Study of algal flora of Rasa Tal, Sunsari District, Nepal

With Financial Support of the Research Management Cell of Sukuna Multiple Camlpus

A Mini-research Report

Submitted to

Research Management Cell

Sukuna Multiple Campus, Sundarharaincha, Morang, Nepal

Submitted by

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2024

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Inspiration and encouragement act as catalysts to do any kind of work in our practical lives, which may activate and sharpen our workability in any field of study. Therefore, I would like to express my deep gratitude to respected sir, Associate Prof. Ganesh Prasad Dahal, chief of the Research Management Cell and Assistant Campus Chief of Sukuna Multiple Campus, Sundarharaicha for his continuous encouragement and precious suggestions for accomplishment of this mini research work at first. Similarly, I express my heartfelt gratitude to Research Management Cell (RMC- Sukuna) for providing me financial support to accomplish this research project work.

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Finally, I am very indebted to my family members and my fried Mr. Shailendra Chaudhary for kind cooperative and moral support throughout my research work. All of you have played the important role to make this research work successful and build a literature in this field.

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Study of algal flora of Rasa Tal, Sunsari District, Nepal

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Recommendation

It is my great pleasure that I enthusiastically recommend that the teaching assistant at Sukuna Multiple Campus, Mr. Dilli Ram Rai is going to carry out the research work under plant science entitled "Study of algal flora of Rasa Tal, Sunsari District, Nepal" himself under my facilitation.

So far as I remember from the beginning of his involvement in this college, I have found him to be a person with a strong interest in research work and writing journal articles and research papers. While doing this research work and writing this research paper under my facilitation, he has shown his very strong curiosity in the diversity of plant life, their varieties, species, and evolutionary relationships of the algal species found in fresh water bodies. In addition to this, he is very laborious and has high potential to do more research work in the days to come. This research work is original work done by him, which has reflected its originality with a very low similarity index of 2% while testing plagiarism by iThenticate software. This research report may deliver important information about the study of freshwater algal species distributed in Nepal. It may primarily be helpful for the identification of algal species and their morphological characters for other researchers and students in the future. All the steps of this research work, like methodology, results, and implications, have a high global standard of quality, which may be a valuable asset for students and the teaching and learning activities of the college.

The fund has been provided by the RMC- Sukuna for the completion of this research work. So, I am pleased to recommend this research report to the Research Management Cell of Sukuna Multiple Campus for final approval.

Ganesh Prasad Dahal
Research Facilitator
and
RMC Head
Date: 09 July 2024

Sukuna Multiple Campus * Research Management Cell, Sundarharaincha Morang

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Letter of Approval

This mini research report submitted by Mr. Dilli Ram Rai entitled **"Study of algal flora of Rasa Tal, Sunsari District, Nepal"** is funded and approved by the Research Management Cell (RMC- Sukuna) of the campus.

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Thanking Letter

My sincere gratitude goes out to Mr. Dilli Ram Rai, a teaching member in the department of Botany on our campus, for his tremendous assistance with the study report "Study of algal flora of Rasa Tal, Sunsari District, Nepal." We are really grateful for Mr. Rai's efforts, as his commitment and diligence have been crucial to the accomplishment of this project.

We are sure that the results of this study will make a major contribution to our academic community, and the mini-research has received financial assistance from our campus's Research Management Cell. The research paper will therefore be valued as a priceless academic asset on this institution.

I want to thank you one more for your dedication to this project and your hard work. Finally, we are honored to have him as a member of our university community. We're excited to keep working together on upcoming projects.

Date: 11 July, 2024

Arjun Raj Adhikari
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Abstract

A broad class of aquatic creatures with the ability to perform photosynthesis is called algae. Since, algae are aquatic plant, they are found in freshwater bodies of aquatic ecosystem in different size and composition with presence of various types of organism. Various types of freshwater algae belonging to different families have been reported globally around the world. Most algae are photosynthetic due to presence of chlorophyll a and chlorophyll b even though they belong to different groups. They can be found in numerous forms, such as long filaments, colonies, or single cells (Chaterjee & Raziuddin, 2006).

Aquatic ecosystem of RaSaTaal (Rastriya Sampada Taal) with fresh flowing waters source also contains more fresh water algae where algal exploration has never been done before this time. It is established at 64 Bigha of Ramdhuni Municipality, Ward No. 7 in 2071 BS. .It is bounded by Charkoshe forest from north, village from south, and localities of 75 bigha from west. It is situated toward north east side from Jhumakabajar of Itahari Sub-Metropolitan city. The Tal covers an area of 2.5 ha with water body only.

A total 12 algal samples, 2 samples from each site were collected from six algal sample collection sites at Rasa Lake randomly. Plankton net (mesh size 0.5 mm) was used to collect floating algae. For sample of other types of algae, submerged leaves and roots of aquatic macrophytes were squeezed and quarter of sample collection container was filled with water containing algal specimens .Some water was added in the container bottle and closed with lid.

Next, each container was appropriately labeled with information on the sample number, collection date, collection method, sites, etc. Using a GPS coordinates app, the latitude, longitude, and altitude of six significant locations were determined. Each site's water temperature and pH were also assessed using a portable Henna pH meter and a Mercury thermometer, respectively.

In this research work, a total of 52 algae belonging to 6 phyllum, 8 classes, 17 orders, 26 families and 31 genera were identified under compound microscope by following many refereces books as listed in references list. The phylum charophyta includes the maximum number of algal taxa -23 with 1 class, 3 order, 6 famillies and 10 generas which is followed by the another phylum Bacillariophyta with 10 algal taxas , 2 classes ,6 orders ,8 families and 8 generas. Similarly , the third position is followed by the phylum chlorophyta with 7 algal taxas , 2 classes , 3 order , 5 families and 6 gnera , 4th position by

the phylum Cyanobacteria with 6 algal taxas , 1 class, 3 order , 4 families and 3 generas ; 5th position by the phylum Euglenozoa with 5 algal taxas , 1 class , 1 order , 2 families and 3 genera and 6th position by the phylum Ochrophyta with 1 algal taxa , 1 class, 1 order ,1 fmailies and 1 genera respectively.

While overviewing, the presence of algal taxa in aquatic ecosystem of Rasa Lake, it is found rich in fresh water algae like in other fresh water bodies of eastern Nepal.

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CHAPTER I

INTRODUCTION

Aquatic ecosystem in freshwater bodies is different in size and composition with presence of various types of organism. Many groups of freshwater algae are prevalent globally around the world. Most of the algae belonging to various groups are photosynthetic due to presence of chlorophyll a and chlorophyll b. They can be found in various forms, such as long filaments, colonies, or individual cells (Chaterjee & Raziuddin, 2006). They lack multicellular gametangia and genuine tissues, although they typically have spores that spread through water. The size of algae varies greatly, ranging from 0.5 μm diameter unicellular plants to 30 m or longer colonial, palmelloid, filamentous, and bushy plants. Some algae reproduce asexually by dividing their parent body into two or more cells, while other algae can reproduce sexually (St. Amand, 1995). Algae reproduce according to the water flow and stagnancy; in turbulent waterways, for example, they may reproduce more quickly to replenish cells washed downstream than in quiet waters, where algal biomass might build up (Caduto, 1990). Algae are important because they can carry out photosynthesis in aquatic food chains by absorbing large amounts of CO2 from the atmosphere and act as primary producer.

The main criteria used to categorize algae include their pigmentation, the chemical and physical qualities of their cell walls, other biochemical traits, the quantity, shape, and direction of their flagella, and the type of food that they store. Except cyanobacteria, algae cells are typically eukaryotic. In some algae, in addition to normal cell organelles there is presence of dense structures within the chloroplast called pyrenoids. Flagella are also present in motile forms. There are four kinds of the pigments which provide the basis of classification such as chlorophyll, carotenes, xanthophylls and phycobillins. There are five different types of chlorophylls, five carotenes, twenty xanthophylls and six phycobillins found in algae (Sharma, 1992). Algae are photosynthetically active and they store food in the form of starch, amylase, amylopectin, Floridian-starch, lamiranin, carbohydrates, chrysolaminarin, leucosin, lipid, oil, cyanophycean starch etc. in separate groups.

Algae exist in various shapes, size and forms which help them to remain at upper level of water body so that they can get sunlight for photosynthesis. Because of their large, flat cell morphologies and body spines, which increase friction and lessen the effects of gravity, algae take on anti-sinking characteristics. Certain phytoplankton have altered their bodies to include unique systems that allow them to move quickly across water (Caduto, 1990). While some phytoplankton develop gas-filled sacs called vacuoles to travel through

the water column, others grow tail-like structures called flagella. Algae and other organisms also collaborate for mutual benefit. For instance, lichens are formed when algae coexist with fungi. The algae known as Zooxanthellae resides within the cells of coral that forms reefs. In both situations, the algae give their partner oxygen and complicated nutrients in exchange for simple nutrients and protection (e.g. Azolla leaf, coralloid root of Cycas).

They can be used as source of food for human and animals, biofertilizer to increase fertility and productivity in crop fields, fuel in the form of biodiesel, bioindicator of water pollution, medicines, cosmetics and research work (Prescott, 1969). Men and animals use different species of algae as food. People in coastal regions in countries like India, China, Japan, England, and Mexico have been using *Porphyra, Chlorella, Laminaria, Sargassum, Alaria, Nostoc, Spirogyra, and Oedogonium* species as food (Hickel, 1973a; Baral et al., 1988). Some species of *Spirulina* and *Porphyra* reported from Kathmandu and Pokhara are edible species (Hickel, 1973a; Baral et al., 1988). Protein-rich blue-green algae known as Spirulina sp. are currently marketed as protein capsules at a premium and are regarded as a global health food (Rai, 2011a).

Algae are considered as very good bioindicator of water quality as well as fresh water ecosystem due to their position at base of aquatic food webs (Stoermer, 1977).They have a short life span and show rapid response to pollutants in comparison to higher organisms (Kawecka & Eloranta, 1994; Zebek, 2004)**.** For instance, the Florida diatom community's decline offered compelling evidence of phosphorus-related alterations to the region's distinctive ecology. Numerous streams and rivers in central and eastern Nepal have had their water quality evaluated using diatom analysis (Jüttneret al., 1996; 2003).

Algae exhibit some detrimental properties, such as the production of algal blooms, which can reduce the amount of oxygen in the water, injure fish and plants, and obstruct light penetration for algae at lower depths, which inhibits photosynthesis. Water supply issues are caused by blue green algae,which grows in water tanks and other containers and forms bottom gelatinous layers.

Statement of the Problems

Algal flora of Bagh Jhoda wetland, Betana wetland, and Hasina wetland has been studied. All these localities lie in the eastern side of Itahari – Dharan highway. They are rich in algal flora because they lie at the southern border of Charkoshe Jungel and receive water as a permanent source. Literature showed that, algal flora of western localities from Itahari-Dharan highway has not been studied. Rasa Tal also located in western side in the

southern border of Charkoshe Jungle, but its algal flora is not known. Thus, an endeavor is made to study the algal flora of Rasa Tal.

Objective of the Study

Examining Rasa Tal's algal flora is the study's primary goal.

The specific objectives are:

- To enumerate the total algaeof Rasa Tal.
- To identify the dominant algae of this Tal.
- To observe the water parameters of this Tal.

Research Questions

- Are the algal species found in this Tal similar with species present in its periphery region or different?
- Are there any new species of algae in this region for Nepal?
- Are there presences of any economically important algae?

Rationale of the Study

Different people have investigated fresh water algae at different times in various streams, ponds, and rivers in eastern Nepal.Although, this lake has been noted as a tourist destination for ecotourism and picnic spots, algal exploration has not been done yet by any person. Once the algal floras are identified in this region, it may add more literature on the study of algae in Nepal. It will be the preliminary study for this area.

Delimitations of the Study

- The present study will focus on a single artificial pond located in a specific geographic location.
- The study will only include algal samples collected using specific sampling techniques, such as by squeezing and using plankton net.
- The study will be limited to a 3 months period which is not sufficient to explore whole algae in different seasons.
- Identification of algae is entirely based on morphological characters rather than cytogenetical or databases of nucleotide sequence.

CHAPTER II
LITERATURE REVIEW

International Status

When the importance of algae came to know human, they started algal exploration around the world from 1980th. Many authors like West and West (1902), Fritsch and Rich (1937), Scott and Prescott (1961), Turner (1892), Bruehl and Biswas (1926), Geitler (1932), Hendy (1964), Foged (1980, 1982) and Gandhi (1999) have studied algae flora from different countries in the globe. Most of the developed countries have almost completed their algal database and further regular explorations help them to updating their algal flora.

A number of Indian authors have studied various groups of algae, including cyanophyta (Desikachary, 1959), zygnemaceae (Randhawa, 1959), vaucheriaceae (Venkataraman, 1961), charaphyta (Pal et al., 1962), ulotrichales (Ramanathan, 1964), chlorococcales (Philippose, 1967), volvocales (Iyenger and Desikachary, 1981), and oedogoniales (Gonzalves, 1982). The Indian Council of Agricultural Research (ICAR), New Delhi, published monographs on Indian algae.

National Status

There hasn't been much algal exploration in Nepal for taxonomic research; what little that has been done has primarily been restricted to the country's midhills and higher mountains. Examining the literature's historical background reveals that Carter (1926) may have been the first to document Nepal's algal flora when he identified *Hydrodictyon reticulatum*, *Cladophora glomerata*, and *Monostroma sp*. from Nuwakot and *Navicula confervacea* from Makawanpur district.Afterwards, some Nepalese, Indian, Japanese and German teams have studied algae of Nepal mainly from the mountain and Himalaya regions of the country. It is still essential to explore of the algal flora of terai region in Nepal since there are large number algal species due to favorable hot and humid climate.

The algal flora of Nepal has benefited greatly from the work of the Japanese laborers. Hirano (1955, 1963, 1969, and 1984) of Kyoto University published the first significant reports, which included 271 taxa from Central and Eastern Nepal, including 79 species of desmids. From Eastern and Central Nepal, Watanabe (1971, 1982) of the National Science Museum, Tsukba, has reported 24 species of Closterium. Additionally, 50 taxa of algae from Rara Lake and its environs have been identified by Watanabe (1995).

Similarly, 79 taxa from the Himalayan regions of Lobuche, Pheriche, Karyolung, and Thodung have been documented by Foerster (1965). Dwivedi (1985) has reported 6 taxa of chaetophorales from Janakpur, all new for the country. Prasad *et al.* (1985) have also reported 4 taxa of green algae i.e., *Characiosiphonrivularis* from Karmaiya, *Dimorphococcus lunatus* from Chandranigahpur, *Cylindrocystis depressa* from Chandi river and *Schizomeris leibleinii* from Sagarnath along the border of North Bihar. 38 algal taxa from the Kaski lakes of Phewa, Begnas, and Rupa have been documented by Ishida (1986). According to Haga (1988) of Hokkaido University, Kathmandu is home to nine different filamentous chlorophyceae species. Similarly, Nakano and Watanabe (1988) reported on eleven species associated with chlorococcals from Kathmandu. After studying the desmid flora of Kathmandu, Bando et al. (1989) discovered 49 species, 5 variations, and 3 forms from 10 genera.

Sahay*et al.* (1992 & 1993) has reported total 110 taxa from Terai and along the Indo-Nepal boundary. A total of 103 desmid taxa have been reported by Habib and Chaturvedi (1995 & 1997) from Mahendranagar and the Mahakali River. Additionally, Chaturvedi and Habib (1996) listed all 50 taxa of Chlorococcales found in Mahendranagar. 26 cyanophycean, 23 chloraphycean, and 3 euglenophycean forms have been identified by Das and Verma (1996) from various lakes, ponds, and rivers in the districts of Chitwan and Nawalparasi. Of these, two euglenophycean forms, fourteen cyanophycean forms, and fourteen chlorophycean forms were first documented from the nation. Habib (1997) provided a description of the algal flora of Mahendranagar, reporting 61 taxa in all, 38 of which were new to the nation. Four species of Stigeoclonium from the border region of Nepal and North Bihar, India, have been reported by Kargupta and Jha (1997).

Additionally, Nepalese phycologists have contributed to the nation's algal flora. The literature that is currently available states that Joshi (1977) documented five species of Oscillatoria from Kathmandu. Further 16 taxa of cyanophyceae from Kathmandu were later reported by Joshi (1979), including 7 new records for the nation.

O. princeps has also been reported by Upadhyaya (1979) from the Narayani River near Narayanghat. Shrestha and Manandhar (1983) have reported a list of 48 algal taxa from Kathmandu, Nepal. Additionally, from the Narayani and Orahi rivers, Pradhanang et al. (1988) collected the taxa Myxophycean (4), Chlorophycean (10), Bacillariophcean (8), and Chrysophycean (1).

Similar research was done by Lacoul (1993) on the freshwater algae found in the rivers of Chitwan National Park. Nineteen Bacillariophycean species have been identified by Aryal and Lacoul (1996) from the Punyamati River in Panauti. Comparably, 29 species of Cyanophyceae have been identified by Pant and Gupta (1998, 1999) from Lamjung's rice field. According to Baral's collective checklist (1999), 687 algal taxa (including Cyanophyceae 141, Chlorophyceae 306, Chrysophyceae 201, Euglenophyceae 38, and Rhodophyceae 1) under 150 genera and 50 families comprise the complete algal flora of Nepal.Several algal species from Taudaha Lake in Kathmandu have been documented by Bhatt et al. (1999).

The Cyanophycean forms from the Bagmati (Kathmandu, Lalitpur, Bhaktapur, and Dhading districts) and Narayani (Bara, Parsa, Rautahat, and Chitwan districts) zones have also been investigated by Prasad and Prasad (2001). Rai and Misra (2007) have also described some *Spirogyra* and *Sirogonium* species new to Nepal. Rai *et al.* (2008) have been reported 36 desmids from Bees Hazaar Lake, Chitwan. Rai and Misra (2010) have been given the latest record of cyanobacteria of Nepal which includes a total 274 taxa under 61 genera.

Algal flora of Koshi Tappu Wildlife Reserve and its surrounding area has been studied by the following workers. Twenty-four cyanophycean taxa from the Sapta Koshi Basin were described by Jha and Kargupta (2001), of which fifteen were new records for Nepal. Four further reports for Nepal were included in the 14 taxa of the genus *Oscillatoria* that they later (2006) described from the same sites. 26 desmids from Koshi Tappu Wildlife Reserve, including 11 new taxa for the nation, have been reported by Rai and Misra (2008). Prasad (2011) has published a modern checklist of algae of Nepal.

Algal studies on fresh water algae of eastern side water resources from Rasa Lake have been conducted**.** Rai (2011) investigated the algal flora of the Betana wetland in Morang and found 23 taxa, including six new records for the nation's diatom population. Similarly, 52 taxa, including 10 new species for Nepal, were reported by Shrestha et al. (2013) after studying the algae in Itahari and the surrounding area. The algal flora of Koshi Tappu Wildlife Reserve, including desmids, has also been examined by Rai (2013a & 2014). Freshwater red algae thrive in the Haseena Wetland. Recently, the diatom of HaseenaWetland was also studied by Adhikari (2016) but the rest algae of this locality have not been studied yet. Rajopadhyaya (2016) had also studied algae of Bagh Jhoda Wetland, Morang, Nepal. Later, rest algae of Haseena Wetland had been studied by Rai (2017). However, Rasa Lake is completely new site for fresh water algal exploration.

CHAPTER III

MATERIALS AND METHODS

Study Area

RaSa Taal (Rastriya Sampada Taal), is located at 64 Bigha of Ramdhuni Municipality, Ward No. 7 which was established in 2071 BS. It is also known as Iman Singh Chemjong Taal (Fig. 1). It is bounded by Charkoshe forest from north, village from south, and localities of 75 bigha from west. It is situated toward north east side from Jhumaka bajar of Itahari Sub-Metropolitan city. The Tal covers an area of 2.5 ha with water body only. It has plane to be extended its area up to 3.8 h in the future. There can be reached by moving along the Jhumka to Chatara roads upto Seuti Bridge and then subway of north east.

Figure 1

Study area: Rasa Taal

Sunsari Community Forest established in B.S. 2056 encompasses this lake occupying an area of 500 ha. The lake is surrounded by different taxa like *Shorea robusta*,

Pinus roxburghii, alien invasive species i.e., *Chromolaena odorata* etc. Water collected in this lake passes out through an outlet door made at southern side of this lake which is used for irrigation purpose in agricultural fields. Local people have made 13 temples on the lake premises which belong to different religion of different ethnic groups. They have more plans to make more religious temples in future. For the economic activity in this tourism area, even fish keeping, boating services and picnic spots are run by the by Lake Development Committee.

