : April-June.

Free floating in a puddle near Asan reservoir along with *Closterium* sp. (93123).

2. *Coelosphaerium kuetzingianum* Näg., Gatt. einzell. Algen 54. pl. 1c. 1849; Geitler, Kryptogamen-flora 253. figs. 121. c, d, 1932; Desikachary, Cyanophyta 148. pl. 28. figs. 7, 8. 1959.

**Pl. 60, Fig. 1**

Colony globose, 54.65-85.78  $\mu\text{m}$  broad, surrounded by thin mucilage; cells spherical closely arranged at periphery of colonial envelope forming central cavity having few cells, 2.48-3.98  $\mu\text{m}$  broad; cell contents light blue-green, homogeneous; gas vacuoles and granules absent.

*Phenology* : September-October.

Free floating in a puddle near Mothranowala, associated with certain other blue green algae and diatoms (97925).

**5. GLOEOCAPSA Kütz.**

Thallus crustaceous, leathery, lubricous or mucilagenous; cells spherical or ovoid, 2-8 in colonies; sheaths lamellated or unlamellated; cell contents coloured or colourless, homogeneous; reproduction by fragmentation or nannocytes.

**KEY TO THE SPECIES**

- |   |                            |
|---|----------------------------|
| 1a. Sheath colourless                             | 2                          |
| b. Sheath coloured                                | 3                          |
| 2a. Sheath unlamellated                           | 1. <i>G. atrata</i>        |
| b. Sheath lamellated                              | 3. <i>G. polydermatica</i> |
| 3a. Sheath brownish orange                        | 5. <i>G. sanguinea</i>     |
| b. Sheath yellowish brown                         | 4                          |
| 4a. Cells without sheath 6-11 $\mu\text{m}$ broad | 4. <i>G. rupestris</i>     |
| b. Cells without sheath 3-5 $\mu\text{m}$ broad   | 2. <i>G. kuetzingiana</i>  |

1. *Gloeocapsa atrata* (Turp.) Kütz., Tab. Phyc. 1: 21. fig. 4, 1845; Geitler, Kryptogamen-flora. 188. fig. 83c. 1932; Desikachary, Cyanophyta, 116. pl. 24. fig. 8. 1959.

**Pl. 59, Figs. 8a-b**

Thallus blackish; crustaceous; mucilagenous; cells spherical, without sheath, 3.65-4.87  $\mu\text{m}$  broad, with sheath, 10.96-14.63  $\mu\text{m}$  broad; sheath

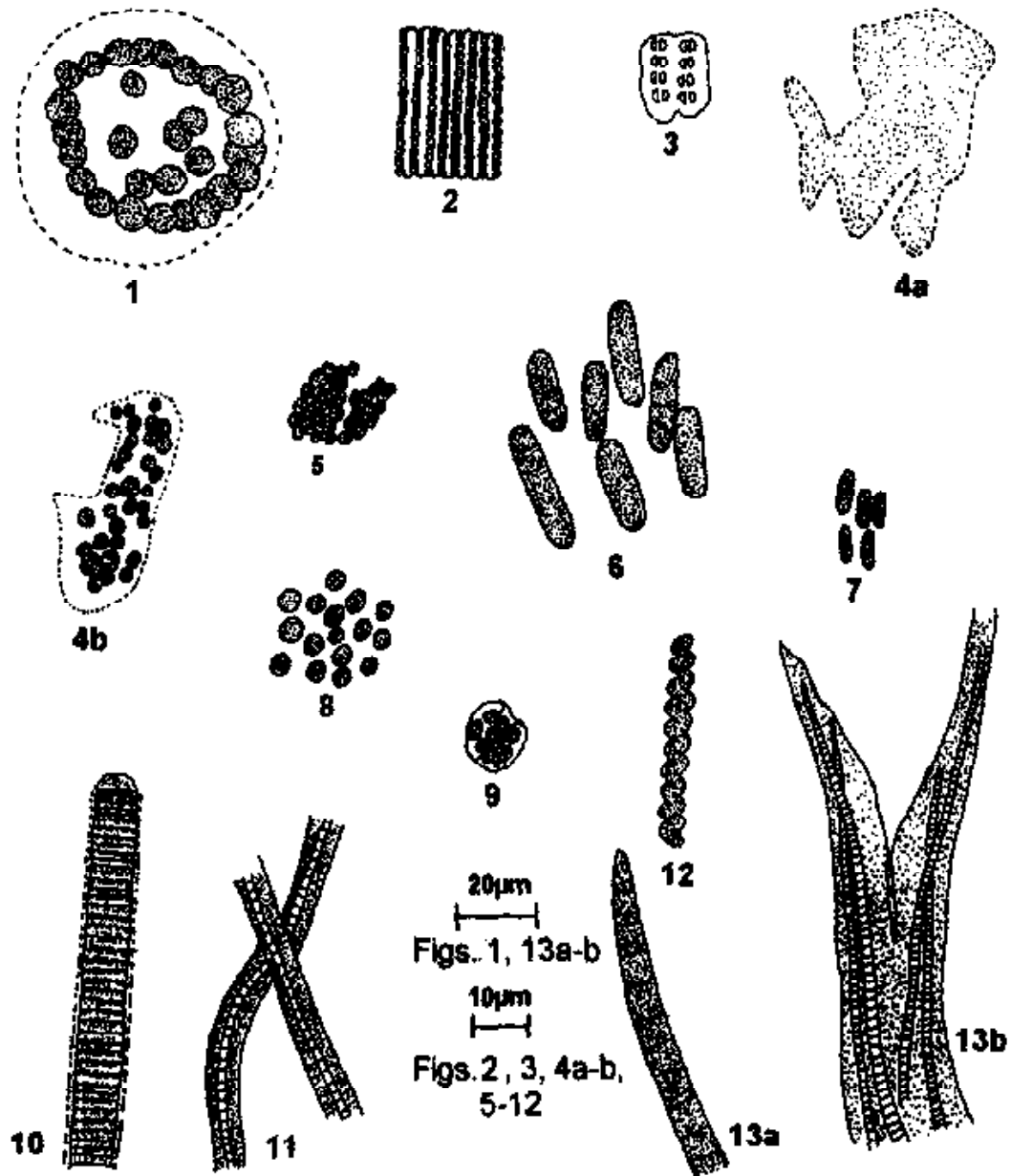


Plate 60 : Figs. 1-13 : 1. *Coelosphaerium kuetzingianum*; 2. *Merismopedia convoluta*; 3. *Merismopedia minima*; 4a-b. *Microcystis aeruginosa*; 5. *Microcystis flos-aquae*; 6. *Synechococcus aeruginosus*; 7. *Synechococcus elongatus*; 8. *Microcystis pulverea*; 9. *Chlorogloea microcystoides*; 10. *Phormidium microtomum*; 11. *Schizothrix muelleri*; 12. *Spirulina major*; 13a-b. *Schizothrix beccarii*.



colourless, unlamellated.

*Phenology* : August-October.

Attached on the rocky beds at Asan barrage, along with certain diatoms (93118).

2. *Gloeocapsa kuetszingiana* Näg., Gatt. einzell. Algen 50. 1849; Geitler, Kryptogamen-flora 194. fig. 91a. 1932; Desikachary, Cyanophyta 118. pl. 23. fig. 4, pl. 24. fig. 12. 1959.

**Pl. 59, Figs. 12a-b**

Thallus pale bluish-brownish, densely aggregated colonies, 136.54-146.37  $\mu\text{m}$  broad; cells spherical, without sheath, 3.21-4.11  $\mu\text{m}$  broad, with sheath, 4.28-7.22  $\mu\text{m}$  broad; sheath yellowish to brown; lamellae absent.

*Phenology* : January-February.

Attached on dripping rocks at Asan barrage along with members of euglenoids (93110).

3. *Gloeocapsa polydermatica* Kütz., Tab. Phyc. 1: 15, pl. 20. fig. 3. 1846; Geitler, Kryptogamen-flora 185. figs. 82c, 83e. 1932; Desikachary, Cyanophyta 114. pl. 25. fig. 1. 1959.

**Pl. 59, Figs. 11a-b**

Thallus bluish-brown, mucilaginous, compact; cells spherical, without sheath, 3.13-4.28  $\mu\text{m}$  broad; sheath colourless, lamellated, 2.67-3.87  $\mu\text{m}$  broad.

*Phenology* : May-June.

Attached on moist soil at Asan barrage, along with certain diatoms (93110).

4. *Gloeocapsa rupestris* Kütz., Tab. Phyc. 1: 22. fig. 2. 1846; Geitler, Kryptogamen-flora. 194. figs. 88c, 89. 1932; Desikachary, Cyanophyta 117. pl. 25. fig. 4. 1959.

**Pl. 59, Fig. 9**

Thallus brownish, crustaceous; cells spherical without sheath, 7.31-8.52  $\mu\text{m}$  broad, with sheath 10.98-12.81  $\mu\text{m}$  broad; cell contain blue green homogeneous; sheath yellowish brown, lamellated.

*Phenology* : March-April.

Attached on submerged grass at Asan reservoir, along with certain zooplanktons (93118, 93125).

**5. *Gloeocapsa sanguinea* (Ag.) Kütz., Phyc. generalis 175. 1843; Geitler, Kryptogamen-flora 202. fig. 94a. 1932; Desikachary, Cyanophyta, 121. pl. 27. fig. 7. 1959; Kant & Gupta, Algal Fl. Ladakh 42. pl. 7. figs. 15. 1998.**

**Pl. 59, Figs. 10a-b**

Colonies pale blue-green; cells without sheath, 4.81-6.42  $\mu\text{m}$  broad, with sheath, 11.23-12.84  $\mu\text{m}$  broad; sheath red or brownish orange.

*Phenology* : October-December.

Epiphytic on grass at Asan reservoir, associated with certain zooplanktons (93113).

#### 6. MERISMOPEDIA Meyen

Thallus forming flat tubular colonies; cells 4-16 or more, spherical, subspherical, oblong or polygonal with rounded ends, arranged in single plane, individual cell sheaths distinct or confluent; cell contents homogeneous; reproduction by fragmentation.

#### KEY TO THE SPECIES

- |                          |                        |
|--------------------------|------------------------|
| 1a. Thallus convolute    | 1. <i>M. convoluta</i> |
| b. Thallus not convolute | 2. <i>M. minima</i>    |

**1. *Merismopedia convoluta* Breb. in Kütz., Species Algarum, 472. 1849; Geitler, Kryptogamen-flora 262. 1932; Desikachary, Cyanophyta, 152. pl. 24. figs. 8, 12, 13. 1959; Kant & Gupta, Algal Fl. Ladakh 43. pl. 8. fig. 10. 1998.**

**Pl. 60, Fig. 2**

Colony blue-green quadrangular, flat with convolute margins; cells oblong, 6.14-7.23  $\mu\text{m}$  long, 3.17-4.78  $\mu\text{m}$  broad, arranged in groups

of 4 cells, with individual envelope; cell contents bright blue-green, homogeneous; gas vacuoles and granules absent.

*Phenology* : August-September.

Free floating in a stagnant water at Asan along with members of diatoms mixture (93119, 93126).

**2. *Merismopedia minima*** Beck in Sched. ad Krypt. exsicc. Cent. III. Nr. 227. 1897; Geitler, Kryptogamen-flora 263. 1932; Desikachary, Cyanophyta 154. pl. 29. fig. 11. 1959.

**Pl. 60, Fig. 3**

Colony pale blue-green, flat without convolute margins; cells oblong 1.5-2.8  $\mu\text{m}$  broad, arranged in groups of 4-8 cells with individual envelope; cell contents homogeneous; gas vacuoles and granules absent.

*Phenology* : August-September.

Free floating in a stagnant water at Asan, along with members of diatoms and desmids (93111, 93112).

### 7. *MICROCYSTIS* Kütz.

Colonies free floating, spherical, ellipsoidal or irregularly overlapping net-like; cells spherical or elongated, densely arranged, distributed irregularly within homogeneous hyaline diffluent mucilage; individual cell sheath absent or confluent; cell contents homogeneous; gas vacuoles present; reproduction by cell division in three directions.

### KEY TO THE SPECIES

- |                                 |                         |
|---------------------------------|-------------------------|
| 1a. Colonies clathrate          | 1. <i>M. aeruginosa</i> |
| b. Colonies not clathrate       | 2                       |
| 2a. Colonial mucilage diffluent | 2. <i>M. flos-aquae</i> |
| b. Colonial mucilage distinct   | 3. <i>M. pulverea</i>   |

**1. *Microcystis aeruginosa*** Kütz., Tab. Phyc. 1: 8. pl. 8. fig. 1. 1846; Geitler, Kryptogamen-flora 137. fig. 59d. 1932; Desikachary, Cyanophyta 93. pl. 17. figs. 1, 2, 6; pl. 18. fig. 10. 1959; Kant & Gupta, Algal Fl. Ladakh. 40. pl. 7. fig. 2. 1998. *Clathrocystis aeruginosa*

(Kütz.) Henfrey 1856, *Anacystis cyanea* (Kütz.) Drouet & Daily Rev. 1956.

Pl. 60, Figs. 4a-b

Colonies pale blue-green, spherical or slightly elongated, clathrate with distinct hyaline mucilage; cell spherical, 3.25-5.15  $\mu\text{m}$  broad, closely arranged; gas vacuoles present.

