HYDROBIOLOGICAL RESEARCH

Hydrobiological Research 3(2), 31-47 (2025) https://www.doi.org/10.5281/zenodo.16410693

Research Article

A comprehensive study on the diatom flora of Anasagar Lake, Ajmer, Rajasthan

Manju Parihar[a], **Arvind Pareek**[a]*

[a]*Maharshi Dayanand Saraswati University, Department of Botany, 305009-Rajasthan, India*

Abstract: Freshwater diatoms of Anasagar Lake, Ajmer was investigated between July 2023 to June 2024. Samples were collected on the interval of for months and variation in flora was analyzed seasonally, including monsoon, post-monsoon, winter, and summer seasons. The range of Shannon diversity indices was found between 1.60 and 3.84, the species evenness between 0.37 and 0.66, and the Simpson's diversity index between 0.022 and 0.22. The diversity indices indicated that there is light to moderate level of pollution in the studied sites, with moderate diversity level. This study suggested that the post-monsoon was more favorable for diatom growth, possibly due to nutrient availability. Sixty-two species of diatom were identified. Twenty-seven genera and sixty-two species represented these species.

Keywords: Ajmer, Anasagar Lake, Diatoms, Diversity Indices, Freshwater, Systematic Position

Manju Parihar ORCID ID: 0009-0005-8598-8162
Arvind Pareek ORCID ID: 0000-0002-2989-1930

*Corresponding author: arvindmdsu@gmail.com
(Received: 29.05.2025, Accepted: 03.07.2025, Online Publication: 25.07.2025)

1. INTRODUCTION

Diatoms are ubiquitous, unicellular algae that form most of the planktonic population in freshwater. They are characterized by a silica-containing cell wall called frustules and are therefore well preserved in sediments. The diatom structure comprises two valves with flat surfaces, connected by a girdle.

Researchers from various regions of India have reported the presence of diatoms in multiple locations throughout the country of freshwater diatoms were made extensive studies by Gandhi (1955, 1956, 1960, 1961) in India. Krishnamurthy (1954) contributed to the diatom flora of South India. Gonzalves & Gandhi (1952, 1953) have given a systematic account of the diatoms of the Bombay. Sarode & Kamat (1983) studied freshwater diatoms taxonomy of Vidarbha. Jena et al., (2006) reported the seventy-eight taxa of diatoms including *Aulacoseira*, *Cyclotella*, *Tabellaria*, *Thallasionema*, *Grammatophora*, *Fragilaria*, *Synedra*, *Achnanthes*, *Cocconeis*, *Diadesmis*, *Diplonies*, Gyrosigmaf, *Pleurosigma*, *Navicula*, *Pinnularia*, *Stauroneis*, *Eunotia*, *Himantidium*, *Gomphonema*, *Cymbella*, *Cocconema*, *Amphora*, *Rhopalodia*, *Nitzschia of Surirella* from different fresh water habitats of Orissa state and its neighbouring regions of India (Jena et al., 2006). All the taxa were recorded for the first time from this region. Patil & Kumawat (2007) worked on the centric diatom of Abhora Dam, Jalgaon, Maharashtra. Jadhawar & Papdiwal (2012) studied the diatom diversity of Nath Sagar water reservoir, Maharashtra. Recent studies have revealed the necessity for examining regional diatom-based composition, abundance, and biotic indices, because of their important functions in assessing water quality and environmental conservation (Shah et al., 2017; Rana et al., 2023; Mukherjee et al., 2024)

Information regarding the diatom of Rajasthan is known through the work of Gandhi (1955), Pascher (1930), Trivedi (1982), Jakher et al. (1990), Dadheech et al. (2000), Kumar et al. (2008), Kumar et al. (2009), Narayan & Barupal (2015) Singh et al. (2010), Pareek et al. (2011), Kumar & Singh (2017) Barupal & Meghwal (2018), Barupal (2019), Barupal & Singh (2023). The Anasagar Lake, constructed by King Anaji of the Chauhan dynasty between 1135-1150 AD, is now a polluted lake of Ajmer (Ranga, 1995). However, no work has been done on the diatoms of Ajmer Anasagar Lake. Diatoms are the vital part of lake, producing 20-50% of the planet's oxygen. They play a key role in biodiversity of Anasager lake and a good indicator of lake pollution. Hence, the present study attempts to fill this gap.

2. MATERIAL AND METHOD

2.1 Study Area

Anasagar is an artificial freshwater lake situated in Ajmer, Rajasthan, India, with coordinates ranging from 26.25' N to 26.29' N in latitude and 74.38' E to 74.42' E in longitude. The lake covers an area of around 13 square kilometers, has a maximum depth of 4.4 m (14 ft.), and has a water volume capacity of around 4.75 $\times 10^6$ m^3. In the current study, shallow-water zones and deep-water zones of Anasagar Lake were selected for sampling.

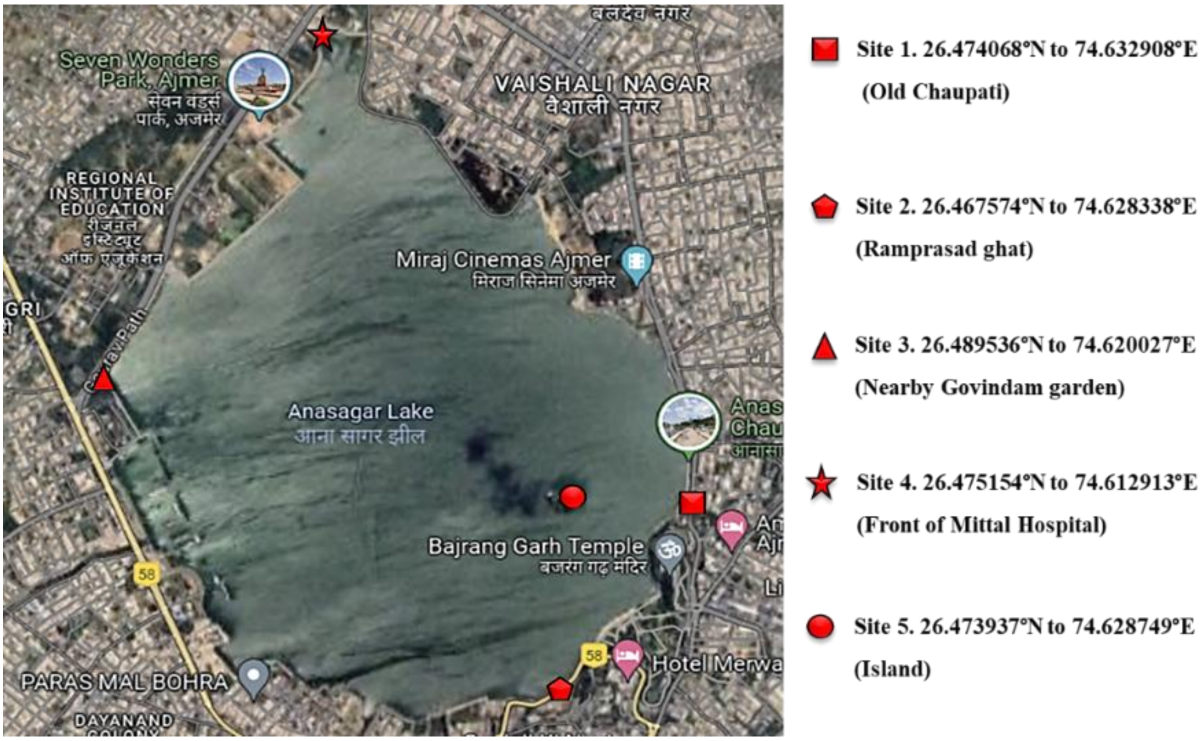

Figure 1. Sample collection sites of the Anasagar Lake

2.2. Collection Sites

Five different collection sites were selected for the study of diatoms. These sites were selected on four directions of the lake and one island that broadly represents sampling from all around the lake. (Figure 1).

Five sampling sites were selected to comprehensively represent the spatial heterogeneity of Anasagar Lake. These sites were strategically chosen to cover the entire lake area and to reflect variations in ecological conditions and pollution sources. Site 1 (old chaupati) indicates recreational disturbance, Site 2 captures pollutant input from the Bandi River drain, Site 3 represents sewage-affected zones, Site 4 (mid-lake) shows relatively undisturbed conditions, and Site 5 (urban fringe) receives mixed natural and anthropogenic inflows. This site selection enables a holistic assessment of water quality and diatom diversity across the lake.

2.3. Determination of Diatom Diversity

Samples were collected at 15-day intervals over one year period from July 2023 to June 2024. For the detailed analysis of diatoms, firstly the diatom valve was cleaned with concentrated hydrogen peroxide to remove organic matter, followed by treatment with concentrated HCL to dissolve calcium carbonates. After washing with distilled water, the samples were mounted on a slide with Canada balsam mounting medium.

The identification of diatom species was carried out with the help of a Radical Light Microscope RXLr-4. The permanent slides were prepared and observed at 40X magnification without immersion oil and at 100X with immersion oil. The observed diatom species were photographed with black-and-white filters for best results using Radical ProCAM software in the laboratory at the Department of Botany, Maharshi Dayanand Saraswati University, Ajmer. The relative abundance of all observed taxa was expressed as relative counts.

The whole year was divided into 4 seasons- Monsoon (June-August), Post-Monsoon (September- November), Winter (December to February), and Summer (March-May). Season-wise Abundance of diatoms (at different sites of the study area) was determined. A heatmap was constructed for study of species diversity and abundance using PAST 4.03 statistics software.