Algae Collection and Identification

In the course of collecting samples after choosing sites, atotal 12 algal samples, 2 samples from each site were collected from six algal sample collection sites at Ra.Sa. lake randomly. During sample collection ,plankton net (mesh size 0.5 mm) were used for collecting floating algae and submerged leaves and roots of aquatic macrophytes were squeezed to collect other types of algae during the period Chaitra, 2079. Only quarter of sample collection container were filled to keep algae alive longer. Optimum amount of water was added in the container bottle and closed providing saturated atmosphere. After filling each bottle with algal sample ,it was labeled properly by mentioning sample numner, date of collection, method of collection, sites etc.With the help of GPS coordinates app installed in Samsung Galaxy A32 5G,the latitude, longitude and altitude of six major sites were measured. Using the same mobile, necessary photos of the collection sites were obtained. Each site's water temperature and pH were also assessed using a portable Henna pH meter and a Mercury thermometer, respectively. Latitude, longitude, water temperature and pH were recorded properly in the field.

To preserve the material sample from decaying and further studies, FAA solution and 4% formaldehyde solution were added in optimum amount in the bottles. The specimen material from each sample was mounted with glycerin jelly on the slides (Sharma, 1992). Different magnification viz., 100X, 400X and 1000X of the compound microscope were used to examine the prepared slides precisely. Some confused taxas belonging to family chlorophyceae were recognized by staining with 1% aqueous methylene blue solution and iodine solution. Using microscope model Olympus Ch20i and Samsung Galaxy A32 5G, necessary microphotographs with clear focusing were taken under flash- light off and macro-mode condition. Algae were measured using stage and ocular micrometers.

The identification of the algal taxa was done by consulting a number of books and monographs, such as Prescott (1951), Tiffany and Britton (1952), Desikachary (1959), Randhawa (1959), Scott and Prescott (1961), Philipose (1967), Croasdale and Flint (1986, 1988), Croasdale et al. (1994), Prasad and Srivastava (1992), Prasad and Mishra (1992), etc. Identification and the most recent nomenclature modifications were also approved by browsing through online algae databases such as http://algaebase.org, http://desmids.science4all.nl, http://digicote.info, etc.

CHAPTER IV
RESULT AND DISCUSSION

52 algae in all, representing 6 Phylum, 8 classes, 17 orders, 26 families, and 31 genera, were identified using a compound microscope throughout this study project by consulting numerous reference books, as indicated in the references list (Table 1). The phylum charophyta includes the maximum number of algal taxa -23 with 1 class, 3 order, 6 famillies and 10 generas which is followed by the another phylum Bacillariophyta with 10 algal taxas, 2 classes, 6 orders,8 families and 8 generas. Similarly, the third position is followed by the phylum chlorophyta with 7 algal taxas, 2 classes, 3 order, 5 families and 6 gnera, 4th position by the phylum Cyanobacteria with 6 algal taxas, 1 class, 3 order, 4 families and 3 generas; 5th position by the phylum Euglenozoa with 5 algal taxas, 1 class, 1 order, 2 families and 3 genera and 6th position by the phylum Ochrophyta with 1 algal taxa, 1 class, 1 order, 1 fmailies and 1 genera, respectively.

Table1

Respresentation of total algae under class, family and genera

S.No.	Phylum	Class	Order	Family	Genera	Algae taxa
1	Cyanobacteria	1	3	4	3	6
2	Bacillariophyta	2	6	8	8	10
3	Chlorophyta	2	3	5	6	7
4	Charophyta	1	3	6	10	23
5	Ochrophyta	1	1	1	1	1
6	Euglenozoa	1	1	2	3	5
Total	6	**8**	**17**	**26**	**31**	**52**

In the same way, families – Desimidaceae with 13 taxas, Chlosteriaceae with 6 taxas and Euglenaceae with 5 taxas were dominant over other families. While observing the dominancy of genus, genus Cosmarium stands on first position with 7 taxas, Closterium on 2nd position with 6 taxas and Staurastrum on 3rd position with 3 taxas.

Table 2

Classification table of total algae reported from Rasa Lake

Phyllum	Class	Order	Family	Genera	Species
Cyanobacteria	Cyanophyceae	Chroococcales	Microcystaceae	*Aphanothece*	1. *Aphanothece stagnina*
			Cyanothrichaceae	*Johannesbaptistia*	2. *Johannesbaptistia* sp.
		Oscillatoriales	Oscillatoriaceae	*Oscillatoria*	3. *Oscillatoria crassa*
					4. *Oscillatoria* sp.
		Nostocales	Aphanizomenonaceae	*Anabaena*	5. *Anabaena inaequalis*
					6. *Anabaena* sp.
Bacillariophyta	Coscinodiscophyceae	Aulacoseirales	Aulacoseiraceae	*Aulacoseira*	7. *Aulacoseira granulata*
	Bacillariophyceae	Licmophorales	Ulnariaceae	*Ulnaria*	8. *Ulnaria ulna*
		Eunotiales	Eunotiaceae	*Eunotia*	9. *Eunotia bilunaris*
		Naviculales	Naviculaceae	*Navicula*	10. *Navicula rostellata*
			Pinnulariaceae	*Pinnularia*	11. *Pinnularia* cf. *cardinaliculus*

					12. *Pinnularia grunowii*
		Cymbellales	Gomphonemataceae	*Gomphonema*	13. *Gomphonema acidoclinatum*
					14. *Gomphonema pseudoaugur*
			Cymbellaceae	*Encyonema*	15. *Encyonema silesiacum*
		Bacillariales	Bacillariaceae	*Nitzschia*	16. *Nitzschia palea*
Chlorophyta	Trebouxiophyceae	Chlorellales	Chlorellaceae	*Dictyosphaerium*	17. *Dictyosphaerium pulchellum*
	Chlorophyceae	Chlamydomonadales	Sphaerocystidaceae	*Sphaerocystis*	18. *Sphaerocystis schroeteri*
		Sphaeropleales	Selenastraceae	*Anikistrodesmus*	19. *Ankistrodesmus falcatus*
				Kirchneriella	20. *Kirchneriella lunaris*
				Monoraphidium	21.*Monoraphidium griffithii*
			Scenedesmaceae	*Scenedesmus*	22. *Scenedesmus obtusus var. apiculatus*
			Hydrodictyaceae	*Pediastrum*	23. *Pediastrum tetras*

Charophyta	Zygnematophyceae	Desmidiales	Spirogyraceae	*Spirogyra*	24. *Spirogyra sp.*
			Gonatozygaceae	*Gonatozygon*	25. *Gonatozygon monotaenium*
			Closteriaceae	*Closterium*	26. *Closterium dianae*
					27. *Closterium dianae var. arcuatum*
					28. *Closterium ehrenbergii*
					29. *Closterium gracile*
					30. Closterium setaceum
					31. *Closterium cf. striolatum*
			Desmidiaceae	*Pleurotaenium*	32. *Pleurotaenium ehrenbergii*
				Euastrum	33. *Euastrum binale*
				Cosmarium	34. *Cosmarium auriculatum*
					35. *Cosmarium blyttii*
					36. *Cosmarium* cf. *lundellii*
					37. Cosmarium circulare
					38. *Cosmarium connatum*

					39. *Cosmarium obsoletum* var. *sitvense*
					40. *Cosmarium obtusatum*
				Micrasterias	41. *Micrasterias zeylanica* var. *rectangularis*
				Staurastrum	42. *Staurastrum forficulatum* var. *verrucosum*
					43. *Staurastrum lunatum*
					44. *Staurastrum muticum*
		Zygnema tales	Zygnemataceae	*Cylindrocystis*	45. *Cylindrocystis brebissonii*
			Mesotaeniaceae	*Netrium*	46. *Netrium digitus*
Ochro phyta	Chryso phyceae	Chromu linales	Dinobryaceae	*Dinobryon*	47. *Dinobryon sertularia*
Euglenozoa	Euglenophyceae	Euglenales	Euglenaceae	*Trachelomonas*	48. *Trachelomonas armata*
					49. *Trachelomonas intermedia*
				Euglena	50. *Euglena proxima*
			Phacaceae	*Phacus*	51. *Phacus longicauda*
					52. *Phacus orbicularis*

Rajopadhyaya and Rai (2016) studied fresh water algae of Bagh -jhoda wetland and reported 74 algal taxa belonging 43 genera. Among them 20 taxa have been reported new to Nepal from Bagh-jhoda wetland but new species for Nepal from Rsasa Lake were not studied. While comparing presence of various algal species between Rasa Lake and Bagh-jhoda wetland, *Gomphonema pseudoaugur* who is also a new species reported from Bagh -jhoda wetland for Nepal was also found in Rasa Lake.

Rai (2011) studied algal flora of Betana wetland and reported a total 23 epiphytic as well as planktonic taxa among which 6 taxa belong to the class cyanophyceae, 1 taxon to chlorophyceae and 16 taxa to bacillariophyceae. However, even a single species was not found common to each other among 23 taxa reported from Betana wetland and 52 taxa reported from Rasa Lake. *Gomphonema constrictum Ehr. var capitata*, *Gomphonema intricatum Kütz. var. vibrio*, *Gomphonema parvulum (Kütz.) var. lagenula* Hust., *Rhopalodia gibba (Ehr.) O. Müll. var. ventricosa*, *Nitzschia amphibia* Grun., and *Surirella tenera* Greg. *var. ambigua* Gandhi are six of the 23 taxa that have been reported from the Betana wetland as new species for Nepal. With sixteen species, diatoms dominated the algae community, whereas the only species of green algae found in the Betana wetland was Cosmarium maculatiforme.

On the other hand, algal species belonging to the family desmidiaceae are the most dominant algae and each of other 17 families like microcystaceae, Cyanothrichaceae,Aulacoseiraceae,Ulnariaceae,Eunotiaceae,Naviculaceae, Cymbellaceae, Bacillariaceae, Chlorellaceae , Sphaerocystidaceae, Scenedesmaceae , Hydrodictyaceae, Spirogyraceae , Gonatozygaceae , Zygnemataceae, Mesotaeniaceae and Dinobryaceae are represented by a single species.

Rai (2017) studied the fresh water algal flora (excluding diatoms) and reported a total 70 freshwater algae belonging to 6 divisions, 9 classes, 15 orders, 26 families, and 45 genera from five different localities of Hasina wetland and its periphery. Altogether, 16 genus were found common between Hasina and Rasa lake viz. *Oscillatoria* , *Anabaena , Sphaerocystis, Ankistrodesmus , Ankistrodesmus , Scenedesmus, Pediastrum ,Spirogyra ,Closterium, Pleurotaenium, Cosmarium, Staurastrum , Netrium , Dinobryon, Trachelomonas , Phacus.* On the other hand, even in such less number of algal species found in Rasa Lake and Hasina wetland, some species were also recorded common e.g. Sphaerocystis schroeteri , Pediastrum tetras , Closterium dianae , Closterium ehrenbergii

, Cosmarium blyttii , *Cosmarium* cf. *lundellii* **,** Netrium digitus and Trachelomonas armata etc.

The phylum charophyta includes the maximum number of algal taxa -23 and another phylum Ochrophyta includes only one algal taxa in Rasa Lake. Whereas, the division Chlorophyta includes the largest number of algal taxa-46 and each of the three remaining divisions *viz*. Chrysophyta, Euglenophyta, Pyrrhophyta is represented by 2 species in Hasina wetland.

While studying the distribution of algal species family wise in Rasa lake and Hasina wetland, the families – Desmidiaceae with 13 taxa, Chlosteriaceae with 6 taxa and Euglenaceae with 3 taxa were dominant over other families and each of 18 families includes only 1 taxa in Rasa lake. Whereas, families Desmidiaceae with 14 taxa, Oscillatoriaceae with 13 taxas, Oocystaceae with 6 taxa are dominant and other families such as Scytonemataceae, Rivulariaceae, Stigonemataceae, Palmellaceae, Oedogoniaceae, Hydrodictyaceae, Dictyosphaeriaceae, Vaucheriaceae, Mesotaeniaceae, Characeae, Tribonemataceae, Ochromonadaceae, Glenodiniaceae, Peridiniaceae are represented by single species in Hasina wetland .

Algae Description

Phylum: Cyanobacteria

Class: Cyanophyceae

Order: Chroococcales

Family: Microcystaceae

Genus: *Aphanothece* Nägeli (1849)

Holotype species: *Aphanothecemicroscopica* Nägeli

This species' colonies are made up of many cells that might be microscopic or macroscopic, mucilaginous, irregularly spherical or irregular, and distributed sparingly or thickly throughout the colony. Greenish, blue, brownish, or reddish-colored colonial cells are visible, while colonial slime is diffluent or (comparatively) restricted, typically amorphous, colorless, or at the surface, yellowish, yellow-brownish, or reddish-colored. Cells either have facultatively, occasionally concentrically lamellated mucilaginous envelopes (subg. Aphanothece) or no mucilaginous envelopes at all (subg. Anacystis). A few species have facultative aerotopes in their cells, which are broadly oval, oval, ellipsoidal or rod-like, straight or slightly curved, and occasionally have visible peripheral

chromatoplasm. The color of the cells varies from mild grayish blue-green to vivid blue-green or reddish. only transverse cell division in successive generations, perpendicular to the longitudinal axis; occasionally,

Aphanothece stagnina (Sprengel) A. Braun (1863) (Pl. 1, fig. 1-2)

References: Prescott, 1951, P.469, Pl. 103, Fig. 14-16; Desikachary, 1959, P.137, Pl.21, Fig. 10

Characters: The thallus, or main body of the algal plant, can have a diameter of several centimeters and might be spherical, ellipsoidal, dull brown, brownish, or pale blue-green. Its interior frequently contains calcareous crystals. The cells are long, 3.5-11 μm broad, somewhat ovoid or cylindrical, and blue-green in color. They are arranged either densely or sparsely, usually densely in the colony's periphery and sparsely within, without individual envelopes and homogeneous mucilage.

Collection number and collection date: RL-03, 2079/12/21

Family: Cyanothrichaceae

Genus: *Johannesbaptistia* G.De Toni (1934)

Holotype species: *Johannesbaptistiaprimaria* (N.L.Gardner) G.De Toni

Characters of genus**:** They are free-living, solitary and cylindrical, up to 1 mm long, uniseriate, very rarely pseudodichotomously divided and again joined, unicellular pseudofilamentous algae. They are made up of a simple row of "transversely elongated," roughly discoid cells that are oriented by their "longer" axis crosswise to the axis of the pseudofilaments and of the enveloping sheath.Sheaths are fine, thin, to slightly expanded from cells, colorless, gelatinous, and occasionally diffluent at the periphery. They are also not stratified. Even though they stay connected for a brief period of time following the division of the daughter cells, cells are either marginally or visibly separated from one another. Following the division of both daughter cells and the movement of one daughter cell away from the original pseudofilament direction, divarication begins. The cell content appears light blue-green.

***Johannesbaptistia* sp.** Toni (1934) (Pl. 1, fig. 2-3)

Reference: Desikachary, 1959, P. 163, Pl.14. fig. 19

Characters: This type of algae has tiny, linear, elongated, cylindrical, straight, or curved thallus. The discoid-shaped cells are organized in a single series within the narrow, cylindrical hyaline mucilage. They divide in a single plane that runs transverse to the thallus, and they proliferate by breaking apart into fragments that can contain one or more cells.

Collection number and collection date**:** RL-05, 2079/12/21
Order: Oscillatoriales

Family: Oscillatoriaceae

Genus: *Oscillatoria* Vaucher ex Gomont (1892)

Lectotype species: *Oscillatoriaprinceps* Vaucher ex Gomont

Trichomes of *Oscillatoria* are blue- green to brownish-green but occasionally it turns to be purple while getting old. Their core portion of trichomes (19) is 22-80 µm wide and frequently narrows toward the frequently bent extremities. They are extremely motile and exhibit minor or no constriction at the cross-walls. Apical cells have rounded terminal ends and can occasionally have a yellowish color when grouped with several neighboring cells. Granulation never lies at the cross-walls, even though the cells may contain fine to large granules. Less than half of the cells are broad. Usually before the preceding division is finished, new cell walls are generated perpendicular to the trichome axis. The cell wall is thick and colorless. There exist necrotic cells, but they are only visible in cultures under stress. There is no Calyptra.

Oscillatoria crassa (C.B. Rao) Anagnostidis (2001) [Old name: *Oscillatoria ornate* var. *crassa*C.B. Rao (1938)] (Pl. 1, fig. 5-6)

References: Desikachary 2059, P. 206, Pl. 39, Fig. 11; Anagnostidis 2001, P. 372

Characters: Thallus is dark blue-green. The trichome is narrow at the cross wall, granular at the cross wall, straight, and uniformly thick, measuring 11–15 µm in width. Cells have a length of 2-5.5 µm and are shorter than broad.End cells is convex in shape at terminal side without calyptra, not capitate.

Collection number and collection date**:** RL-08, 2079/12/25
***Oscillatoria* sp.** Gomont (1892) (Pl. 1, fig. 7-8)

Reference: Prasad and Srivastava, 1992, P. 55.

Characters: Trichome can occur alone or in the shape of a flat, spongy, free-swimming thallus without a sheath; it is sometimes found with a more or less fragile sheath. Trichome is motile, mostly through a crawling movement that rotates along the longitudinal axis. Trichomes have clearly defined ends that are pointy, bent like a sickle, coiled, or less like a screw. There are hormogones produced when the trichome divides.

Collection number and collection date: RL-01, 2079/12/21
Order: Nostocales

Family: Nostocaceae

Genus: *Anabaena*Bory ex BornetetFlahault (1886)

Holotype species: *Anabaenaoscillarioides* Bory ex Bornet & Flahault

The main feature of this algae is its filaments, which can be found alone, in free groups (subgroup Dolichospermum) or in large mats on the substrate (subgroup Anabaena). These filaments can also be coiled, tangled, or screw-like, with trichomes arranged roughly parallel to each other, deep constrictions at cross walls, and an absence of firm sheaths. On occasion, nevertheless, there are mucilaginous, hyaline, colorless, and frequently diffluent envelopes present. Heterocytes develop solitarily and intercalarially on the uniserial, frequently moniliform, isopolar, and always metameric trichomes at about certain distances from one another. Every fully grown trichome has three to nine heteroocytes in it. The cells exhibit a variety of shapes and sizes, including cylindrical, barrel-shaped, spherical, shorter than wide, pale or bright blue-green, or olive-green, with or without aerotopes (subg. Dolichospermum), and occasionally with granular material (subg. Anabaena). Occasionally, the terminal cells are not vacuolized, conical, rounded, or spherical, but rather slightly elongated. Heterocytes are often marginally larger than vegetative cells and are spherical, broadly oval or cylindrical, occasionally elongated. Akinetes are spherical, oval, or cylindrical, solitary, or in groups of several in a row, intercalary, and always develop in a paraheterocytic manner, either in close proximity to or somewhat apart from heterocytes on both sides. Without meristematic zones, cells divide across and resize to their initial size before dividing again. Heterocytes and akinetes are the usual sites of trichome fragmentation reproduction.

***Anabaena inaqualis* (Kutz.) Bornet and Flahault** (Pl. 2, fig. 1-3)

Reference: Desikachary, 1959, P. 413

Characters: Thallus looks like floccos, free-floating or attached to other algae, blue green color. Trichome has a breadth of up to 4–5 μ and is always parallel, straight, and occasionally free of a mucilaginous sheath. The 5–6μ length, spherical or barrel-shaped cells have rounded ends and barely attenuated apices. Spores can be single or numerous distant from the heterocyst, 6-8 μ broad and 14-17 (-20) μ long; episporesare smooth and yellowish. Heterocyst appears spherical, 6μ broad, or elongate and up to 10 μ long.

Collection number and collection date: RL-04, 2079/12/21

***Anabaena* sp.**Bory ex Bornet & Flahault (1822) (Pl. 2, fig. 4)

Ref: Prescott 1951,P. 510 ,511; Desikachary 1959

Characters: These are filamentous algae, which are typically gregarious, heavily entangled, and enclosed in amorphous mucilage. A few species are solitary and planktonic, and they occasionally attach themselves to damp substrates to produce films and gelatinous expansions. This type of algae has trichomes that are straight, flexible, or

spirally coiled, and can have a sheath or not. The cells are cellulose, formed like a barrel, or, in some cases, cylindrical. Unlike other species, heterocysts are typically found in large numbers, dispersed throughout the trichome, which can be spherical, oval, or cylindrical. On the other hand, gonidia are typically round, ovate, or cylindrical (sometimes elongate-ovate), and they can be found either close to or far from the heterocysts.