*Phenology* : November-December.

Planktonic in a ditch at Kaunwala, associated with certain zooplankton (97920).

2. *Microcystis flos-aquae* (Wittr.) Kirch. in Engler & Prantl, *Natürlichen Pflanzenfam. I. (1a)*: 56. fig. 49 (N). 1898; Geitler, *Kryptogamen-flora* 138. figs. 59. c.f., 1932; Desikachary, *Cyanophyta*, 94. pl. 17. fig. 11; pl. 18. fig. 11; 1959. *Microcystis aeruginosa* f. *flos-aquae* (Wittr.) Elenkin 1938, *Anacystis cyanea* (Kütz.) Drouet & Daily 1952.

Pl. 60, Fig. 5

Colonies blue-green, spherical, ellipsoidal or elongate with diffluent colonial mucilage; clathrate absent; cells spherical, closely arranged, 4.56-5.23  $\mu\text{m}$  broad; gas-vacuoles present.

*Phenology* : November.

Planktonic in a puddle and form water bloom at Kaunwala, associated with few zooplanktons (97922).

3. *Microcystis pulverea* (Wood) Forti in De Toni *Sylogae Algarum* 5: 92. 1907; Geitler, *Kryptogamen-flora* 143. 1932; Desikachary, *Cyanophyta* 96. 1959. *Anacystis montana* f. *minor* Drouet & daily 1952.

Pl. 60, Fig. 8

Colonies blue-green rounded to ellipsoidal with distinct mucilage; clathrate absent; cells spherical, closely arranged, 3.47-5.15  $\mu\text{m}$  broad; gas vacuoles absent.

*Phenology* : September-November.

Planktonic in a puddle at Mothmowala, associated with *Oscillatoria* sp. (97931).

#### 8. SYNECHOCOCCUS Näg.

Cells oblong, ellipsoidal or cylindrical, with rounded apices; mucilage envelope absent or very thin; cell contents homogeneous; reproduction by fragmentation.

#### KEY TO THE SPECIES

- |                                    |                          |
|------------------------------------|--------------------------|
| 1a. Cells 5-6 $\mu\text{m}$ broad  | 1. <i>S. aeruginosus</i> |
| b. Cells 1.5-2 $\mu\text{m}$ broad | 2. <i>S. elongatus</i>   |

✓1. *Synechococcus aeruginosus* Näg., Gatt. einzell. Algen. 56. pl. 1. fig. 1, 1849; Geitler, Kryptogamen-flora 274. figs. 133 d, e. 1932; Desikachary, Cyanophyta 143. pl. 25. figs. 6, 12. 1959; Kant & Gupta, Algal Fl. Ladakh 43. pl. 8. fig. 3. 1998. *Synochococcus fuscus* Zeller 1873.

Pl. 60, Fig. 6

Colony with very thin mucilage envelope; cells 2-4, pleae blue-green, cylindrical, 6.56-8.43  $\mu\text{m}$  long, 5.73-6.28  $\mu\text{m}$  broad; cell contents homogeneous, light blue-green.

*Phenology* : September.

On moist soil at Mothranowala, associated with *Chara* sp. (97932).

2. *Synechococcus elongatus* Näg., Gatt. einzell. Algen 56. pl. 1. E. fig. 3. 1849; Geitler, Kryptogamen-flora 273. figs. 133a-c. 1932; Desikachary, Cyanophyta, 143, pl. 25, figs. 7, 8, 1959. *Synechococcus racemosus* Wolle 1881.

Pl. 60, Fig. 7

Colony with very thin mucilage envelope; cells 2-4, cylindrical, 3.27-5.62  $\mu\text{m}$  long, 1.51-1.86  $\mu\text{m}$  broad; cell contents homogeneous, light blue-green.

*Phenology* : September.

On moist soil at Mothranowala, associated with certain diatoms (97928).

## 2. ENTOPHYSALIDACEAE

### 1. CHLOROGLOEA Wille

Colony hemispherical or flat irregularly lobed; cells spherical or ellipsoidal with or without homogeneous thin sheath, arranged radial; reproduction by gonidia or nannocytes.

1. *Chlorogloea microcystoides* Geitler in Arch. Protistenk. 51: 359. fig. 4. 1925; Geitler, Kryptogamen Flora 310. fig. 155. 1932; Desikachary, Cyanophyta 163. pl. 19. fig. 8. 1959.

Pl. 60, Fig. 9

Thallus gelatinous green to brownish, hemispherical; cells spherical or ellipsoidal without individual sheath, arranged radial, 2.32-3.66  $\mu\text{m}$  broad; cell content homogeneous.

*Phenology* : March-April.

Attached on cemented tank at Jharipani, associated with species of *Scenedesmus* and *Pediastrum* (93183).

## 2. Order : Chamaesiphonales

Thallus unicellular or colonial; epiphytes or lithophytes; hormogones absent; reproduction by endospores or exospores.

### KEY TO THE FAMILIES

- |                                |                      |
|--------------------------------|----------------------|
| 1a. Reproduction by endospores | 2. SIPHONONEMATACEAE |
| b. Reproduction by exospores   | 1. CHAMAESIPHONACEAE |

### 1. CHAMAESIPHONACEAE

#### 1. CHAMAESIPHON A. Br. & Grunow

Cells ovoid, pyriform or cylindrical, enclosed by sheath; epiphytic;

sporangia with or without stalk, attached by mucilage disc; reproduction by exospores.

1. *Chamaesiphon rostafinskii* (Rostaf.) Hansg., Prodr. Alg. Fl. Bohmen 2: 123. 1892; Geitler, Kryptogamen-flora 432. 1932; Desikachary, Cyanophyta 171. pl. 32. figs. 7, 8. 1959. *Sphaerogonium gracile* Rostaf. 1883.

Pl. 61, Fig. 5

Cells ovoid or pyriform, 4.37-6.23  $\mu\text{m}$  long, 3.16-5.18  $\mu\text{m}$  broad; sporangia pale rose, gregarious, club-shaped, 14.27-16.37  $\mu\text{m}$  long, 2.14-4.56  $\mu\text{m}$  broad; pseudovagina thin colourless; exospores 1-2.

*Phenology* : December.

Epiphytic on *Lyngbya* sp. in a puddle at Tiuni, associated with certain diatoms (97901).

## 2. SIPHONONEMATACEAE

### 1. SIPHONONEMA Geitler

Thallus gelatinous; cells cylindrical; cell content homogeneous; epiphytic; sheath unlamellated; vacuole absent; reproduction by endospores.

1. *Siphononema polonicum* Geitler, Kryptogamen-flora 446. figs. 265-268. 1932.

Pl. 61, Fig. 4

Thallus elongate, gelatinous; cells cylindrical, 12.46-15.62  $\mu\text{m}$  long, 4.23-6.21  $\mu\text{m}$  broad; sheath present; endospores arranged in rows, 5.17-7.14  $\mu\text{m}$  long, 4.53-6.24  $\mu\text{m}$  broad.

*Phenology* : December.

Epiphytic on *Spirogyra* sp. in a puddle at Tiuni, associated with other blue-green algae (97906).

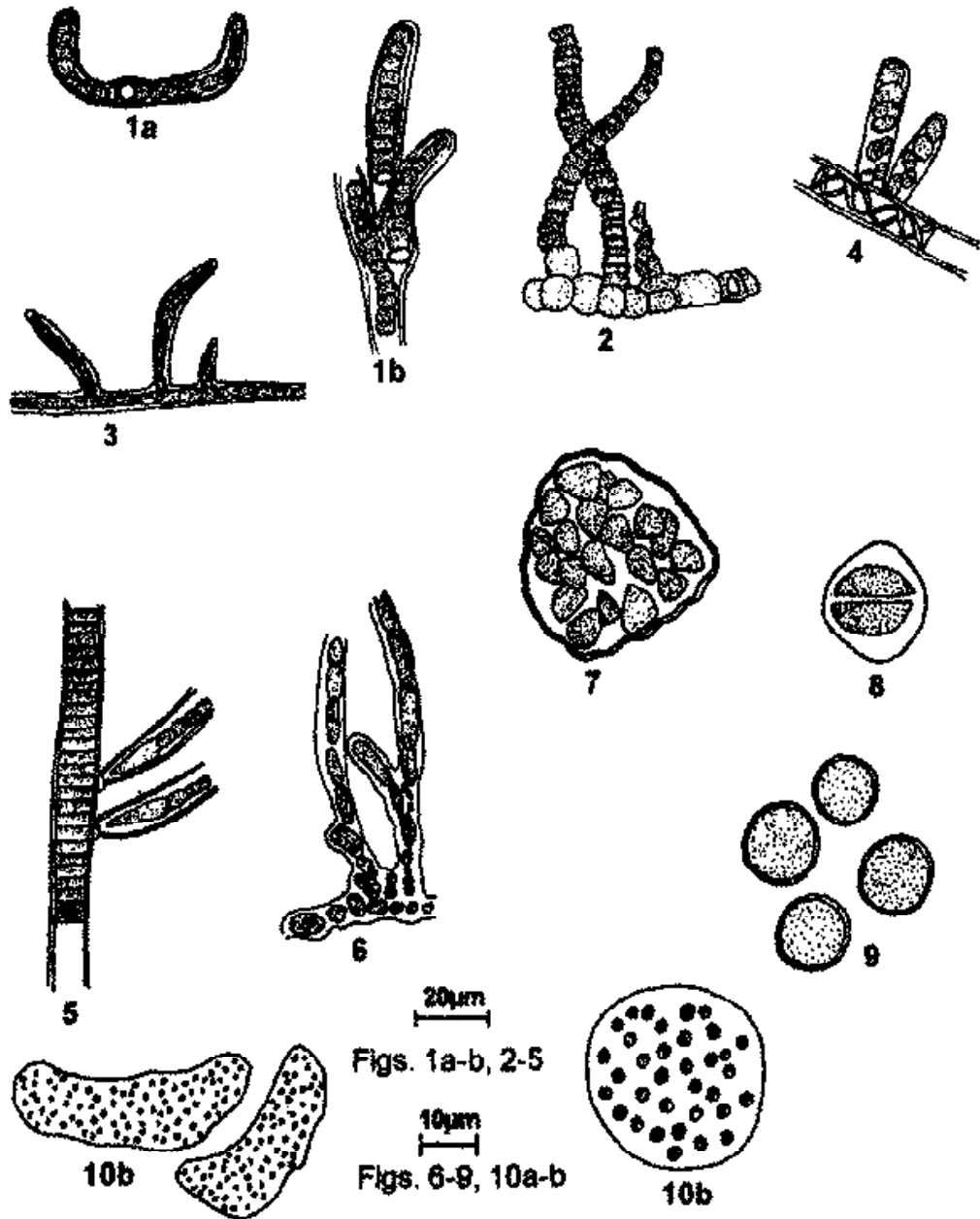


Plate 61 : Figs. 1-10 : 1a-b. *Camptylonema indicum*; 2. *Westiellopsis prolifica*; 3. *Hapalosiphon welwitschii*; 4. *Siphononema polonicum*; 5. *Chamaesiphon rostafinskii*; 6. *Hyella caespitosa*; 7. *Myxosarcina spectabilis*; 8. *Aphanocapsa bififormis*; 9. *Aphanocapsa banaresensis*; 10a-b. *Aphanocapsa roeseana*.



## 3. Order : Pleurocapsales

Thallus pseudoparenchymatous but not forming trichome; attached; heterocysts or hormogones absent; reproduction by endospores.

## KEY TO THE FAMILIES

- |                                   |                    |
|-----------------------------------|--------------------|
| 1a. Thallus not forming filaments | 1. PLEUROCAPSACEAE |
| b. Thallus forming filaments      | 2. HYELLACEAE      |

## 1. PLEUROCAPSACEAE

## 1. MYXOSARCINA Printz

Thallus flat, densely packed; attached; cells cubical; wall thick or thin; reproduction by endospores.

1. *Myxosarcina spectabilis* Geitler in Arch. Hydrobiol. 12(4): 624. 1933; Desikachary, Cyanophyta 178. pl. 30. figs. 1-5; pl. 31. figs. 17-22. 1959.

Pl. 61, Fig. 7

Thallus colonial, flat, sarcinoid; sheath thin, hyaline; cells cubical, 6.45-9.78  $\mu\text{m}$  broad; cell contents homogeneous, blue-green; endospores present.

*Phenology* : December.

On moist soil at Chakrata, associated with *Botrydium granulatus* (96300).

## 2. HYELLACEAE

## 1. HYELLA Born. &amp; Flah.

Thallus filamentous on calcareous substrates; branch dichotomous or lateral; lower portion creeping and erect filaments short with thick lamellated gelatinous wall; reproduction by endospores.

1. *Hyella caespitosa* Born. & Flah. in J. Bot. 2: 163. 1888; Geitler, Kryptogamen-flora 369. fig. 198. 1932; Desikachary, Cyanophyta 183.

pl. 34. figs. 1-15. 1959. *Hyella voluticola* Born. & Flah. 1898.

**Pl. 61, Fig. 6**

Thallus cushion shaped, gelatinous, yellow-brown; filaments upper surface, prostrate bent or curved; perforating filaments elongate, single row; cells cylindrical, 14.28-21.47  $\mu\text{m}$  long, 4.15-7.85  $\mu\text{m}$  broad; wall thick lamellated, colourless; sporangia intercalary or terminal; endospores present.

