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Study of climate change effects on algal

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Abstract

Algae are a diverse group of organisms that have enormous effects on various types of ecosystems on the earth as well as the aquatic ecosystem. They have existed on the planet for billions of years and have profound influence on global biogeochemistry. They produce a big amount of organic carbon in the earth's biogeochemical cycle in addition to oxygen. Algae play a wide range of roles in the biogeochemical cycles of the planet, ranging from single cells to multicellular filamentous gigantism thallus. Algae are one of the most important contributors to global biodiversity; the estimated number of large biodiversity ranges from 36000 to one million. Each species has its own characteristics and contributes significantly to global biodiversity.

Algae are linked to other organisms through the food web, biogeochemical cyclers, and symbiotic relationships. In this research work, we report the algal biodiversity of one of the ponds in Rajasthan's Banswara area. Although the amount of water is reduced in the summer, we have tried to enumerate the diversification of the algae are of that pond in different areas and we found great diversity. In the algae district, a total of 6 Ponds have been discovered. We chose the following Indicators for this study: Chlorophyceae, Euglenophyceae, Bacillariophyceae, and Cyanophyceae.

Keywords: algae, heterogeneous, biodiversity, Ponds

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1. Introduction

(Chaudhary, 1999)

Biodiversity refers to the diversity of all living things, such as plants, animals, and microorganisms, or the total quantity, variety, and variability of life forms, levels, and combinations found in the living world. It expresses genetic variety and diversity within and between species, as well as within and between ecosystems. Genetic, Species, and Ecosystem diversity are the three essential and hierarchical components of biodiversity.

Algae are a diverse group of creatures that range in size from single cells to huge thallus. The thallus length varies from filamentous to giant kelps, which cover many metres of seabed in India and other areas of the world. Algae are the most photosynthetic species, producing primarily oxygen and living in aquatic environments. The algae lack the body of higher plants as well as the other higher plant feathers. The photosynthetic properties of algae include both eukaryotes and prokaryotes natures, with cyanobacteria being one of the prokaryotes natures. The blue green algae is the name given to these organisms. Algae come in a variety of body shapes, some of which are so small that humans need to use a microscope to see them clearly; these algae are known as microalgae.

Prescott (1969)

"Algae are chlorophyll-bearing creatures (and their colourless relatives) that are thalloid, meaning they lack genuine roots, stems, and leaves, as well as leaf-like organs," he says. They are a diverse group of basic, plant-like creatures that lack real tissues and always have unicellular sex organs. None of them have a sporophytic generation that is parasitic on the gametophyte (except some red algae).

Macro algae are microscopic algal bodies that cover a large area in the aquatic body. Many microalgae are single-cell organisms; however, some algae are spherical in shape and exist in coccid forms, with some of the coccid forms combining to form colonies. In the coenobium, which has a specific number of cells, some algae are propelled by flagella and are referred to as

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flagellates. Filamentous cells that are joined one to one by the end are another feature of the algae. Periphyton refers to microalgae, while phytoplankton refers to algae. Periphyton is a type of microalgae that is attached to a substratum in the aquatic body, whereas phytoplankton is a type of free-swimming microalgae. Algae use both asexual and sexual reproductive methods to reproduce. The utilisation of spores such as zoospores and nonmotile aplanospores, in which the complete cytoplasm of the aplanospores is converted into nonmotile aplanospores, allows for asexual reproduction.

Figure: 1 Algae Biodiversity

Algae are an important component of the earth's biogeochemical cycle and play a significant role in biogeochemistry. Algae can be found in the sea, oceans, and other wet areas. Some algae species are classic pollution indicators; they are found in settings rich in a range of contaminants, and hence serve as markers of high pollution levels in the concerned sea or river. The body of the algae

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is relatively simple; it lacks actual roots, stems, leaves, and other types of fruiting structures, which are particularly common in higher plants. 1–5 Marine algae are incredibly valuable and abundant sources of food, vitamins, minerals, and other compounds. Algal genera are potential sources of a variety of food resources, as well as some medicines and environmental indicators, and many algae are used as sources of pharmaceuticals in the form of medicines. 815 Algae genera include Stigcolonium, Nitzia, Gomphonema, Cocoonei, Navicula, and Ulothrix. A number of other genera are also used as pollution indicators.

1.1.Classifications of Algae

Algae are classified mostly based on their physical characteristics. Among the most important are:

- Pigment constitution of the cell,
- Chemical nature of stored food materials,
- Kind, number, point of insertion and relative length of the flagella on the motile cell,
- Chemical composition of cell wall and
- Presence or absence of a definitely organized nucleus in the cell or any other significant details of cell structure.