2.4 Determination of Diversity Indices

2.4.1. Shannon-Weiner diversity index (H')

The following formula was used to determine the Shannon-Weiner diversity index;

$$H = -\sum_{I=1}^{S} Pi * Inpi$$

Where is

H= Shannon's- Wiener diversity index

Pi = ni/N (total sample proportion belonging to i^{th} species)

Pi = Relative abundance of species

S= Total individuals count of a species

If the value of Shannon's index is less than 1.5= low diversity, if the value is greater than 1.5 but less than 2.5 means medium diversity, and if the value is higher than 2.5, indicates the higher diversity.

2.4.2. Simpson's diversity index

The measure equals the probability that two entities taken at random from the dataset of interest represent species;

$$D = \sum_{i=1}^{R} pi^{2}$$

Where is

D= Simpson's diversity index

R= Richness

Pi= Relative abundance of species

2.4.3. Species Richness/ evenness (J)

Evenness expresses how uniformly the individuals in a population group are dispersed among the different species. For calculating the evenness of species, the Pielou's evenness index (J) was used (Pielou, 1966) –

$$J = \frac{H\prime}{In(s)}$$

Where is

H= Shannon- Wiener diversity index

S= total species number in the sample

If the evenness value is close to 1= more evenness is found; if the value is closer to 0=less evenness is present.

3. RESULTS

During the survey, a total number of 62 diatoms species were reported at the study sites. The microscopic images of the identified diatoms are given in Figures 1-3.

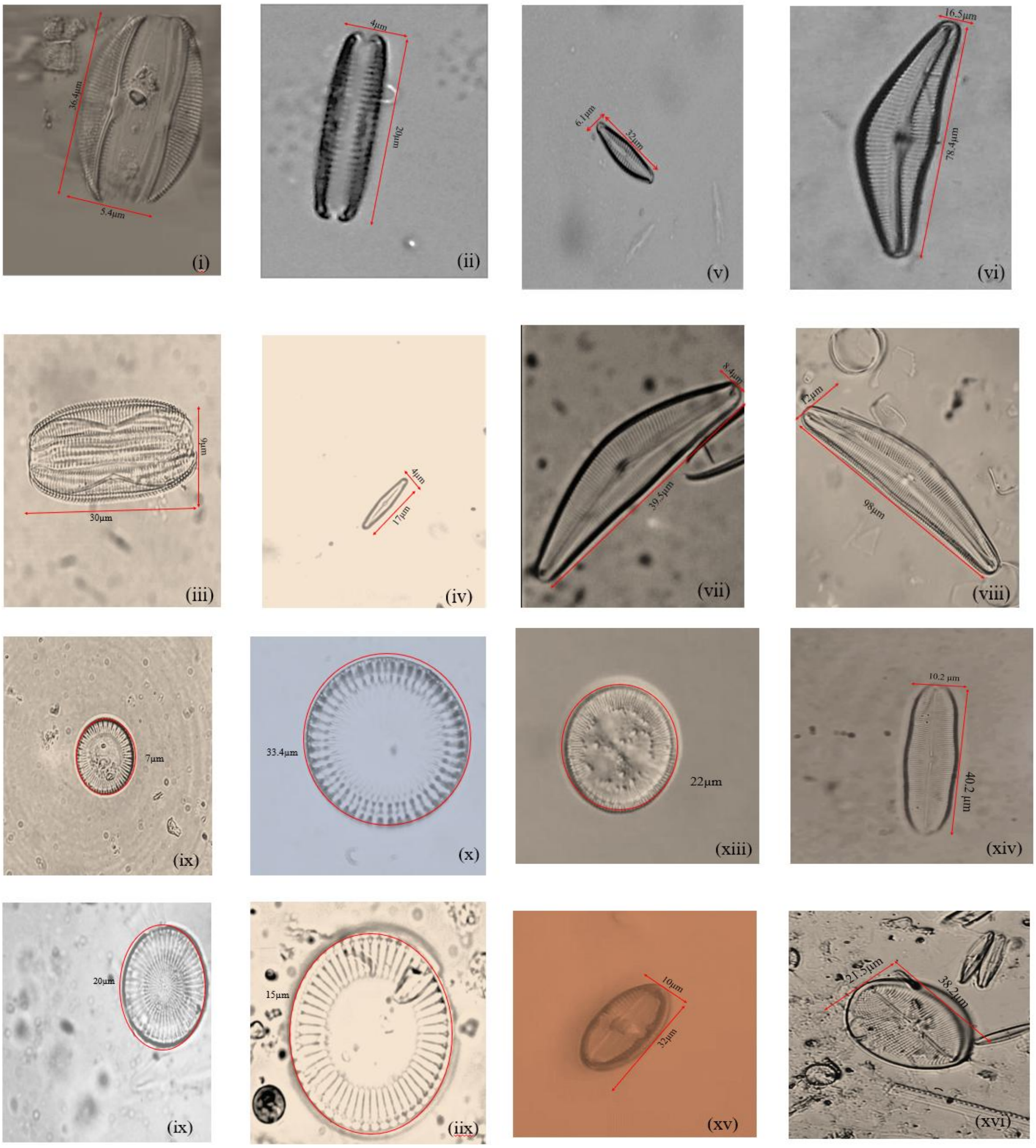

Figure 2. (i) *Amphora ovalis* (ii) *Amphora pediculuas* (iii) *Amphora copulate* (iv) *Brachysira microcephala* (v) *Cymbella excise* (vi) *Cymbella tumida* (vii) *Cymbella vulgate* (viii) *Cymbella bengalensis* (ix) *Cyclotella atomus* (x) *Cyclotella bifacialis* (xi) *Cyclotella distinguenda* (xii) *Cyclotella meneghiniana* (xiii) *Cyclotella ocellata* (xiv) *Caloneis silicule* (xv) *Cocconeis placentula* (xvi) *Cacconeis pedicul*

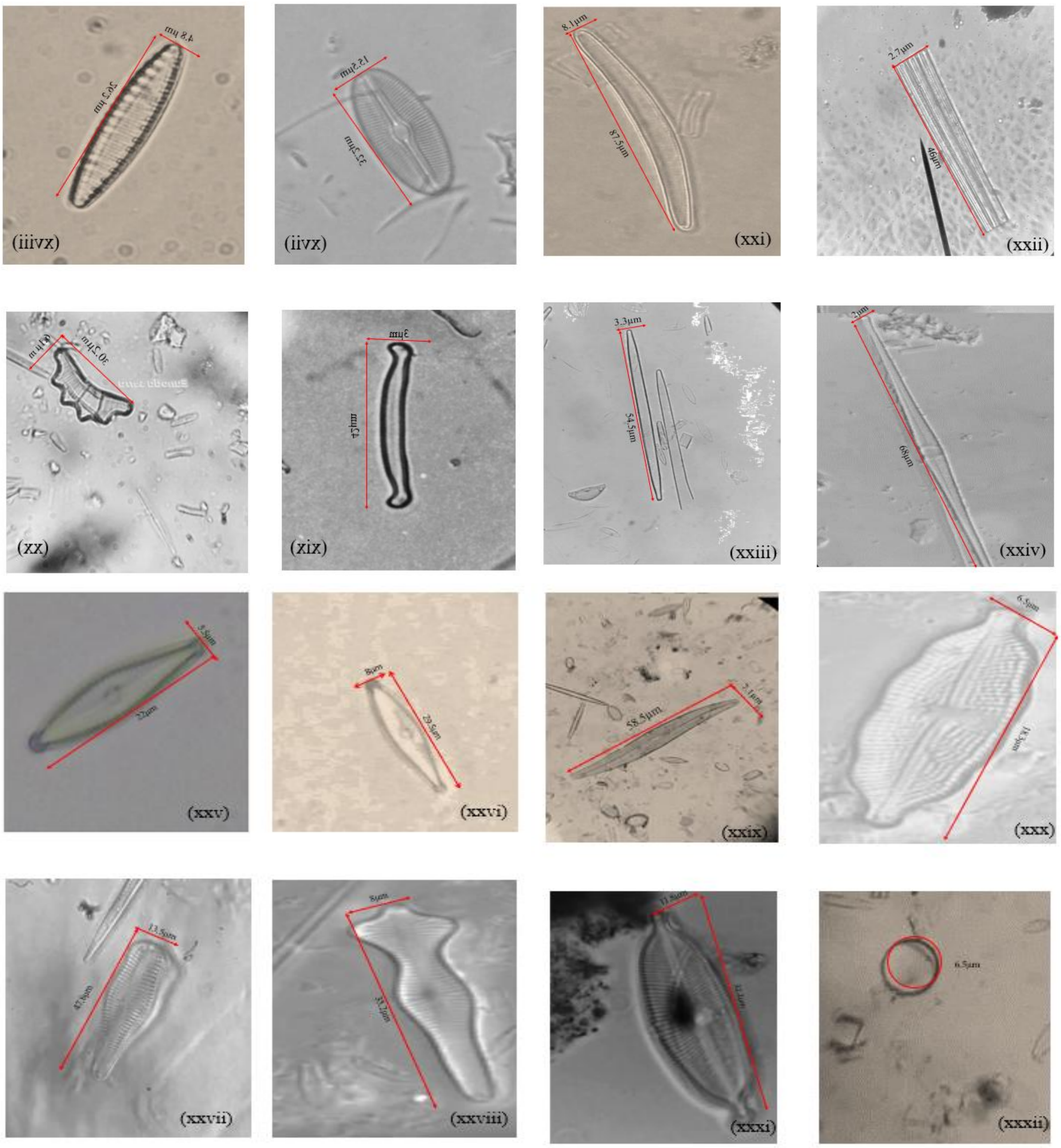

Figure 3. (xvii) *Diploneis oblongella* (xviii) *Denticula kuetzingii* (xix) *Eunotia neocompacta* (xx) *Eunotia camelus* (xxi) *Eunotia pectinalis* (xxii) *Fragilaria crotonensis* (xxiii) *Fragilaria subconstrica* (xxiv) *Fragilaria tenera* (xxv) *Gomphonema exilissimum (*xxvi) *Gomphonema pseudosphaerophorum* (xxvii) *Gomphonema truncatum* (xxviii) *Gomphonema acuminatum* (xxix) *Gyrosigma eximium* (xxx) *Luticola contii* (xxxi) *Mastogloia smithii* (xxxii) *Melosira varia*