Collection number and collection date: RL-07, 2079/12/25

Phylum: Bacillariophyta

Class: Coscinodiscophyceae

Order: Aulacoseirales

Family: Aulacoseiraceae

Genus: *Aulacoseira* Thwaites (1848)

Holotype species: *Melosiracrenulata* (Ehrenberg) Kützing

Characters of genus: Long filaments that are straight, curved, or even coiled are created by closely joining cells. Plastids have a discoid form. a common planktonic genus found in freshwater that was once assigned to Melosira. There are valves that go round. The valve face can be either plain or have sporadic poroids, which are often limited to its edges. Deep valve mantle that is sharply separated from the planar valve face by rows of areolae that are either straight or curved. The mantle edge appears to be plain. At the valve face/mantle junction, spines are present. These spines have larger tips, and they join forces with other cell spines to create a bond that can only be severed by rupturing the spines. Certain species' spines have two "roots" that cross a row of mantle pores, whereas others have a single root along rows of pores. A. granulata has separation cells sporadically spaced apart, with lanceolate spines that vary in length. The areolae of separation valves are frequently arranged in straight rows, whereas the areolae of other valves spiral away from the sibling junction in different directions. There is a thickening (ringleiste) inside the valve mantle, which is hollow in A. ambigua, where the plain mantle border and the areolate part meet. Simple, circular to rectangular mantle areolae with volate occlusions are present. Tiny rimoportulae develop inside the ringleiste and open outward through it. With an advalvar pars media, the copulae are delicately areolate, divided rings with ligulae.

Aulacoseira granulata (Ehrenberg) Simonsen 1979 (Pl. 2, fig. 5)

Reference: Karthick et al., 2013, Pl. 3

Characters: The valve diameter of the plant body is 13-30μm, the valve mantle depth is 3-6μm, and the striga density is 8-12/ 10μm. Long filaments are formed by the end-to-end

elongated linking spines that adjoin the frustules; smaller spines may also be present around the valve margin. The valve is primarily viewed in girdle view, and it has coarse areolae that are distributed randomly on the valve face. However, in many specimens, the concentrated areolae are present or nearly exclusively restricted to the margin.

Collection number and collection date**:** RL-06, 2079/12/21
Class: Bacillariophyceae

Order: Licmophorales

Family: Ulnariaceae

Genus: *Ulnaria* (Kützing) Compère (2001)

Holotype species : *Ulnaria biceps* (Kützing) Compère

Characters of Genus: Valves are linear and elongated; some species are about 50 µm long, while others are longer than 500 µm. There is a narrow central sternum with striae that either slightly offset or meet from each side of the valve. There could be a core region that varies in size from small and oval to rectangular and reaches the valve borders. "Ghost striae" are striae that are faint and may cover all or part of the central region. At one or both apices, there are one to two rimoportulae. The apices of numerous species are noticeably rostrate. Striae can be uniseriate or biseriate, and they are punctate. The girdle bands are shut.In rivers and lakes, living cells are prevalent. An apical porefield secretes a mucilage pad that holds them to the substrate. There is complexity in the taxonomic history of Fragilaria that led to the creation of Ulnaria (Morales 2003, Silva and Hasle 2006, Williams 2011).

Ulnaria ulna (Nitzsch) Compère (2001**)** (Pl. 2, fig. 6; Pl. 3, fig. 1-3)

Reference: Karthick, Hamilton & Kociolek, 2013, Pl.18

Characters: Valves linear, with margins parallel, tapering to protracted to rostrate apices; central sternum narrow, straight; central area transversely expanded rectangular area, nearly square in shape; There may be short or "ghost" striae present at the margins of the central area; striae parallel; Near the valve's apex on one end is a single labilate process; valve length 74-103.5µm, valve breadth 6.5- 8.0 µm, stria density 8 – 11/10 µm.
Cells linked cell – to – cell to form a stellate colony. This taxon has a wide geographic distribution and often found in mesotrophic to eutrophic, alkaline waters.

Collection number and collection date: RL-03, 2079/12/21
Order: Eunotiales

Family: Eunotiaceae

Genus: *Eunotia*Ehrenberg (1837)

Characters of Genus: There is a little sternum close to the valve face's border. Raphe slits are located close to each pole and are quite short. Striae uniseriate into small, spherical areolae that is sometimes unevenly distributed and parallel to radiate. Valves are symmetrical to the transapical axis, dorsiventral, and frequently curved. Poles rounded to capitates, ventral margin straight or concave, and dorsal margin convex, smooth, or undulate.Raphe is primarily found on the mantle, somewhat asymmetrically relative to the sternum. It has observable terminal fissures that curve either back towards the valve center or towards the dorsal border. It is coiled onto the valve face around the apices, either gently or aggressively.Raphe is frequently limited to girdle view only.Several open girdle bands with rows of pores.

Eunotia bilunaris (Ehrenberg) Schaarschmidt (1880) (Pl. 3, fig. 4)

Reference: Karthick et al., 2013, Pl. 33

Only a little section of the raphe is visible on the valve face, and the valves are lunate or curved; apices slightly swollen, rounded; striae indistinctly punctate; valve length 66-86μm, valve breadth 2-3 μm, stria density 19- 20/10μm.They are distributed in oligotrophic to dystrophic waters with low pH and electric conductivity; present mostly in epiphytic habitats.

Collection number and collection date: RL-06, 2079/12/21

Order: Naviculales

Family: Naviculaceae

Genus: NaviculaBory (1822)

Holotype species:*Naviculatripunctata* (O.F.Müller) Bory

Characters of Genus: Typically, plants are free-floating. Certain organisms congregate in frondose mucus to form colonies that radiate erratically. This genus has smooth girdles and a rectangular girdle view. There may or may not be intercalary bands. This algae has linear, lanceolate, elliptical, or elliptic valve views that are occasionally oblong with undulate edges and ends that are sharp, rounded, rostrate, or capitates. The raphe of Navicula, which has recognizable central or polar nodules, is located in the axial portions of both valves and runs the entire length of the valves. It might be straight or curved, middle, thick or thin, and undulating. The surface of the valve is striated, with transverse, radial, or punctate striae that are sometimes convergent toward the ends and may or may not be crossed by longitudinal striae. There are sometimes coastae with a single or double row of dots.Two chromatophores, which resemble flattened band-like bodies and are

typically lobed or crenulate, are typically present. They normally lie along the girdle with one or more pyrenoids.

***Navicula rostellata* Kützing 1844** (Pl. 3, fig. 5)

Reference: Karthick et al., 2013, Pl.66

Characters: The valves have a lanceolate to slightly linear appearance; they have a thin axial region, a moderately wide, rounded central area that is symmetrical, and a central nodule that is thicker on one side.Raphe lies in the middle axially straight, filiform, with proximal raphe ends dilated slightly and bent towards one side.Striae is located radially at the centre becoming convergent near the poles; valve length 25.0- 40.5μm, valve breadth 7-9 μm, stria density 13- 15/10 μm.

These are cosmopolitan eutrophic species having tolerance of critical levels of pollution.

Collection number and collection date: RL-05, 2079/12/21

Family: Pinnulariaceae

Genus: *Pinnularia* Ehrenberg (1843)

Holotype species: *Pinnulariaviridis* (Nitzsch) Ehrenberg

Characters of genus: Pinnularia algal species are solitary, free-floating, and sometimes form brief filaments. These plants have a relatively rectangular girdle aspect; septa and intercalary bands are lacking. The valve view has parallel or convex borders that occasionally undulate, giving it a linear or linear lanceolate appearance. Terminal ends typically have a rounded appearance, either broadly or precisely. Usually, the axial area appears thin or large, but on occasion, the core part gradually widens. The shape of the central section varies and it may or may not reach the sides. The raphe, which is located on the central axis, can be thick or thin, straight or curved, and have or lack definite polar and central nodules. The smooth, lineate, transverse, radial, or transverse pores that make up the costae or striae may or may not converge toward the poles. Typically, each frustule contains two sizable plates that resemble chromatophores.

Pinnularia* cf. *cardinaliculus Cleve (1895) (Pl. 3, fig. 6)

Reference: Friedman and Potapova, 2021.

Characters: The sides of a valve are almost parallel and linear. The cuneate apices are marginally wider than the valve's overall width. The linear axial region makes up around one-third of the valve width. The transverse fascia, which is rhombic or rounded in the center, is frequently decorated with marks of different shapes. In LM, the thick sternum is

visible running across the middle. The raphe is lateral, ending in pores that are curved toward the secondary side and with proximal parts that are softly inclined toward the main side. The cracks in the terminal raphe resemble question marks. Striae become slightly convergent toward the apices, and are slightly radiating around the valve center. Length 76-123µm, Width 15-19µm and striae 8-8.5µm

Collection number and collection date: RL-09, 2079/12/25

Pinnularia grunowii Krammer (2000) (Pl. 4, fig. 1)

Reference: JüttnerandCarter

Characters : This algal species' morphological body structure is as follows: length: 27–55 µm, width: 6.5–9 µm; shape: linear with undulating margins, capitates, and subcapitate ends; symmetry: isopolar, bilaterally symmetrical; radiate striae, becoming strongly convergent at capitate valve ends, some striae curved, 11–14 in 10 µm, with a rhombic center that frequently extends into a narrow or broad fascia and a narrow, linear axial region; occasionally, the central area is smaller and surrounded by short striae in the center of the valve; raphe–straight with proximal ends slightly expanded and deflected.

Collection number and collection date: RL-01, 2079/12/21

Order: Cymbellales

Family: Gomphonemataceae

Genus: GomphonemaEhrenberg (1832)

Lectotype species: *Gomphonemaacuminatum* Ehrenberg

Valves are rarely single, colonies usually appear fan shaped which attach to dichotomously branched gelatinous stalks and sometimes immovably fixed on substrate. They are asymmetrical transversely and remain as free floating algae. Intercalary bands and costae are absent on them. While observing from valve view, they appear cuneate, clavate, lanceolate, or nearly straight, sometimes broad and lanceolate. These algae's plant body is circular, unilateral, centric, and has a wide center area with dots arranged asymmetrically. They have polar and central nodules on the slender raphe that runs through the middle of their body. Fine or coarse, lineate or punctate, parallel or slightly radial, and occasionally convergent towards poles striae are seen on their body.Most of them have generally single chromatophores with single pyrenoid.

Gomphonema acidoclinatum Lange-Bertalot & Reichardt (2004) (Pl. 4, fig. 2-3)

Reference: Rai and Khadka, 2017; Werum and Lang- Bertalot 2004, Pl.92, Fig.1-5, 6-11

Characters: Valves have a somewhat claviform shape that is similar to lanceolate; they are briefly heteropolar and usually somewhat bent; the unilateral middle area is roughly

rectangular and considerably elongated; the tip is blunt and rounded triangular, roughly stretched and tapering. The raphe, which is thread-like and somewhat wavy, is located in the center of the body, aligned with the longest central streak and the distal ends of the same curved hook side. The striae are normally fairly radiating, measuring 20-25 μm in length, 6.5-9 μm in width, and 12-15 in 10 μm in striae.

Collection number and collection date: RL-02, 2079/12/21

Gomphonema pseudoaugur Lange-Bertalot (1979) (Pl. 4, fig. 4)

Reference: Marquardt et al., 2011. P. 226, Fig. 21

Character: Strongly heteropolar, oval to lanceolate club-shaped valves with rounded foot poles and strongly prolonged head poles have weakly radical, indistinctly punctate striae throughout, and a small central area formed by the shortening of central striae. The stigmata are connected to the end of a single central stria.

A widely distributed species that can be found in waters that are meso- to eutrophic but not overly contaminated. It is held in place by dichotomous mucilage stalks that cling to the substrate.

Collection number and collection date: RL-05, 2079/12/21

Family: Cymbellaceae

Genus: EncyonemaKützing (1834)

Characters of genus: Dorsiventral valves: frustules rectangular or slightly biconvex in girdle view; valves symmetrical to the transapical axis; convex dorsal edge straight, occasionally gibbous or rearely convex; apices rounded or prolonged. Uniseriate striae exist. At the proximal end of the central ventral striae, close to the raphe ends, sigmoids may be seen.Raphe is usually closer to the ventral boundary, with internal proximal raphe fissures deflected to the dorsal side, proximal ends somewhat deflected to the dorsal side, and distal terminals curved to the ventral side.

Encyonema silesiacum (Bleisch) D.G. Mann (1990) (Pl. 4, fig. 5)

References: Karthick et al., 2013, Pl. 100.

Character: Dorsiventral valves that are strongly widespread have a straight ventral margin with a little center expansion, a convex dorsal margin, and a half-elliptical to half-lanceolate form. The tip is blunt, rounded, and does not extend. The axial region is linear and tapering, the central portion is lanceolate and asymmetrical, and the proximal end is small, rounded, and slightly dorsally deflected. The raphe is bent and lateral.Ventrally deflected curved digital ending; striae more or less parallel or slightly radiate at the ends.Valve length 37.5-68.0μm, Vave breadth 10.0-13.5 μm, and stria density 7-11/10 μm.

A widely distributed species that can survive highly contaminated environments. It is found in both stationary and moving oligo to eutrophic streams.

Collection number and collection date: RL-02, 2079/12/21
Order: Bacillariales

Family: Bacillariaceae

Genus: *Nitzschia* Hassall (1845)

Holotype species: *Nitzschiaelongata* Hassal

Characters of genus: This genus's algae exist solitary, freely float, occasionally join to form colonies, or are immersed in branching gelatinous mucus. The majority of valves are linear, elongated, or sigmoid, occasionally having rostrate or capitates ends and undulating edges with excentric keels positioned diagonally on the frustules. The valve's surface is lined, punctate, or striated; the striae can be organized transversely, diagonally, or obliquely, and a longitudinal hyaline area or fold may or may not pass across it. Laminated chromatophores are typically found.

Nitzschia palea (Kützing) W. Smith (1856) (Pl. 4, fig. 6)

Reference: Karthick, 2013, Pl. 118

Characters: From linear-lanceolate to linear or lanceolate, the valve appears. The stria are hardly discernible under Lm; the poles are thin with apices subcapitate or weakly capitates; the marginal raphe is supported by a short block that resembles different fibulae and is less regularly distributed.It has valve with length 27.5 – 47.5µm, valve breadth 3.5-5 µm, fibula density 9-14/ 10 µm, stria density more than 30/ 10 µm, scale bar,LM 10 µm. This is the most cosmopolitan taxa with wide variation in its ecology, typical dominant in industrial polluted and hypereutrophic waters.

Collection number and collection date: RL-04, 2079/12/21

Phylum: Chlorophyta

Class: Trebouxiophyceae

Order: Chlorellales

Family: Chlorellaceae

Genus: *Dictyosphaerium* Nägeli (1849)

Holotype species: *Dictyosphaeriumehrenbergianum* Nägeli

Thalli are free-floating, spherical to irregular colonies that have a diameter of 10-100 µm and contain four to sixty-four cells embedded in a shared envelope. The surface of the

colony and the cells are perpendicular to one another. The cells adhere to the tips of thin stalks that emerge from the colony's center to produce dichotomous or tetrachotomous branches.Cells are spherical to oval to ellipsoid or cylindrical, 1-10 µm in diameter or length. Almost all species have spineless typical smooth cell walls except in one species which have rough cell walls. Cells are uninucleate where as mostly single cup- shaped parietal chloroplast is present in vegetative cells. However, two such chloroplasts are always found in mature or dividing cells. Each chloroplast possesses a single pyrenoid.

Asexual reproduction takes place by 2 or mostly 4 autospores produced in each sporangium. Mother cells are typically divided into two perpendicular planes and also perpendicular to thallus surface. Rupturing of parental cells liberates spores which attach to parental wall remnants; cell wall remnants develop into mucilaginous stalks.Multiple cycles of autospore formation produces large colonies. Some early authors reported presence of zoospores but poorly documented and considered absent by recent specialists. Sexual reproduction is oogamous type which has been reported only in *D. indicum*. Male gamete extends with two apical flagella. *Dictyosphaerium* are common and perhaps cosmopolitanly distributed in a variety of freshwater habitats soil. Green water blooms may occur in eutrophic reservoirs and fishponds. At the end of the growing season colonies break up, forming single cells that later regenerate new thalli. Specialized dilute and low pH media have been developed for growth of particular *Dictyosphaerium* spp. Pyrenoids are absent in a separate genus *Pseudodictyosphaerium*.

Dictyosphaerium pulchellum Wood 1874 (Pl. 4, fig. 7)

Reference: Prescott, 1951, P. 238, Pl. 51, fig. 5-7

Characters: This algae species comprises an ovoid to spherical colony with around 32 spherical cells arranged in four series on dichotomously branched colony threads. The cells in the colony range in diameter from 3 to 10 µm, and the colony is coated in mucilage.On rare occasions, this species makes up a significant portion of the plankton in acid swamp lakes. Pitcher plant leaves (Sarracenia purpurea L.) are said to contain it, according to Taylor (1935).

Collection number and collection date: RL-06, 2079/12/21

Class: Chlorophyceae

Order: Chlamydomonadales

Family: Sphaerocystidaceae

Genus: SphaerocystisR. Chodat (1897)

Holotype species: *Sphaerocystisschroeteri* Chodat

The plant body of algal species under this genera exist in the form of spherical colonies with diameter of more than 1 mm and 4-32 (-64) cells embedded in extensive mucilage. Cells are spherical in shape with 4-16 &m diameter and remain in clustered form within mucilage in groups of four or more or less dispersed. Cells contain smooth cell walls, single nucleus, single chloroplast and single parietal pyrenoid. Asexual reproduction occurs generally by the autospores enclosed 2, 4, or 8 in number per sporangium and released by fragmentation of sporangial wall. However, cell wall fragments are not distinctly visible but remain dissolved in colonial mucilage. Zoospores have two apical flagella and cup-shaped chloroplast with pyrenoid. *Sphaerocystis* are planktonic in freshwater that have been reported from Europe, North America and South Africa. Some genus has unsure affinities which have positioned by recent authors in Hormotilaceae, Radiococcaceae and Palmellaceae.*S. signiensis, S. bilobata, S. polycocca, S. sphaerocystiformis* and *S. bavarica* have been relocateed to *Coenochloris, Coenocococcus* or *Planctococcus* by various authors.

Sphaerocystis schroeteri Chodat 1897 (Pl. 5, fig. 1)

Reference: Prescott 1951, P.83, Pl. 3, Fig. 6, 7

Characters: Within the colonial envelope, a colony typically consists of small spherical clusters made up of both newly divided and undivided cells. The diameter of a cell is 6–20 μ, but a colony can reach 500 μ in diameter.

It is appropriate to relate this plant to Planktosphaeria gelatinosa. These algae are abundant and widely dispersed in both soft and hard water lakes.

Collection number and collection date: RL-07, 2079/12/25

Order: Sphaeropleales

Family: Selenastraceae

Genus: AnkistrodesmusCorda (1838)

Lectotype species: *Ankistrodesmusfusiformis* Corda

Characters of genus: Cells rarely solitary, exists in colonies of few to many cells. Mucilaginous envelopes present or absent. Cells are sometimes straight but more often curved or twisted pointed and highly attenuate tips. Cells are mostly found in parallel bundles, in some species individual cells or bundles rotating to give spiked or stellate appearance to colony. Cells have single nucleus, smooth cell wall and single band shaped parietal chloroplast but number of chloroplast multiply and become many in number before formation of autospore. Pyrenoids are absent. Asexual reproduction produces autospore development and colony breakup, with 2-4-8 (-16) spores per sporangium. After

being released, spores become more or less distinct and occur in parallel in one or two series in bundles. Spores are released by transversely separating the core portion of the sporangial wall; wall fragments are then discarded or dissolve. Sexual reproduction and flagellated stages are unknown.

Ankistrodesmus falcatus (Corda) Ralfs 1848 (Pl. 5, fig. 2-4)

References: Prescott, 1951, P. 253, Pl. 56, Fig. 5, 6; Philipose 1967, P. 211, 212, Fig. 121 a, c

Characters: Chloroplast 1, a parietal plate devoid of pyrenoids, is a form of needle-like to somewhat spindle-shaped cell that can be found alone or in groups of two to three people and is not covered by a colonial sheath.The cells are 2–6 µ in diameter and 25–100 µ long, occasionally longer.