2. Background of the Study

2.1.History of Algae

Carolus Linnaeus (1754) classified algae and lichens together in his 25th class Cryptogamia, he did not go into detail on algae classification.

Jean Pierre Étienne Vaucher (1803) is credited with being the first to establish a categorization system for algae, dividing them into three groups: Conferves, Ulves, and Tremelles. While **Johann Heinrich Friedrich Link (1820)** classed algae according on pigment colour and structure, suggested a classification system based on habitat and pigment. J. Diatomaceae, Nostochineae, Confervoideae, Ulvaceae, Floriadeae, and Fucoideae are the six orders divided. Algae and fungi were placed together under the Thallophyta classification by Eichler around 1880.

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Adolf Engler and Karl A. E. Prantl (1912) proposed a revised method of algae categorization that included fungus, as they believed fungi had evolved from algae. Schizophyta, Phytosarcodina, Flagellata, Dinoflagellata, Bacillariophyta, Conjugatae, Chlorophyceae, Charophyta, Phaeophyceae, Rhodophyceae, Eumycetes are the groups postulated by Engler and Prantl (Fungi).

The algae have chloroplasts that are similar to cyanobacteria in structure. Chloroplasts are thought to represent reduced endosymbiotic cyanobacteria because they contain circular DNA similar to that seen in cyanobacteria. However, distinct lineages of algae have different chloroplast origins, indicating that they were acquired during different endosymbiotic processes. The composition of the three major categories of algae is shown in the table below. The image at the upper right depicts their lineage links. Many of these communities include people who are no longer photosynthetic. Some have retained plastids but not chloroplasts, while others have completely lost plastids.

2.2.Kushalgarh Tehsil Banswara

Figure: 2 Location of Kushalgarh Tehsil Banswara

Kushalgarh in the Indian state of Rajasthan, is a town and municipality. It is located in the Banswara District, about 65 kilometres south of Banswara. Kushalgarh was also the name of a princely state in India that lasted till 1949 in the same area. Kushalgarh is located at 23.17 degrees north latitude and 74.45 degrees east latitude. It is at a height of 302 metres (991 feet) above sea level on average. Kushalgarh has a population of 10,096 people according to the 2011 Indian

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census. Males make up 51% of the population, while females make up 49%. Kushalgarh has a higher literacy rate than the national average of 59.5 percent, with male literacy at 80 percent and female literacy at 66 percent. 15 percent of the population in Kushalgarh is under the age of six.

Banswara is a city in Rajasthan, India, located in the Banswara district. Banswara got its name from the "Bans wala" (bamboo) trees that existed in abundance near this location. [1] Banswara is also known as the "City of a Hundred Islands," and is often referred to as the "Cherrapunji of Rajasthan" because of the numerous islands in the Mahi River, which flows through the city and is also referred to as "Mahati," an alternate name for Mahi river in Vayu Purana text. [2] Due to the heavy rainfall it receives, it is Rajasthan's greenest city. [3] The city's population is 101,017 people, with 51,585 men and 49,432 women.

3. Review of Literature

(Myers, 2003; Ebert, 2005)

India is one of the world's mega-diversity hotspots. Three of the reserved thirty-four hotspots are located in India. Despite having only 2.4 percent of the world's land area, India contributes to a diverse spectrum of geographical and meteorological circumstances. Biodiversity has suffered greatly in recent years as a result of anthropogenic activity at the local, regional, and global levels (Lee et al., 1994). According to recent estimates, human actions have drastically affected more than half of the land's livable surface. As a result of global warming and changing precipitation patterns, major changes in biodiversity are projected (Gates, 1993).

(Hader and Figueroa, 1997)

Algae are significant because they contribute significantly to the planet's primary productivity. There are more than 10 million species of algae. According to the paper, over 40,000 species of algae have been reported so far, with about 1500 species belonging to 150 genera of blue-green algae (Cyanophyta or Cyanobacteria).

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Lewin (1989), Castenholz (1992),

They are examples of this. Traditional approaches favor their classification as blue-green algae (Cyanophyta) in the International Code of Botanical Nomenclature, whereas microbiologists classify them as Gram-negative bacteria in the International Code of Bacteriological Nomenclature (Cyanobacteria).