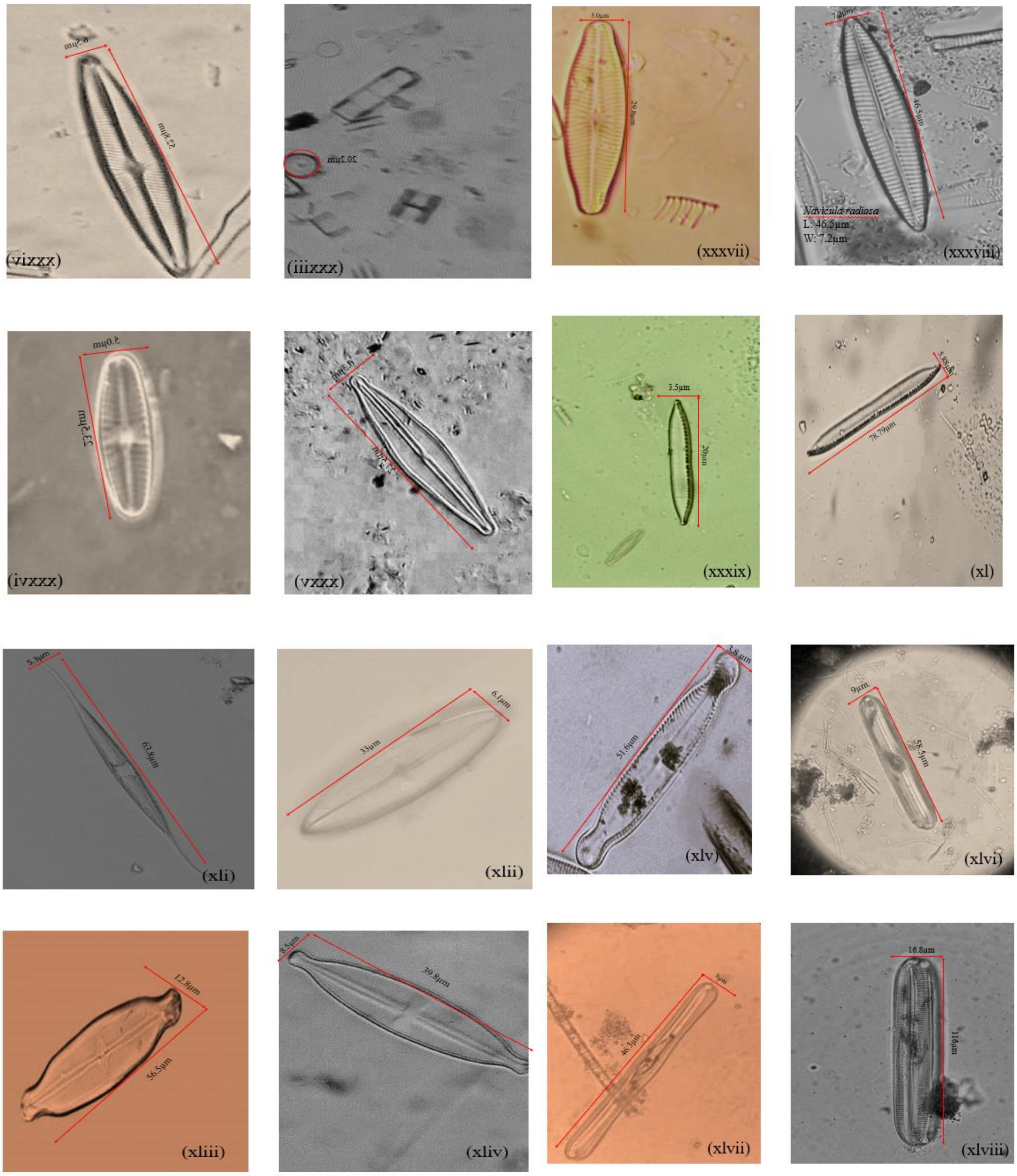

Figure 4. (xxxiii) *Melosira lineata* (xxxiv) *Navicula hemansioioides* (xxxv) *Navicula cryptocephala* (xxxvi) *Navicula gregaria* (xxxvii) *Navicula angusta* (xxxviii) *Navicula radiosa* (xxxix) *Nitzschia desertorum* (xl) *Nitzschia umbonate* (xli) *Nitzschia reversa* (xlii) *Nidium herrmanni* (xliii) *Neidium productum* (xliv) *Neidium affine* (xlv) *Pinnularia joculata* (xlvi) *Pinnularia divergens* (xlvii) *Pinnularia acrosphaeria* (xlviii) *Pinnularia viridis*

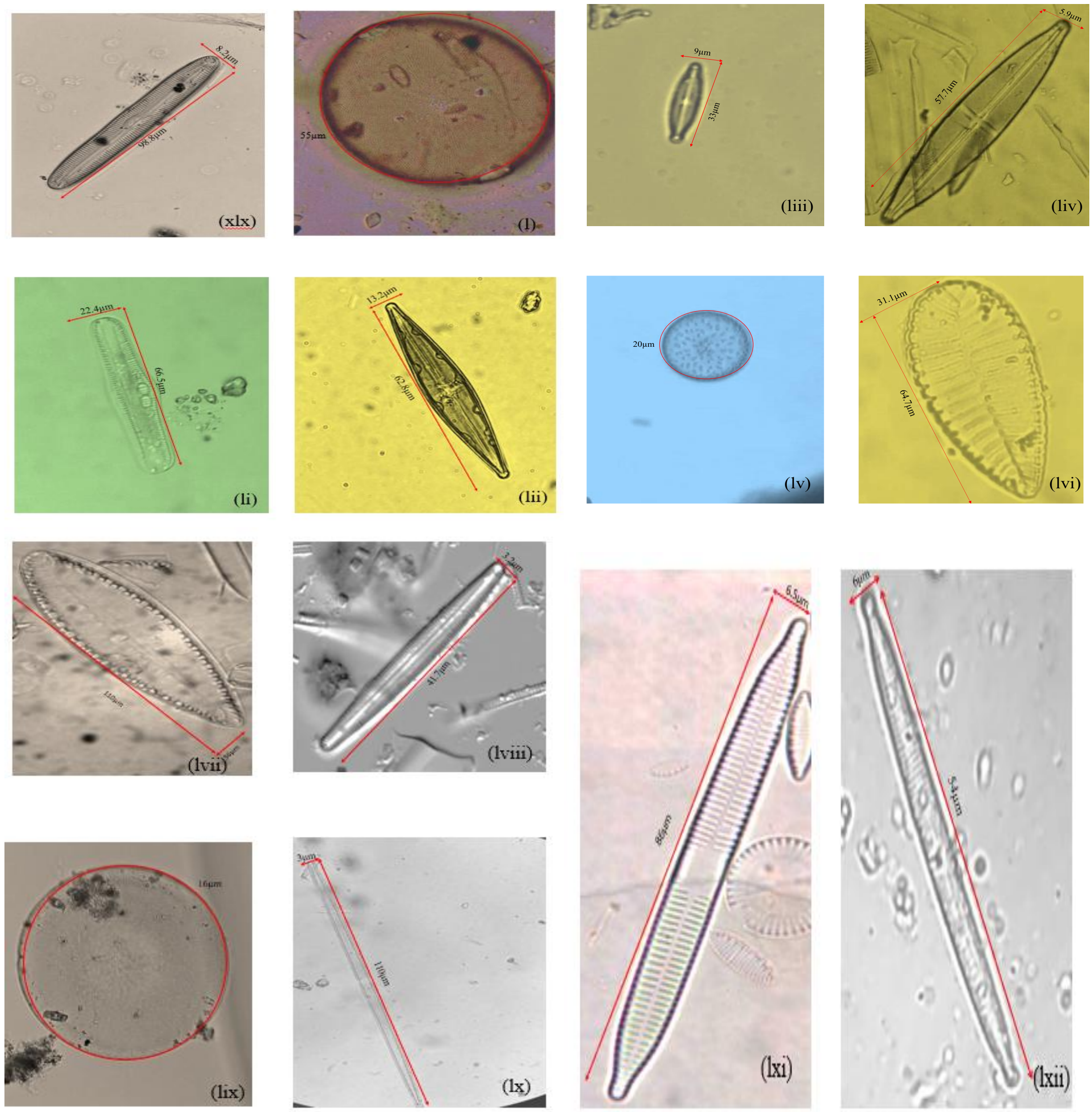

Figure 5. (xlx) *Pinnularia lokana* (l) *Pleurosira laevis* (li) *Rhopalodia gibba* (lii) *Stauroneis acuta* (liii) *Stauroneis amphicephala* (liv) *Stauroneis phoenicenteron* (lv) *Spicaticribra Kodaikanaliana* (lvi) *Surirella lange* (lvii) *Suriella pinnigera* (lviii) *Tabularia fasciculata* (lix) *Thalassiosira weissflogi* (lx) *Ulnaria acus* (lxi) *Ulnaria ulna* (lxii) *Ulnaria inaequalis*

Systematic account of reporting diatom flora (Karthick et al., 2013)
Order: Naviculales
Family: Catenulaceae
Genus: Amphora Ehrenberg ex Kutzing

Amphora ovalis Kutzing Figure 2. (ii)

- The frustule consists of an eccentric axial field and has a gibbous raphe and central nodules near the concave margin.
- In the girdle view, the cells are elliptical with truncated ends.
- The intercalary bands are decorated with punctae or striae.
- The frustule measures 12-20 µm in width and 33-52 µm in length.