Collection number and collection date: RL-03, 2079/12/21

Genus: Kirchneriella Schmidle (1893)

Holotype species:*Kirchneriellalunaris* (Kirchner) Möbius

Characters of genus: Thalli microscopic and colonial with 2-4-8 to 64 cells dispersed in homogenous mucilaginous envelope. The smooth cell walls of the cylindrical, lunate, sickle-shaped, twisted fusiform, or spirally twisted cells measure 3-40 x 1-7 µm. Each cell contains one nucleus, one parietal chloroplast, and one to four pyrenoids.Asexual reproduction takes place by 2-4-8 autospores formation per sporangium which are produced in a series and released by rupture of parental cell wall.

Kirchneriella lunaris (Kirchner) Moebius (Pl. 7, fig. 1-2)

Reference: Prasad & misra, 1992, P. 28, Pl. 4, fig.3

Characters: With a thin outer gelatinous coat, colonies are spherical to subelliptical in form. The cells are flattened, crescent-shaped, highly curved, and have pointed ends. The chloroplasts are solitary, almost filling the cell, and contain a single pyrenoid. The cells are haphazardly grouped in groups of four or eight.They have colonies with diameter 46-51µm; cell length 8.5- 13 µm & lat. Cell. 2.5-4 µm.These is planktonic in ponds.

Collection number and collection date: RL-01, 2079/12/21

Genus: *Monoraphidium*Komárková-Legnerová, 1969

Holotype species:*Monoraphidiumgriffithii* (Berkeley) Komárková-Legnerová

Plant is unicellular, not embedded in mucilage envelope. Cells range in size from 2-182 x 1-8 µm, and they might be straight, lunate, sigmoid, or helically twisted, frequently with elongated ends. The walls of cells are smooth. With a single parietal chloroplast and no pyrenoid, or a compound one when present, and no starch sheath, the cells seem

uninucleate.Autospores, ranging from two to sixteen per sporangium, are formed in one or two parallel series during asexual reproduction and are discharged through longitudinal or transverse parental wall rupture. Sexual reproduction and flagellated stages are unknown. Monoraphidium: reported from Europe, Asia, and North America; planktonic or attached; found in freshwater or in soil.

Monoraphidium griffithii (Berkeley) Komárková-Legnerová (1969) (Pl. 7, fig. 3-6)

Reference: Peixoto Ramoset al. 2012, P. 429, Fig. 3c

Character: The parietal chloroplast is absent from the solitary, fusiform, elongated cells, which are 16–22 times length than broad, straight or slightly curved, gradually narrowing, and ending in an acute or short spine. Dimensions of the cell: length 45 58 μm, width 2 3.5 μm.

Collection number and collection date: RL-05, 2079/12/21
Family: Scenedesmaceae

Genus: *Scenedesmus*Meyen (1829)

Lectotype species: *Scenedesmusobtusus* Meyen

Characters of genus: Thalli are single-celled or colonial structures made up of two to thirty-two cells. Four or eight-celled coenobia are typically present, and they may or may not have a mucilaginous matrix surrounding them. The arrangement of cells is either alternating, linear, or in two to three rows that only adhere to the subpolar region or the lateral walls. Cells range in size from 3-78 x 2-10 μm and are almost spherical to ellipsoidal, elongate or fusiform, or elongate fusiform. Polar ends of cells can be long and tapering, acute, obtuse, or capitate. In the subgenus Acutodesmus and Scenedesmus, the hemicellulosic and sporopolleninic layer present in the cell wall is usually smooth, however in the subgenus Desmodesmus, it is partially visible under a light microscope as ribs, granulations, or dents. Although cells lack spines, the subgenus Desmodesmus contains some species with slightly sporopolleninic spines.Excretion of proteinaceous bristles has been observed. Cells contain a single nucleus, a single chloroplast and parietal pyrenoid respectively. Asexual reproduction takes place by autospores (almost 2-32) stored per sporangium.

Usually, these autospores dissolve into a single cell or are arranged in a single coenobium. Once they mature, their parents' cell walls burst, releasing them. In the subgenus Acutodesmus, S. obliquus has been seen to reproduce sexually, however this is reportedly incredibly uncommon. Gametes are isogamous and biflagellate. If there is no syngamy, gametes will break apart.Chromosome numbers of species belonging to these

genera has been rarely reported however, number of chromosome, n = 11 or 13 have been observed in *S. quadricauda*

Scenedesmus obtusus var. apiculatus (West &G.S.West) P.M.Tsarenko (2000) (Pl. 8, fig. 5)

Reference: West and West 1984, P. 16, Pl. 2, Fig. 38 (As *S. alternans*var. *apiculatus* - Old name)

Characters: Colonies enclose 4-8 cells. The alternating series of cells has fusiform, ellipsoid, oblong-ellipsoid to ovoid-shaped cells with obtuse poles that are only partially in contact with one another. Colonies are often aggregated in syncoenobia due to fragmented parent cell wall remnants. Cells measure 4.5-7.9 μm in width and 10-16.7 μm in length.

Collection number and collection date: RL-05, 2079/12/21

Family: Hydrodictyaceae

Genus: PediastrumMeyen (1829)

Lectotype species: *Pediastrumduplex* Meyen

Characters of genus: Colonial thalli comprises 4-64 (-128) coenobia cells which has 15-400 mm diameter. These coenobia cells are grouped into a single-cell-thick, flat, circular to oval plate. When 16 or more cells are present, they usually stay in concentric rings. A certain number of cells make up each ring; the disc can be continuous or have holes in between the cells. Ring development is influenced by zoospore behavior during coenobial formation. The diameter of a cell varies greatly, ranging from 8 to 32 &m. The interior of a cell is usually polyhedral, with four to many sides. Similar or with one or two horn-like projections are peripheral cells. Peripheral cells typically have bristles, but central cells do not. The walls of cells might be extremely granulate, delicately reticulate, or smooth.Cells are multinucleated. Each cell has single chloroplast diffuse at parietal region and one or more pyrenoid.

Pediastrum tetras (Ehr.) Ralfs. (Pl. 8, fig. 6)

Reference: Prasad & Misra, 1992, P.11, Pl.1, Fig. 9

Characters: Circular colonies are composed of 8 cells lacking intercellular spaces and perforation on wall; outerside of marginal cell with a deep, cuneate incision upto the middle of cell; each lobe slightly truncate, inner cell six- sixed with a single linear incision. The size of colonies varies from 24- 26.5 μm, cell legth 7.0- 9.0 μm & lat.cell. 8-9.5 μ

Collection number and collection date: RL-02, 2079/12/21

Phylum: Charophyta

Class: Zygnematophyceae

Order: Spirogyrales

Family: Spirogyraceae

Genus: *Spirogyra* Link (1820)

Characters of genus: Algal species have long, filamentous, branchless plant bodies that typically lack basal distal differentiation. They do, however, occasionally have rhizoidal branches that emerge laterally on the filament that makes contact with the substrate. Cylindrical, smooth, planar, and ranging in length from small to very long in certain species, cells multiply and attach to one another via their end walls. Chloroplasts (1–16) are found in each cell as a parietal band or ribbon. They can be almost straight (as in the genus Sirogonium, which is not divided here) or spirally twisted ½ to 3 (rarely 8) turns. Either lateral or ascalariform conjugation—which typically involves the development of tubes—occurs during sexual reproduction. Rarely, however, geniculate filament bendings occur to bring conjugating cells close to one another. Zygospores are formed in one of the gametangial cells after conjugation at the end of the growing season of Spirogyra which may enlarge to different extent in various species. Zygospores have three layers of walls, with the middle layer being either smooth or colorfully decorated. They can be oblong, subglobose, ellipsoid, or ovate in shape. Aplanospores do not form regularly, but they resemble zygospores in shape and wall patterns. Aplanospores, however, do not usually occur alone.

Spirogyra sp. Link (1820) (Pl. 8, fig. 4)

Reference: Prasad and Misra, 1992, P. 77.

Characters: Filaments seem simple, unbranched, with short to very long cylindrical cells. Vegetative cells have septa that are plane, colligate, semi-replicate, replicate, or unduliseptate; chloroplasts 1–16 are parietal ribbon-like (typically with lacinate or crenate margins), spiral, or sporadically nearly straight, with multiple prominent pyrenoids; the nucleus is positioned in the middle of the protoplasmic strand. Aplanospores, parthenospores, akinetes, and zygospores are the fragmentation mechanisms used in reproduction; sexuality is typically scalariform, although occasionally lateral conjugation results in tubes generated by both or one of the gametangia; zygospores usually ellipsoid but may be ovoid or lenticular; median spore wall smooth or ornamented and of various colours.

Collection number and collection date: RL-04, 2079/12/21

Order: Desmidiales

Family: Gonatozygaceae

Genus: *Gonatozygon* De Bary (1858)

Lectotype species: *Gonatozygonmonotaenium* De Bary

Characters of genus: Algal cells exist in solitary or short filamentous form. Cells can be medium to large (48-759 um long), elongate-cylindric to elongate fusiform (length 7–40 times width), and have truncated ends. These genera contain algae with plant bodies that have smooth cell walls or occasionally show granules, setae, or spines; some species even exhibit girdle-bands on their walls. The cell wall possesses two ultrastructure layer, an outer perforated layer with any granules or spines and an inner, more or less continuous, layer. Axially arranged in a ribbon-like row, each cell has one or two chloroplasts made up of up to sixteen pyrenoids. The nucleus is located in the middle, either next to or between the chloroplasts, if there are two.

Transverse cell division is the method used in asexual reproduction. Three species are known to use conjugation for sexual reproduction. Prior to the establishment of the narrow conjugation tube, gametangia geniculate. In the conjugation tube, zygospores have smooth walls and a spherical shape. *Gonatozygon* are cosmopolitanly distributed in acidic, oligotrophic lakes and ponds, or in *Sphagnum* bogs all over the world.

Gonatozygon monotaenium De Bary (1858) (Pl. 8, fig. 1-3)

Reference: Kalina; Walne & Houk, 2001, P.121; Das & Keshari, P. 142, Pl.XXVII, Fig.455, 456.

Characters: The apices of the cylindrical, occasionally curved cells are truncate and somewhat dilated. Longer than broad by up to 10 times, creating short chains of 4–8 cells. Each cell has two axial, undulate chloroplasts that hold three to four pyrenoids each. Under a light microscope, the minute and heavily granular cell wall is nearly undetectable. The minute pores and electron-opaque granules that make up the cell wall's fine structure are shown in figure 2b. Cell length ranges from 105- 112μm, breadth 9-10 μm & apex 6-8 μm.

Collection number and collection date: RL-05, 2079/12/21

Family: Closteriaceae

Genus: *Closterium* Nitzsch ex Ralfs (1848)

Lectotype species: *Closteriumlunula* Ehrenberg & Hemprich ex Ralfs

Characters of genus: These algae have only one cell and range in size from 72 to 1700 um. They are often elongate-cylindric to elongate-fusiform, straight or, more frequently,

curved (at least at ends). They are not frequently encountered in clusters, though. A cell's two terminal ends typically taper to an acute, rounded, or truncate end. These single-celled algae have smooth cell walls or smooth cell walls with longitudinal striae or costae. The walls might be white, yellowish, or brown, but they are occasionally limited to the ends of the cells. The ultrastructure of the cell wall consists of an inner microfibrillar layer and an outside, electron-dense amorphous layer. Desmidiaceae lack comparable permanent pores, but the outer layer of the cell wall is perforated and connected to less dense fibrillar patches in the interior layer. Certain species have additional wall sections called girdle bands. Two or more chloroplasts are present in each cell, arranged axially or randomly on the long, stellate plant body as viewed from the end. With the exception of very small species, pyrenoids are widely distributed throughout the chloroplast or in an axial row. Between the chloroplasts is where the nucleus is located. There is a vacuole at each end of the cell that holds one or more calcium sulfate granules. Transverse cell division is the process of asexual reproduction. Members of the same species undergo morphogenesis, which creates new semicells by gradually expanding from a cut end and developing extra wall components (girdle bands). Certain species have parthenospores and aplanospores. Either homothallic or heterothallic conjugation results in sexual reproduction. The gametangia form a mucilaginous envelope. Gametangia are frequently produced by freshly generated immature sister cells by cell division, and these cells merge inside a mucilaginous membrane. After the two cells break at the median suture, the gametes either fully or partially emerge to fuse between the gametangia. Zygospores can have a spherical, ellipsoid, quadrate, or irregular form. Certain zygospores contain lengthy lobes or sporadic, broad conical protuberances encircled by vacant gametangial wall fragments. The smooth zygospore wall has ridges, spines, pits, and scrobiculations. Meiosis occurs after karyogamy during germination.

Closterium dianae Ehrenbergex Ralfs 1848 (Pl. 8, fig. 7)

Reference: Prasad and Misra 1992, P. 105, Pl. 16, Fig. 7.

Characters: Cells are medium in size, measuring 9–10 times longer than broad. The cell wall is smooth, the chloroplast is ridged with 6–8 pyrenoids arranged in a row, and the cells are 105–303 µm long and 16–35 µm broad. The outer margin is strongly curved, with an arc of 112-125 degrees, and the inner is slightly tumid. The cell gradually attenuates towards an obtusely rounded apex.

Collection number and collection date: RL-05, 2079/12/21

Closterium dianae* var. *arcuatum (Brebisson ex Ralfs) Rabenhorst 1868(Pl. 9, fig. 5-6)

Reference: Croasdale & Flint 1986, P. 58, Pl.

Characters: This variety is characterized by its stronger curvature (130- 176°) of arc and by its dimensions in general greater than 250x20µm. It is distributed widely.

Collection number and collection date: RL-06, 2079/12/21

Closterium ehrenbergii Meneghini ex Ralfs 1848 (Pl. 9, fig. 4)

Reference: Scott and Prescott 1961, P. 11, Pl. 2, Fig. 2; Prasad & Misra, 1992, P. 106, Pl. 17, fig. 1, 2

Cells are large, solid, 6-8 times longer, than broad, moderately curved, outer margin 92-110 degrees of arc, inner margin concave however inflated in the center. Cells containing smooth cell wall reduce in size gradually towards obtusely rounded apices;chloroplast with 6-8 bands and numerous scatteredpyrenoids; cells 450-530 µm long, 65-80 µm broad.

Collection number and collection date: RL-02, 2079/12/21

Closterium gracile Brébisson ex Ralfs 1848 (Pl. 10, fig. 1-4)

Reference: Oliveira, Bicudo &Moura, P.122, Fig.23

Characters: The semi-straight cells have an apex width of 2.5–4 µm, are 112.5–200 µm long, 3.5–6 µm wide, and are 30-33 times longer than wide. The cellular bodies exhibit a slight curvature of 20–40º arc, with a convex dorsal margin, a straight ventral margin in the middle region, and a slight apical region curve. The cellular wall is soft and hyaline, with a single pore, obtuse and truncated poles, and axial chloroplastid, 5–6 pyrenoids.

Collection number and collection date: RL-06, 2079/12/21

Closterium setaceum Ehrenberg ex Ralfs 1848 (Pl. 10, fig. 5-6)

Reference: Oliveira, Bicudo &Moura, P.122, Fig.23

Characters: The shape of the cell is fusiform-lanceolate, measuring 255-350 µm in length, 10-20 µm in width, and 2.5-3 µm at the apex. The dorsal and ventral margins are nearly straight, with equal convexity, and the middle region is fusiform. The apices are slightly curved, and the cell has setaceous, long apical processes, which make up approximately 1/3 of the total length of the cell. The cell wall is striated, with 8-10 striae in 10 µm, sometimes difficult to see, hyaline to brownish, polar thickening; axial chloroplastid, 11. Closterium cf. striolatum.

Collection number and collection date: RL-03, 2079/12/21

Closterium* cf. *striolatum Ehrenberg ex Ralfs (1848) (Pl. 11, fig. 1-3)

Reference: Croasdale and Flint, 1986, P. , Pl.10, Figs. 1, 2

Characters: Cells have dimension of (160)-200-400-(600) x (20) -25-40-(53) µm (8-12X), at apex 7-16, about 30-80° arc, the median portion sometimes straight. Apices of cell are broadly truncate with rounded angles, sometimes slightly capitates with thickened wall; cell wall brownish with girdle bands, striae, 5-10 striae in 10 µm, mostly punctate between striae. The size of zygospores varies from 65-76 µm l., often with a wide gelatinous sheath. Asexual spores have been found.

Collection number and collection date: RL-05, 2079/12/21
Family: Desmidiaceae

Genus: *Pleurotaenium* Nägeli (1849)

Holotype species: *Pleurotaeniumtrabecula* Nägeli

Characters of genus: Typically, cells appear in a filamentous, solitary form, with a shallow central constriction (isthmus) where the semicell walls meet. They are primarily elongate-cylindric, up to 1000 µm long. Semicells feature truncate apexes at both ends and basal swelling close to the isthmus. The apex is smooth or has a ring of small spines or round or conical warts. Granule-containing terminal vacuoles are typically found at apex. Certain species feature smooth or spiny mamillate protuberances on each semicell, as well as sporadic pores on their cell wall. Each semicell often contains many parietal bands, each containing a large number of pyrenoids, and a thin chloroplast. The isthmus contains the nucleus. Cell division results in asexual constriction, and new semicell morphogenesis characteristic of desmids of the Cosmarium type occurs. Either homothallic or heterothallic conjugation results in sexual reproduction.Homothallic conjugation has been reported often between asymmetric daughter cells from recent division. Gametes of different gametangia fuse each other. Zygospores are spherical, sometimes with spines, or mamillate or conical protuberances. Before formation of zygospore and their germination, karyogamy occurs this is followed later by meiosis process for chromosome duplication, recombination, division and formation of four haploid new cells. Several species are cosmopolitanly distributed around the world, mostly in acidic, oligotrophic lacustrine environments or in swamps. Successful crosses involving three morphological species suggest single biological species present. Spontaneous production of diploid clones has been observed. Diploid/diploid and diploid/haploid crosses usually produce zygospores capable of germination.

Pleurotaenium ehrenbergii (Ralfs) Delponte (Pl. 11, fig. 4-5)

Reference: Croasdale & Flint 1986, P. 71, Pl.14, Fig. 8; Das & Keshari 2016, P. 155, Pl. XXIV, fig. 397, 398.

Characters: The cells are large, slightly constricted, and 13–15 times longer than broad. They have semicells with one or two smaller swellings usually beyond a conspicuous basal inflation; the wall is punctate, and the semicell margins tapered slightly to a rounded, truncate apex where six rounded tubercles were visible in the face view; the chloroplast is in longitudinal bands with four parietal bands in the face view, and numerous pyrenoids; the cells measure 621–626 μm in length, 23–30 μm in width, and 23–25 μm at the apex.
Collection number and collection date: RL-02, 2079/12/21

Genus: *Euastrum* Ehrenberg ex Ralfs (1848)

Lectotype species: *Euastrum ansatum* Ehrenberg ex Ralfs

Characters of genus: Solitary cells have semicell wall overlap, a deep central constriction (isthmus), and are typically longer than broad. An apical view often has a widened central section and is oval to elliptical (biradiate) in shape (rare triangular variations exist). Every semicell typically has separate apical and lateral lobes, as well as an apical lobe with an emarginate apex or an apical incision. The smooth cell wall has sporadic holes or is decorated in different ways with small spinules, granules, or verrucae. Typically, each semicell contains one chloroplast containing one or more pyrenoids. The isthmus contains the nucleus. Cell division results in asexual reproduction, and new semicell morphogenesis typical of desmids of the Cosmarium type is created. The process of conjugation results in sexual reproduction. those cells that participate in gelatinous envelope formation through conjugation pairings. Between gametangia, gametes fuse. With numerous short, sharp spines or mamillate protuberances, mature zygospores have a globose to ellipsoidal appearance.*Euastrum* commonly collected from acidic, oligotrophic, aquatic habitats or from bogs. Several species are cosmopolitan. *Euastrum* cannot be distinguished with absolute confidence from *Cosmarium* or *Micrasterias*; placement of certain taxa is arbitrary.

Euastrum binale (Turp.) Her.ex Ralfs, Plate 22, fig. 8

References: Suseela and Toppo, 2007, P. 109, Pl. 1, Fig. 7

Characters: Cells possess dimension of (12) – 15-25- (30) x (10)-12-21-(23) μm (C.1.25 X), 3-9μm at isthmus, 10-12 μm at apex, 8.5- 17μm thick. Semicells emerge subpyramidal, basal angles entire and broadly rounded, sides concave above to broad, truncate apex, its middle slightly retuse, its outer angles usually sharp; face with an inconspicuous median protuberance and no other ornamentation. Zygospore appears globose with numerous blunt spines, diam. 20- 26μm ssp., spines 5.7- 11.6 μm.

