

Taxonomic approach to freshwater algal diversity in the district Kasur, Punjab, Pakistan

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Abstract

The diversity of freshwater algae plays a crucial role in aquatic ecosystems, serving as primary producers and bioindicators of water quality. This study aims to investigate the taxonomic diversity of freshwater algae in District Kasur, Lahore, analyzing species composition, distribution, and ecological significance. Water samples were collected from various freshwater bodies. The algae were identified based on morphological and microscopic techniques. The results provided insights into the dominant algal groups, their seasonal variations, and their response to environmental factors. The presence of sensitive taxa like *Cosmarium botrytis* alongside more tolerant forms such as *Oscillatoria curviceps* suggests a gradient of ecological conditions across the sites, from oligotrophic to eutrophic states. Overall, the observed diversity underscores the ecological significance of the region's freshwater systems and offers a valuable baseline for future biomonitoring and conservation efforts.

Keywords: Algae preservation, freshwater algae, Kasur, seaweed, taxonomy

1. Introduction

Algae are a group of simple autotrophs, thallus-like unicellular or multicellular autotrophs of both marine and freshwater habitats (Croce et al., 2021). The growth of algae is fast when adequate nutrients like sunlight, pH, and temperature are available (Yin et al., 2024). Intense growth of algae turns the lake water cloudy within a few days. Heavy growth of algae in water bodies turns into an algal bloom (Seebacher, 2012).

Algae are also known as pond scum, seaweed, and frog spittle. The importance of algae is to change the earth's atmosphere and provide much-needed oxygen for all seafood, and land food for us and other animals (Chapman, 2013). Freshwater algae are found in rivers, streams, ponds, underwater on rocks and mud (Khalid Et al., 2014).

All freshwater habitats are important due to the physical properties of water. As water is a universal solvent, it can dissolve and hold mineral ions in solution. A perfect way of providing nutrients to plants and other organisms (Field, 1943).

Freshwater algae are ubiquitous and diverse organisms on the earth that occupy a huge range of ecological conditions, wetlands, lakes, islands, saline lakes, rivers, damp soils, acidic peat swamps, snow and ice, desert soil, wastewater treatment plants, and as symbionts in fungi, plants, and animals. They are the bases of the most aquatic food webs. They are significant to ecosystem productivity, biodiversity, water quality, and interaction with other aquatic organisms (Wehr et al., 2002).

Algae are the major indicators to calculate environmental variations in aquatic habitats of the world (Dubey et al., 2022). Algae respond to a wide range of



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pollutants and are the best markers of ecological signals (Moslah et al., 2012).

Chlorophyta is also known as green algae, comprising 6,000 to 8,000 estimated species, ninety percent of which are found in freshwater. Higher plants and green algae share a common ancestor (Meinesz et al., 2001). Instead, red algae are also widespread, with around 4k – 5k species are of 90% marine. Some unicellular red algae are macroscopic, abundantly growing on rocky shores. Blue-green algae are another group with different characteristics. They contain 3 main carotenoids: beta-carotene, echinenone, and myxoxanthophyll. Beta-carotenoid is present in all blue-green algae, whereas echinenone is a unique not known so far from any other group of plants (Fogg, 1956; Goodwin, 1957).

Various environmental and physical factors influence the growth and population of algal groups. Temperature is the most important factor controlling the population of phytoplankton. With the rise in temperature, the concentration of dissolved oxygen in water decreases. High temperatures have a direct effect on the growth of algal species (Khan et al., 2011).

The present research aimed to investigate the algal flora of formally or poorly explored water areas and bodies of different localities of the district Kasur. Preparation of taxonomic keys to identify algal diversity can be helpful to other researchers to find out the possibility of new additions in the algal flora of Kasur.

2. Materials and Methods

2.1 Study area and collection sites

Freshwater algae, including many types, i.e., epiphytic and epithalic algae, were collected from different freshwater bodies of the district Kasur, Pakistan, in different months of the year. The algae that collected may be near the pond or stagnant water, river on the wall, soil on the stream and tube-well. The collections were made from October to December 2024 and from January to March 2025 (Table 1).

Several surveys were conducted to collect algae from various freshwater habitats. Rain pole, temporary pond, permanent water riser, wire river brooks, rice field, canal irrigation channels, lakes, and tanks. From the place where the algal samples were collected, the surface temperature and the water depth were also noted.