*Phenology* : December.

Attached on submerged stone at Chakrata (96248).

**4. Order : Nostocales**

Thallus filamentous, non heterotrichous, free floating, attached or epiphytic; filaments or trichomes simple, single or many within common mucilaginous envelope; branching false; sheath simple, thin or thick; lamellae may or may not present, confluent or hyaline; heterocysts present or absent; cell contents homogeneous; granules and gas-vacuoles present or absent; reproduction by hormogones, hormocysts, akinetes or endospores.

**KEY TO THE FAMILIES**

- |                                    |                     |
|------------------------------------|---------------------|
| 1a. Trichomes without heterocysts  | 1. OSCILLATORIACEAE |
| b. Trichomes with heterocysts      | 2                   |
| 2a. Trichomes without false branch | 2. NOSTOCACEAE      |
| b. Trichomes with false branch     | 3                   |
| 3a. Trichomes with terminal hair   | 3. RIVULARIACEAE    |
| b. Trichomes without terminal hair | 4. SCYTONEMATACEAE  |

**1. OSCILLATORIACEAE**

**KEY TO THE GENERA**

- |                              |                 |
|------------------------------|-----------------|
| 1a. Trichomes without sheath | 2               |
| b. Trichomes with sheath     | 4               |
| 2a. Trichomes straight       | 4. OSCILLATORIA |
| b. Trichomes spiral          | 3               |

- |     |  |                |
|-----|--|----------------|
| 3a. | Cells of trichome not visible          | 7. SPIRULINA   |
| b.  | Cells of trichome clearly visible      | 1. ARTHROSPIRA |
| 4a. | Trichome one within a sheath           | 5              |
| b.  | Trichome more than one within a sheath | 6              |
| 5a. | Sheath confluent                       | 5. PHORMIDIUM  |
| b.  | Sheath distinct                        | 2. LYNGBYA     |
| 6a. | Sheath mucous; filaments unbranched    | 3. MICROCOLEUS |
| b.  | Sheath firm; filaments branched        | 6. SCHIZOTHRIX |

#### 1. ARTHROSPIRA Stizenb.

Trichomes cylindrical, loosely and regularly spirals; terminal cell rounded; sheath absent; cross-walls distinct; calyptra absent; reproduction by hormogonia.

#### KEY TO THE SPECIES

- |     |                                     |                        |
|-----|-------------------------------------|------------------------|
| 1a. | Trichomes 6-8 $\mu\text{m}$ broad   | 2. <i>A. platensis</i> |
| b.  | Trichomes 10-16 $\mu\text{m}$ broad | 1. <i>A. jenneri</i>   |

1. *Arthrospira jenneri* Stizenb. ex Gomont in Hedwigia 1: 32. 1852; Gomont, Monogr. Oscillariees 247. pl. 7. fig. 26. 1892; Desikachary, Cyanophyta 192. pl. 35. fig. 3. 1959. *Spirulina jenneri* (Stizenb.) Geitler 1925.

Pl. 64, Fig. 1

Trichomes blue-green, regularly spirally coiled, 12.18-14.63  $\mu\text{m}$  broad; cross wall granulated, unstricted, not attenuated at ends; end cell rounded.

*Phenology* : August-September.

Free floating in a stagnant water at Asan, along with members of euglenoids (93125).

2. *Arthrospira platensis* (Nordst.) Gomont, Monogr. Oscillariees 247. pl. 7. fig. 27. 1892; Desikachary, Cyanophyta 190. pl. 35. fig. 2. 1959. *Spirulina platensis* Nordst. 1925.

Pl. 64, Fig. 2

Trichomes blue-green, slightly constricted at cross-wall, not attenuated at ends; spiral coiled regularly, 6.18-7.84  $\mu\text{m}$  broad; cross-wall granulated; end cell rounded.

*Phenology* : November.

Free floating in a stagnant water at Kaunwala, associated with diatoms mixture (97923).

## 2. *LYNGBYA* Agardh

Filaments free or entangled forming expanded thallus; sheath thin or very thick; trichomes single, constricted or unconstricted; filaments straight with large number of hormogones; end cell rounded or flat with outer membrane; reproduction by hormogonia.

### KEY TO THE SPECIES

- |   |                                |
|---|--------------------------------|
| 1a. Filaments solitary or loosely entangled | 1. <i>L. aerugino-coerulea</i> |
| b. Filaments densely intricate              | 2. <i>L. allorgei</i>          |

1. *Lyngbya aerugineo-coerulea* (Kütz.) Gomont, Monogr. Oscillariées 146. pl. 4. figs. 1-3. 1892; Geitler, Kryptogamen-flora, 1062. fig. 670. 1932; Desikachary, Cyanophyta 315. pl. 48. fig. 9, 1959. *Oscillaria aerugineo-coerulea* Kütz. 1843.

Pl. 62, Fig. 12

Filaments solitary or loosely entangled forming light blue-green expanded thallus; flexuous; sheath thin, firm, colourless not lamellated; trichomes not attenuated, not constricted at cross-walls, 8.52-9.16  $\mu\text{m}$  broad; cell contents homogeneous, 3.56-5.18  $\mu\text{m}$  long; granules and gas-vacuoles absent; end cell rounded or rotund.

*Phenology* : December-January.

Free floating in a ditch at Kaunwala, Hardwar road, along with some diatoms species (93165).

2. *Lyngbya allorgei* Frey, Myxo d'Afr. equat. franc. 189. fig. 156. 1929; Geitler, Kryptogamen-flora 1059. fig. 671. 1932; Desikachary, Cyanophyta 313. pl. 54. fig. 6. 1959.

Pl. 62, Fig. 11

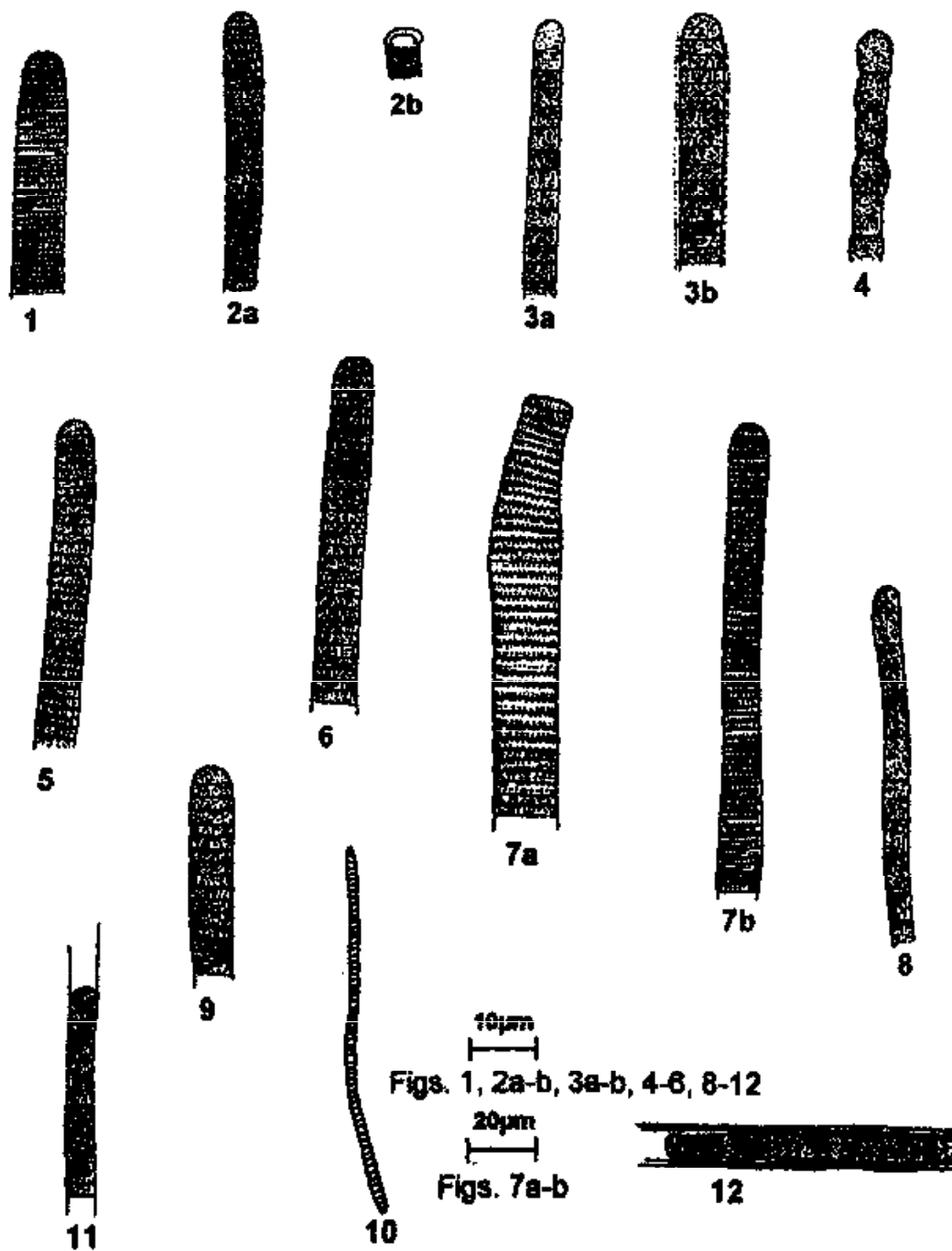


Plate - 62 : Figs. 1-12 : 1. *Phormidium anomala*; 2a-b. *Phormidium lucidum*; 3a-b. *Phormidium purpurascens*; 4. *Phormidium retzii*; 5. *Phormidium ambiguum*; 6. *Oscillatoria subbrevis*; 7a-b. *Oscillatoria princeps*; 8. *Oscillatoria amphibia*; 9. *Oscillatoria limosa*; 10. *Oscillatoria angustissima*; 11. *Lyngbya allorgei*; 12. *Lyngbya aerugineo-coerulea*.

Filaments densely intricated, tortuous, elongate; sheath thin; trichomes not attenuated, not constricted at cross wall, 6.13-6.87  $\mu\text{m}$  broad; cells quadrate, 4.62-6.57  $\mu\text{m}$  long; cell contents blue-green homogeneous; granules and gas-vacuoles absent; wall thick, smooth.

*Phenology* : December-January.

Free floating in a ditch at Kaunwala, Hardwar road, along with some diatoms species (93165).

### 3. MICROCOLEUS Desmazieres

Trichomes coiled or contorted like rope; sheath homogeneous; cells cylindrical or quadrate; cell contents homogeneous with or without granules and gas-vacuoles; end cell conical, rounded or pointed; reproduction by hormogonia.

#### KEY TO THE SPECIES

- |                             |                             |
|-----------------------------|-----------------------------|
| 1a. Trichomes unconstricted | 1. <i>M. acutissimus</i>    |
| b. Trichomes constricted    | 2                           |
| 2a. End cell conical        | 2. <i>M. chthonoplastes</i> |
| b. End cell rounded         | 3. <i>M. lacustris</i>      |

1. *Microcoleus acutissimus* Gardner in Mem. New York Bot. Gard. 7: 55. pl. 11. fig. 2. 1927; Geitler, Kryptogamen-flora 1138. fig. 744a. 1932; Desikachary, Cyanophyta 344. pl. 60. fig. 1, 1959.

Pl. 64, Fig. 3

Filaments 15-20, straight, 452.75-495.67  $\mu\text{m}$  long, 23.53-25.38  $\mu\text{m}$  broad; sheath gelatinous; trichomes parallel, not constricted, 1.57-2.54  $\mu\text{m}$  broad; cross wall granulated; cells 3.46-5.78  $\mu\text{m}$  long, 1.51-2.12  $\mu\text{m}$  broad; end cell conical.

*Phenology* : December-February.

On moist soil at Chakrata (96299).

2. *Microcoleus chthonoplastes* Thuret ex Gomont in Ann. Sci. Nat. Bot. 1: 378. 1875; Gomont, Monogr. Oscillariees 353. pl. 14. figs. 5-8. 1892, Geitler, Kryptogamen-flora 1133. fig. 739. 1932; Desikachary,

Cyanophyta 343. pl. 60. figs. 7-9. 1959. *Chthonoblastus salinus* Kütz. 1843, *Chthonoblastus yngbyei* Kütz. 1843.

Pl. 64, Fig. 4

Filaments 6-7, coiled; sheath gelatinised, thick; trichomes constricted at cross wall, 3.56-5.72  $\mu\text{m}$  broad, not granulated; cells 6.36-9.48  $\mu\text{m}$  long, 2.18-4.48  $\mu\text{m}$  broad; end cell pointed granules; gas-vacuoles absent.

*Phenology* : June-August.

On moist soil at Sahasradhara, associated with *Rhizoclonium* sp. (93154).

3. *Microcoleus lacustris* (Rabenh.) Farlow in Alg. es. Am. bor. nr. 227 bis. 1877; Geitler, Kryptogamen-flora 1142. figs. 749. 750a, 1932; Desikachary, Cyanophyta 345. pl. 60. figs. 4, 5. 1959.

Pl. 64, Fig. 5

Filaments branched with 12-15 straight trichomes; sheath thin, mucous; trichomes constricted at cross wall, 4.67-5.88  $\mu\text{m}$  broad; cell cylindrical, 5.48-8.23  $\mu\text{m}$  long, 3.48-4.18  $\mu\text{m}$  broad; cell contents homogeneous, without granules and gas-vacuoles; end cell rounded; cell wall thin smooth.