Amphora pediculus Grunow Figure(i)

- Valves are half-elliptical with rounded apices, sometimes slightly deflected toward the ventral side.
- Central area is absent, instead a hyaline fascia is present and slightly broader on the ventral surface.
- Raphe ride on both ventral and dorsal sides of the raphe.
- Dorsal striae have 2-3 areolae.

Amphora copulate Kutzing Figure 2. (iii)

- Valves are narrow and half-lanceolate in shape, with a convex dorsal margin and weakly concave ventral margin.
- Apices are narrow, elongated, and capitate.
- The raphe is slightly arcuate, positioned close to the ventral margin, with proximal raphe endings slightly deflected towards the dorsal side.

- Ventral striae are very short, while dorsal striae are parallel in the middle and radiate towards the ends.
- Puncta are not visible under light microscopy (LM).

Order: Naviculales
Family: Brachysiraceae
Genus: Brachysira

Brachysira microcephala Grunow Figure 2. (iv)
- Valves are lanceolate to rhombic-lanceolate in shape, with elongated, capitate apices.
- The axial area is narrow and straight.
- The central area is small and asymmetrically rounded.
- Striae are radiate near the center and parallel near the apices.
- The straight raphe is located within two ribs on the external surface of the valve.

Order: Cymbellales
Family: Cymbellaceae
Genus: Cymbella

Cymbella excise Kutzing Figure 2. (v)
- Valves are moderately to strongly dorsiventral and broadly lanceolate in shape.
- The dorsal margin is strongly convex, and the ventral margin is slightly concave.
- A gibbous or excised feature may be present at the center of the ventral margin.
- The ends of the valves are substrate to subrostrate or narrowly rounded.
- The raphe is slightly displaced ventrally and lateral, becoming filiform near the distal ends, with curved proximal raphe ends.
- Striae are slightly radiated, becoming more strongly radiated near the valve ends, and are linear in structure.

Cymbella tumida Ven Heurck Figure 2. (vi)
- Valves exhibit a strongly dorsiventral structure.
- The dorsal margin is markedly convex, and the ventral margin is convex with a swollen or tumid mid-region.
- Apices are protracted and rostrate in appearance.
- The axial area is narrow with linear margins defining the central region.
- The central area is rounded to rhombic in shape, a key identifying feature.
- The raphe is lateral, with distinct proximal endings deflected ventrally.

Cymbella vulgate Krammer Figure 2. (vii)
- Moderately dorsiventral, lanceolate valves.
- Dorsal margin strongly arched; ventral margin moderately convex.
- Both ends are rounded, smooth appearance.
- Linear axial area, tapering at the ends, broadening at the center.
- Lateral raphe along the mid-line, filiform at proximal ends.

Cymbella bengalensis Grunow Figure 2. (viii)
- Valves are moderately dorsiventral and lanceolate in shape.
- The dorsal margin exhibits a strong arch, while the ventral margin is moderately convex.
- Both ends of the valve are rounded, providing a smooth appearance.
- The axial area is linear, tapering towards the ends and broadening at the center.
- The raphe runs along the mid-line, distinctly lateral, and becomes filiform at the proximal ends.

Order: Thalassiosirales
Family: Stephanodiscaceae
Genus: Cyclotella Kutzing

Cyclotella atomus Hustedt Figure 2. (xi)
- Valves show slight tangential undulation, visible in girdle view.
- Narrow marginal zone with striae, extending one-fourth to one-third from the margin to the center.
- Marginal zone may have 3 to 4 thickened ribs.
- Central zone unornamented, with one or two isolated processes.

Cyclotella bifacialis Hustedt Figure 2. (x)
- Drum-shaped frustules with tangential undulations and a flat valve face.
- Marginal striae strongly radial, tapering towards the valve center.
- Fascicles not visible under light microscopy (LM).
- Interfascicular costae separate fascicles, each ending in a spine.

Cyclotella distinguenda Hustedt Figure 2. (xi)
- Valves have a distinct circular central area surrounded by a marginal ring of striae.
- Central area occupies one-third to one-half of the valve face, tangentially undulate.
- The central area is generally smooth but may feature verrucae or grooves.
- Marginal striae are broadest at the valve/mantle interface and taper towards the center.
- A faint circular shadow line crosses the striae, appearing as a subtle ring.
- Striae consist of 2-3 areolae near the center and 4-5 areolae near the margin under SEM.
- Internally, the shadow line corresponds to the inner border of alveolar openings, occluding most striae.
- Numerous marginal fultoportulae present, short with two satellite pores.
- Single rimoportula on the valve mantle, internal opening parallel to the margin.

Cyclotella meneghininiana Kutzing Figure 2. (xii)
- Frustules are drum-shaped with tangential undulations or a flat valve face.
- Marginal zone has strongly radial striae, broader at the margin and tapering towards the center.
- Central region contains 1 to 5 valve face fultoportulae.

- Fascicles are not visible under light microscopy (LM).
- Fascicles are separated by interfascicular costae, defining the intricate surface pattern.

Cyclotella ocellata Pantocsek Figure 3. (xiii)

- Valves have an unornamented, tangentially undulated surface.
- The middle part of the valve features 3 to 4 rounded depressions, about 1 µm in diameter.
- Fascicles are not visible under light microscopy (LM).
- Fascicles are separated by interfascicular costae, contributing to the intricate surface structure.

Order: Naviculales
Family: Caloneiscaceae
Genus: Caloneis (Ehrenberg) Cleve

Caloneis silicule (Ehrenberg) Cleve Figure 3. (xiv)

- Valves have a variable outline: elliptical-lanceolate to linear-lanceolate.
- Some valves exhibit marginal undulations or appear slightly tumid at the center.
- Axial area is variable: from linear and narrow to lanceolate and wider.
- Central area often features slight depressions.
- Striae are either radiate or parallel, with prominent Voigt faults.
- Longitudinal lines, isolated groups of areolae, are present on either side of the axial area.

Order: Achnanthales
Family: Cocconiedaceae
Genus: Cocconies Ehrenberg

Cocconeis placentula (Ehrenberg) Van Han Heurck Figure 3. (xv)

- Valve: Relatively flat with an elliptical to linear-elliptical outline.
- Central area: Small, rounded and well defined.
- The raphe valve has a hyaline rim positioned marginally, bordered by interrupted striae near the margin.
- Axial area is very narrow, with a small, rounded central area.
- The raphe is straight and filiform, with slightly dilated external proximal raphe ends.
- Striae are punctate, composed of dash-like areolae, radiating across the valve surface.

Cocconeis pediculus Ehrenberg Figure 3. (xvi)

- Valves are elliptical in outline, with a highly arched or flexed shape along the longitudinal axis.
- Largest valves are circular in outline.
- Raphe valves have a well-defined, asymmetrical central area, rhombic to rounded in shape.
- Rateless valve is narrow, widening at the ends, and constricted in the middle, lacking a distinct central area.
- Axial area is narrow, with a small, circular to diamond-shaped central area.
- Punctate striae are parallel at the center, arched or curved, and become more parallel at the apices.

Order: Naviculales
Family: Naviculaceae
Genus: Diploneis

Diploneis oblongella Cleve Figure 3. (xvii)

- Valve: Linear-elliptical with rounded ends.
- Central area: Rounded.
- Longitudinal canals: Narrow.
- Pores: One row, appears to continue the alveoli.
- Costae: Transverse and radiate throughout the valve.
- Alveoli: One row between the costae.

Order: Bacillariales
Family: Bacillariaceae
Genus: Denticula

Denticula kuetzingii Grunow Figure 3. (xviii)

- Valve shape: Lanceolate to elliptic-lanceolate or linear-lanceolate.
- Apices: Narrowly rostrate or sharply (sometimes bluntly) rounded.
- Fibulae: Extend onto the valve face.
- Striae: Notable for discernible puncta.
- Key identification features: Shape, surface texture, and fibulae.

Order: Eunotiales
Family: Eunotiaceae
Genus: Eunotia Ehr

Eunotia neocompacta Ehr. Figure 3. (xix)

- Lanceolate shape.
- Visible fibulae across the valve face.
- Apex: Narrowly rostrate or sharply rounded.

Eunotia camelus Figure 2. (xx)

- Shape: Slightly curved, with four undulations on the dorsal margin.
- Ventral margin: Concave.
- Striae: Radial, becoming parallel at the center.
- Raphe: Near the apices.
- Key features: Undulating dorsal margin, curved shape, distinct striae.