Tiwari et al. (1999) studied blue-green algae in dry parts of Rajasthan; Shrivastava (2000) studied cyanophycean species in rice fields in Durg district, Chhattisgarh. Mishra et al. (2001) studied blue-green algae from Basti, Uttar Pradesh; Tiwari et al. (2001) studied non-heterocystous filamentous cyanobacteria from rice fields in Uttar Pradesh. Ara et al. (2002) studied cyanobacterial diversity in Kashmiri agro-ecosystems. Das (2002) found cyanbacterial diversity in rice field soils in Sambalpur district, Orissa; Hazarika et al. (2002) found the genus Oscillatoria in Lakhmipur district, Assam; Singh and Srivastava (2002) studied soil algae in Etah, Uttar Pradesh; Verma et al. (2002) studied blue-green algae in a contaminated environment in Uttar Pradesh. Jha and Barat (2003) conducted a hydrobiological study of Lake Mirik in the Darjeeling Himalayas. Prabina et al., (2003) used DNA amplification fingerprinting to perform phylogenetic study of symbiotic and free-living cyanobacterial cultures. Chatterjee and Keshri (2005) found Borzia indica in West Bengal, whereas Rao et al. found Cyanobacterial flora in paddy fields in Andhra Pradesh (2006).

Ghose (1919, 1923, 1933) The work of West and West throughout the first decade of the twentieth century greatly enriched the literature on Indian algae (1907). He identified 59 diatom species, 148 desmid species, and 53 additional green algae species. He made a significant contribution to India's algological study. He described the Lahore and Simla Cyanophyceae. He discovered and described a number of new species and variations during his research. Iyengar began conducting studies on numerous groups of algae in 1920 and made significant contributions to the knowledge of Indian algae. His initial paper focused on Madras Volvocales observations.

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Iyengar (1925) described two new Hydrodictyon species and a new Hydrodictyon species. He identified the genus Fritschiella in 1932. The discovery of this genus is extremely important. Numerous publications and volumes by Bruhl and Biswas (1922) have contributed significantly to our understanding of Indian algae, including descriptions of many new species and observations on their habitat, periodicity, ecology, and distribution.

Biswas (1949) made a significant contribution to the study of Eastern Indian algae. He researched algae in Manipur, Assam, and Calcutta's salt lakes, Chilka Lake, and the Khassi and Jaitia hills. Allen (1925) studied the Charophytes of the United Provinces extensively and named several species. Randhawa (1936) pioneered work on Indian Zygnemaceae and conducted considerable research on North Indian freshwater algae.

Man Chand and Kaushik (2000) studied the algal flora of Rohtak's aridisols as well as the indigenous Cyanobacteria's salt tolerance. Muralidharan et al. (2002) investigated the phytoplanktonic diversity of Tumkur's Gubbi Tank. Dwivedi and Pandey (2002) investigated the algal variety of certain Faizabad water bodies. Misra et al. (2005) examined the morpho-taxonomy of algae in Eastern Uttar Pradesh's Talkunda Pond. Kumar and Rai (2005) identified thirteen taxa in the Chlorophycean flora of Namchi, Sikkim. The seasonal phytoplanktonic biodiversity of Kitham Lake, Agra, was studied by Tiwari and Chauhan (2006).

Johnson (2006) identified 116 algal taxa in Hyderabad's Banjara and Nadimi lakes. Kolayli and Sahin (2007) conducted a comprehensive investigation of the phytoplankton in Karagol Lake's littoral zone. Senthil Kumar and Sivakumar (2008) discovered 160 phytoplankton species in Tamil Nadu's Veernam Lake. Bacillariophyceae has 74 species, Chlorophyceae has 43 species, Cyanophyceae has 38 species, and Euglenophyceae has five species. Thakur and Behere (2008) identified 25 taxa in the filamentous algal flora of Gangapur Dam in Nashik, Maharashtra. The fresh water algae of Meghalaya were described by Das et al. (2009). Suseela and Toppo (2009) list the freshwater algal flora of Padampur, Himachal Pradesh's Chandpur river. Laskar and Gupta (2009) investigated the phytoplanktonic diversity of Chatla Flood Plain Lake in Assam, identifying 34 Chlorophyceae, Cyanophyceae, Euglenophyceae, and Bacillariophyceae species.