Collection number and collection date: RL-06, 2079/12/21

Genus: *Cosmarium* Corda ex Ralfs (1848)

Lectotype species:*Cosmariumundulatum* Corda ex Ralfs

Characters of genus: Isthmus-shaped solitary cells range in size from small to big, with shallow to profound median constriction. Semicells are subcircular to elongate-oval (biradiate) in apical view; they are rounded, reniform, pyramidate, quadrate, and have an entire or undulating edge. There are recognized triradiate forms in collections and civilizations. Spread pores can be seen on the smooth wall of the cell or they can be decorated with little or big granules, triangular or round pits, emarginate verrucae, or short spinules. Marginal and central decoration are either the same or different. Mucilaginous sheaths that are secreted from cylindrical cell wall holes frequently envelop cells. There are one to many chloroplasts per semicell, either axial or parietal, and each chloroplast contains one to multiple pyrenoids. The isthmus contains the nucleus.Cell division and the creation of new semicells, as in the case of Cosmarium-type desmids, are the processes involved in asexual reproduction. At the isthmus, cytokinesis occurs after mitosis. Primary wall material's transverse septum separates, with the top becoming the primary wall layer of the newly formed semicells. As they grow, the principal wall-bound new semicells eventually take on the dimensions and form of their parent semicell. During expansion, a new semicell forms its nucleus, which then migrates back to the isthmus. Following expansion, a secondary wall with pores and decoration forms beneath the main wall. Usually, the daughter cell's primary walls unite at their apices before splitting apart or disintegrating.

Either homothallic or heterothallic conugation is used in sexual reproduction. Within the mucilaginous membrane, cells approach one another to conjugate; semicells separate at the isthmus. Between gametangia, amoeboid gametes fuse. Round, mature zygospore with short, sharp, or truncate spines (sometimes with furcate points). In zygospores, only one form of chloroplast survives. At germination, meiosis comes after karyogamy. One pair of Mendelian alleles controls the type of mating that occurs. In C. turpinii, zygote mortality is caused by a recessive gene. Viable diploid and nonviable triploid zygospores are produced by crossings of haploid and diploid triradiate cells and normal biradiate cells with normal biradiate cells. The majority of cosmarium habitats are found in oligotrophic, acidic water environments. On the other hand, subaerial or basic, eutrophic water occasionally contains them.

Cosmarium auriculatum Reinsch **1875**

References: Prasad & Misra, 1992, P. 153, Pl.22, Fig. 14

Characters**:** Cells are small with shallow constriction at middle part, open sinus outwards with rounded apex,semicells sub –elliptical, sides 5 – undulate with sharp and pointed ridges, apex narrow and straight; cell wall arranged in transverse series; cell length: 41.5-45μm,

Collection number and collection date**:** RL-07, 2079/12/25

Cosmarium blytii Wile forma Croasdale (Pl. 12, fig. 4-5)

Reference: Prasad & Misra, 1992, P. 155, Pl. 24, fig. 2, 3.

Characters: Forma exhibits six rather elongate granules around the central granule in each semicell, marginal crenations not so prominent; chloroplast axile with one central pyrenoid, cell length 16.5μm, width 13μm, isthmus 3μm.

Collection number and collection date**:** RL-05, 2079/12/21

Cosmarium* cf. *lundellii Delp. (Pl. 12, fig. 6-8)

References: Prasad & Misra, 1992, P. 163, Pl. 22, fig. 1, 5.

Characters: Medium-sized, somewhat shorter in length than wide, highly constricted, sinus linear, and open cells are what they are. Semicells are sub- semicircular to sub-pyramidal in shape, with a round basal angle and a roughly punctuated cell wall.Cell has length of 62.5- 71 μm, width 51- 56 μm and isthmus 20.5- 23μm.

Collection number and collection date: RL-05, 2079/12/21

Cosmarium circulare Reinsch, nom. illeg. 1867 (Pl. 13, fig. 1-2)

Reference: Prasad & misra, 1992, P. 156, Pl. 22, fig .8

Characters: Semi cells are close, sinusoidally linear, and roughly semicircular. There are two pyrenoids in each semicell, a ridged chloroplast axile, and prominent punctures on the cell wall. Cell length 70.5μm, lat. Cell 59 μm, lat. Isthmus 21 μm.

Collection number and collection date**:** RL-05, 2079/12/21

Cosmarium connatum Brébisson ex Ralfs (1848) (Pl. 13, fig. 3-4)

Reference: Prasad & Misra, 1992, p.157, pl.23, fig.10, 15; Croasdale, H. &Flint, E.A., 1988, p.60, pl.37, fig. 30

Characters: Cells 60- 105 X 42-90 μm (c.1.3X), at isthmus 31-71 μm, sinus very shallow and widely open; semicells transversely subelliptic with apex rounded or slightly flattened; in end view subcircular; wall rather thick, finely scrobiculate and punctate; chloroplast with two pyrenoids and with numerous, somewhat irregular lobes which become flattened against the inner surface of the cell wall.

Collection number and collection date: RL-03, 2079/12/21

Cosmarium obsoletum (Hantzsch) var.***sitvense*** (Gutw) Krieger (Pl. 13, fig. 5-7)

Reference: Prasad & Misra, 1992, P. 171, Pl.22, fig. 13; Scott, A.M. & Prescott, G.W., 1961, P.63 64, Pl.25, fig. 11, Pl. 26, fig. 2
Characters: Cell is larger, almost circular with relatively broader apices, widest part in the middle and thick, mucrate basal angles. Cell wall has distinctly punctuation with cell length: 55 µm, lat.cell. 69 µm and lat. isthmus 31µm.
Collection number and collection date: RL-06, 2079/12/21

Cosmarium obtusatum (Schmidle) Schmidle 1898, (Pl. 13, fig. 8)
Reference: Croasdale & Flint, 1988, P. 81, Pl. 36, fig. 14-16
Characters: Cells have dimension o f 48-60 (87) x 41-50 (54) µm, at isthmus 15- 18µm, 22µm thick, sinus deep and closed but dilated within. Semicells are semicircular to truncate- pyramidal with rounded angles, sides convex with about eight small undulation and with two intramarginal series of undulation, resembling granules; in side view broadly elliptic, in end view oblong ellipitic, with poles undulate and four to five short parallel series of undulations within each pole; wall punctate; 2 pyrenoids. Zygospore is globose, with numerous sharp, conical spines, in diam. 42- 45 µm ssp, 57- 62µm csp.
Collection number and collection date**:** RL-09, 2079/12/25

Genus: *Micrasterias* C. Agardh ex Ralfs (1848)

Lectotype species: *Micrasteriasfurcata* C.Agardh ex Ralfs

Characters of genus: Small to large, solitary cells with a very deep median constriction (isthmus) are characteristic of M. foliacea, which is a filamentous species. Each semicell is typically divided into an apical lobe and two lateral lobes by other shallow or deep incisions, which may then be further dissected. Both M. dickiei and M. ralfsii have undivided semicells. Typically, cells are disc-shaped and flattened. M. dickiei, on the other hand, possesses elliptic, triradiate cells. Certain species have spines or protuberances that might be little or enormous. Each semicell typically has one chloroplast, which can contain one, several, or even many pyrenoids. The isthmus is where the nucleus is located.
Micrasterias zeylanicavar. rectangularis A.M.Scott & Prescott 1961 (Pl. 14, fig. 3)
Reference: Das & Keshari, 2016 ,P.150 ,Pl. XXX ,fig. 517, 518 ; croasdale & flint ,1986 ,P. 102-110,Pl. 24, fig. 3,4 ; Scott & Prescott 1961: 53, pl. 21: figs 5-7
Characters: Small cells with a length slightly greater than breadth make up the sinus, which is open, deep, acuminate, triangular, and has a pointed inner terminal. The lateral lobes of semicells are composed of two blunt processes, one of which bends down toward

the sinus and the other of which is horizontal. The polar lobe is widely distributed, slightly drawn out at each extremity into a horizontal or deflected process. The apex is flatly convex, and the cell wall is smooth. The three lobes of semicells are separated by inclusion, penetrate deeply, and are inclined towards the sinus. The ends of the terminal lobe are bluntly pointed. The cell length ranges from 62 to 65 μm, the width from 60 to 62 μm, and the isthmus are between 10 and 12 μm.

Collection number and collection date:

Genus: *Staurastrum Meyen* ex Ralfs (1848)

Lectotype species: *Staurastrumparadoxum* Meyen ex Ralfs

Characters of genus: Small to big cells exist. Two intergrading cell morphologies are seen, and cells feature shallow or deep median constriction (isthmus) between two smicells where the semicell walls overlap, ranging from two to twelve radians on the marginal surfaces of the cells. Long, hollow processes that correspond to the radiation pattern of each semicell are present in almost all species. Processes usually include two or more terminal spinules in addition to one or more series of denticulations, spines, or verrucae along the process, as well as on the apex and body of the semicell's central axis. The semicell angles of certain species have short processes, are truncate, or are rounded. The cell walls of these species are either smooth or covered with rows of microscopic spinules or granules. Typically, each semicell has one chloroplast; in end view, this structure is radiating and lobed like. There are two ways that reproduction occurs: asexual and sexual. As in the case of Cosmarium-type desmids, asexual reproduction occurs by cell division and the generation of new semicells. However, in many species, sexual reproduction takes place through conjugation. Gametangia unite within a wide gelatinous envelope during sexual reproduction, fusing to create a conjugation tube. After zygote formation, zygospores mature and take on a spherical form with long, furcate spines. While many species in this genus are found around the world, some are only found in tropical regions or on certain continents. Planktonic species are often those with lengthy processes. The majority of the species in acidic, oligotrophic lakes, ponds, and wetlands are bethic or periphytic. Groups of species have not been assembled to classify distinct genera. Former genera of some taxa, such as Staurastrum, which had a single spine or thicker cell walls at each angle, are now considered to be Staurodesmus. Except in Russian and Ukrainian literature, Palamar-Mordvintseva (1976) divided species without lengthy processes into many genera; this division was not widely accepted.There are species in the genus Cylindriastrum that feature elongated, angular, cylindrical cells. Certain species have been

assigned to the genus Cosmoastrum, despite having smooth walls, rows of granules or spinules covering the entire wall, or only around cell angles. The species belonging to the following genus, Raphidiastrum, have two or more spines at each angle, and their cell walls include rows of granules or spinules in the case of those with a single angular spine. Since these genera exhibit intergrading forms, the placement of certain taxa is discretionary.

Staurastrum forficulatum var**. *verrucosum*** Grönblad (1920) (Pl. 14, fig. 4-5)

Reference: Grönblad 1920, P.64, Pl. 3, Figs. 47, 50-51.

Characters: Cells small, about 1.5 longer than wide without spines and processes, deep, constricted, the sinus sharply open but pointed at the apex; semicells elliptical or subtrapeziform, lateral angles slightly produced in processes and two long robust spines diverging and vertically oriented, tips of semicells slightly convex or subtruncat's and four short processes or emarginate spines arranged in protrusions, upper and lower margins with 2-3 warts at the margin and inside edge seen from above, 3-4-gones, concave sides with two short processes at the margin and the tips of the emarginate processes and also two processes near the inside of the margin, with slightly produced angles.Cells are 47.6µm long, Lat. 39µm, Lat. isth. 14µm.

Collection number and collection date: RL-08, 2079/12/25

Staurastrum lunatum Ralfs (1848) [Recent name: *Staurastrum avicula* var. *lunatum* (Ralfs) Coesel & Meesters (2013)] (Pl. 14, fig. 6)

Reference: Croasdale, Flint & Racine, P.111, Pl.83, Fig. 4-6

Characters: Cells are as broad as long or slightly broader, SSP 20-37 x 20-40 µm, isthmus 10-15 µm, rather deeply constricted. Sinus widely opens from an acute interior. Semicells are semicircular or shallowly cup-shaped the ventral margin strongly convex, the apex only slightly convex; angle obtuse, typically ending in a single short, stout spine, projecting obliquely upwards. End views: semicells 3- angular, with sides slightly concave and obtuse, ending typically in a single spine. Wall envenly granular, the granules sometimes sharper and spine – like at the ends of the angles and becoming smaller toward the centre.

Collection number and collection date: RL-05, 2079/12/21

Staurastrum muticum Brébisson ex Ralfs 1848 (Pl. 14, fig. 7-8)

Reference: Das & Keshari, 2016, P.168, Pl. VII, Fig. 223-225

Characters: Medium-sized cells are somewhat longer than wide. In a vertical view, the cells are triangular, narrowly rounded at the angles, with finely and densely punctate cell

walls. The cell length is 21–22 µm, the cell width is 19–21 µm, and the isthmus is 7-8 µm. The semicells are narrowly elliptic–oval and wide, with a dorsal margin that is less convex than the ventral.

Collection number and collection date: RL-07, 2079/12/25
Order: Zygnematales

Family: Zygnemataceae

Genus: *Cylindrocystis* Meneghini ex De Bary (1858)

Holotype species: *Cylindrocystisbrebissonii* (Ralfs) De Bary

Algal cells of this genus are usually solitary. Nonetheless, a common gelatinous matrix is where short or long filaments or cell aggregations originate. The size of cells ranges from 18-96 µm, which is 1.5–4 times longer than the width. They can be elliptic to elongate-cylindric, straight or curved, and have broadly rounded ends. Each axial cell has two chloroplasts containing often large elongated pyrenoids and appears stellate in end view. Nucleus lies at middle between chloroplasts. Two ultrastructural layered cell wall covers around protoplast. Asexual reproduction takes place by transverse cell division. Sexual reproduction occurs by homothallic or heterothallic conjugation. Zygote forms in broad conjugation tube; may extend into both gametangia. Mature zygospores usually spherical to rectangular, smooth-walled or with spines or small papillae. Mesospore layer of *C.splendida* has large pits. Mature zygospores are usually required for identification. *Cylindrocystis* are cosmopolitanly distributed in subaerial, acidic aquatic or bog habitats. *C.brebissonii* and *C.crassa* are widely distributed.

Collection number and collection date: RL-07, 2079/12/25

***Cylindrocystis brebissonii* (Ralfs) De Bary 1858** (Pl. 15, fig. 1)

Reference: Croasdale & Flint, 1986, P. 34, Pl. 1, fig. 15, 16.

Characters: Cellspossess dimension of 26-87 x14-22 – (35) µm (2-4X), cylindric with broadly rounded apices. Chloroplast is located axially, usually with a few large rays and large central pyrenoids, sometimes elongated. Zygospore quadrate to subspherical, 26-62µm diam. Homo and heterothallic strains and asexual spores recorded (Biebel 1975).

Collection number and collection date: RL-06, 2079/12/21
Family: Mesotaeniaceae

Genus: *Netrium* (Nägeli) Itzigsohn et Rothe (1856)

Cells are straight, usually more than three times longer than broad, oblong cylindrical or fusiform, lateral margins gradually or sharply tapering to more or less truncate apices, unconstricted or rarely with a moderate constriction. Mostly 2 (rarely 1 or 4) chloroplast

are found in each semicell with 6-12 radiating longitudinal plates, often prominent notch present at the edges. Each chloroplast contains several pyrenoids scattered or arranged in median series.

Netrium digitus (Ehr.) Itzigs.et Rothe (Pl. 15, fig. 2)

Reference: Prasad & Misra, 1992, P. 89, 90, Pl.15, fig. 2

Characters: Cell walls are smooth; chloroplasts contain longitudinal plates and deeply serrated borders; cells are medium in size, 4-5 times length than broad, not constricted, oblong-elliptic, and have convex margins that gradually attenuate towards rotundo-truncate apices.Cell length varies from 171- 204 μm, lat. Cell.41- 44.5 μm, lat. Apex. 15-16.5 μm. Planktonic in a pond.

Collection number and collection date: RL-05, 2079/12/21

Phylum: Ochrophyta

Class: Chrysophyceae

Order: Chromulinales

Family: Dinobryaceae

Genus: *Dinobryon* Ehrenberg (1834)

Lectotype species: *Dinobryonsertularia* Ehrenberg

A free-living, solitary or connected in branched colonies lorica envelops each cell. The cylindrical, vase- or funnel-shaped Lorica has smooth or undulating walls, and some species have spiral thickenings. During cell rotation, lorica is released as spiral-shaped loops of cellulose microfibrils. The distinctive colony shape is created by daughter cells of colonial species building the lorica inside the mother cell lorica close to the mouth. The new lorica in certain species develops on the exterior of the old one. A contractile stalk holds the fusiform, cylindrical cells to the bottom of the lorica. Asymmetrically, two heterokont flagella are introduced into a pit. There are two chloroplast lobes, one of which has stigma and remains adjacent to photoreceptor of short flagellum.One sizable Golgi body can be seen in the front portion of the cell under light microscopy. During reproduction, a cell divides longitudinally, with one daughter cell resting on top of the mother cell.

There is sexual reproduction, where a male gamete lacking lorica approaches a colony and fuses with a female cell that has lorica to generate a zygotic cyst. In solitary species, such as isogamy, sexual reproduction takes place, and the two empty loricae stay joined to the zygote. At the lorica's mouth, zygotic and asexual stomatocysts develop.

Dinobryon sertularia Ehrenberg 1835 (Pl. 15, fig. 3-4)

Reference: Prescott, 1951, P.378, Pl. 98, Fig. 10

Characters: Colonies gradually diverge. Loricas are fusiform-campanulate in appearance, with a blunt-pointed posterior and smooth, convex lateral margin that narrows above the midregion before slightly flaring to a large mouth. They are 10-14µ in diameter and 30-40µ in length.

Collection number and collection date: RL-04, 2079/12/21

Phylum: *Euglenozoa*

Class: Euglenophyceae

Order: Euglenales

Family: Euglenaceae

Genus: TrachelomonasEhrenberg (1834)

Lectotype species: *Trachelomonas volvocina* (Ehrenberg) Ehrenberg

The Algal Taxa in this Genus are solitary, free-swimming cells that resemble Euglenas. They are completely enveloped in an envelope with an apical aperture that permits the very long locomotory flagellum to emerge and a well-defined neck or collar. During reproduction and other events, the naked cells shed their envelope, but they swiftly produce a new one that is specific to their species. This new envelope might be ovoid, spherical, ellipsoid, or elongated. These cells are initially smooth and colorless, but they quickly change to dark, brittle with iron and manganese salts, decorated with pores, punctae, spines, warts, and ridges. Nearly all species have chloroplasts of various types, including numerous, small, discoid, without pyrenoids; flat plates with double-sheathed pyrenoids; flat plates with inwardly-projecting pyrenoids; or flat plates with bare pyrenoids.The remaining species share all other Euglena traits and are osmotrophic and colorless. Deflandre's (1926) monograph extended Conrad's (1916) artificial split of the genus into portions based on envelope shape by describing a number of species based on the size, form, and design of their envelopes. Huber-Pestalozzi (1955), Bourrelly (1970), and Starmach (1983), among others, have adopted these systems; however, Pringsheim (1953c) demonstrated that the structure of the chloroplast and pyrenoid should serve as the basis for natural groups (as in Euglena, Pringsheim, 1956).More than 600 recognized species and variants have been discovered to be identical, despite the fact that the chemistry and decoration of envelopes belonging to the same species can differ in culture (Pringsheim, 1953c). Several Trachelomonas species' chemistry, structure, and envelope synthesis have also been investigated by Leedale (1975), West and associates (1980), and

other researchers. These algae are frequently found in peaty pools and other freshwater environments with pH values between 4.5-7 that include higher concentrations of iron and manganese. They have a widespread range and are cosmopolitan.

Trachelomonas armata Ehrenberg (1834) (Pl. 15, fig. 6)

Reference: Prescott, 1951, P. 410, Pl.83, fig 32

Characters: The flagellum aperture of some sorts of cells is encircled by a circle of straight spines, while the cells themselves have a widely elliptical form. Test 22μ in diameter and 38–40μ long, including spines; the front part of the wall appears to be spiny, while the midregion has a poor distribution of spines, and the posterior part has long spines pointing backward.

Collection number and collection date: RL-09, 2079/12/25

Trachelomonas intermedia P.A.Dangeard 1902 (Pl. 15, fig. 7)

Reference: Prescott, 1951, P.415, Pl.83, fig. 10

Characters: The form of the cells is subspherical to oval, with a small anterior narrowing; the flagellum aperture is thickened but lacks a definite collar; the wall is brown and heavily punctate.Cell has diameter of 16-18μ and length 20-25μ.