*Phenology* : October-November.

On moist soil at Sahasradhara, associated with other blue green algae (93134).

#### 4. OSCILLATORIA Vaucher

Trichome single or forming flat, spongy thallus; sheath absent or rarely very thin; terminal cell pointed, bent, coiled or screw shaped; cells cylindrical, oval, disciform; granules present or absent; calyptra and gas-vacuoles present or absent; reproduction by fragmentation and hormogonia.

#### KEY TO THE SPECIES

- |                      |   |
|----------------------|---|
| 1a. Trichome bent    | 2 |
| b. Trichome straight | 3 |

- |                          |                           |
|--------------------------|---------------------------|
| 2a. End cell capitate    | 4. <i>O. princeps</i>     |
| b. End cell not capitate | 2. <i>O. angustissima</i> |
| 3a. Calyptra present     | 3. <i>O. limosa</i>       |
| b. Calyptra absent       | 4                         |
| 4a. Septa granulated     | 1. <i>O. amphibia</i>     |
| b. Septa not granulated  | 5. <i>O. subbrevis</i>    |

1. *Oscillatoria amphibia* Ag. ex Gomont in Flora 10: 632. 1827; Gomont, Monogr. Oscillariees 221. pl. 7. figs. 4-5. 1892; Geitler, Kryptogamen-flora 966. 1932; Desikachary, Cyanophyta 229. pl. 37. fig. 6. 1959.

**Pl. 62, Fig. 8**

Trichomes blue-green, straight; apices without attenuated and capitate; cross wall uncontracted; cells cylindrical, 4.58-6.12  $\mu\text{m}$  long, 8.73-10.14  $\mu\text{m}$  broad; septa with 2 granules; end cell not capitate, rounded; calyptra absent.

*Phenology* : May-July.

Attached on moist soil and submerged stone at Chandrabani, associated with unicellular diatoms (93196).

2. *Oscillatoria angustissima* West & West in J. Bot. Lond. 35: 300. 1897; Geitler, Kryptogamen-flora 965. 1932; Desikachary, Cyanophyta, 227. 1959.

**Pl. 62, Fig. 10**

Trichomes thin, bent, hairy; cross-wall uncontracted, not tapering towards apices; cells, 0.41-1.12  $\mu\text{m}$  long; cell wall thin smooth; cell contents light blue-green homogeneous; granules and gas-vacuoles absent; end cell bluntly rounded; calyptra absent.

*Phenology* : May-July.

Attached on moist soil at Chandrabani, associated with unicellular diatoms (93192, 93196).

3. *Oscillatoria limosa* Ag. ex Gomont Disp. Alg. Suec. 35. 1812; Gomont, Monogr. Oscillariees 210. pl. 6. fig. 13. 1892; Geitler,



Kryptogamen-flora 944. fig. 598 d. 1932; Desikachary, Cyanophyta 206. pl. 42. fig. 11. 1959.

**Pl. 62, Fig. 9**

Thallus deep blue-green; trichomes straight, not constricted at cross-walls, 14.28-15.63  $\mu\text{m}$  broad; cells 2.47-5.38  $\mu\text{m}$  long, 0.33-0.16  $\mu\text{m}$  broad; cross-wall granulated; end cell rounded; calyptra present.

*Phenology* : Throughout the year.

In a standing water at Asan reservoir along with *Dichotomosiphon tuberosus* (93120); free floating in a ditch at Rajaji National Park (93193); free floating in a road side ditch at Dhanaulti (94809).

**4. *Oscillatoria princeps*** Vaucher ex Gomont, Hist. Conf. 190. pl. 15. fig. 2. 1803; Gomont, Monogr. Oscillariees 206. pl. 6. fig. 9. 1892; Geitler, Kryptogamen-flora 947. figs. 598a. 601c-g, 1932; Desikachary, Cyanophyta 210. pl. 37. figs. 1, 10, 11, 13, 14. 1959.

**Pl. 62, Figs. 7a-b**

Trichomes blue-green, bent, not constricted at cross-walls, 29.32-34.52  $\mu\text{m}$  broad; apices slightly attenuated; cells, 3.65-5.53  $\mu\text{m}$  long, 0.19-0.25  $\mu\text{m}$  broad; end cell capitate with or without thickened membrane.

*Phenology* : Throughout the year.

Free floating in a stagnant water at Sahasradhara along with *Chara* sp. (93127, 93132, 93133, 93141, 93142, ); free floating at Kaunwala, Hardwar road, (93165).

**5. *Oscillatoria subbrevis*** Schmidle in Engl. Bot. Jahrb. 30: 243. pl. 4. fig. 7. 1901; Geitler, Kryptogamen-flora 946. fig. 601b. 1932; Desikachary, Cyanophyta 207. pl. 37. fig. 2; pl. 40. fig. 1. 1959; Kant & Gupta, Algal Fl. Ladakh 50. pl. 10. figs. 2a,b,c; pl. 86. fig. 5. 1998.

**Pl. 62, Fig. 6**

Trichomes straight, not attenuated at apices, 5.47-6.13  $\mu\text{m}$  broad; cells not granulated at cross wall, 1.25-1.54  $\mu\text{m}$  long; end cell rounded; calyptra absent.

*Phenology* : April-May.

Free floating in a stagnant water at Sahasradhara along with certain diatoms (93141).

### 5. PHORMIDIUM Kütz.

Filaments forming leathery stratum with torn margins; sheath firm, diffuent or thin; trichomes cylindrical or constricted; apices attenuated, straight, capitate or non capitate; granules and gas-vacuoles present or absent; calyptra present or absent; reproduction by fragmentation and hormogonia.

#### KEY TO THE SPECIES

1a. Trichomes constricted	4. <i>P. microtomum</i>
b. Trichomes unconstricted	2
2a. Sheath thick	1. <i>P. ambiguum</i>
b. Sheath thin or diffuent	3
3a. Trichomes granulated	4
b. Trichomes not granulated	5
4a. Cells shorter than broad	3. <i>P. lucidum</i>
b. Cells longer than broad	5. <i>P. purpurascens</i>
5a. End cell truncate	6. <i>P. retzii</i>
b. End cell rounded	2. <i>P. anomala</i>

1. *Phormidium ambiguum* Gomont, Monogr. Oscillariaceae. 178 pl. 5. fig. 10. 1892; Geitler, Kryptogamen-flora 1015. fig. 647e. 1932; Desikachary, Cyanophyta 266. pl. 44. fig. 16, pl. 45. figs. 5-8. 1959; Kant & Gupta, Algal Fl. Ladakh 53. pl. 11. fig. 4. 1998.

Pl. 62, Fig. 5

Thallus expanded, blue-green; filaments flexuous, entangled; trichomes unconstricted at cross-wall, without attenuated and capitate, 4.58-5.98  $\mu\text{m}$  broad; cells, 1.53-2.67  $\mu\text{m}$  long; sheath thick lamellated; cross wall not granulated; end cell rounded; calyptra absent.

*Phenology* : May-August.

Attached on submerged stones at Asan near the bridge along with other members of blue-green algae (93110); free floating in a Varubala Pond (93198).

2. *Phormidium anomala* Rao, C.B. in Proc. Indian Acad. Sci. 6: 371. figs. 7f-i 1937; Desikachary, Cyanophyta 266. pl. 45. figs. 11-13. 1959.

Pl. 62, Fig. 1

Thallus thick expanded, mucilaginous, deep blue-green; trichomes subparallel, 9.74-10.98  $\mu\text{m}$  broad; cross wall unconstricted; sheath thin, colourless; cells 0.92-1.22  $\mu\text{m}$  long; end cells bluntly rounded; calyptra absent.

*Phenology* : August-October.

Free floating in a standing water at Asan, along with other members of blue green algae (93110); on damp soil at Asan (93114).

3. *Phormidium lucidum* Kütz. ex Gomont, Phyc. gen. 194. 1843; Gomont, Monogr. Oscillariées 199. pl. 5. figs. 11, 12. 1892; Geitler, Kryptogamen-flora 10-25. figs. 648 f-h. 1932; Desikachary, Cyanophyta 275. pl. 44. figs. 17, 18. 1959.

Pl. 62, Figs. 2a-b

Thallus thick, upper surface light blue-green, inner portion colourless; filaments flexuous, subparallel; sheath diffluent; trichome unconstricted at cross wall, 7.31-8.52  $\mu\text{m}$  broad; end capitate; cells 2.48-2.58  $\mu\text{m}$  long, 3.38-4.18  $\mu\text{m}$  broad; cross wall granulated; end cell with subconical calyptra.

*Phenology* : April-August.

On moist soils at Asan near the bridge (93109).

4. *Phormidium microtomum* Skuja, Zur Süßwasseralgen-flora Burmas 51. pl. 8. figs. 26, 27. 1949; Desikachary, Cyanophyta, 257. pl. 43. figs. 16, 17. 1959.

Pl. 60, Fig. 10

Thallus expanded, coriaceous, lamellose, light bluish; filaments straight, 6.42-7.49  $\mu\text{m}$  broad; sheath thin or diffluent, colourless; trichome constricted, ends attenuated 6.42-7.22  $\mu\text{m}$  broad; cross wall constricted; cells, 0.83-1.62  $\mu\text{m}$  long; septa not granulated; apical cell rounded with hyaline calyptra.

*Phenology* : August-December.

On moist soil at Asan near the bridge (93108).

**5. *Phormidium purpurascens* (Kütz.) Gomont** in J. de Bot. 4: 355, 1890; Geitler, Kryptogamen-flora 1009, fig. 644c. 1932; Desikachary, Cyanophyta, 262, pl. 44, fig. 4 and pl. 45, figs. 1-4. 1959; Kant & Gupta, Algal Fl. Ladakh 52, pl. 11, fig. 2. 1998. *Leptothrix purpurascens* Kütz. 1847.

**Pl. 62, Figs. 3a-b**

Thallus compact, leathery, purple to brownish violet; trichome bent, uncontracted, entangled; cell wall uncontracted; trichomes granulated, ends not attenuated, 1.38-2.47  $\mu\text{m}$  broad; sheath diffluent; cells, 2.26-4.34  $\mu\text{m}$  long, 1.26-1.87  $\mu\text{m}$  broad; end cell rounded; calyptra absent.

*Phenology* : Throughout the year.

On moist soils and stagnant water at Asan near the bridge (93109, 93110, 93112, 93114, 93117, 93118, 93119, 93125, 93126).

**6. *Phormidium retzii* (Ag.) Gomont** in J. de Bot. 4: 355. 1890; Geitler, Kryptogamen-flora 1012, fig. 647. 1932; Desikachary, Cyanophyta, 268, pl. 44, figs. 13, 15. 1959. *Oscillatoria retzii* Ag. 1812. *Phormidium papyrinum* Kütz. 1843.

**Pl. 62, Fig. 4**

Thallus compact, light blue-green; filaments straight, cross-wall uncontracted; trichomes not attenuated at ends, 4.87-11.98  $\mu\text{m}$  broad; sheath thin or diffluent; cells, 4.82-7.38  $\mu\text{m}$  long; septa not granulated; end cell truncate; calyptra absent.

*Phenology* : August-September.

On moist soils and stagnant water at Asan near the bridge (93112, 93114).

## 6. SCHIZOTHRIX Kütz.

Trichomes enclosed in thin or thick, lamellated or unlamellated colourless to yellow-brown sheath; trichomes two or more twisted around

one another; cell quadrate or barrel shaped; granules and gas-vacuoles present or absent; end cell rounded with or without calyptra; reproduction by fragmentation.

#### KEY TO THE SPECIES

- |                      |                       |
|----------------------|-----------------------|
| 1a. End cell rounded | 1. <i>S. beccarii</i> |
| b. End cell obtuse   | 2. <i>S. muelleri</i> |

1. *Schizothrix beccarii* Gomont, Monogr. Oscillariees. 323 pl. 10. figs. 8, 9. 1892; Geitler, Kryptogamen-flora 1110. figs. 708a, b. 1932; Desikachary, Cyanophyta 329. 1959.

#### Pl. 60, Figs. 13a-b

Thallus yellowish; filaments intricate, tortuous, unbranched; sheath colourless, thin; trichomes 6 blue-green, twisted around one another, constricted at cross wall, 6.17-6.88  $\mu\text{m}$  broad; cells 2.47-5.65  $\mu\text{m}$  long, 1.28-3.15  $\mu\text{m}$  broad; end cell rounded.

*Phenology* : June-July.

Attached on stones in a shallow slowly flowing water at Dhanaulti, associated with diatoms mixture (94813).

2. *Schizothrix muelleri* Näg. ex Gomont in Kütz. Species Algarum 320. 1849; Gomont, Monogr. Oscillariees 321. pl. 10. figs. 5-7. 1892; Geitler, Kryptogamen-flora 1110. fig. 715. 1932; Desikachary, Cyanophyta 330. pl. 57. figs. 9, 10. 1959. *Hormosiphon cylindraceus* Zanard. 1872.

#### Pl. 60, Fig. 11

Thallus expanded; filaments arranged in creeping bundles; sheath gelatinised, lamellated; trichomes slightly constricted at cross-wall, 9.13-12.36  $\mu\text{m}$  broad; cells, 5.38-7.89  $\mu\text{m}$  long, 1.82-3.65  $\mu\text{m}$  broad; end cell obtuse.