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Bolyshev and Manucharova (1947) Algae from the desert have also gotten a lot of interest from scientists. The distribution of desert algae was explored. The distribution of terrestrial algae at the Nevada test site was documented by Shield and Drought (1962). The soil algae of the dry Steppes were described by Shtina and Bolyshev (1963). Friedmann (1964, 1968) investigated the Negev Desert's endolithic and xerolithic algae. The Chlorococcalean desert algae was first characterised by Ocampo-Pous and Friedmann (1966). Forest and Wetson (1966) described the algae of the Atacama Desert and proposed the existing algal taxonomic line.

4. Research Methodology

The aquatic ecosystem is home to more than 80% of the world's plant and animal species, and 34 of the 36 phyla of life are represented. Algae account for more aquatic plant species than any other. Algal studies draw on knowledge from a variety of fields and require a large number of comprehensive field and laboratory experiments in order to gain a holistic understanding of the structural and functional elements of the fresh water environment. The observations were conducted from January 2018 to December 2020, a span of 24 months, from various ponds in the Banswara region, while preliminary work began in July 2017. Preservation and identification of algal taxa, staining, analysis of phytoplankton in terms of fluctuation, and illustration (camera lucida diagrams, micro and macro photography of algae) were all used to complete the project.

4.1.Collection of algal samples

Different types of sample tools are used to capture the diversity of phytoplanktons and other algae that are commonly found in standing water bodies. Phytoplanktonic sampling methods include bottle samples, plankton pumps, and plankton nets. Bottle samples and plankton nets were employed in this study. The present study looked at all types of algae, including planktonic, adherent, and mud algae. Algal samples were taken at the same time as water samples from various ponds in the Banswara region, at random. The bottle sample approach is the most basic method for obtaining a correct image of the phytoplankton's quantitative composition. A water bottle sample comprises all except the most unusual organisms in the water mass examined, and spans the size spectrum from the largest entities, such as diatom colonies, to the tiniest single cells

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(Tomas, 1997). These are ideal for collecting quantitative phytoplankton because they can collect the needed amount of water from the specified depth. Plankton nets allow for quantitative research because the mesh size determines the type of phytoplankton that is captured. The mesh size of the gauze, the net towing speed, and the species present in the water all influence how selective net sampling is. Nets with very fine meshes (5 or 10 fim), on the other hand, often filter too little water to obtain an acceptable diatom sample. 25 p.m. mesh is the most useful mesh size for collecting diatoms. Net hauls offer the advantage of collecting and concentrating plankton at the same time, allowing for species identification. A conical bolting silk net with a diameter of 15 cm and a length of 75 cm was employed in this study. A glass tube with a capacity of 50 ml was attached to the net's lower narrow end. The bolting silk cloth had a mesh density of 50 meshes per centimetre. A hundred litres of lake water was poured through the net, and the sample was collected in a glass tube, which was then transferred to a marked bottle with a collection number.

4.2.Morphological characteristics

Several essential features were employed to help with algae classification. Cell form, size, amount, pattern, organisation, type appendages, and so on are examples of these features. Algae in freshwater are classified into various groups, each with its own set of characteristics. Charophytes specimens were soaked in IN HCI for five minutes and then washed thoroughly under running water to determine the kind of cortication. The number of coronal cells, the length and width of sex organs, and other critical criteria are used to determine the position of oogonia in relation to antheridia. For various filamentous forms, the number of nuclei, shape and number of chloroplasts, type of branching, type of septa between cells, position, number size, and shape of sex organs; conjugation tube (presence or absence) and its type; opening of oogonia, cap cells (presence or absence), type and shape of terminal portion, absence or presence of hairs, and other characteristics were investigated.

5. Data analysis

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Site no.	Name of the Pond	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Cyanophyceae
A-1	**Kupda**	**52.60**	**22.60**	**5.42**	**25.36**
A-2	**Nathelav**	**45.23**	**13.23**	**8.41**	**22.36**
A-3	**Raj**	**32.66**	**25.22**	**5.45**	**19.23**
A-4	**Thikkaria**	**43.23**	**17.33**	**7.23**	**22.36**
A-5	**Bai**	**72.20**	**16.23**	**6.23**	**27.36**
A-6	**Kagdi pickup**	**64.45**	**18.21**	**7.23**	**26.66**

Table: 1 Percentage Contribution of Different Groups of Algae in Different Sites (Ponds) of Banswar Region, During 2018-2020.