Eunotia pectinalis Ehr. Figure 3. (xxi)

- Margins: Concave ventral, convex dorsal (slightly parallel in longer specimens).
- Apices: Slightly rounded, deflected toward the dorsal side.
- Raphe: Long terminal fissures extending to the dorsal margin.
- Striae: Parallel, punctate from the center to apices.
- Key features: Deflected apices, punctate striae, characteristic margin shap.

Order: Fragilariales
Family: Fragilariaceae
Genus: Fragilaria

Fragilaria crotonensis Kitton Figure 3. (xxii)
- Frustules: Form filamentous colonies with opposing valves attached at the midpoint
- Valve shape: Linear-lanceolate, tumid or slightly swollen central area.
- Apices: Nearly capitate, rounded form.
- Central sternum: Narrow at the ends, widening towards the center.
- Striae: "Ghost" striae in the central region, parallel striae across the valve.
- Key features: Central sternum, unique striae pattern for identification.

Fragilaria subconstricta Grunow Figure 3. (xxiii)
- Girdle view: Reveals colony structure with rimoportulae (black arrows) for material exchange.
- Close-up of apices: Shows rimoportulae and spatulate linking spines for colony integrity.
- Internal valve view: Details of valve ribbing and fibulae
- Close-up of apices and central area: Highlights striae pattern and central sternum
- Key features: Rimoportulae, linking spines, ribbing, fibulae, striae, and central sternum essential for identification.

Fragilaria tenera (Smith) Lange-Bertalot Figure 3. (xxiv)
- Valve shape: Needle-shaped with narrow, rounded apices.
- Hyaline area: Well-defined at the center, often with "ghost" striae visible under closer observation
- Key identifying features: Needle-like shape, central hyaline area, and ghost striae.
- Striae arrangement: Crucial for distinguishing from similar species.

Order: Cymbellales
Family: Gomphonemaceae
Genus: Gomphonema Ehrenberg

Gomphonema affine Kutzing Figure 3. (xxv)
- Valve shape: Heteropolar, club-shaped with apices ranging from blunt to sharply rounded.
- Axial area: Linear, narrowing slightly towards the apices.
- Central area: Small, formed by shortened central striae.
- Raphe: Lateral, with small, rounded proximal endings and comma-shaped distal endings
- Striae: Radial, becoming strongly radial at the apices.

Gomphonema pseudosphaerophorum Ehrenberg Figure 2. (xxvi)
- Valve shape: Heteropolar, club-shaped with apices ranging from blunt to sharply rounded.
- Axial area: Linear, slightly narrowing towards the apices.
- Central area: Small, due to shortened central striae.
- Raphe: Lateral, with small rounded proximal endings and comma-shaped distal endings

Gomphonema truncatum Ehrenberg Figure 3. (xxvii)
- Valve shape: Clavate with a swollen center.
- Headpole: Constricted with a broad, distinctly capitate apex.
- Footpole: Narrow and rounded.
- Axial area: Straight, expanding to form a "bowtie" shaped central area.
- Stigma: Single, rounded external stigma opening in the central area.
- Raphe: Lateral, undulate, with expanded external proximal ends.
- Striae: Radiated, faintly punctate, parallel toward the headpole.

Gomphonema acuminatum (Kutzing) Rabenhorst Figure 3 (xxviii)
- Valve shape: Weakly heteropolar, narrow lanceolate to rhombic-lanceolate.
- Apices: Blunt to sharply rounded.
- Axial area: Formed by the shortening of central striae.
- Raphe: Weakly lateral, with slightly enlarged proximal endings
- Stigma: Single, located on one side of the central area.

Order: Naviculales
Family: Gyrosigma
Genus: Gyrosigma

Gyrosigma eximium (Thwaites) Boyer Figure 3. (xxix)
- Valve shape: Slightly sigmoid, linear with parallel sides and scalpel-like ends.
- Axial area and raphe: Eccentric, diagonal, and sigmoid.
- Central area: Elongated and elliptical.
- Poles: Not narrowed or slightly narrowed.
- Apices: Rostrated or bluntly rounded.

Order: Naviculales
Family: Diademidaceae
Genus: Luticola

Luticola conii D.G.Mann Figure 3. (xxx)
- Valve shape: Smaller valves are broadly elliptical; larger valves are linear-elliptical with convex margins and rounded, non-protracted ends.
- Size: Valve length 12–20 µm, breadth 7.0–7.5 µm.
- Axial area: Narrow, linear, slightly widening towards the central area.
- Central area: Rectangular to weakly wedge-shaped stauros, bordered by small, rounded areolae.
- Stigma: Single circular stigma, isolated or at the end of a short series of areolae.
- Raphe: Weakly curved, with deflected central endings and elongated terminal fissures extending onto the valve mantle.

- Striae: Radiate in the middle, strongly radiate towards the apices with 20–22 striae in 10 µm, composed of 2–5 small, rounded areolae.
- Areolae near margin: Slightly transapically elongated.

Order: Mastogloiales
Family: Mastogloiaceae
Genus: Mastogloia

Mastogloia smithii Thwaites Figure 3. (xxxi)
- Valves: elliptic-lanceolate, convex sides, protracted and broadly rounded apices.
- Axial area: narrow, straight, expanding into an asymmetric, elliptic to irregularly rectangular central area.
- Raphe: filiform, becomes lateral halfway from apices to center.
- External proximal raphe ends slightly dilated and rounded.
- Striae: less radiate, punctate.
- Locule count: 6 to 9 in 10 µm.

Order: Thalassiosirales
Family: Melosiraceae
Genus: Melosira

Melosira varians Agardh Figure 3. (xxxii)
- Cells: cylindrical, form filaments of connected cells in girdle view.
- Valve face and margin: lack noticeable ornamentation under light microscopy.
- Valve mantle: covered with small granules.
- M. varians cell walls: lightly silicified compared to M. lineata.
- M. varians valve mantle: thin and straight; M. lineata mantle: thick and curved.

Melosira lineata (Dilwyn) Figure 4. (xxxiii)
- Cells: cylindrical, form long chains.
- Valve face: slightly convex, covered with fine areolae.
- Valve mantle: thick, with a curved interior.

Order: Navicuales
Family: Naviculaceae
Genus: Navicula

Navicula hemansioioides Lange-Bertalot Figure 4. (xxxiv)
- Valves: narrow-lanceolate, tapering from center to bluntly rounded apices.
- Raphe: filiform.
- Proximal raphe endings: subtle, slightly deflected.
- Central area: rhombic to lanceolate in shape.
- Striae: strongly radiate in center, strongly convergent towards poles.

Navicula cryptocephala Kutzing Figure 4. (xxxv)
- Valves: lanceolate to narrowly lanceolate, poles gradually narrowing, apices weakly rostrate, subcapitate, or obtusely rounded.
- Central area: large, circular to transversely elliptical, slightly asymmetrical.
- Raphe: filiform, narrow axial area, drop-like expanded proximal ends.
- Striae: strongly radiate, weakly convergent at poles.
- Areolae: occasionally visible under light microscopy.

Navicula gregraria Donk Figure 3. (xxxvi)
- Valves: lanceolate to elliptic-lanceolate, apices highly variable (protracted or subcapitate).
- Axial area: very narrow and linear.
- Central area: elliptical, widened transapically, asymmetric.
- Raphe: filiform, distinct proximal endings slightly deflected to one side.
- Striae: strongly parallel, weakly radiate at center, convergent towards poles.

Navicula angusta Grunow Figure 4. (xxxvii)
- Valves: linear, poles cuneate, apices broadly rounded, sometimes slightly protracted.
- Raphe: lateral, outer fissure close to axial area, returning to midline towards center.
- Central area: broadened, shape variable, larger on one side.
- Axial area: very narrow, forming circular to elliptical (sometimes asymmetrical) central area.
- Striae: radiate at center, convergent towards poles.

Navicula radiosa Kutzing Figure 4. (xxxviii)
- Valves: narrow-lanceolate, acutely rounded apices.
- Axial area: narrow.
- Central area: rhombic, asymmetrical, central nodule thicker on one side.
- Raphe: straight, filiform, distal ends deflected onto mantle on the same side.
- Striae: strongly radiate, convergent towards poles.

Order: Bacillariales
Family: Bacillariaceae
Genus: Nitzschia

Nitzschia desertorum Hustedt Figure 4. (xxxix)
- Valves: elliptic-lanceolate, short, protracted, rostrate apices.
- Marginal raphe: supported by narrow, evenly spaced fibulae, equidistant in the middle.
- Striae: punctate, visible under light microscopy.
- Ecology: Cosmopolitan, abundant in brackish waters, especially electrolyte-rich water bodies.

Nitzschia umbonate Eherenberg Figure 4. (xl)
- Valves: linear, weakly concave center.
- Poles: apiculate, protracted, or slightly capitated apices.
- Raphe: marginal, irregularly spaced fibulae, interrupted in the middle.

- Striae: undulating, visible under light microscopy.

Nitzschia reversa W Smith Figure 4. (xli)
- Frustules: weakly silicified.
- Valves: spindle-shaped, long, narrow, needle-like poles with rostrate apices.
- Poles: curved or twisted, turning in opposite directions.
- Fibulae: irregularly spaced, central fibulae widely spaced, forming a gap.
- Striae: fine, not visible under LM.

Order: Naviculales
Family: Neidiaceae
Genus: Neidium

Nidium herramanni Hustedt Figure 3. (xlii)
- Valve: linear, apices gradually tapering, obtusely rounded.
- Axial area: narrow and linear.
- Raphe: filiform, proximal ends curved in opposite directions, distal ends slightly bifurcated.
- Central area: diagonally elliptical, irregular shape.
- Striae: radiate around central area and converge at ends.