*Phenology* : October-December.

On moist soil at Sahasradhara along with few zooplanktons (93134).

## 7. SPIRULINA Turpin

Trichomes loosely or tightly coiled; cross wall between cells not clear; sheath absent; apex not attenuated; terminal cell rounded; calyptra absent; reproduction by fragmentation.

1. *Spirulina major* Kütz. ex Gomont, Phyc. gene. 183. 1843; Gomont, Monogr. Oscillariées 251. pl. 7. fig. 29. 1892; Geitler, Kryptogamen-flora 930. fig. 595. 1932; Desikachary, Cyanophyta 196. pl. 36. fig. 13. 1959; Kant & Gupta, Algal Fl. Ladakh 49. pl. 9. fig. 12, pl. 87. fig. 2. 1998.

Pl. 60, Fig. 12

Trichomes regularly spirally coiled, blue-green, 1.17-1.62  $\mu\text{m}$  broad; sheath absent; terminal cell rounded; calyptra absent.

*Phenology* : August.

Free floating in a ditch at Asan near the bridge along with certain desmids (93108).

## 2. NOSTOCACEAE

## KEY TO THE GENERA

- |  |                    |
|--|--------------------|
| 1a. Heterocyst terminal  | 2                  |
| b. Heterocyst intercalary  | 3                  |
| 2a. Heterocysts at one end of trichome                                 | 4. CYLINDROSPERMUM |
| b. Heterocysts at both end of trichome                                 | 2. ANABAENOPSIS    |
| 3a. Trichomes twisted definite form with firm gelatinous envelope mass | 5. NOSTOC          |
| b. Trichomes solitary or inter twined in an amorphous mass             | 4                  |
| 4a. Sheath of trichomes firm and narrow                                | 3. AULOSIRA        |
| b. Sheath of trichomes watery and broad                                | 1. ANABAENA        |

## 1. ANABAENA Bory

Thallus mucilaginous, floccose; trichomes uniformly broad throughout or slightly attenuated apices; sheath absent or diffluent; heterocysts intercalary; spore single or in chain formed near heterocysts or between heterocysts; reproduction by akinetes.

## KEY TO THE SPECIES

- 1a. Trichome spirally coiled 2. *A. spiroides*  
 b. Trichome straight 1. *A. ambigua*

1. **Anabaena ambigua** C.B. Rao in Proc. Indian Acad. Sci. 5: 101. figs. 1, 2. 1937; Desikachary, Cyanophyta 400. pl. 76. fig. 2. 1959. *Wolleea ambigua* (Rao) Singh 1942.

Pl. 63, Fig. 3

Trichomes straight with slightly tapering end, enclosed in mucilaginous envelope; sheath absent; cells barrel-shaped with deep constrictions at cross wall, 3.56-4.98  $\mu\text{m}$  long, 5.15-6.27  $\mu\text{m}$  broad; cell contents deep blue-green, granular; heterocysts spherical, 7.47-8.65  $\mu\text{m}$  broad; spore ellipsoidal with rounded ends, 8.76-9.23  $\mu\text{m}$  broad.

*Phenology* : December-January.

Attached on submerged grass at Sahiya, associated with members of Chlorococcales (94849).

2. **Anabaena spiroides** Klebahn in Flora 80: 25. pl. 4. figs. 11-13. 1895; Geitler, Kryptogamen-flora 881. 1932; Desikachary, Cyanophyta. 395. pl. 71. fig. 9, 1959.

Pl. 63, Fig. 2

Trichome single spirally coiled, with thick and mucilaginous sheath; cells spherical 6.69-7.31  $\mu\text{m}$  broad; gas-vacuoles present; heterocysts sub-spherical, 6.57-7.16  $\mu\text{m}$  broad; spores spherical, 8.87-10.18  $\mu\text{m}$  broad.

*Phenology* : October.

Attached on moist rocks at Sahasradhara along with diatoms sp. (93143).

## 2. ANABAENOPSIS Wolosz.

Trichomes spirally coiled; heterocysts at both end; cells elongate-ovoid to subcylindric; spores intercalary formed away from heterocyst; reproduction by akinetes.

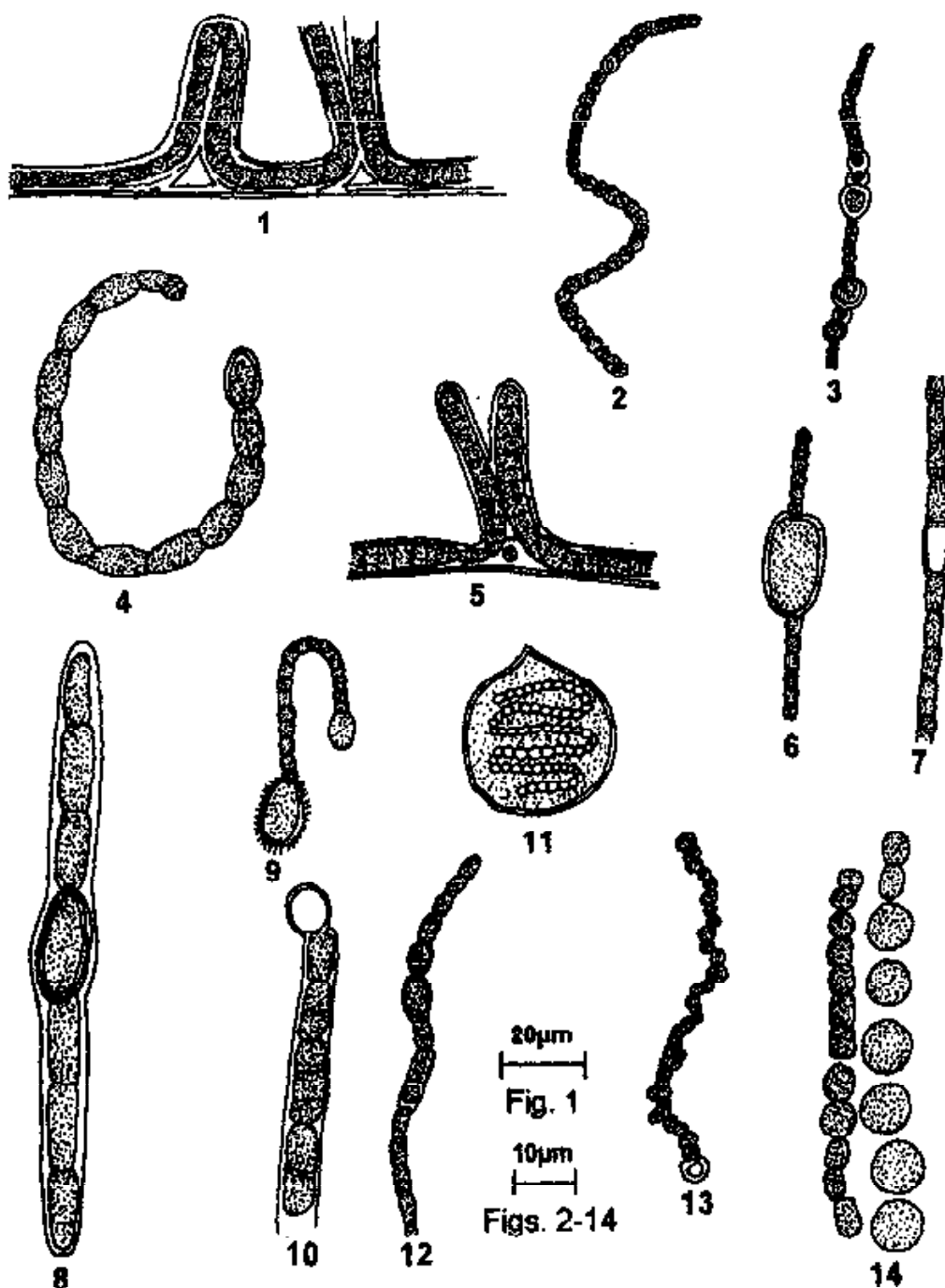


Plate 63 : Figs. 1-14 : 1. *Scytonema pseudoguyanense*; 2. *Anabaena spiroides*; 3. *Anabaena ambigua*; 4. *Anabaenopsis tanganyikae*; 5. *Aulosira pseudoramosa*; 6. *Cylindrospermum indentatum*; 7. *Nostoc muscorum*; 8. *Aulosira prolifica*; 9. *Cylindrospermum majus*; 10. *Nostoc carneum*; 11. *Nostoc commune*; 12. *Nostoc ellipsosporum*; 13. *Nostoc paludosum*; 14. *Nostoc piscinale*.



1. *Anabaenopsis tanganyikae* (West, G.S.) Wolosz. & Miller in Arch. Soc. russe Prot. 2: 125. 1923; Geitler, Kryptogamen-flora 808. fig. 516b. 1932; Desikachary, Cyanophyta 354. pl. 63. figs. 4, 8. 1959. *Anabaena tanganyikae* G.S. West 1907.

**Pl. 63, Fig. 4**

Trichomes spirally coiled, 2.37-3.97  $\mu\text{m}$  broad; sheath absent; trichomes not constricted at cross-wall, 2.41-2.58  $\mu\text{m}$  broad; cells cylindrical, 7.32-9.64  $\mu\text{m}$  long, 4.68-7.48  $\mu\text{m}$  broad; gas-vacuoles absent; heterocysts ellipsoidal, 5.47-6.13  $\mu\text{m}$  long, 3.48-4.17  $\mu\text{m}$  broad; spore single ellipsoidal, colourless, smooth, 9.36-12.68  $\mu\text{m}$  long, 5.23-6.97  $\mu\text{m}$  broad.

*Phenology* : November-January.

On moist soil, at Mohand, associated with other blue-green algae (94838).

**3. AULOSIRA Kirchn.**

Filaments straight or curved, uniformly broad; trichomes cylindrical with flattened ends; sheath thick, homogeneous; heterocysts intercalary; reproduction by akinetes.

**KEY TO THE SPECIES**

- |                                    |                           |
|------------------------------------|---------------------------|
| 1a. False branch with hormogones   | 2. <i>A. pseudoramosa</i> |
| b. False branch without hormogones | 1. <i>A. prolifica</i>    |

1. *Aulosira prolifica* Bharadw. in Ann. Bot. Lond. 47: 131. figs. 5, 6. 1933; Desikachary, Cyanophyta 426. pl. 81. figs. 1-6, 1954.

**Pl. 63, Fig. 8**

Filaments parallel, straight, 4.81-5.23  $\mu\text{m}$  broad; false branch without hormogones; sheath thin homogeneous; trichomes constricted at cross-walls; apical cell tapering to rounded apex; cells with flattened ends, 6.87-9.72  $\mu\text{m}$  long, 3.56- 4.97  $\mu\text{m}$  broad; heterocysts intercalary, ellipsoidal, 7.22-16.46  $\mu\text{m}$  long, 4.54-7.18  $\mu\text{m}$  broad.

*Phenology* : September-December.

Form dense mucilaginous scum on moist soil at Mothranowala, associated with other blue green algae (97926).

2. *Aulosira pseudoramosa* Bharadw. in Ann. Bot. Lond. 47: 137. figs. 7, 9. 1933; Desikachary, Cyanophyta 430. pl. 81. figs. 7-14. 1959.

Pl. 63, Fig. 5

Filaments densely entangled, 8.47-13.15  $\mu\text{m}$  broad; false branch with hormogones; sheath thick, hyaline; trichome constricted at cross walls; cells cylindrical, 8.36-9.78  $\mu\text{m}$  broad; heterocysts intercalary, 6.56-12.93  $\mu\text{m}$  long, 7.18-9.64  $\mu\text{m}$  broad.

*Phenology* : September - October.

Attached on moist rock at Mothranowala, associated with member of Conjugales (97930).

#### 4. CYLINDROSPERMUM Kütz.

Thallus mucilaginous; trichomes straight; sheath absent; cells barrel-shaped or cylindrical; cross wall constricted; cell contents homogeneous with or without granules; gas-vacuoles present or absent; heterocysts terminal at one end; reproduction by fragmentation, akinetes.

#### KEY TO THE SPECIES

- |  |                         |
|--|-------------------------|
| 1a. Spore ellipsoidal, episporium sculptured | 2. <i>C. majus</i>      |
| b. Spore oval, episporium smooth             | 1. <i>C. indentatum</i> |

1. *Cylindrospermum indentatum* G.S. West in J. Bot. Lond. 47: 6. 1909; Geitler, Kryptogamen-flora 820. fig. 523a. 1932; Desikachary, Cyanophyta 364. 1959.

Pl. 63, Fig. 6

Thallus gelatinous; trichomes, 4.57-4.86  $\mu\text{m}$  broad; cells quadrate, 2.36-3.65  $\mu\text{m}$  long; heterocysts ellipsoidal, 7.78-9.35  $\mu\text{m}$  long, 5.53-5.97  $\mu\text{m}$  broad; spore 1, oval, 32.47-34.67  $\mu\text{m}$  long, 16.12-17.48  $\mu\text{m}$  broad; episporium smooth.

*Phenology* : October-November.

Attached on moist soil at Kaunwala, associated with *Spirogyra* sp. (97922).