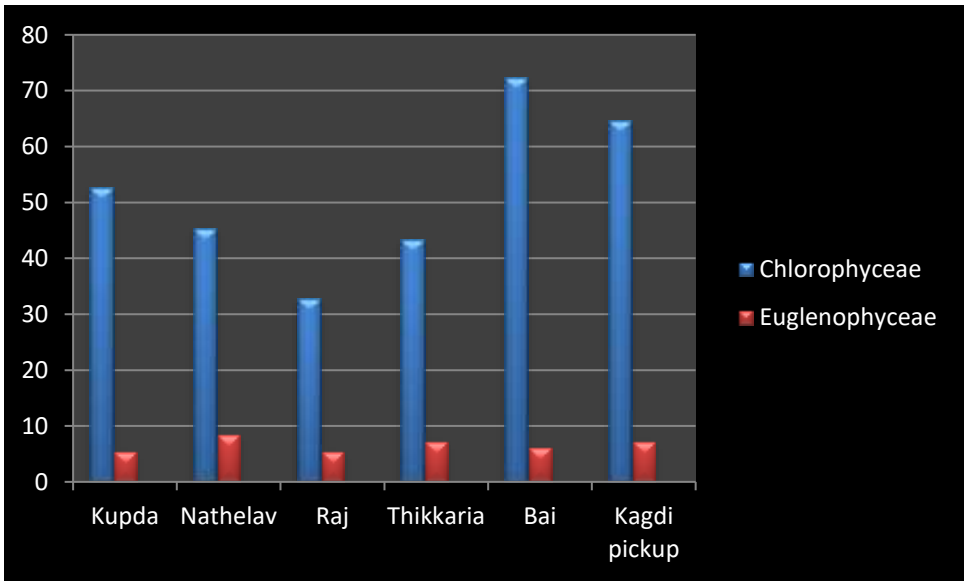

Figure: 2 Comparative Variations in I lie Algal Species of Various Groups from Different Sites (Ponds) of Banswar Region, During 2018-20

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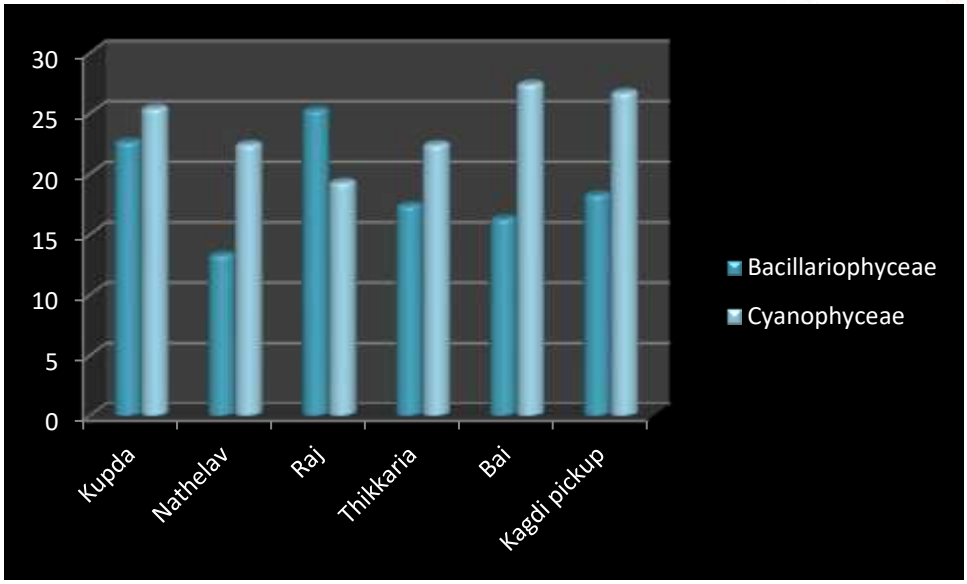

Figure: 3 Comparative Variations in I lie Algal Species of Various Groups from Different Sites (Ponds) of Banswar Region, During 2018-21

- **Chlorophyceae:** The Chlorophyceae family of freshwater green algae is big and diverse. They include numerous members that are important both environmentally and scientifically, as well as some of the most common species. Chlorophyceans are divided into 350 genera and 2650 extant species. Free-swimming unicellular species, colonies, non-flagellate unicells, filaments, and other forms are among them. They reproduce in a variety of ways, but they all follow a haploid life cycle, with the zygote cell being the only diploid cell. The zygote is frequently used as a dormant spore, able to survive potentially harmful environmental changes such as dessication.
- **Bacillariophyceae**: Bacillariophyceae is a phylum of Bacillariophyceae (diatoms) Unicellular algae that are normally seen individually but can also be colony or filamentous. The size of the cells varies from 5 to 2000 m. The silica-impregnated cell wall (frustule) is made up of two valves, one of which overlaps the other like a box lid.
- **Euglenophyceae:** are a well-known group of flagellates that are excavating eukaryotes belonging to the phylum Euglenophyta, and their cell structure is typical of that phylum. With a few marine and endosymbiotic members, they are frequently found in freshwater,

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especially when it is rich in organic compounds. Many euglenids eat via phagocytosis or by diffusion alone. Rapaza viridis (1 species) and the two groups Eutreptiales (24 species) and Euglenales (983 species) form a monophyletic group with chloroplasts and manufacture their own food through photosynthesis. The carbohydrate paramylon is included in this category.