Collection number and collection date: RL-04, 2079/12/21

Genus: Euglena Ehrenberg (1830)

Lectotype species: *Euglena viridis* (O.F.Müller) Ehrenberg

Characters of genus: Green flagellates, or elongate, ovoid, or fusiform cells, ranging in length from 20 to 500 μm and are found in this species of algae. Two flagella develop in the cells' anterior enfoldment. The elongated flagellum that is incredibly mobile emerges from the subapical canal opening for mobility, while the other flagellum is so short that it ends inside the reservoir (basal region of the invasion). The paraflagellar rod thickens the locomotory flagellum twice over by carrying a complex array of fibrous material and a unilateral row of long, thin hairs that are only visible under an electron microscope. Locomotion is achieved by the cell's helical rotation; most species exhibit euglenoid mobility, in which they quickly change their body shape when swimming ceases, however some are nearly rigid. Chloroplasts can be found in a variety of shapes and sizes, such as discs, plates, or ribbons. They can have anywhere from two to several hundred of these structures per cell, and they can have one or more pyrenoid kinds, such as sheathed, bare, projecting, submerged, etc. Chlorophylls A and B, carotene, astaxanthin, antheraxanthin, diadinoxanthin, and neoxanthin are among the components of the grass-green chloroplasts. Chloroplast lamellae have three or more thylakoids, with the exception of the pyrenoid

matrix, where there are only two. Every species is facultatively heterotrophic, some photoauxotrophic, and none phagotrophic. The reserve carbohydrate is paramylon, which are solid grains or links of a 1, 3-linked glucan with helical topology. Older cells are loaded with brown droplets of lipofuscin and cyclic metaphosphates. In all species, the base of the long flagellum has a crystalline swelling that may be a photoreceptor located opposite an extraplastidial orange red eye spot that contains carotene and partially arcs around the canal reservoir junction in the anterior cytoplasmic matrix.Every species exhibits pronounced phototaxis. Cells are helical in shape and typically exhibit bilateral symmetry, which might be somewhat flattened or not. Pellicles are made up of spiral-shaped, elastic, interconnecting, proteinaceous strips with intussusceptions at both ends. The cell membrane contains the pellet, and aside from a thin coating of mucilage released by subpellicular muciferous structures, cells are bare. Certain species produce palmellae, or mucilaginous cysts. A persisting and dividing nucleolus, a large number of chromosomes (approximately 45 in E. gracilis and 86 in E. spirogyra), a haphazard and staggered segregation of chromatids, only nucleoplasmic microtubules (no cytoplasmic ones), and, in the case of E. gracilis, tiny kinetochores (only 4 microtubules) per chromatid are all present, along with completely intranuclear mitosis.

Cross-sectional fission is the method of reproduction. Unconfirmed reports of sexual reproduction are unusual. The ultrastructural characteristics of contractile vacuoles, endoplasmic reticulum, flagellar roots, Golgi bodies, and mitochondria are well-documented and indicative of their class. Euglena gracilis (and less readily E. anabaena, deses, pisciformis, stellata, and viridis) can be produced in pure culture on ambiguous medium such as 0.2% beef extract. Euglena gracilis grows phototrophically or heterotrophically on acetates, organic acids, alcohols, or sugars; cobalamin, or vitamin B12, is essential for this process.As a result, hospitals use it to test blood for B12, which is deficient in humans and causes pernicious anemia. Despite being rather uncommon in nature, *E. gracilis* is the most researched organism in euglenology as well as many other areas of physiology and biochemistry. The best material for studying the physiology and development of chloroplasts is obtained from dark-grown cells, which transform their chloroplasts into proplastids that can split and survive for years, but which, upon exposure to light, expand, manufacture chlorophyll, and resume photosynthesis in less than a day. Certain permanent colorless races devoid of chloroplasts can be created in culture by applying heat; certain naturally occurring *Astasia* such as *A.longa* have similar structure of few bleached races.

Euglena proxima Dangeard 1902 (Pl. 16, fig. 1)

Reference: Prescott, 1951, P.394, Pl.85, fig. 25

Characters: The metabolic cells have a fusiform shape and are constricted posteriorly to a blunt tip. The periplast is spirally striated, the chloroplast is a large, irregularly shaped disc, and the paramylon bodies are numerous tiny rods scattered throughout the cell. The diameter of the cells is 14.5–19–(21) μm, and their length is (50–70–85–95)μ.

Collection number and collection date: RL-07, 2079/12/25

Family: Phacaceae

Genus: Phacus Dujardin (1841)

Holotype species: *Phacuslongicauda* (Ehrenberg) Dujardin

Characters of genus: With inflexible, compressed cells that are very flat and leaf-shaped, and frequently with ridges, folds, or grooves running helically or longitudinally, giving the cells irregular or triradiate cross-sections, the majority of Phacus' algal species are green flagellates. A lengthy posterior spine, resembling flattened spinning tops, is seen in many species. Certain species have flat corkscrew-like twists. There are certain anatomical similarities between Euglena and other animals, such as eyespots and well-developed flagellar swelling. Chloroplasts are typically tiny, discoid, abundant, and free of pyrenoids. Pyrenoids are found in big, flat chloroplasts in certain species, such as P. splendens. The typical way that paramylon is stored is as a mixture of numerous tiny and a few large grains. Pochmann (1942) examined the genus and suggested the subgenus Hyalophacus for colorless species and Phacus for green forms.

Phacus longicauda (Ehrenb.) Dujardin 1841 (Pl. 16, fig. 2)

Reference: Prescott, 1951, P.400, Pl.87, Fig. 1

Characters: The cells seem broadly ovoid to pyriform, tapering gradually posteriorly to create a long, straight, sharply pointed caudus; the flagellum is shorter than the cell length, and the periplast is longitudinally striated. The anterior portion of the cells is widely spherical. The typical form of a paramylon body is one large or tiny circular plate; the cells range in width from 4 to 70 μ and length from 85 to 170 μ.

Collection number and collection date: RL-01, 2079/12/21

Phacus orbicularis Huebner 1886 (Pl. 16, fig. 3-4)

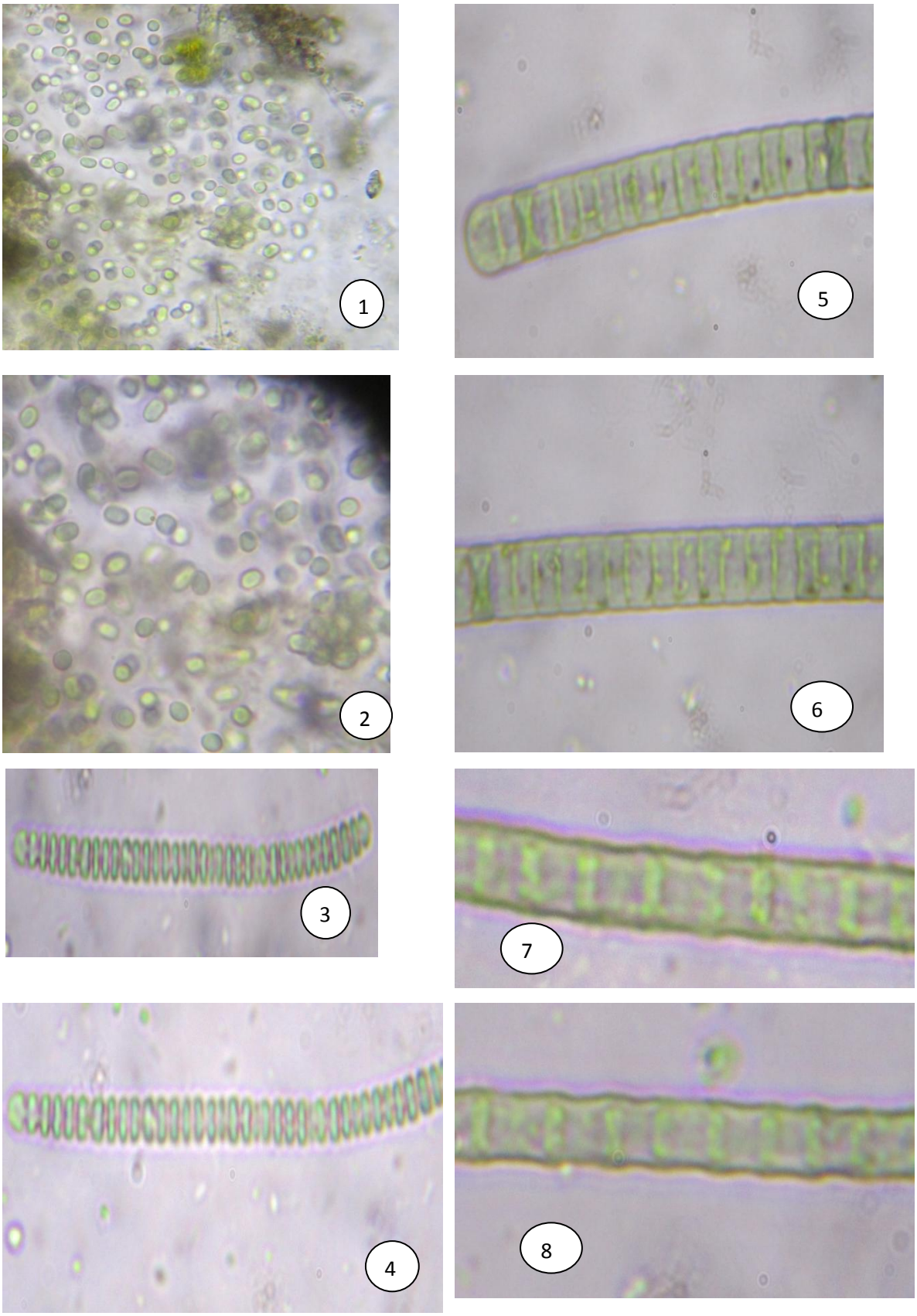
Reference: Presscott, 1951, P. 401, Pl. 87, fig. 10

Characters: The cells have an orbicular shape and are broadly rouded anteriorly.

The flagellum is twice as long as the body, the periplast has fine longitudinal striating, and the paramylon bodies are two disc-shaped plates with a short caudus that, when viewed in ventral view, curves to the right. The cells are 39–45 μ in diameter and 60–70–100 μ long.

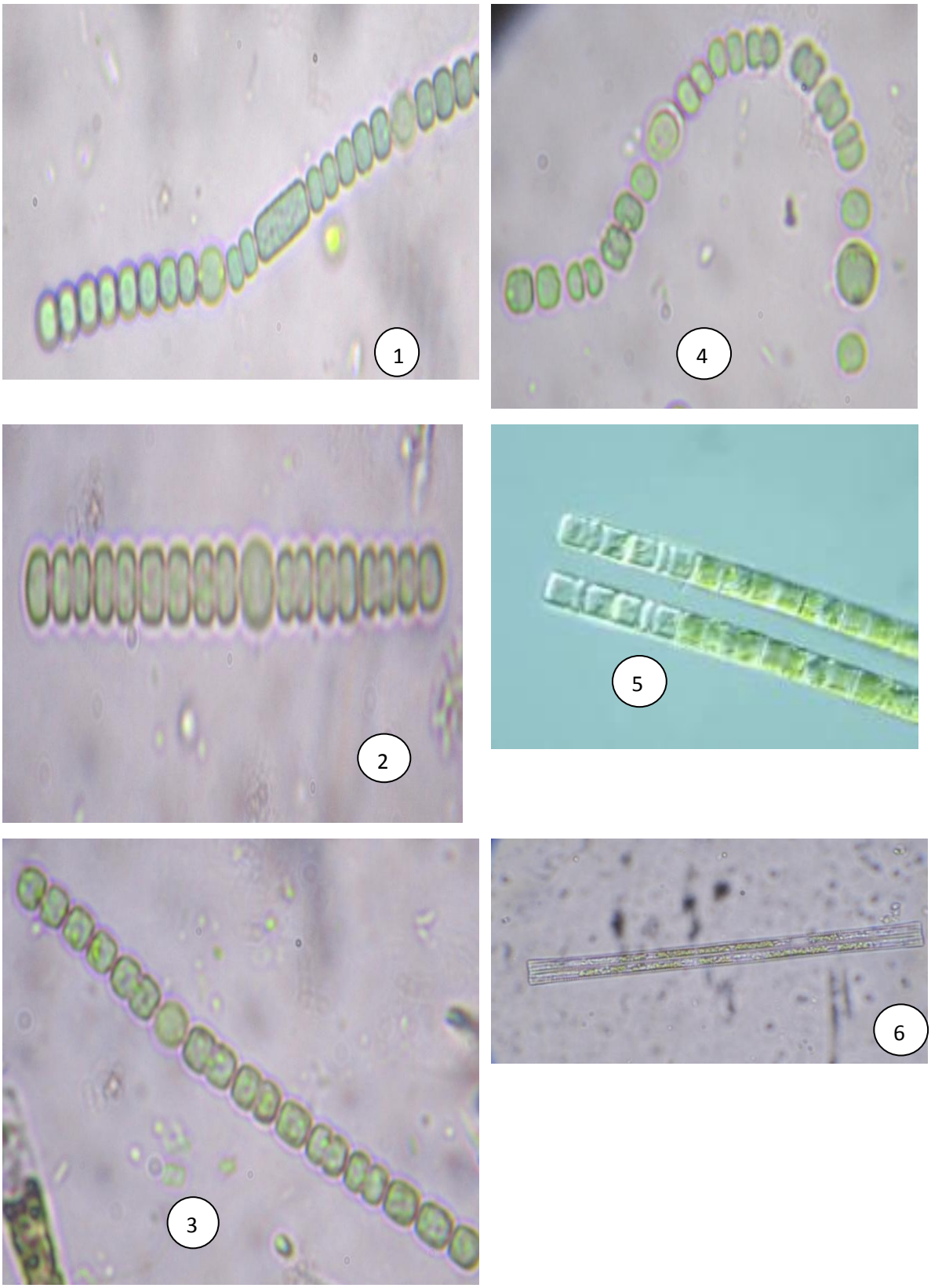
Collection number and collection date: RL-06, 2079/12/21

PLATE 1



Figures: (1- 2) *Aphanothece stagnina*, (2-3) *Johannesbaptistia*, (5-6) *Oscillatoria crassa*, *(7-8) Oscillatoria* sps.

PLATE 2



Figures: (1-3) *Anabaena inaequalis*, (4) *Anabaena* sps,(5) *Aulacoseira granulate*,(6) Ulnaria *ulna*

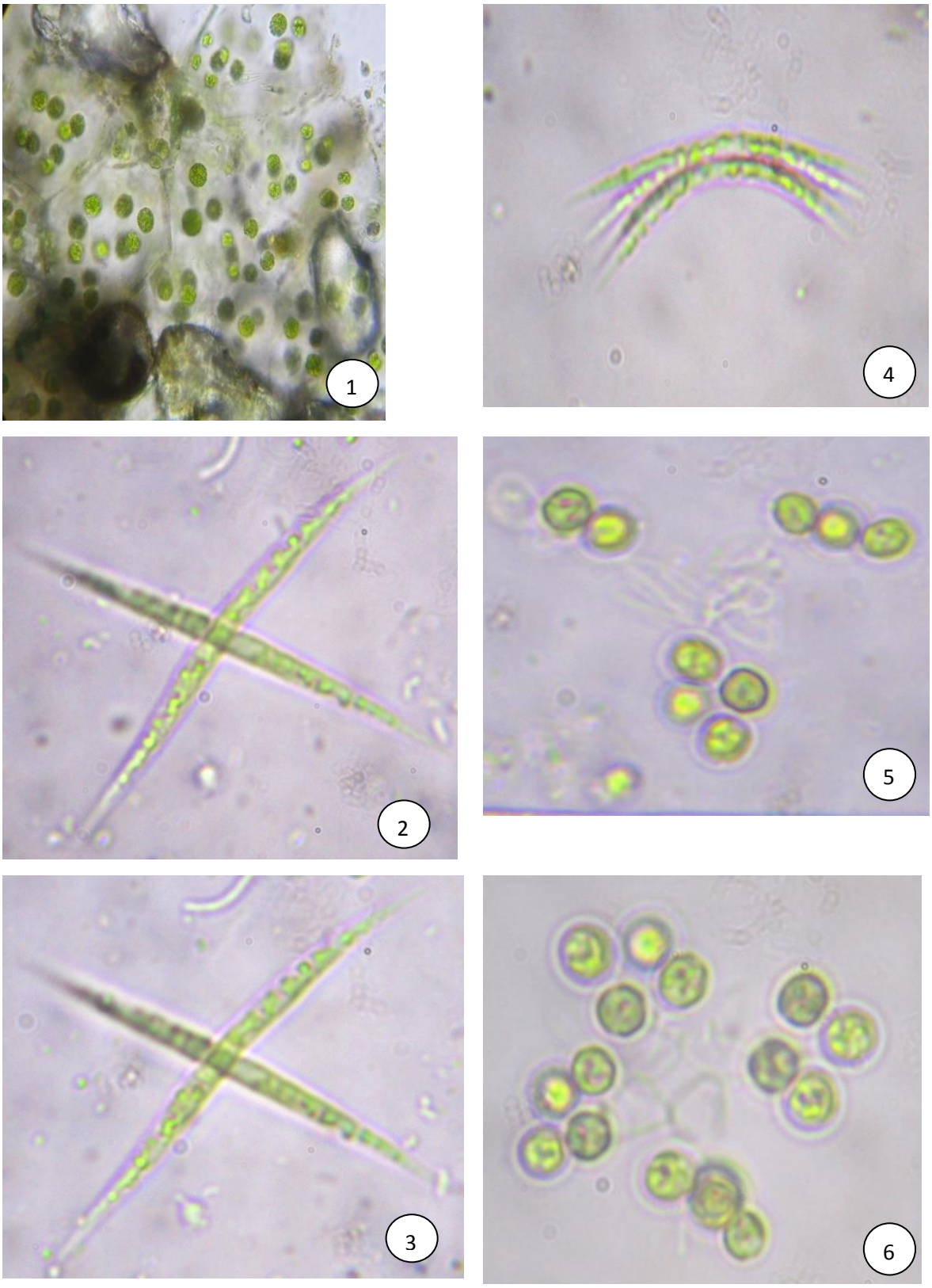
PLATE 3

Figures: (1- 3) *Ulnaria ulna,* (4) *Eunotia bilunaris,* (5) *Navicula rostellata,* (6) *Pinnularia cardinaliculus*

PLATE 4

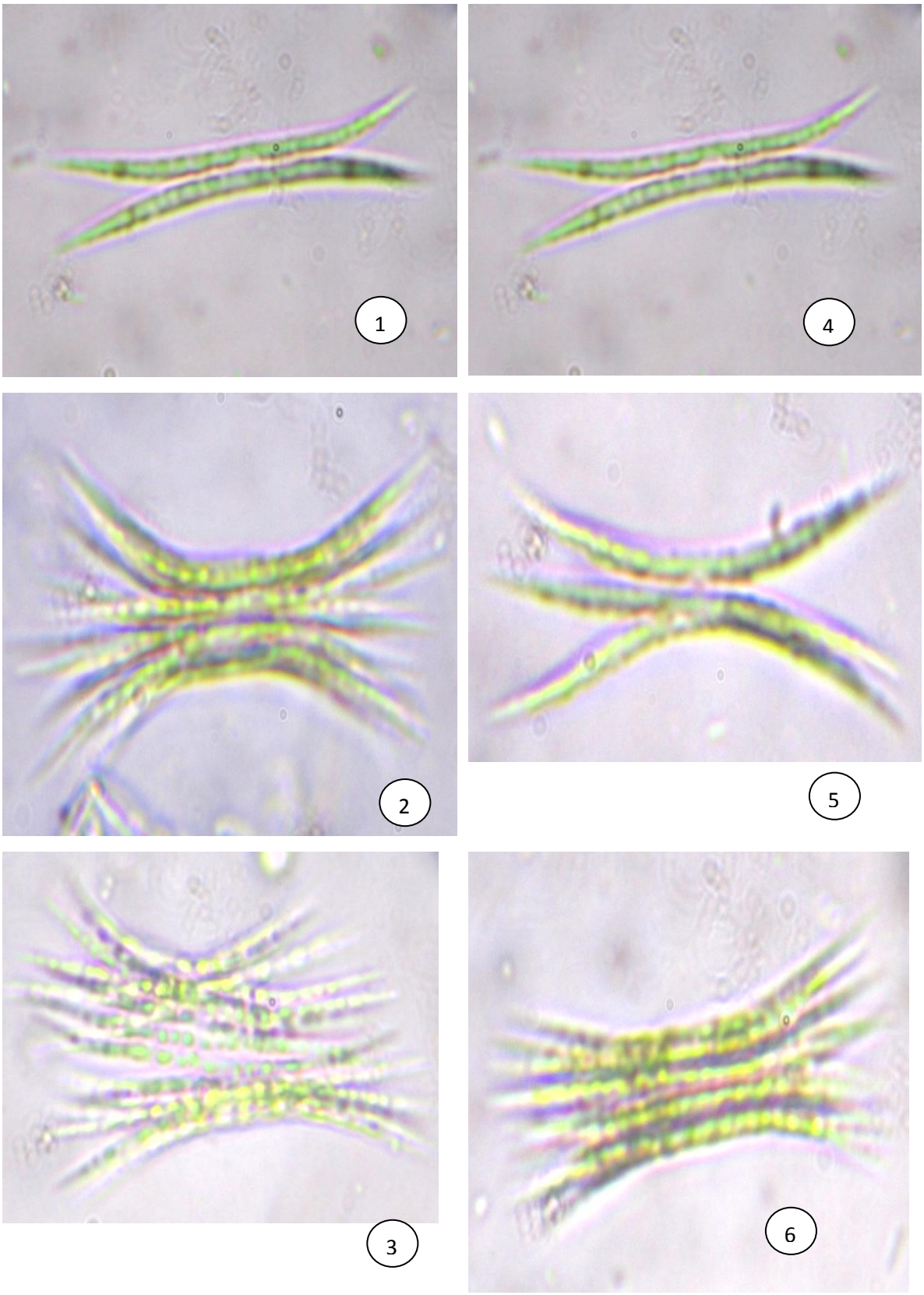
Figures: (1) *Pinnularia grunowii*, (2-3) *Gomphonema acidoclinatum*, (4) *Gomphonema pseudoaugur*, (5) *Encyonema silesiacum*, (6) *Nitzschia palea*, (7) *Dictyosphaerium pulchellum*