2. *Cylindrospermum majus* Kütz. ex Born. & Flah. in Kütz., Phyc. gene. 212. 1843; Bornet & Flahault, Revision des Nostocacees heterocystees 252. 1888; Geittler, Kryptogamen-flora 815. fig. 520b. 1932; Desikachary, Cyanophyta 360. pl. 80. fig. 1. 1959; Kant & Gupta, Algal Fl. Ladakh 58. pl. 12. fig. 15. 1998.

**Pl. 63, Fig. 9**

Thallus mucilaginous; trichomes, 4.23-4.79  $\mu\text{m}$  broad; cross wall constricted; cells cylindrical, 5.17-5.93  $\mu\text{m}$  long; heterocysts oblong, 7.85-9.66  $\mu\text{m}$  long, 5.48-6.77  $\mu\text{m}$  broad; spores ellipsoidal, 20.57-24.34  $\mu\text{m}$  long, 11.16-13.43  $\mu\text{m}$  broad; epispores sculptured.

*Phenology* : December-April.

Attached on moist soil at on the way Chakrata to Mussoorie, associated with certain desmids (97916).

5. NOSTOC Vaucher

Thallus mucilaginous, gelatinous, various shapes; attached or free floating; trichomes flexuous, contorted entangled; sheath distinct or diffuent; cells spherical, barrel-shaped or cylindrical; cell contents homogeneous; granules and gas-vacuoles present or absent; heterocysts intercalary; spores spherical, ellipsoidal or oblong; reproduction by fragmentation, spores, akinetes.

KEY TO THE SPECIES

- |                                |                        |
|--------------------------------|------------------------|
| 1a. Thallus with firm layer    | 3. <i>N. commune</i>   |
| b. Thallus without firm layer  | 2                      |
| 2a. Trichomes densely arranged | 5. <i>N. linckia</i>   |
| b. Trichomes loosely arranged  | 3                      |
| 3a. Thallus aquatic            | 4                      |
| b. Thallus subaerial           | 6                      |
| 4a. Thallus microscopic        | 7. <i>N. paludosum</i> |

b.	Thallus macroscopic	5
5a.	Spores spherical	8. <i>N. piscinale</i>
b.	Spores ellipsoidal	2. <i>N. carneum</i>
6a.	Cells cylindrical	4. <i>N. elliposporum</i>
b.	Cells barrel shaped	7
7a.	Trichomes 3.5-5 $\mu\text{m}$ broad	6. <i>N. muscorum</i>
b.	Trichomes 2.2-3 $\mu\text{m}$ broad	1. <i>N. calcicola</i>

1. *Nostoc calcicola* Brebisson ex Bornet & Flahault. in Brebisson, Monogr. Nost. ital. 121. 1843; Bornet & Flahault, Revision des Nostocacees heterocystees 202. 1888; Geitler, Kryptogamen-flora. 842. fig. 534. 1932; Desikachary, Cyanophyta 384. pl. 68. fig. 1. 1959; Kant & Gupta, Algal Fl. Ldakah 60. pl. 13. fig. 9, pl. 89. fig. 4. 1998.

Pl. 64, Fig. 11

Thallus mucilaginous expanded, blue-green; filaments loosely entangled; sheath at periphery; trichomes 2.23-2.97  $\mu\text{m}$  broad; cells barrel-shaped, subspherical; heterocysts subspherical, 3.38-3.86  $\mu\text{m}$  broad; spores subspherical, 4.17-4.77  $\mu\text{m}$  broad, with smooth membrane.

*Phenology* : October-December.

Attached on moist rock at Tiuni, associated with other blue-green algae (97904).

2. *Nostoc carneum* Ag. ex Bornet & Flahault in Agardh Syst. Alg. 22, 1824; Bornet & Flahault, Revision des Nostocacees heterocystees, 196, 1888; Geitler, Kryptogamen-flora 839. fig. 530. 1932, Desikachary, Cyanophyta 381. pl. 69, fig. 6, 1959. *Nostoc purpurascens* Kütz. 1843.

Pl. 63, Fig. 10

Thallus tuberculate, leathery and irregularly expanded gelatinous, brown; filaments loosely contorted, flexuous; sheath hyaline; trichomes, 3.28-3.92  $\mu\text{m}$  broad; cells cylindrical, 5.16-6.47  $\mu\text{m}$  long, 4.14-5.26  $\mu\text{m}$  broad; heterocysts oblong, 4.53-5.67  $\mu\text{m}$  broad; spores ellipsoidal, 6.38-9.18  $\mu\text{m}$  long, 4.48-5.68  $\mu\text{m}$  broad; epispore smooth and hyaline.

*Phenology* : August-December.

Free floating in a slowly flowing water at Mothranowala, associated with *Oscillatoria* sp. (97925).

3. *Nostoc commune* Vaucher ex Bornet & Flahault. in Vaucher, Hist. Conf. d'eau douce 222. pl. 16. fig. 1. 1803; Bornet & Flahault, Revision des Nostocacees heterocystees 203. 1888; Geitler, Kryptogamenflora 845. fig. 536. 537. 1932; Desikachary, Cyanophyta 387. pl. 68. fig. 3. 1959. *Nostoc kurzianum* Zeller 1873.

**Pl. 63, Fig. 11**

Thallus firm, gelatinous, flattened, undulated, leathery, brown; filaments flexuous, entangled; sheath thick, yellow-brown; trichomes 4.57-5.87  $\mu\text{m}$  broad; cells spherical, 4.23-4.57  $\mu\text{m}$  broad; heterocysts spherical, 5.36-6.42  $\mu\text{m}$  broad.

*Phenology* : Throughout the year.

Attached on moist rock at Chakrata, associated with *Spirogyra* sp. (96255).

4. *Nostoc ellipso sporum* (Desm.) Rabenh. ex Bornet & Flahault in Rabanh., Fl. Eur. Alg. 2: 169. 1865; Bornet & Flahault, Revision des Nostocacees heterocystees 198. 1888; Geitler, Kryptogamenflora 841. fig. 533. 1932; Desikachary, Cyanophyta 383. pl. 69. fig. 5. 1959.

**Pl. 63, Fig. 12**

Thallus gelatinous, irregularly expanded, brown; filaments flexuous, loosely arranged; trichomes, 3.26-3.87  $\mu\text{m}$  broad; cells cylindrical, 7.42-9.35  $\mu\text{m}$  long, 3.38-4.65  $\mu\text{m}$  broad; heterocysts oblong, 8.15-9.48  $\mu\text{m}$  long, 6.13-6.5  $\mu\text{m}$  broad; spores ellipsoidal, 14.52-16.19  $\mu\text{m}$  long, 6.51-7.92  $\mu\text{m}$  broad; episore smooth.

*Phenology* : August-October.

Attached on moist rock at Raiwala (96235).

5. *Nostoc linckia* (Roth) Bornet & Flahault in Bornet & Thuret., Notes Alg. 2: 86, pl. 18, figs. 1-12, 1880; Bornet & Flahault, Revision

des Nostocacees heterocystess 192. 1888; Geitler, Kryptogamen-flora. 838. fig. 528b. 1932; Desikachary, Cyanophyta pl. 69. fig. 4. 1959.

**Pl. 65, Fig. 7**

Thallus tuberculate, irregularly expanded, torn, gelatinous, blue-green; filaments densely entangled; sheath diffluent inside, distinct in peripheral portion; trichomes densely arranged, pale blue-green, 3.47-3.83  $\mu\text{m}$  broad; cells barrel shaped; heterocysts subspherical; spores subspherical, 7.34-7.87  $\mu\text{m}$  long, 6.18-7.22  $\mu\text{m}$  broad; epispore smooth.

*Phenology* : Throughout the year.

Attached on submerged rocks at Guller ghati (93194).

6. *Nostoc muscorum* Ag. ex Bornet & Flahault in Agardh, Disp. Alg. Suec. 44. 1812; Bornet & Flahault, Revision des Nostocacees heterocystees 200. 1888; Geitler, Kryptogamen-flora 844. fig. 535. 1932; Desikachary, Cyanophyta. 385. pl. 70. fig. 2. 1959. Kant & Gupta, Algal Fl. Ladakh 60. pl. 13. fig. 5. pl. 89. fig. 1. 1998.

**Pl. 63, Fig. 7**

Thallus gelatinous irregularly expanded, tuberculate, brown; filaments entangled, yellow brown; trichomes, 3.57-4.98  $\mu\text{m}$  broad; cells barrel shaped, 5.78-6.18  $\mu\text{m}$  long, 3.48-4.17  $\mu\text{m}$  broad; heterocysts spherical, 6.54-6.94  $\mu\text{m}$  broad; spores oblong, 8.12-11.64  $\mu\text{m}$  long, 4.13-6.78  $\mu\text{m}$  broad; epispore smooth yellowish.

*Phenology* : October-December.

Attached on moist rock at Sahiya, associated with other blue-green algae (94849).

7. *Nostoc paludosum* Kütz.ex Bornet & Flahault in Kütz. Tab. Phyc. 2: 1. pl. 1. fig. 2. 1850; Bornet & Flahault, Revision des Nostocacees heterocystees 191. 1888; Geitler, Kryptogamen-flora 836. fig. 528a. 1932; Desikachary, Cyanophyta 375. pl. 69. fig. 2. 1959; Kant & Gupta, Algal Fl. Ladakh 59. pl. 13. fig. 6. 1998.

**Pl. 63, Fig. 13**

Thallus microscopic, punctiform, gelatinous; sheath yellow brown; trichomes loosely arranged, 3.18-3.42  $\mu\text{m}$  broad; cells barrel-shaped, blue-green; heterocysts, 4.38-5.22  $\mu\text{m}$  broad; spores oval with smooth membrane, 6.78-7.65  $\mu\text{m}$  long, 4.28-4.48  $\mu\text{m}$  broad.

*Phenology* : December.

Free floating on the stagnant water of a crop field at Sahiya, associated with diatoms (94853).

8. *Nostoc piscinale* Kütz. ex Bornet & Flahault in Kütz., Phyc. gene. 208. 1843; Bornet & Flahault, Revision des Nostocacees heterocystees 194. 1888; Geitler, Kryptogamen-flora 838. fig. 529. 1932; Desikachary, Cyanophyta 377. pl. 69. fig. 3. 1959.

**Pl. 63, Fig. 14**

Thallus globose, tuberculate, mucilaginous, brown; filaments flexuous, loosely entangled; sheath brown; trichomes loosely arranged, 4.47-5.76  $\mu\text{m}$  broad; cells, 6.19-8.38  $\mu\text{m}$  long; heterocysts oblong, 4.52-5.24  $\mu\text{m}$  broad; spores globose, 6.26-6.98  $\mu\text{m}$  broad; episporium smooth and hyaline.

*Phenology* : December-January.

On moist soil at Asan (94845).

**3. RIVULARIACEAE**

**KEY TO THE GENERA**

- |   |                 |
|---|-----------------|
| 1a. Filaments clustered, loosely arranged         | 1. CALOTHRIX    |
| b. Filaments radial or parallel, densely arranged | 2               |
| 2a. Akinetes absent                               | 3. RIVULARIA    |
| b. Akinetes present                               | 2. GLOEOTRICHIA |

**1. CALOTHRIX Agardh**

Filaments clusters, caespitose, tomentose, pulvinate or penicillate, unbranched or false branched; trichomes broad at basal portion; apical portion attenuated; sheath firm, homogeneous or lamellose; cells cylindrical;