Nidium productum Hustedt Figure 3. (xliii)
- Valves: linear to elliptical, with protracted capitate apices.
- Proximal raphe endings: hooked, deflected in opposite directions.
- Striae: punctate.
- One large canal along each margin.

Nidium cf. affine Ehrenberg Figure 3. (xliv)
- Valves: linear to linear elliptical, broadly rostrate apices.
- Raphe ends fork-shaped, deflected in opposite directions at the center.
- Central area: expanded, transversely elliptical.
- Striae: punctate, parallel but slightly oblique, interrupted by longitudinal hyaline lines.

Order: Naviculales
Family: Pinnulariaceae
Genus: Pinnularia

Pinnularia joculata Krammer Figure 4. (xlv)
- Valves: linear, slightly concave sides.
- Ends: capitate with a narrow neck.
- Axial area: narrow and linear, broad fascia at the center.
- Raphe: filiform, drop-like proximal ends bent laterally.
- Striae: radiate in the middle and converge at the poles.

Pinnularia divergeus W.Smith Figure 3. (xlvi)
- Valve outline: linear, lanceolate, or linear-elliptical, with parallel and triundulate sides.
- Ends: broadly rounded or rostrate to subcapitate.
- Axial area: broad and linear, widening near the central area.
- Terminal fissures: very large, sickle-shaped, varying in different varieties.
- Striae: moderately to strongly radiate in the middle, strongly convergent at the ends.
- Longitudinal lines: absent.

Pinnularia acrosphaeora W.Smith Figure 3. (xlvii)
- Valve outline: linear, straight margins slightly convex and swollen in the middle.
- Ends: broadly rounded, sometimes capitate.
- Axial area: broad and linear, slightly widening near the central area.
- Terminal fissures: very large, sickle-shaped, varying across varieties.
- Striae: parallel to weakly radiate, becoming parallel or slightly convergent towards the ends.
- Axial and central areas: distinct irregular surface structure.

Pinnularia viridis Ehrenberg Figure 4. (xlviii)
- Valve outline: linear, straight margins, slightly convex and swollen in the middle.
- Ends: broadly rounded, sometimes capitate.
- Axial area: broad and linear, slightly widening near the center.
- Terminal fissures: large, sickle-shaped, varying across varieties.
- Striae: parallel to weakly radiate, slightly convergent towards the ends.
- Axial and central areas: distinct irregular surface structure.

Pinnularia lokana Krammer Figure 5. (xlix)
- Valves: linear, parallel sides, broadly rounded apices.
- Axial area: broad, up to two-thirds of the valve width, expands into an elongated rhombic central area with a narrow, asymmetric or symmetric transverse fascia.
- Raphe: lateral, terminal fissures shaped like a question mark.
- Striae: radiate in the center, become longer and convergent towards the ends.
- Central area: contains four irregular markings, sometimes resembling ghost striae, variable and may not always be visible under light microscopy.

Order: Eupodiscales
Family: Eupodiscaceae
Genus: Plesurosira

Pleurosia laevis Ehrenberg Figure 4. (l)
- Valves: circular to elliptical, slightly hemispherical valve face.
- Ocelli: 2-3, positioned opposite each other, made up of fine rows of porelli.
- Rimoportulae: 2-3, each surrounded by a small hyaline area around the opening.

Rhopalodia gibba (Ehren.) O Muller Figure 5. (li)

- Valves: strongly dorsiventral, claw-like, convex dorsal margin with slight indentation, straight ventral margin.
- Apices: narrow, rounded, ventrally deflected.
- Raphe canal: follows the dorsal margin.
- Raphe: supported by fibulae, with round or oval portulae between them.
- Costae: prominent, extending across the valve face.

Order: Naviculales
Family: Stauroneidaceae
Genus: Stauroneis

Stauroneis acuta Smith Figure 5. (lii)

- Valves rhombic-lanceolate with broadly rounded, non-protracted ends.
- Gibbous at the center.
- Pseudosepta are very prominent at the apices.
- The axial area is narrow near the valve apices, becoming much wider toward the central area.
- The central area is a wide bow-tie shaped stauros.
- Striae are strongly radiate throughout and continue onto the valve mantle.

Stauroneis amphicephala Kutzing Figure 5. (liii)

- Valves: linear-elliptic-lanceolate, abruptly protracted, rostrate to subcapitate apices.
- Axial area: narrow and linear, widening near the central area.
- Central area: bow tie-shaped, wider near the valve margins.
- Striae: shortened in the central area, radiate throughout the valve.

Stauroneis phoenicenteron Kutzing Figure 5. (liv)

- Valves: lanceolate, broadly rounded, weakly protracted apices.
- Axial area: narrow, slightly widening near the central area.
- Stauros: rectangular, tapering slightly towards the valve margins.
- Striae: shortened in the central area, strongly radiate near the poles, weakly radiate near the center.
- Raphe: lateral, straight with slightly inflated proximal ends.

Order: Thalassiosirales
Family: Thalassiosiraceae
Genus: Spicaticribra

Spicaticuribra kodaikanaliana Karthick & Kociolek Figure 4. (lv)

- External valve face: slightly domed.
- Marginal fultoportulae present, with rimoportulae having internal extensions at the same height.
- Striae: radial and straight, extending from the margin to the center.
- Areolae: 2-4 times larger in the center than at the valve periphery.

Order: Surirellales
Family: Surirellaceae
Genus: Surirella

Surirella lange Karthick Figure 5. (lvi)

- Valves: heteropolar, elliptical, rounded head pole, cuneate base.
- Porcae: weakly radiated at the center, radiated at the poles.
- Median area: lanceolate and hyaline.
- Wings: extend vertically from the valve face, with clear alar canals and fenestrae.
- Striae: indistinct under light microscopy.

Surirella pinnigera Bramburger& Hamilton Figure 4. (lvii)

- Valves: clavate to elliptical, strongly heteropolar, rounded head pole, acute base.
- Porcae: parallel at the center, strongly radiate near the poles.
- Median area: narrowly lanceolate.
- Median ridge: visible, with a fin spine near the head pole.
- Striae: fine and visible.
- Wings: noticeable along the vertical axis of the valve.

Order: Fragilariales
Family: Fragilariaceae
Genus: Tabularia

Tabularia fasciculata Williams & Round Figure 5. (lviii)

- Valves: linear-lanceolate to lanceolate in shape.
- Some specimens: slightly or distinctly asymmetrical along the transapical axis (not typical).
- Apices: slightly set off, rounded, not capitate.
- Axial area: very broad, width varying within populations.
- No central area visible.
- Striae: costate, puncta not visible under light microscopy.

Order: Thalassiosirales
Family: Thalassiosirales
Genus: Thalaassiosira

Thalassiosira weissflogi Fryxell & Hasle Figure 5. (lix)

- Valves: round, flat, with short mantles.
- Frustules: relatively lightly silicified.
- Areolae: fine, structure not visible under light microscope.
- Rimoportula: single, prominent, located on the valve margin.
- Central fultoportulae: 4-5 present.

Order: Fragilariales
Family: Fragilariaceae
Genus: Ulnaria

Ulnaria acus Kutzing Figure 5. (lx)

- Valves: linear, with sub-capitate apices.
- Hyaline area: well-defined, at the center, reaching one valve margin only.
- Striae: parallel, ghost striae may be visible in the hyaline area.

- Labiate process: single, located near the apex of one end of the valve.

Ulnaria ulna Compere Figure 5. (lxi)
- Valves: linear, parallel margins, tapering to protracted, rostrate apices.
- Central sternum: narrow and straight.
- Central area: transversely expanded rectangular shape, nearly square.
- Striae: parallel, with short or "ghost" striae at the central area margins.

- Labiate process: single, located near the apex at one end of the valve.

Ulnaria inaequalis Kobayasi Figure 5. (lxii)
- Valves: linear, with cuneate poles.
- Valve margin: concave in the middle portion.
- Hyaline area: well-defined, present at the center of the valve.
- Striae: parallel, ghost striae may be visible in the hyaline area.
- Labiate process: single, located near the apex at one end of the valve.

Table 1. Season-wise distribution of the identified diatoms

	Site 1	Site 2	Site 3	Site 4	Site 5
Monsoon (June-August)	200	137	152	139	189
Post-Monsoon (September-November)	238	200	229	259	303
Winter (December-Feb)	118	65	54	41.5	64
Summer (March-May)	141	90	88	89	113

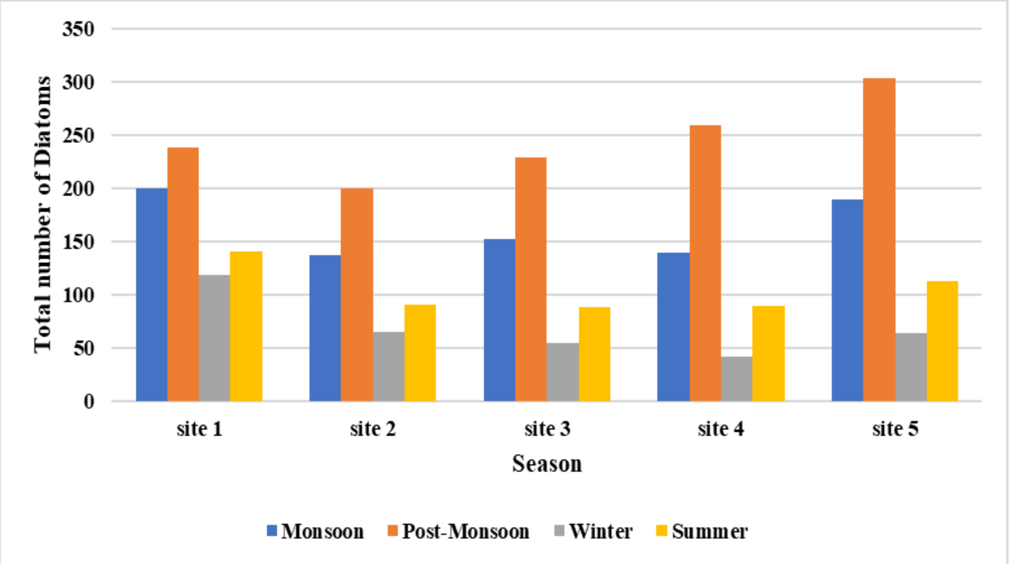

Figure 6. Season-wise distribution of total Diatoms in the study sites.