PLATE 5



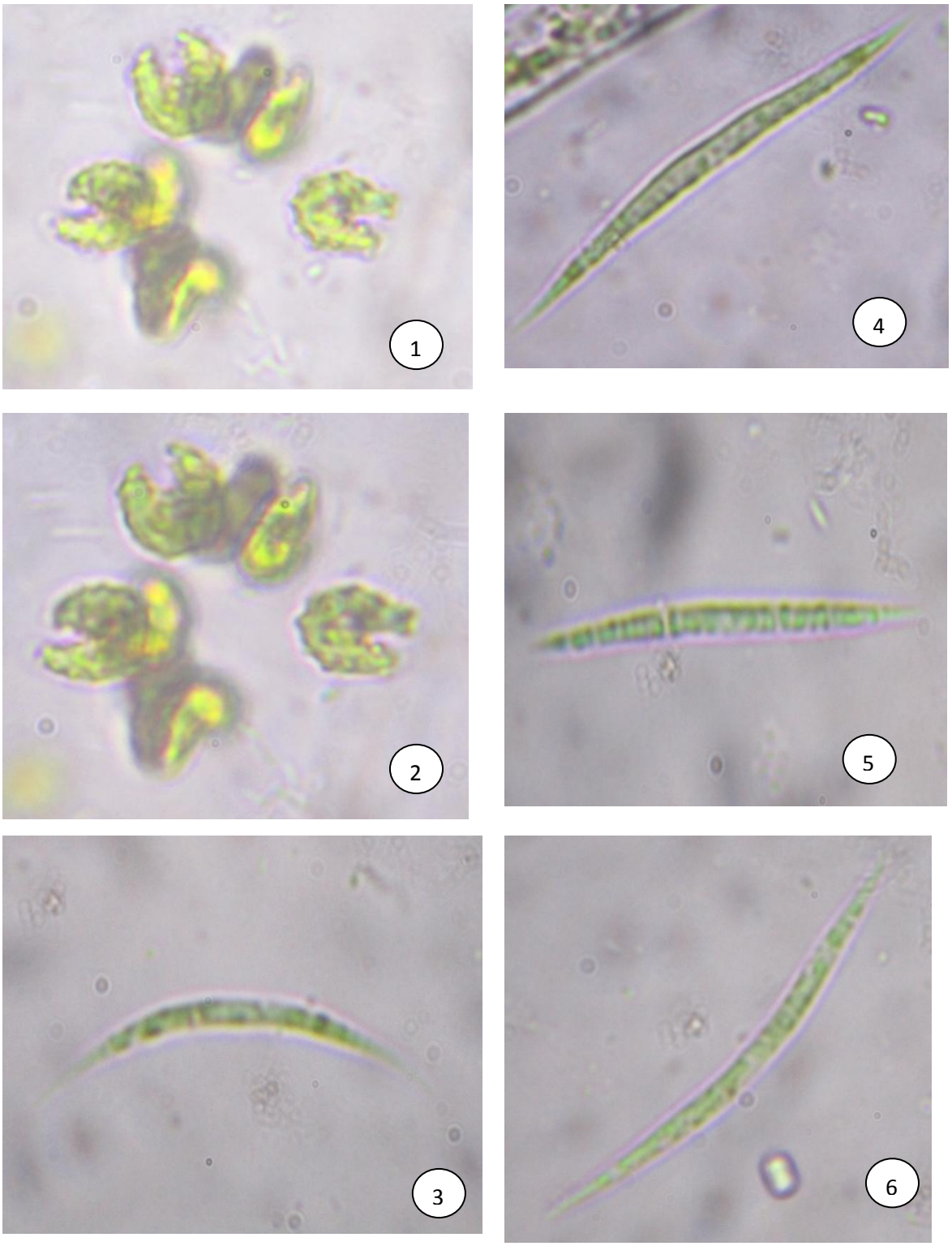
Figures: (1) *Sphaerocytis schroeteri*, (2-4) *Ankistrodesmus falcatus*, (5-6) *Dictyosphaerium pulchellum*

PLATE 6



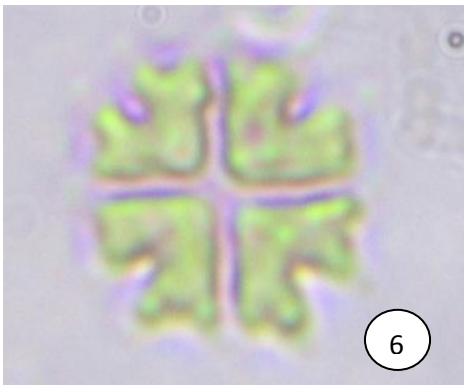
Figures: (1- 6) *Ankistrodesmus falcatus*

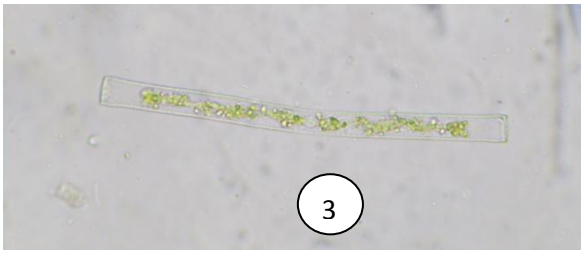
PLATE 7

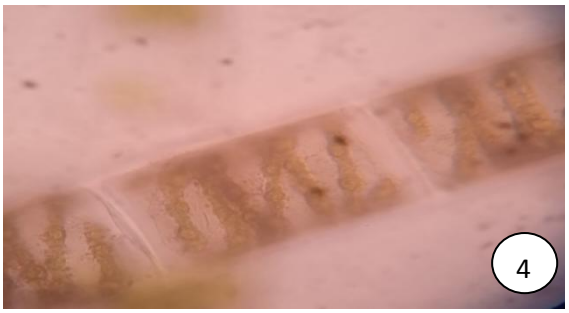


Figures: (1-2) *Kirchneriella lunaris*, (3-6) *Monoraphidium griffithii*

PLATE 8

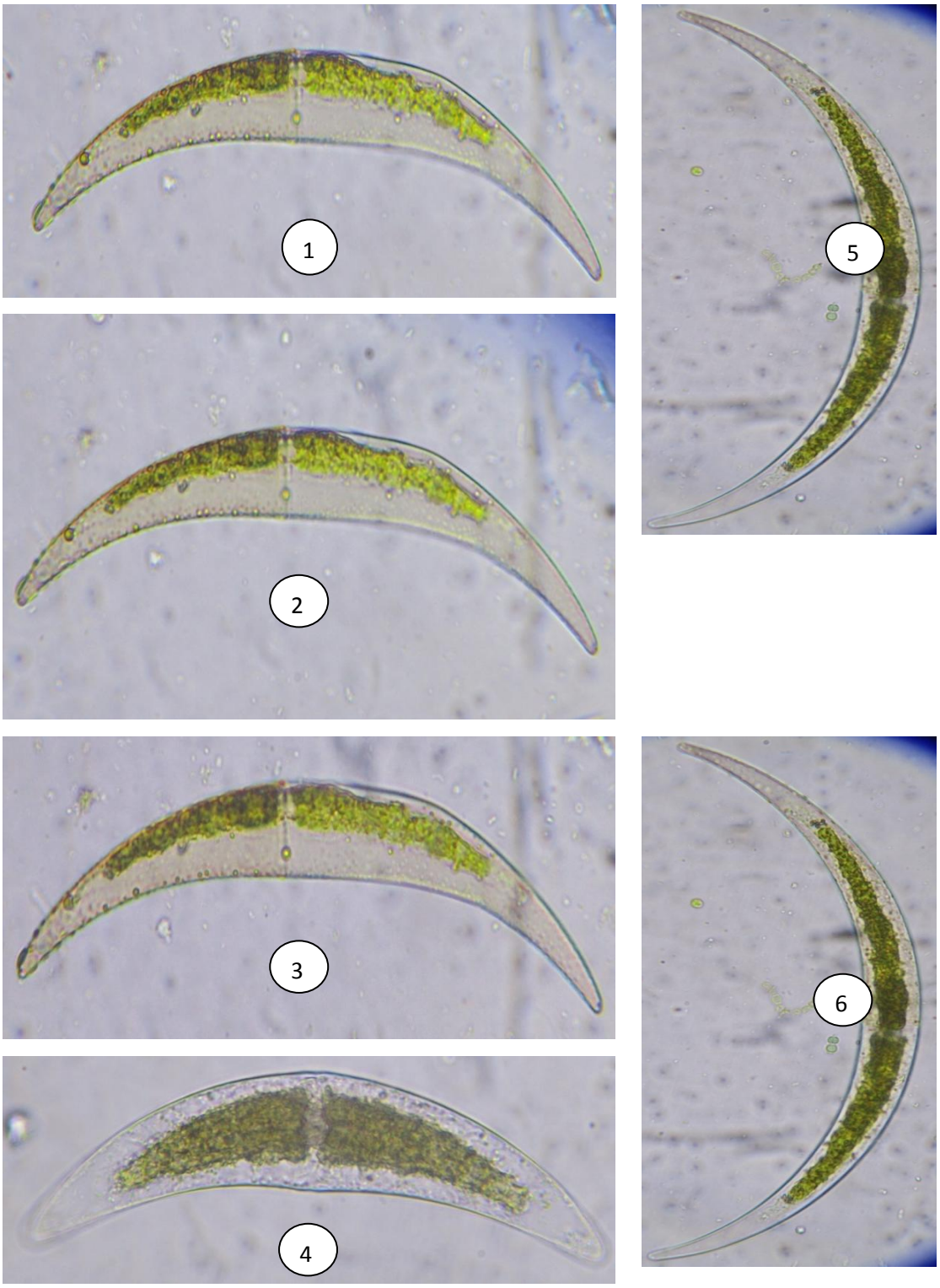






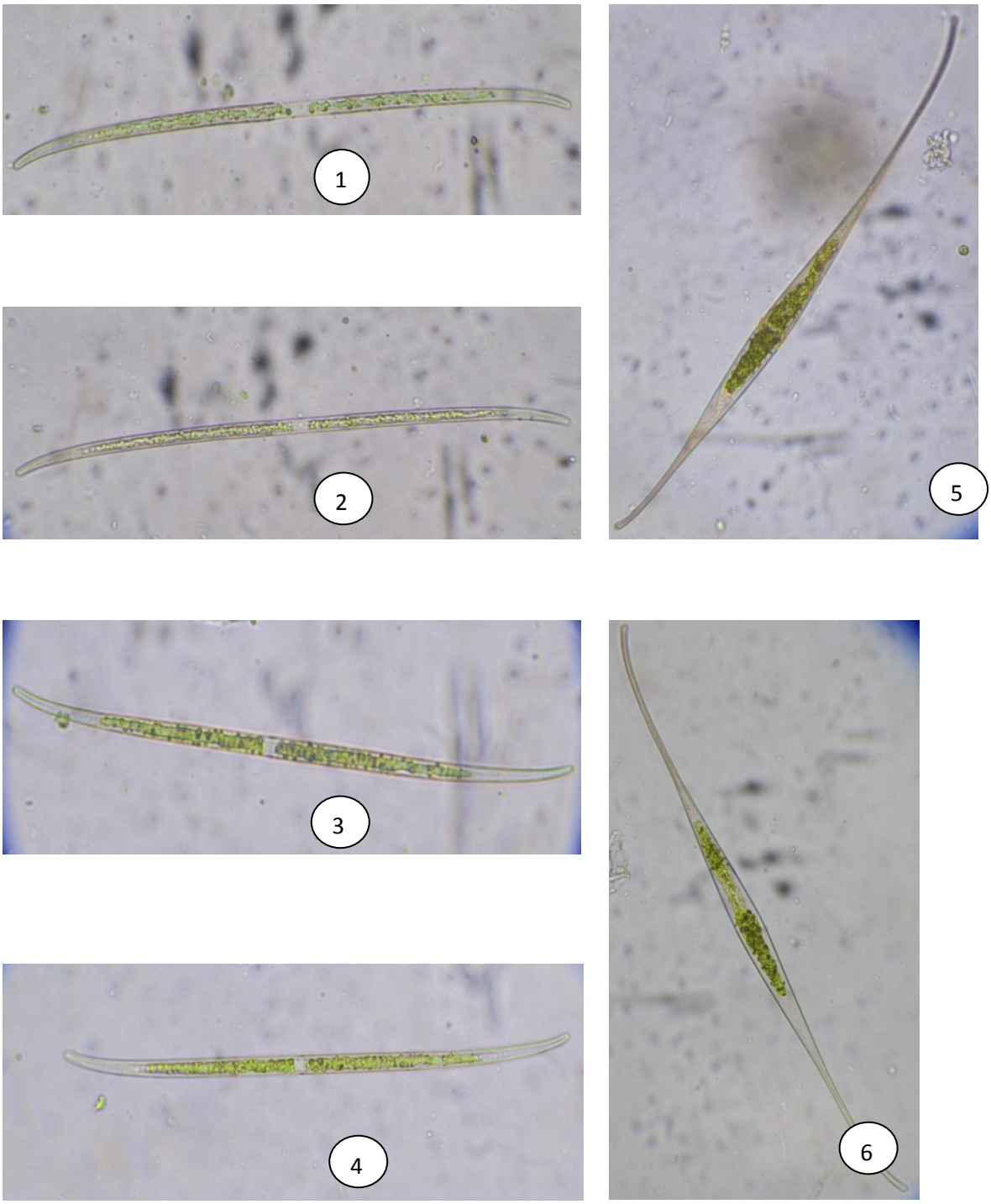
Figures: (1-3) *Gonatozygon monotaenium*, (4) *Spirogyra Sps.* (5) *Scenedesmus obtusus*, (6) *Pediastrum tetras*, (7) *Closterium dianae*

PLATE 9



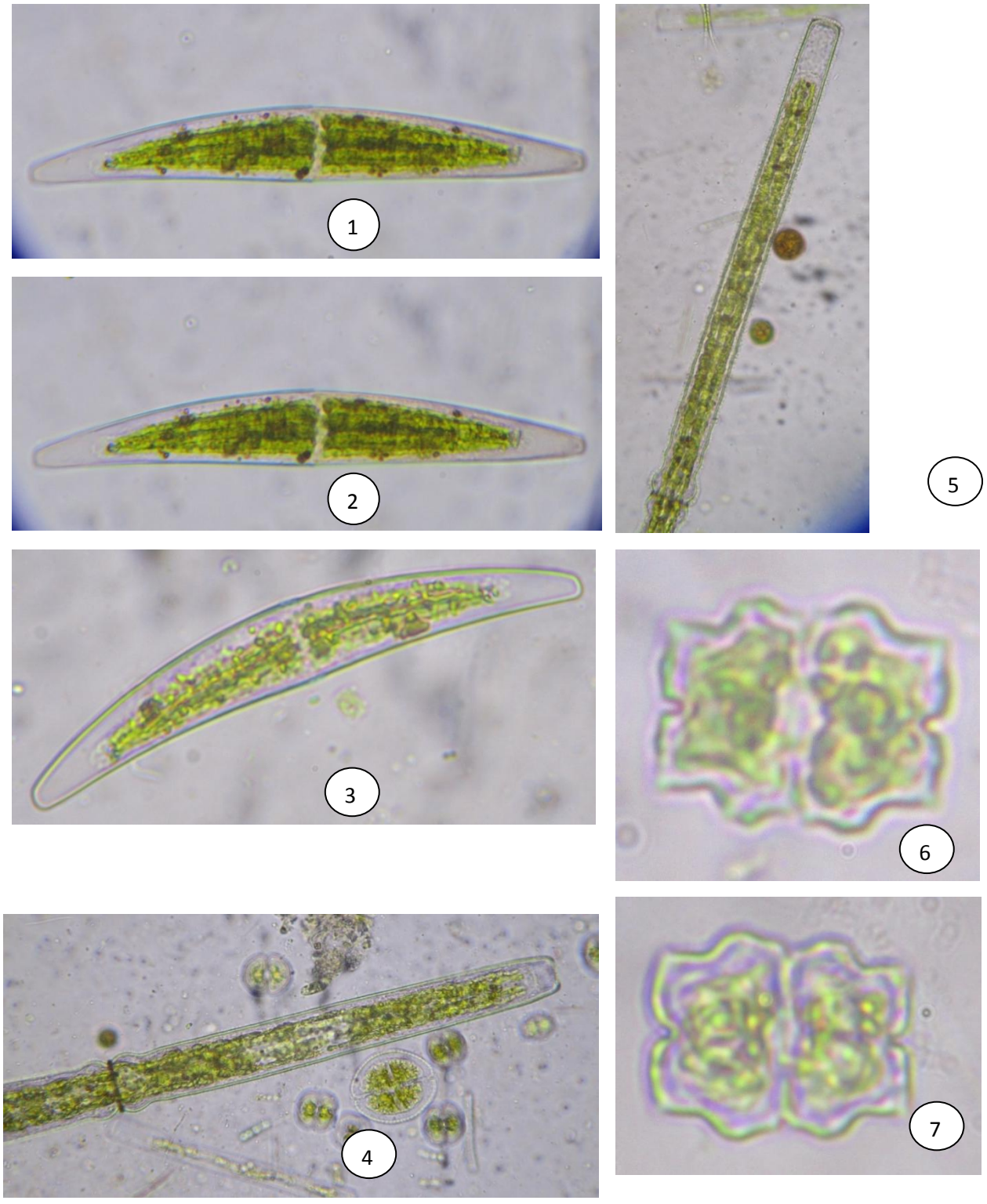
Figures: (1-3) *Closterium dianae*, (4) Closterium *ehrenbergii*, (5-6) *Closterium dianae var. arcuatum*