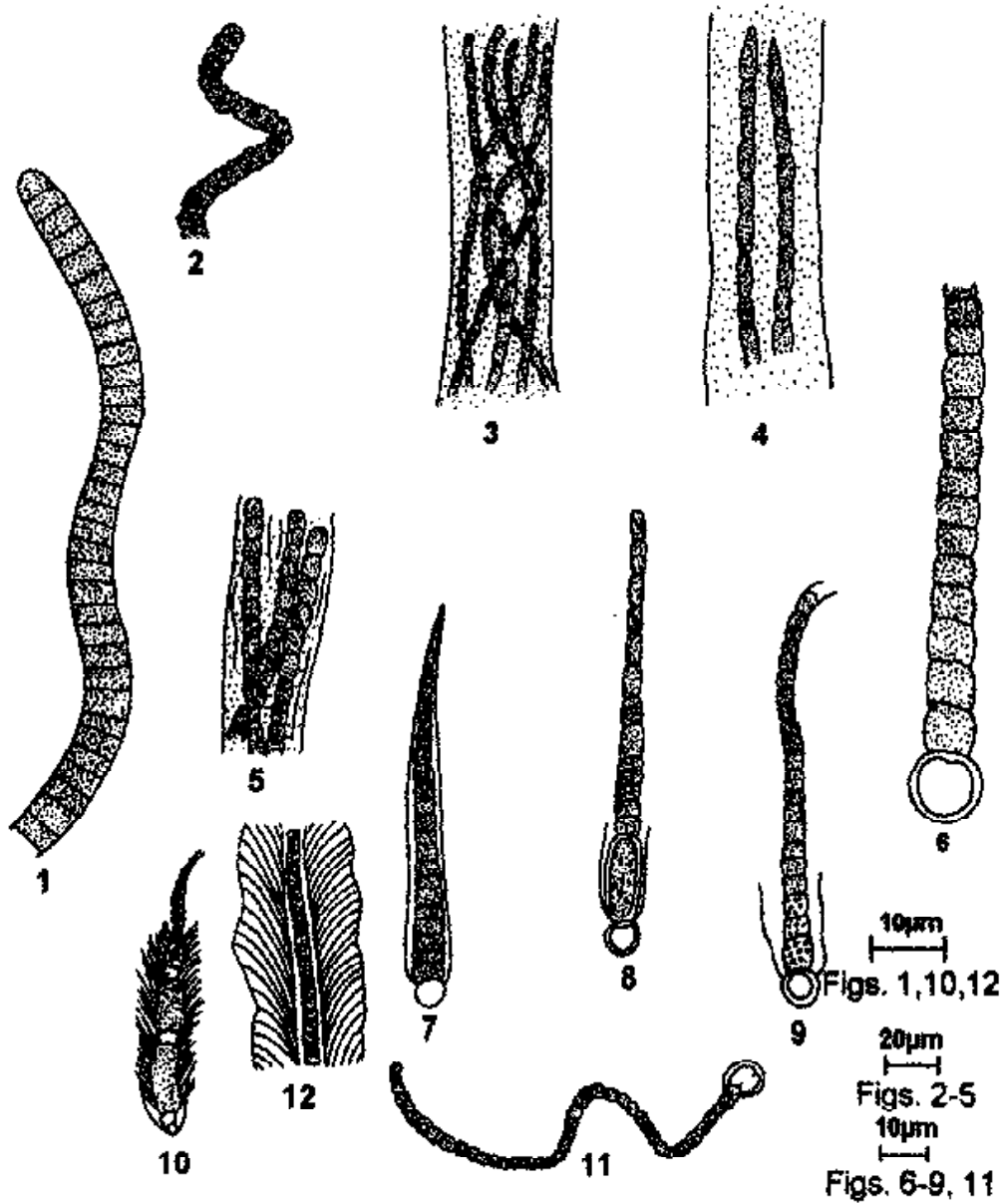


Plate - 64 : Figs. 1-12 : 1. *Arthrospira jenneri*; 2. *Arthrospira platensis*; 3. *Microcoleus acutissimus*; 4. *Microcoleus chthonoplastes*; 5. *Microcoleus lacustris*; 6. *Rivularia aquatica*; 7. *Calothrix braunii*; 8. *Gloeotrichia intermedia*; 9. *Gloeotrichia raciborskii*; 10. *Gloeotrichia pilgeri*; 11. *Nostoc calcicola*; 12. *Petalonema striato-theca*.



apical region hair-like; heterocysts basal; reproduction by spore or hormogonia.

1. *Calothrix braunii* (A. Br.) Bornet & Flahault, *Revisión des Notocacees heterocystes* 368. 1886; Geitler, *Kryptogamen-flora* 606. fig. 381. 1932; Desikachary, *Cyanophyta* 535. pl. 114. fig. 3. 1959.

**Pl. 64, Fig. 7**

Thallus caespitose, brown; filaments straight, 247.47-265.52  $\mu\text{m}$  long, 9.13-9.78  $\mu\text{m}$  broad, with swollen base, 12.48-15.13  $\mu\text{m}$  broad; sheath thin, colourless; trichomes, 6.14-6.48  $\mu\text{m}$  broad with hair; cross wall constricted; cells cylindrical, 4.53-4.78  $\mu\text{m}$  long, 6.37-7.22  $\mu\text{m}$  broad; heterocyst basal, hemispherical.

*Phenology* : November.

Attached on moist rock at Mohand (94832).

2. GLOEOTRICHIA J.G. Agardh

Thallus spherical or hemispherical solid or hollow; filaments radial or parallel arranged; sheath firm; trichomes with hair; heterocyst basal; reproduction by akinetes or hormogonia.

KEY TO THE SPECIES

- |                                       |                          |
|---------------------------------------|--------------------------|
| 1a. Hairs protruding out of colony    | 2. <i>G. pilgeri</i>     |
| b. Hairs not protruding out of colony | 2                        |
| 2a. Sheath not saccate                | 1. <i>G. intermedia</i>  |
| b. Sheath saccate                     | 3. <i>G. raciborskii</i> |

1. *Gloeotrichia intermedia* (Lemm.) Geitler in *Pascher's Süßwasser-flora* 12: 233. 1925; Geitler, *Kryptogamen-flora* 635. 1932. Desikachary, *Cyanophyta* 560. pl. 116. fig. 8, 1959. *Rivularia intermedia* Lemm. 1910.

**Pl. 64, Fig. 8**

Thallus spherical ball-shaped, 4-7 mm broad; filaments densely arranged; sheath not saccate, colourless; trichomes with coiled hairs not protruding out of colony, 6.37-7.64  $\mu\text{m}$  broad; cells 7.15-7.58  $\mu\text{m}$

long; heterocyst 1 elongate, 10.47-13.52  $\mu\text{m}$  broad; spores cylindrical, smooth, colourless, 56.13-58.24  $\mu\text{m}$  long, 13.18-15.12  $\mu\text{m}$  broad.

*Phenology* : November-December.

Epiphytic on grass at Mohand, associated with *Hydrodictyon reticulatum* (94825).

2. *Gloeotrichia pilgeri* Schmidle in *Hedwigia* 40: 54. pl. 4. figs. 14-15. 1901; Geitler, *Kryptogamen-flora* 641. fig. 408. 1932; Desikachary, *Cyanophyta* 558. pl. 116. figs. 6, 7. pl. 118. fig. 8. 1959.

Pl. 64, Fig. 10

Thallus spherical; filaments radiating with 2 heterocysts; sheath diffluent; trichomes with hairs, protruding out of colony, 6.56-7.18  $\mu\text{m}$  broad; cells, 4.38-5.52  $\mu\text{m}$  long, 2.69-4.28  $\mu\text{m}$  broad; apex round; spores ellipsoidal, curved, smooth with rounded ends, 32.78-38.15  $\mu\text{m}$  long, 12.25-14.47  $\mu\text{m}$  broad.

*Phenology* : September-November.

Free floating in a stagnant water at Mohand, associated with *Fragilaria* sp. (94829).

3. *Gloeotrichia raciborskii* Wolosz. in *Bull. Ac. Sc. Cracovie. Sect. 6*: 687. fig. 12. 1912; Geitler, *Kryptogamen-flora*. 637. fig. 405a. 1932; Desikachary, *Cyanophyta* 562. pl. 118. fig. 14. 1959.

Pl. 64, Fig. 9

Thallus spherical; trichomes, 7.13-8.18  $\mu\text{m}$  broad, ending with hair; sheath at base, lamellated, brown; basal cells, 6.38-7.66  $\mu\text{m}$  long, 8.72-9.24  $\mu\text{m}$  broad; heterocysts spherical, 5.16-5.78  $\mu\text{m}$  broad; spores ellipsoidal, 35.19-39.53  $\mu\text{m}$  long, 16.88-18.23  $\mu\text{m}$  broad.

*Phenology* : December-January.

Free floating in a stagnant water at Chakrata, associated with few filaments of *Spirogyra* sp. (96260).

## 3. RIVULARIA (Roth.) Agardh

Thallus spherical; filaments radial or parallel, compactly arranged; sheath thin, colourless; trichomes ending with hair; cells at base broader barrel shaped, towards tip narrower and cylindrical; heterocysts basal, spherical or oval; reproduction by hormogones.

1. *Rivularia aquatica* de Wilde. in J. Massart Ann. Buitenz. 1: 40. 1897; Geitler, Kryptogamen-flora 652. 1932; Desikachary, Cyanophyta 552. 1959. Kant & Gupta, Algal Fl. Ladakh 65. pl. 15. fig. 8. 1998.

Pl. 64, Fig. 6

Thallus spherical; filaments compactly arranged; sheath thin, unlamellated, colourless, attenuated at end; trichome with thin hair, 7.27-8.68  $\mu\text{m}$  broad; cells, 8.86-12.24  $\mu\text{m}$  long, 6.52-7.86  $\mu\text{m}$  broad; heterocysts oval, 8.28-12.31  $\mu\text{m}$  long, 7.87-8.57  $\mu\text{m}$  broad.

*Phenology* : June.

Attached on submerged twigs at Dhanaulati, associated with *Oscillatoria* sp. (94810).

## 4. SCYTONEMATACEAE

## KEY TO THE GENERA

- |                                       |                |
|---------------------------------------|----------------|
| 1a. Filaments without heterocyst      | 2. PLECTONEMA  |
| b. Filaments with heterocyst          | 2              |
| 2a. Sheath with divergent lamellation | 1. PETALONEMA  |
| b. Sheath with parallel lamellation   | 3              |
| 3a. False branch 1                    | 4. TOLYPOTHRIX |
| b. False branch 2                     | 3. SCYTONEMA   |

## 1. PETALONEMA Berk.

Thallus procumbent or erect; trichomes compactly arranged; false branch in pairs; sheath very thick with divergent lamellation; heterocysts intercalary; reproduction by hormogones.

1. *Petalonema striato-theca* Gupta in Ind. J. For. 24(4): 500. figs. 1-6. 2001.

Pl. 64, Fig. 12

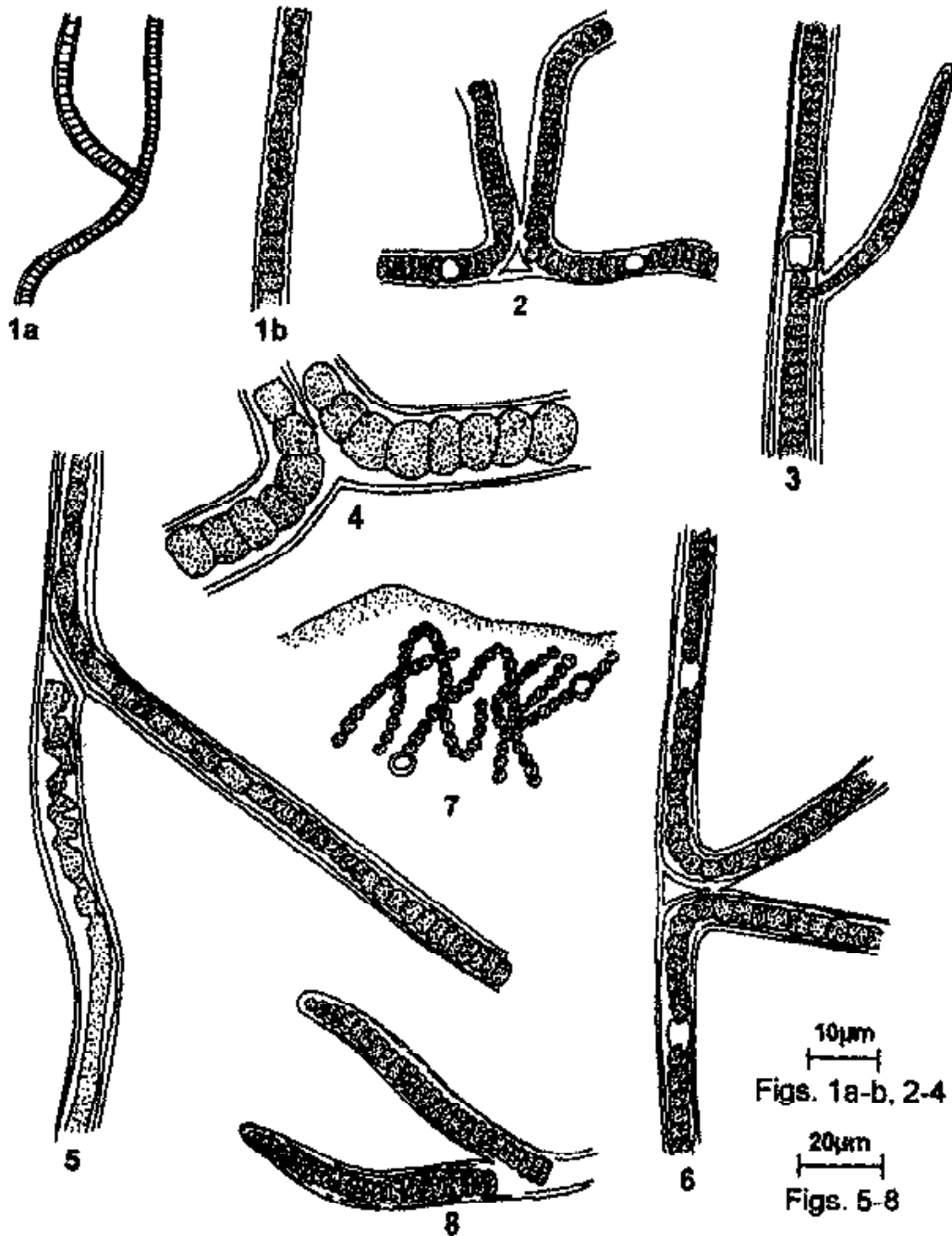


Plate 65 : Figs. 1-8 : 1a-b. *Plectonema radiosum*; 2. *Scytonema cincinnatum*; 3. *Scytonema mirabile*; 4. *Scytonema hofmanni*; 5. *Scytonema iyengari*; 6. *Scytonema ocellatum*; 7. *Nostoc linckia*; 8. *Tolypothrix ceylonica*.