- **Cyanophyceae:** Cyanophyceae (blue-green algae) are bacteria that look like algae and can damage surface water supplies, particularly during the summer. A toxic component called microcystin gives the water a mouldy, musty, grassy, or septic-tank odour. Although these guidelines are not based on horse investigations, the proposed microcystin-LR trigger value in water for horses is 2.3 g/l or 11 500 cells/ml. Surface waters with blue-green algal overgrowths are treated with 1 kg copper sulphate per 2.1 million litres of water using a certified copper sulphate product (Government of Saskatchewan 2008).

6. Result and discussion

Pond and lake biological and hydrodynamic studies give valuable information about the water quality and functioning of these aquatic ecosystems. Phytoplanktons and other algae, among the many elements that influence the diversity of fauna and flora in reservoir systems, play a critical role in the formation of organic matter, which is influenced by a variety of environmental circumstances. Algal diversity, in particular, appears to be highly responsive to water quality in aquatic ecosystems.

6.1.Algal fluctuation and abundance

It's critical to comprehend the relative importance of the various orders and classes of algae in the composition of algal species, particularly in relation to different freshwater bodies. This type of research provides insight into the variability and richness of biodiversity in aquatic habitats. As a result, the variation and abundance of distinct orders and classes of algae at ten key ponds in the Bansawar region are reviewed below.

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- **Chlorophyceae**: Chlorophyceae was found to be dominant over Bacillariophyceae, Euglenophyceae, and Cyanophyceae in the Bansawar region, accounting for 40.66 percent of the total algal species. In comparison to other ponds in the Bansawar region, Bai Pond (A-5) and Kagdi pickup Pond (A-6) had the highest number of Chlorophycean diversity and two peaks of maximum algal taxa. The Chlorococcales had the most diversity (33) in Bai Pond and the least diversity (9) in Raj Pond. The Chlorococcales were best represented by Scenedesmus.
- **Bacillariophyceae:** In the Banswar region, 38 species belonging to 14 genera were found in fresh water sources. It was discovered that it contributed 20.88 percent of the total algal species. Bacillariophyceae has a fluctuating number of species in different water bodies, as can be seen. It was also discovered that the Bacillariophycean diversity in Natho Pond had a single peak.
- **Euglenophyceae**: With 14 species spread over three genera, Euglena, Lepocinclis, and Phacus, this class was underrepresented. This group was responsible for 1.65% of the total algae. In Dron Pond, it revealed a single peak of highest variety. In Kupda Pond, the least amount of Euglenales variety was discovered (A-1). And it was discovered that Euglena has the most diverse display (A-2) among the Euglenales.
- **Cyanophyceae:** In varied habitats of fresh water bodies in the Banswar region, 56 species belonging to 23 genera were found. It was responsible for 30.77 percent of the total number of algal species. In both Kagdi pickup Pond and Bai Pond, Cyanophyceae displayed a bimodal fluctuation with broad maxima. This study looked at algae from the orders Chroococcales, Pleurocapsales, and Nostocales. Chroococcales variety was found in abundance in the Kagdi pickup Pond as compared to other ponds. In terms of species dominance, the genera Chroococcus and Oscillatoria of the Chroococcales and Nostocales, respectively, were shown to be dominant.

7. Conclusion

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Overall, this is a brief study of algae distribution in the Banswara region of Rajasthan; algae are widespread around the world, and much research may be done on them; nonetheless, there are significant seasonal fluctuations in algae composition in the river area. Some of the genera are dominating, forming a vast net on the water's surface. They play an important role in the water body's natural processes. However, because a substantial production never occurs, they cannot be used as food or for other uses. They may have an important function in soil microbiology, but additional research is needed. During the years 2018-2020, we will gather data on the contribution of various groups of algae to various sites (ponds) in the Banswara region. We chose six rivers in the Banswara District to examine and contrast.

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