PLATE 10



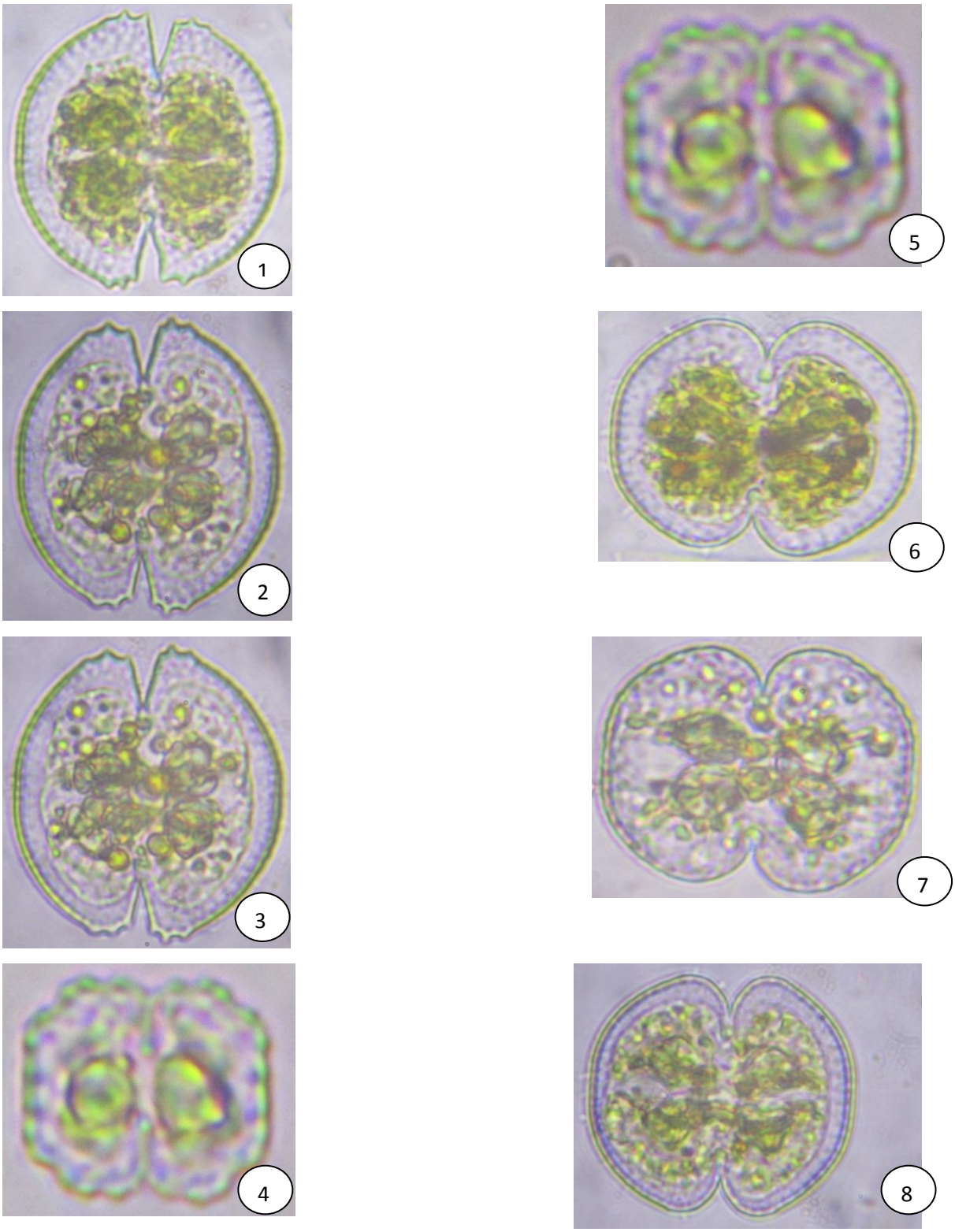
Figures: (1-4) Closterium *gracile* (5-6) *Closterium setaceum*

PLATE 11



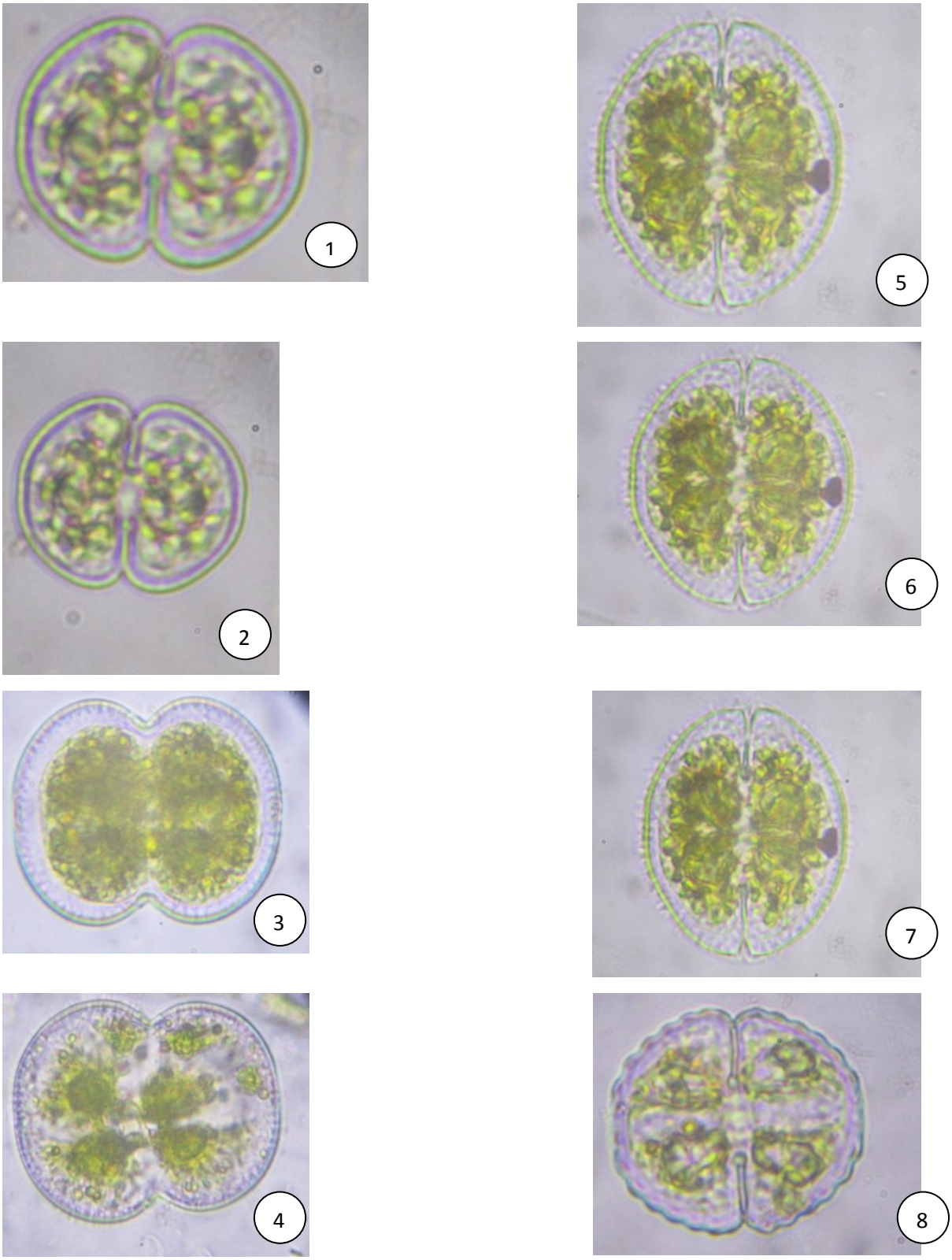
Figures: (1-3) *Closterium striolatum,* (4-5) *Pleurotaenium erenburgii,* (6-7) *Euastrum binale*

PLATE 12



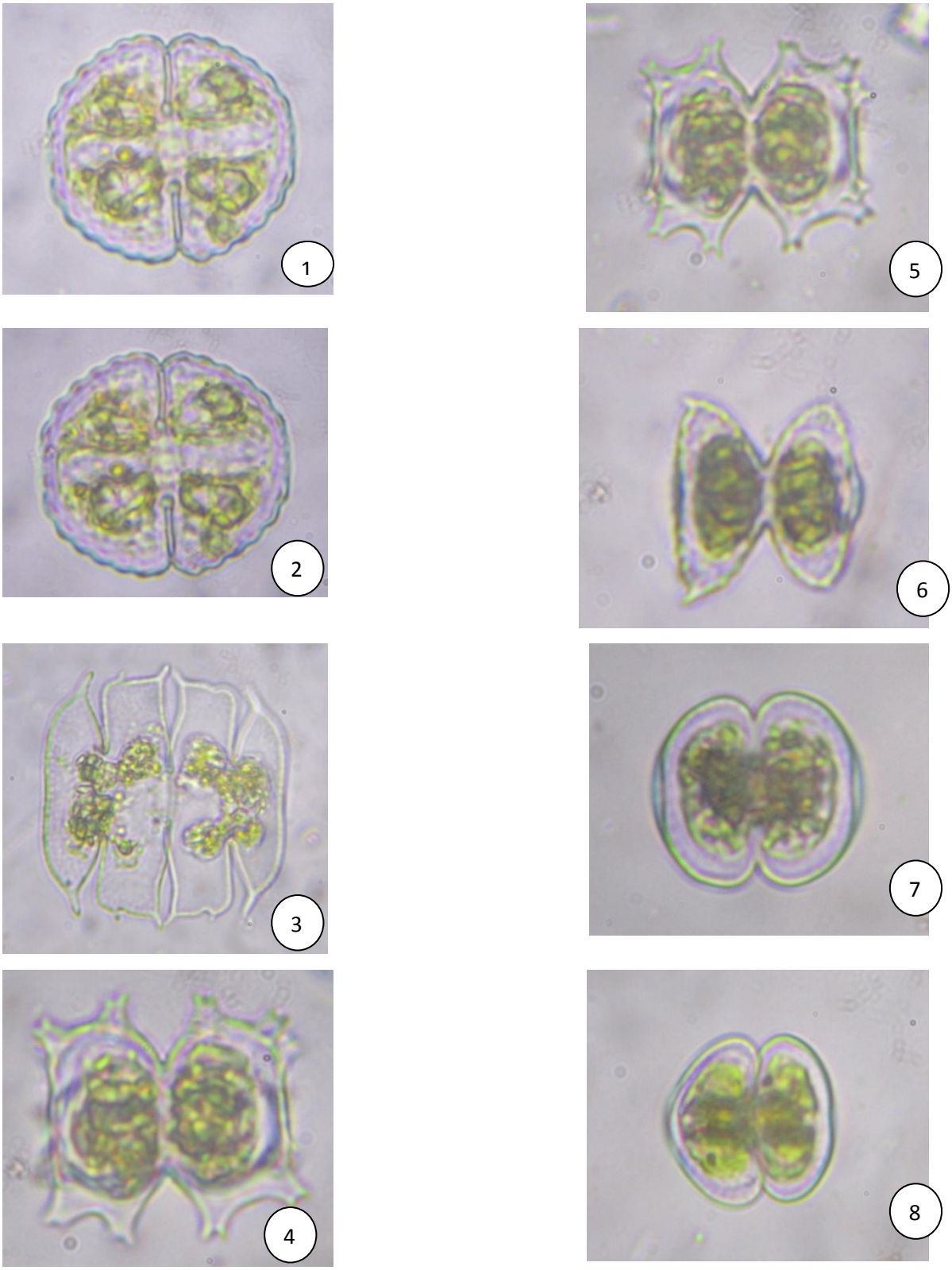
Figures: (1-3) *Cosmarium auriculatum*, (4 -5) *Cosmarium blyttii*, (6 -8) *Cosmarium cf. lundellii*

Plate 13



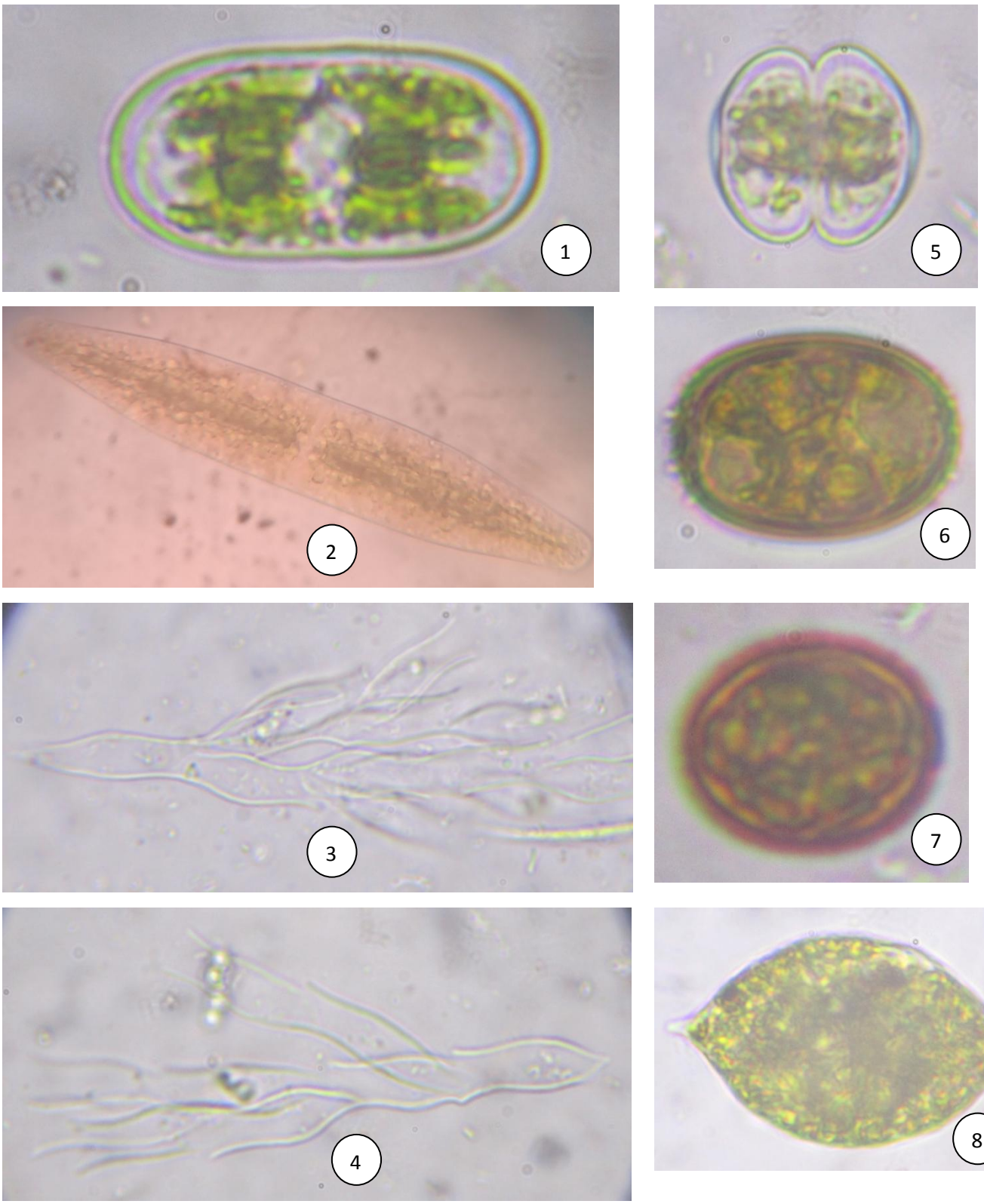
Figures: (1 – 2) *Cosmarium* circulare, (3-4) *Cosmarium connatum*, (5-7) *Cosmarium obsoletum var. sitvense* (8) *Cosmarium obtusatum*

Plate 14



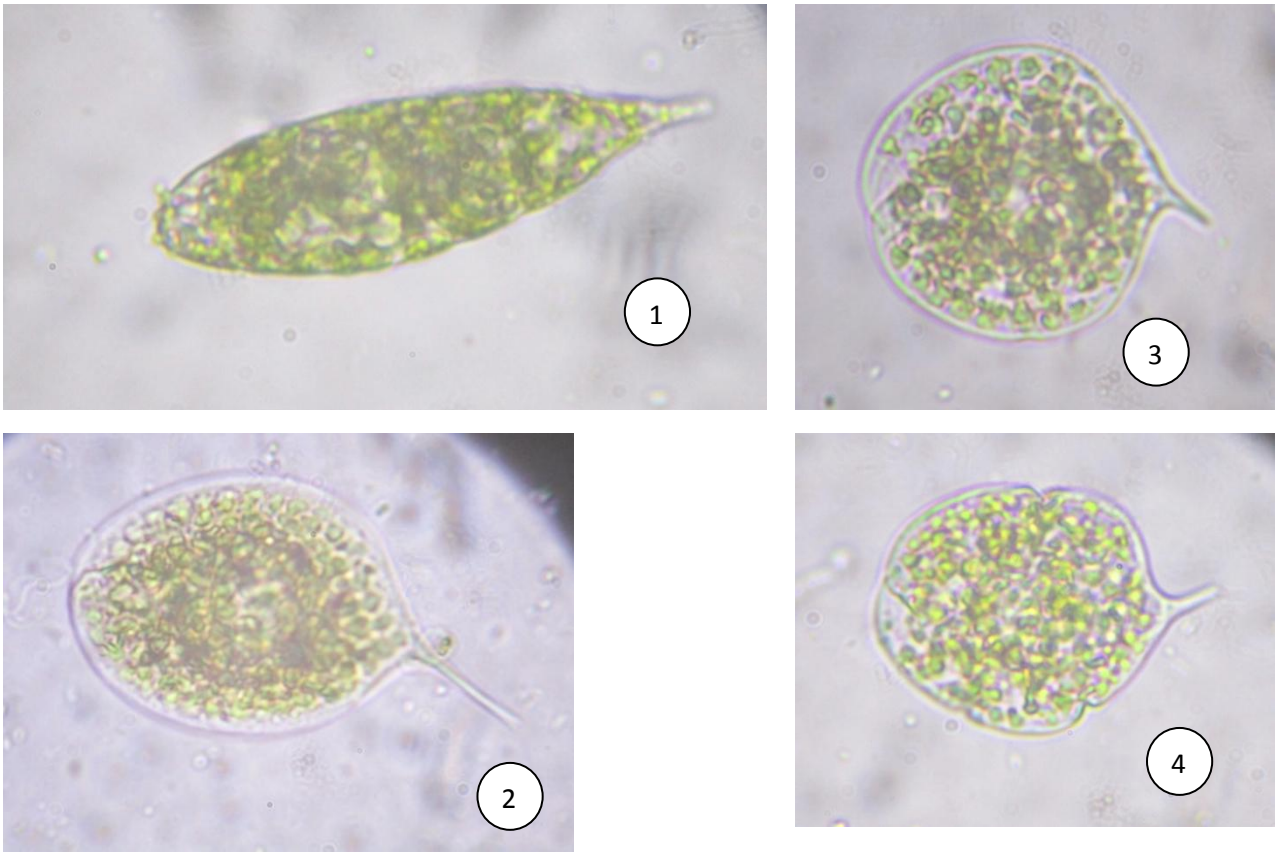
Figures: (1-2) *Cosmarium obtusatum* , (3)*Micrasterias zeylanica var. rectangularis*, (4-5) *Staurastrum forficulatum var.* verrucosum , (6) *Staurastrum lunatum* , (7-8) *Staurastrum muticum*

Plate 15



Figures: (1) *Cylindrocystis brebissonii*, (2) *Netrium digitus*, (3-4) *Dinobryon sertularia* (5) *Staurastrum muticum*, (6) *Trachelomonas armata*, (7) *Trachelomonas intermedia*, (8) *Euglena proxima*

Plate 16



Figures: (1) *Euglena proxima*, (2) *Phacus longicauda*, (3- 4) *Phacus orbicularis*

CHAPTER V

IMPLICATIONS AND CONCLUSION

Aquatic ecosystem of Rasa Lake has many fresh water algae because the water of this ecosystem is very much fresh which flows from the northern forest areas towards the artificially made lake located at southern side. This lake has both kind of habtitat ie. lentic and lotic water bodies for aquatic plants and animals. Most of the algae had been collected from lotic water flowing in northern stream channel of the lake where as presence of less algal taxa were found lentic habitat of the lake. It may indicate that fresh water algae require fresh and flowing water bodies for their proprer growth and development. Unless their growth will be retarded or reduce due to lack of their various requirements.

There are some differences in the feuatures of lotic and lentic water such as lotic water has shallower depth, high velocity, lower salt concentration and relatively narrow withdh of water bodies than in lentic water habitat. Similarly, lotic water has higher percentage of dissolved oxygen due to flowing condition and good penetratin of light due to shallower depth than in lentic water habitat.

In this study many economically important algae belonging to family cynophyceae or cynobacteria have been found which are very useful for making biofertilizer in agriculture field. Difference in these feautures may have developed a suitable habitat for growth of fresh water algae in lotic water bodies than in lentic water bodies.

This mini research on algal flora of Rasa Lake may serve as a literature in the exploration of algae in eastern Nepal in future. Some heterocystous species of algae belonging to phylum cyanobacteria, family nostocaceae - *Anabaena inaqualis, Anabaena sps* and some filamentous, non- heterocystous form of algae from family Oscillatoriaceae like *Oscillatoria* sp. and *Oscillatoria crassa* have capacity to fix atmospheric nitrogen and convert into useable form. Hence, these algae can be used to produce biofertilizer which can be widely used in rice fields of our agriculture farm.

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