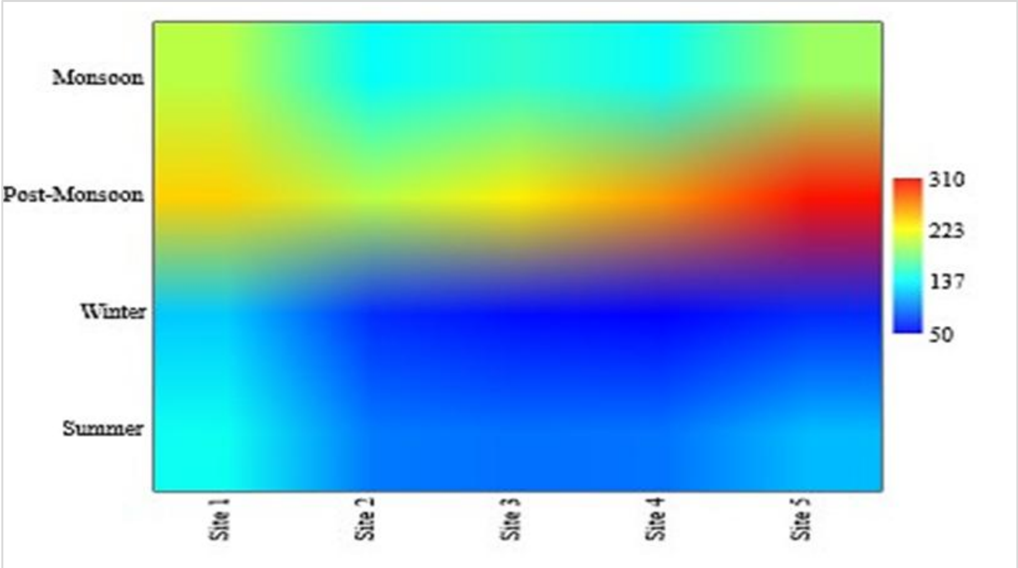

Figure 7. Season-wise abundance of the identified Diatoms

The abundance of the isolated diatoms from five selected sites was observed annually considering four seasons mainly Monsoon (June-August), Post-Monsoon (September-November), Winter (December-February), and Summer (March-May). The highest change in species abundance from the five sites was observed for site 5 and site 1 of post-monsoon season with 304 and 239 species respectively. The lowest relative abundance was observed in site 4 and site 3 of winter season with 42 and 54 species respectively. However, winter season from all the five sites showed lowest species abundance compared to other selected sites and weather seasons. From the five sites studied, site 1 and 5 showed relatively higher species abundance and diversity in comparison to the other sampled sites of all the weather seasons. Additionally, from the four seasons, post monsoon season ranging from September to November showed highest species abundance in comparison to the other seasons studied (Figure 6). Diatom abundance varied seasonally, with higher values during the post-monsoon period and lower values in winter. This trend suggested that environmental conditions post-monsoon was more favorable for diatom growth, possibly due to nutrient availability

Table 2. Shannon-Weiner diversity index of the identified Diatoms

	Shannon-Weiner diversity index				
	S1	S2	S3	S4	S5
Monsoon	3.81	3.79	3.81	3.75	3.86
Post-Monsoon	3.64	3.66	3.72	3.84	3.76
Winter	2.88	2.22	1.99	1.60	1.89
Summer	3.44	3.36	3.45	3.40	3.42

Table 3. Simpson's diversity index of the identified Diatoms

	Simpson's diversity index (D)				
	S1	**S2**	**S3**	**S4**	**S5**
Monsoon	0.023	0.024	0.024	0.026	0.022
Post-Monsoon	0.032	0.031	0.027	0.024	0.027
Winter	0.067	0.122	0.156	0.224	0.161
Summer	0.039	0.045	0.041	0.049	0.041

Table 4. Species richness/evenness of the identified Diatoms

	Species Richness/Evenness (J)				
	S1	**S2**	**S3**	**S4**	**S5**
Monsoon	0.599	0.624	0.616	0.612	0.607
Post-Monsoon	0.623	0.657	0.664	0.659	0.630
Winter	0.528	0.461	0.432	0.374	0.397
Summer	0.630	0.658	0.659	0.648	0.614

Diatom abundance varied seasonally, with higher values during the post-monsoon period and lower values in winter. This trend suggested that environmental conditions post-monsoon was more favorable for diatom growth, possibly due to nutrient availability. Season-wise abundance of the identified Diatoms at different sites is given in Table 1 and Figure 7. The Diversity Index indicate seasonal diversity variation across sites. Relatively higher diversity was observed during monsoon and post-monsoon seasons and comparatively lower in winter. Shannon-Weiner diversity index of the identified species in different seasons at various sites is given in Table 2 while Simpson's diversity index is given in Table 3. Species richness/evenness was relatively higher during monsoon and summer seasons, suggesting more balanced algal populations (Table 4).

4. DISCUSSION AND CONCLUSION

Anasagar Lake, located in Ajmer, Rajasthan, is an artificial lake and serves as a critical water resource and recreational area for the region. However, climate change and human activities exacerbate the lake's significant environmental challenges. Climate change has led to alterations in precipitation patterns, deterioration of water quality, and biodiversity loss that have strongly affected Anasager Lake from past to present and will in the future. Hence, Anasager Lake plays a key role in understanding the dynamics of the water ecosystem. Diatoms, a group of microalgae found in aquatic environments, play a crucial role in both ecosystem dynamics and global climate regulation. Diatoms also contribute significantly to the global carbon cycle and oxygen production and serving as key indicators of environmental health.

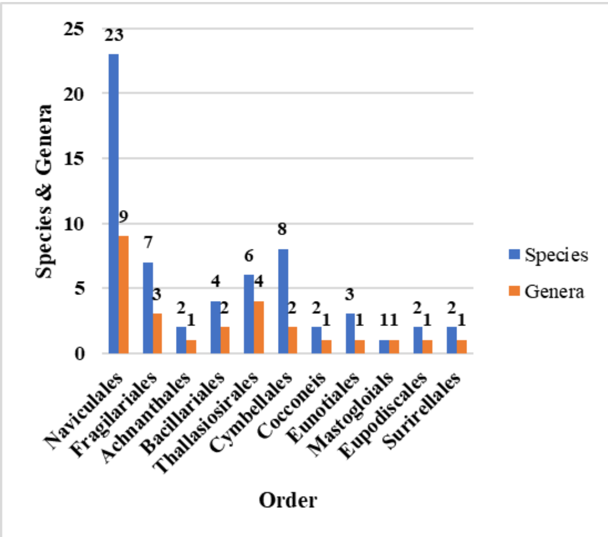

Figure 8. Distribution of diatom species and genera across different taxonomic orders identified from Anasagar Lake.

The present study was planned to survey Anasager Lake for its diatom flora and identified 62 species from 27 genera. The result indicates Naviculales is the most prominent order, consisting of 23 species spread across 9 different genera. Cymbellales, comprising 8 species from 2 genera, followed by Thalassiosirales, which encompasses 6 species across 4 genera. Naviculales order represents 23 species of 9 genera followed by Fragilariales with 7 species of 3 genera, Achnanthales with 2 species of 1 genus, Bacillariales with 4 species of 2 genera, Thallasiosirales with 6 species of 4 genera, Cymbellales with 8 species of 2 genera, Cocconeis with 2 species of 1 genus, Eunotiales with 3 species 1 genus, Mastogloials with 1 species of 1 genus, Eupodiscales with 2 species of 1 genus and Surirellales with 2 species of 1 genus (Figure 8). These diatom orders could be used to unravel the dynamics and climate regulation of lakes caused by natural and anthropogenic activities. These results have also been confirmed from the surface sediments of the Nsonji Lake of Nagaland, North-East, India and revealed the dominance of Discostella stelligera, Achnanthidium sp., Navicula sp., and Nitzschia palea (Kere et al., 2023).

It was observed that in Anasager Lake the diatom community is dominated by the representatives of the genera Navicula, Amphora, Pinnularia, Surirella, and Cocconies. Many other sporadic forms with were in very low counts also exist in this lake. Similarly, Ghandi (1955) also reported freshwater diatoms from Pratapgarh, Rajasthan, and the presence of 22 genera and 35 diatom species in Mansagar Lake of Jaipur. All the 22 genera reported by Gandhi (1955) were reported from Anasagar Lake also in the present study. A study done by Singh et al. (2011) reported 24 diatom species in Galta Kund in Jaipur, Rajasthan. In the present study, 27 genera were reported out of 15 genera were similar reported by Barupal et al., (2015) including, Amphora, Navicula, Diadesmus, Gyrosigma, Stauronies, Gomphonema, Cymbella, Eunotia, Fragilaria, Synendra, Ctenophora, Nitzschia, Achnanthes, Cocconies, and Cyclotella (Narayan & Barupal, 2015).