Thallus procumbent, yellow-brown, mucilaginous, dense, cushions, 10-15 mm thick; filaments flexuous, 487.53-512.68  $\mu\text{m}$  long, 127.43-134.86  $\mu\text{m}$  broad; false branching entangled sparsely; sheath two very thick, inner sheath light blue, parallel, homogeneous with the trichomes, 39.72-43.17  $\mu\text{m}$  broad, outer sheath yellow, 87.58-91.64  $\mu\text{m}$  broad, with deep divergent scar lamellation at 20-65 degrees of arc; interscar, 2.48-3.39  $\mu\text{m}$  long; apices gradually attenuated or trumpet; trichome blue-brown, slightly constricted at the cross wall; cells barrel-shaped, 12.48-14.24  $\mu\text{m}$  long, 10.26-13.12  $\mu\text{m}$  broad; heterocysts blue-brown, intercalary, spherical, 9.68-16.56  $\mu\text{m}$  broad; hormogones with very delicate mucilaginous sheath, 47.63-58.72  $\mu\text{m}$  long, 8.17-12.28  $\mu\text{m}$  broad.

*Phenology* : December.

Grows on the exposed hill-slope, under continuously dripping water at Tiuni, associated with few diatoms (97904).

## 2. PLECTONEMA Thuret

Trichomes bent, with thin firm sheath; false branch single; heterocysts absent; reproduction by hormogones or spores.

**1. *Plectonema radiosum* (Schiederm.) Gomont, Monogr. Oscillariees 100. pl. 1. figs. 2-4. 1892; Geitler, Kryptogamen-flora. 687. fig. 441, 1932; Desikachary, Cyanophyta 437. pl. 83. figs. 6, 8. 1959. *Calothrix radiosa* Schiederm.**

### Pl. 65, Figs. 1a-b

Filaments irregularly curved with false branching; sheath thick or thin lamellated; cells constricted at cross wall, 4.38-7.94  $\mu\text{m}$  long, 12.22-17.19  $\mu\text{m}$  broad; end cell rounded.

*Phenology* : August-September.

Attached on moist rock, at Rajajee National Park, associated with certain zooplanktons (93192).

## 3. SCYTONEMA Agardh

Filaments caespitose, tufts; false branch two arising between dead cells or intercalary heterocysts; trichomes single with firm sheath; reproduction by hormogones or spores.

## KEY TO THE SPECIES

- |  |                              |
|--|------------------------------|
| 1a. Sheath lamellated                      | 4. <i>S. mirabile</i>        |
| b. Sheath homogeneous                      | 2                            |
| 2a. Trichome constricted                   | 1. <i>S. cincinnatum</i>     |
| b. Trichome unconstricted                  | 3                            |
| 3a. Cell longer than broad                 | 4                            |
| b. Cells shorter than broad                | 5                            |
| 4a. Filaments below 15 $\mu\text{m}$ broad | 2. <i>S. hofmanni</i>        |
| b. Filaments above 15 $\mu\text{m}$ broad  | 6. <i>S. pseudoguyanense</i> |
| 5a. Sheath firm                            | 5. <i>S. ocellatum</i>       |
| b. Sheath thick                            | 3. <i>S. iyengari</i>        |

**1. *Scytonema cincinnatum*** Thuret ex Bornet & Flahault in Ann. Sci. nat. Bot. 1: 380. 1875; Bornet & Flahault Revision des Nostocacees heterocystees 89. 1887; Desikachary, Cyanophyta 453. pl. 93. fig. 1. 1959. *Lyngbya cincinnata* Kütz. 1843, *Scytonema crispum* (Ag.) Bornet 1889.

Pl. 65, Fig. 2

Thallus caespitose; filaments, 21.48-24.33  $\mu\text{m}$  broad; false-branches geminate; sheath firm, homogeneous; trichomes constricted at cross wall, 15.34-17.84  $\mu\text{m}$  broad; cells 5.68-8.37  $\mu\text{m}$  long, 5.16-7.27  $\mu\text{m}$  broad; heterocysts elliptical.

*Phenology* : May-June.

Attached on moist rocks at Gullar ghati associated with other members of blue-green algae (93194).

**2. *Scytonema hofmanni*** Ag. ex Bornet & Flahault in Agardh, Syn Alg. Suec. 117. 1817; Bornet & Flahault, Revision des Nostocacees heterocystees 97. 1887; Geitler, Kryptogamen-flora. 772. fig. 495. 1932; Desikachary, Cyanophyta 476. pl. 91. fig. 2. 1959. *Scytonema kurzianum* Zeller 1873.

Pl. 65, Fig. 4

Thallus expanded blue-green; filaments, 8.17-11.26  $\mu\text{m}$  broad; false branches aggregated; sheath firm; trichomes 6.27-8.23  $\mu\text{m}$  broad, blue-green; cells 5.94-6.21  $\mu\text{m}$  long, 3.37-4.48  $\mu\text{m}$  broad; heterocysts oblong.

*Phenology* : August.

Attached on moist tree trunk at Asan, associated with *Phormidium* sp. (93117).

3. *Scytonema iyengari* Bharadw. in Rev. algol. 7: 159. figs. 2c, d. 1934; Desikachary, Cyanophyta 465. pl. 89. fig. 7. 1959.

**Pl. 65, Fig. 5**

Thallus thick, brownish; filaments bent densely entangled, 17.72-19.52  $\mu\text{m}$  broad; false branches. 5-7; sheath thick; trichomes 11.61-13.59  $\mu\text{m}$  broad; cells 5.23-7.58  $\mu\text{m}$  broad; heterocysts cylindrical, 18.56-21.19  $\mu\text{m}$  long, 10.23-11.78  $\mu\text{m}$  broad.

*Phenology* : January-March.

Attached on moist rocks at Asan, associated with other members of blue-green algae (93174).

4. *Scytonema mirabile* (Dillw.) Born. in Bull. bot. Soc. Fr., 36: 155. 1889; Geitler, Kryptogamen-flora 775. figs. 497, 498. 1932; Desikachary, Cyanophyta 483. pl. 91. fig. 3. 1959. *Scytonema figuratum* Ag. 1824.

**Pl. 65, Fig. 3**

Thallus spongy tomentose, blackish green; filaments tortuous with false branch, 17.28-19.44  $\mu\text{m}$  broad; sheath lamellated with slightly divergent lamellation; trichomes blue-green, 7.36-11.27  $\mu\text{m}$  broad; cells cylindrical, 3.52-4.68  $\mu\text{m}$  broad; heterocysts 6.56-8.18  $\mu\text{m}$  long, 4.16-5.72  $\mu\text{m}$  broad.

*Phenology* : October-January.

Attached on moist tree trunks at Lachiwala, associated with mosses (93172).

5. *Scytonema ocellatum* Lyngbye ex Bornet & Flahault in Lyngbye, Hydroph. Danica. 97. pl. 28a. 1819; Bornet & Flahault, Revision des Nostocacees heterocystees 95. 1887; Geitler, Kryptogamen-flora 763. fig. 488. 1932; Desikachary, Cyanophyta 467. pl. 92. fig. 3. 1959. *Scytonema cinereum* Menegh. 1837, *Scytonema murale* Zeller 1873.

**Pl. 65, Fig. 6**

Thallus cushion-shaped, greyish-blue; filaments, 12.84-14.75  $\mu\text{m}$  broad; false branches not agglutinated; sheath firm, lamellated; trichomes, olive-green, 8.55-12.64  $\mu\text{m}$  broad cells quadrate, 5.28-7.12  $\mu\text{m}$  broad; heterocysts sub-quadrate yellowish.

*Phenology* : January-February.

Free floating in a ditch at Lachiwala, associated with certain zooplanktons (93171).

6. *Scytonema pseudoguyanense* Bharadw. in Rev. algol. 7: 164. fig. 3a. 1934; Desikachary, Cyanophyta 472. pl. 89. fig. 2. 1959.

Pl. 63, Fig. 1

Thallus cushion-shaped; filaments curved irregularly densely entangled, 15.87-17.43  $\mu\text{m}$  broad; false branches 7-9; sheath thick; trichomes, 8.47-9.38  $\mu\text{m}$  broad; cells quadrate; heterocysts cylindrical, 12.48-14.62  $\mu\text{m}$  long, 10.18-12.27  $\mu\text{m}$  broad.

*Phenology* : September-December.

Attached on moist rock at Gullar ghati, associated with other blue-green algae (93161).

#### 4. *TOLYPOTHRIX* Kütz.

Filaments irregularly curved, densely interwoven; sheath thin or thick with single trichome; false branch one, arise just below heterocysts; reproduction by hormogones or spores.

1. *Tolypothrix ceylonica* Schmidle in Hedwigia 185. pl. 9. fig. 3. 1900; Geitler, Kryptogamen-flora 724. 1932; Desikachary, Cyanophyta 500. 1959. *Hassallia ceylonica* Schmidle 1900.

Pl. 65, Fig. 8

Thallus soft, green; filaments parallel, straight; false branch, forming acute angle with heterocysts at base, 11.23-12.43  $\mu\text{m}$  broad; sheath hyaline, rough with lamellation; trichomes cylindrical, 7.74-9.56  $\mu\text{m}$  broad; cells rectangular, 6.26-7.27  $\mu\text{m}$  broad.



*Phenology* : October.

Attached on moist soil at Sahasradhra (93150).

### 5. Order : Stigonematales

Thallus filamentous; branch true; heterotrichous; trichomes uniseriate to multiseriate; pit connection between cells present; heterocysts terminal, lateral or intercalary; reproduction by hormogones or endospores.

#### 1. STIGONEMATACEAE

##### KEY TO THE GENERA

- |                                 |                  |
|---------------------------------|------------------|
| 1a. Filaments crescent shaped   | 2. CAMPTYLONEMA  |
| b. Filaments not crescent shape | 2                |
| 2a. Hormogones present          | 1. HAPALOSIPHON  |
| b. Endospores present           | 3. WESTIELLOPSIS |

#### 1. HAPALOSIPHON Näg.

Thallus caespitose, floccose; filaments free; cells one or two rows; sheath present; branch irregular lateral, true, erect; heterocysts intercalary; reproduction by hormogones or spores.

1. *Hapalosiphon welwitschii* West & West in J. Bot. Lond. 35: 242. 1897; West & West in Ann. Roy. bot. Gar. Calcutta 6: 240. 1907; Geitler, Kryptogamen-flora 531. fig. 328a. 1932; Desikachary, Cyanophyta. 588. pl. 137. fig. 5. 1959.

Pl. 61, Fig. 3

Filaments loosely interwoven, flexuous, 5.12-7.18  $\mu\text{m}$  broad; sheath colourless; cells subspherical, 4.67-5.38  $\mu\text{m}$  broad; end cell rounded; branch lateral, slightly attenuated at ends, 3.67-5.48  $\mu\text{m}$  broad; heterocysts intercalary, cylindrical, 6.13-7.44  $\mu\text{m}$  long, 5.28-6.24  $\mu\text{m}$  broad; spores sub-spherical, 6.42-9.53  $\mu\text{m}$  long, 5.64-6.17  $\mu\text{m}$  broad.

*Phenology* : August-September.

Attached on submerged stones at Asan reservoir, along with members of Ulotrichales (93125).

## 2. CAMPTYLONEMA Schmidle

Filaments semicircular, middle prostrate portion bent and both end up; branch sparsely, true; heterocysts intercalary; reproduction by hormocysts.

1. *Camptylonema indicum* Schmidle in Hedwigia 39: 161. 1900; Desikachary in Proc. Indian Acad. Sci. 28: 35. figs. 1-15. 1948; Desikachary, Cyanophyta 598. pl. 132. figs. 1-15. 1959. *Stigonema indica* Schmidle 1900, *Campylonema indicum* Schmidle 1907, *Schmidleinema indicum* (Schmidle) De Toni 1936.

Pl. 61, Figs. 1a-b

Filaments crescent shaped, middle portion, 13.24-14.68  $\mu\text{m}$  broad and erect portion, 9.37-11.47  $\mu\text{m}$  broad; sheath lamellate; branching true and false, true branches arising in prostrate, and false branches from erect portions; cells, 4.72-7.63  $\mu\text{m}$  long, 9.81-10.17  $\mu\text{m}$  broad in prostrate portion and 10.27-14.42  $\mu\text{m}$  long, 4.18-6.76  $\mu\text{m}$  broad in erect portion; heterocyst intercalary.

*Phenology* : October-November.

Attached on moist rocks at Sahasradhara (93153).

## 3. WESTIELLOPSIS Janet

Filaments loosely entangled with true branches; primary filaments creeping, secondary filaments erect; sheath absent; cells barrel shaped, cylindrical; heterocysts intercalary; reproduction by gonidia.

1. *Westiellopsis prolifica* Janet in Ann. Bot. Lond. 5: 167. 1942; Desikachary, Cyanophyta 596. pl. 131. figs. 1-12. 1959.

Pl. 61, Fig. 2

Thallus filamentous; main filaments torulose with barrel-shaped cells; primary filaments creeping, secondary filaments erect; branch elongate not constricted at cross walls; cells cylindrical, 4.86-5.28  $\mu\text{m}$  broad; heterocysts oblong-cylindrical, 11.56-14.77  $\mu\text{m}$  long, 5.64-6.17  $\mu\text{m}$  broad; gonidia, 8.47-9.73  $\mu\text{m}$  broad.

*Phenology* : March.

Attached on moist soil at Mussoorie near Kempty falls, associated with certain zooplanktons (93180).

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**INDEX**  
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