Taylor (2004) investigated Cyclotella meneghiniana, Nitzschia palea, and Cocconies placentula as characteristics of extremely polluted water. The same species of diatoms were reported in Anasager Lake also that is indicating towards high pollution level of lake.
Diatom count data reveals that diatom growth was maximum in September and showed the lowest value in February. A similar observation was made by Kumar and Singh (2017). The mechanism connecting diatoms, like lake variation, hydrochemistry, and climate factors is poorly understood. Presently, multivariate techniques and qualitative assessments were incorporated in contemporary diatoms studies to related with past climate condition (Smol & Stoermer, 2010).

The biological diversity found in Anasagar Lake is demonstrated by the coexistence of oligotrophic indicators like Eunotia pectinalis and eutrophic indicators like Cyclotella meneghiniana and Nitzschia desertorum. This implies that a range of biological niches are supported by the lake, indicating a dynamic ecosystem influenced by human activity and shifting nutrient levels (Sharma, 2022; Wang et al., 2022).

This study revealed that the most common diatoms reported in the Anasager Lake of Rajasthan belong to Bacillariaceae. The survey of diatom flora in Anasagar Lake reported a rich diversity of 62 species across 27 genera, highlighting the lake's ecological significance and sensitivity to environmental changes (fig.2). The dominance of specific diatom orders, particularly Naviculales, shows the impact of natural and anthropogenic factors on the lake's ecosystem. The presence of pollution-tolerant species like Cyclotella meneghiniana and Nitzschia palea indicates deteriorating water quality, further exacerbated by climate change. Seasonal variations in diatom abundance suggest complex interactions between nutrient levels and environmental conditions. The coexistence of oligotrophic and eutrophic indicators reflects the lake's dynamic nature and its ability to support diverse biological niches.

This study emphasizes the necessity for ongoing monitoring and conservation efforts to protect Anasagar Lake's ecological integrity. Understanding diatom communities can provide valuable insights into past climate conditions and inform future management strategies. Overall, Anasagar Lake is crucial for studying the interplay between climate change, human activities, and aquatic ecosystems. Ecologists generally use diatoms taxonomy available in published floras to identify taxa that can be discriminated between diatoms and measurable environmental variables. This Study provides a checklist of diatoms reported in Anasager Lake.

Acknowledgments and Funding

The authors express their sincere gratitude to the Department of Botany, Maharishi Dayanand Saraswati University, Ajmer, for providing laboratory facilities and supporting this study. Special thanks to Dr. Shruti Ojha and Dr. Renu Jangir, Sapna Jain, and Pramila Prajapat for their insightful suggestions and help throughout this work.

The Authors received no financial support for the research, authorship and publication of this research paper.

Authors' Contributions

MP: Manuscript design, Field sampling, Draft checking, Laboratory experiments, Stasistical analyses.
AP: Draft checking, Reading, and Editing. All authors read and approved the final manuscript.

Conflict of Interest

Authors have no competing financial, personal, or professional interests that might have affected the presentation of the work described in this manuscript.

Data Availability Statements

The authors confirm that the data supporting the findings of this study are available within the article.

REFERENCES

Barupal, G. (2019). Algal biodiversity of the arid region of Rajasthan. *Journal of Algal Biomass Utilization*, *10*(1), 26-35.

Barupal, G., & Meghwal, G. (2018). Bacillariophycean Diversity of Churu Region of Rajasthan, India.

Barupal, G., & Singh, E. (2023). Diversity and taxonomy of diatoms from Kot Dam, Jhunjhunu, Rajasthan (India). *BIOINFOLET-A Quarterly Journal of Life Sciences*, *20*(1), 13-21.

Dadheech, P., Srivastava, P., & Sharma, K. (2000). Status of phycodiversity of Rajasthan State (India) in the New Millennium. National symposium on phycology in the New Millennium, Centre for Advanced Studies in Botany, University of Madras, Chennai,

Gandhi, H. (1955). A contribution to our knowledge of the fresh-water diatoms of Partabgarh, Rajasthan.

Gandhi, H. (1956). A contribution to the knowledge of freshwater Diatomaceae of South-Western India. *Journal of Indian Botanical Society*, *35*(2), 194-209.

Gandhi, H. (1960). *The diatom flora of the Bombay and Salsette Islands*. Soc.

Gandhi, H. (1961). Notes on the Diatomaceae of Ahmedabad and its environs. *Hydrobiologia*, *17*, 218-236.

Gonzalves, E. A., & Gandhi, H. (1952). A systematic account of the diatoms of Bombay and Salsette-I. *Journal of the Indian Botanical Society*, *31*, 117-115.

Gonzalves, E. A., & Gandhi, H. (1953). A systematic account of the diatoms of Bombay and Salsette-I. *Journal of the Indian Botanical Society*, *30*, 239-263.

Jadhawar, P., & Papdiwal, P. (2012). Taxonomic diversity of diatom at Nath Sagar Water reservoir, Paithan, Maharashtra. *The Ecoscan*, *6*(1&2), 01-04.

Jakher, G., Bhargava, S., & Sinha, R. (1990). Comparative limnology of Sambhar and Didwana lakes (Rajasthan, NW India). Saline Lakes: Proceedings of the Fourth International Symposium on Athalassic (inland) Saline Lakes, held at Banyoles, Spain, May 1988,

Jena, M., Ratha, S. K., & Adhikary, S. P. (2006). Diatoms (Bacillariophyceae) from Orissa state and neighbouring regions, India. *Algae*, *21*(4), 377-392.

Karthick, B., Hamilton, P. B., & Kociolek, J. P. (2013). *An illustrated guide to common diatoms of Peninsular India*. Gubbi labs.

Kere, Z., Humane, S. S., & Hussain, S. M. (2023). Relationship of Modern Diatoms with Lake Acidification and Water Quality in Nsonji Lake of Nagaland, North-East India.

Krishnamurthy, V. (1954). A contribution to the diatom flora of South India. *Journal of the Indian Botanical Society.*, *33*, 354-381.

Kumar, A., Sharma, L., & Aery, N. (2008). Physicochemical characteristics and diatoms as indicators of trophic status of Kishore Sagar, Rajasthan. *Proceedings of Taal*, *2007*, 12th.

Kumar, M., & Singh, G. P. (2017). Determination of the Freshwater Diatoms flora of Hanumangarh district, Rajasthan, India. *Indian Journal of Pure Biology*, *32*, 227-238.

Mukherjee, D., Moza, B., Pathak, S., Chaudhury, A., Saha, A., & Dhondiyal, P. (2024). Interdisciplinary Collaborations and Advancements: Amplifying the Potential of Diatom Analysis.

Narayan, P., & Barupal, G. (2015). A Systematic Account of the Fresh Water Diatom from Kaylana Lake of Jodhpur District, Rajasthan(India). *International Journal of Recent Scientific Research*, *6*(4), 3435-3439.

Pareek, R., Singh, G. P., & Singh, R. (2011). Some fresh water diatoms of Galta kund, Jaipur, India. *Journal of Soil Science and Environmental Management*, *2*(4), 110-116.

Pascher, A. (1930). Die Sussawasser flora (Diatomeae). Volume-10. In: Jena Verlag von Gustav Fischer.

Patil, S., & Kumawat, D. (2007). Studies on the Centric diatoms from Abhora Dam of Jalgaon District, Maharashtra. *Research link*, *345*(9), 154-155.

Rana, A. S., Verma, P., & Mahajan, M. (2023). Diatoms flora from Sach pass glacier of Himachal Pradesh: Species composition and their relationship to environmental variables. AIP Conference Proceedings,

Ranga, M. (1995). *Limnological studies of Ana Sagar lake at Ajmer with special reference to physicochemical properties and planktonic population* Ph. D. Thesis. MDS Univ., Ajmer (Rajasthan)].

Sarode, P., & Kamat, N. (1983). The diatom flora of Vidarbha, India I. *Bibl. Phycol*, *66*, 259-319.

Shah, R. A., Achyuthan, H., Lone, A. M., & Ramanibai, R. (2017). Diatoms, spatial distribution and physicochemical characteristics of the Wular lake sediments, Kashmir valley, Jammu and Kashmir. *Journal of the Geological Society of India*, *90*, 159-168.

Sharma, R. (2022). Eutrophication Assessment Using Phytodiversity at the Land-Water Interface of Lake Anasagar of Ajmer.

Singh, M., Lodha, P., & Singh, G. P. (2010). Seasonal diatom variations with reference to physico-chemical properties of water of Mansagar Lake of Jaipur, Rajasthan. *Research Journal of Agricultural Sciences*, *1*(4), 451-457.

Smol, J. P., & Stoermer, E. F. (2010). *The diatoms: applications for the environmental and earth sciences*. Cambridge University Press.

Taylor, J. C. (2004). *The application of diatom-based pollution indices in the Vaal catchment* North-West University].

Wang, L.-C., Li, H.-C., & Shiau, L.-J. (2022). Impacts of anthropogenic disturbances on diatom diversity in a shallow spring-fed pool. *Diversity*, *14*(3), 166.