Air, water temperature, and pH of the water at sample sites were recorded. Moreover, water quality (saline,

brackish, or fresh) and collection sites (terrestrial or aquatic), type of algae (free floating, attached or bloomed), turbidity of the water (clean, coloured muddy or polluted), water flow, and EC were measured.

2.2 Materials used during field sampling of algae

The following materials were used during the algal collection: tissue paper, hand wash soap, wipes, swabs plastic bag, gloves Jar and bottle, EC meter, thermometer, pH paper, mobile camera, sanitizer, writing pad, glass slide with cover slip, petri dishes, light microscope, droppers, beakers, looting paper, needles, acetone and camera for microscopic photography. Species were identified based on the collected samples.

2.3 Sampling methods of algae

A dropper was used to collect samples (Ali et al., 2007), and a long stick with a hook (Munir et al., 2009). The scooping method was used using a jar through the water and a scraper. Microalgae (epiphytic) were collected by a knife and hand picking, including some parts or whole substrates. Micro and macro algae were also collected from different water bodies, including the edges of stones in floating water and from aquatic plants. The planktonic organisms were collected with the help of a dropper and scooping (Khan et al., 2011). The sample jars were placed overnight to allow algae to settle in the water. Collections of algae from different sites and areas of the district Kasur have been demonstrated in Figure 1 A-F

2.4 Storage and preservation

Algae were initially collected and stored in zipper bags, jars, and plastic bottles. Some water was also collected from the collection site. All planktonic samples of algae were preserved in 3% (v/v) solution of formaldehyde. Multicellular and thread-like algae were preserved in 4% formaldehyde with a few drops of glycerin (Khan et al., 2011). To avoid degradation, keep on checking the samples randomly and if necessary, add formalin too. Samples were stored in the Phycology Lab, Botany Department of Punjab University, Lahore.

2.5 Microscopy of the algal samples

For a microscopic study, a small amount of the sample

Table 1 Sampling sites of algal collection (GPS).

S.No.	Study areas	Collection sites	Latitude	Longitude
1	Hussain Kahan Wala	Waterways	31 32 33. 108" N	74 20'6.36" E
2	Grand Jamia mosque Fountain	Fountain	31 32'25.62" N	74 20'9.96" E
3	Phool Nagar (Field Area)	Field Area	31 32'23.46" N	74 20'10.032" E
4	Kot Radha Kishan roadside	Roadside	31 32'23.46" N	74 20'9.672" E

was placed on a clean glass slide using a dropper and covered with coverslip. To avoid dehydration, keep adding a drop of distilled water over the glass slide during examination. The sample was observed under high and low power magnifications of the microscope. The size of the cell and the chloroplast was recorded by using ocular micrometer photomicrography.

2.6 Statistical analysis

The number of taxa in each broad taxonomic category was determined. Distribution and abundance of the algal species were determined across different sites by using the software SPSS version 12.

3. Results and Discussion

A total of 20 genera and 22 species of algae belonging to 3 kingdoms (Monera, Protista, and Protoctista, Table 2) were recorded based on their cytological and morphological characters from the district Kasur. All of them were arranged according to Shameel's (2001) classification, which is as follows:

3.1 Kingdom Monera

3.1.1 Species found:

1. *Chroococcus minor* (Kützing) Lemmermann 1909 (Table 3): *Chroococcus* is a genus of unicellular cyanobacteria characterized by spherical cells that often occur singly or in small colonies surrounded by a mucilaginous sheath. It is commonly found in freshwater environments and contributes to primary production through photosynthesis (Figure 2 A). Taxonomic characters: they are identified based on the presence of a small gelatinous sheath attached, and amorphous mass cells are scattered irregularly, in

pairs or in large groups. The individual cell sheath is rarely visible, colourless, thin, and the individual cell is comprised of 3 - 4 μm in size without a sheath.

2. *C. minutus* (Kützing) Nägeli:

This species flourishes in nutrient-rich waters with moderate light availability. Cells are spherical or oblong, single or in groups of 2-4, bright blue-green or dark green, 11-12 μm sheath diameter, 6-7 μm without sheath, non-lamellated (Figure 2B).

References: (Desikachary, 1959; Naz et al., 2004)

Locality: Kot Radha Kishan roadside

3. *Arthrospira stizenbergeri*: This is a filamentous, helical cyanobacterial genus known for its spiral-shaped trichomes and high protein content. It thrives in alkaline and brackish waters and is widely cultivated as a nutritional supplement (Figure 2 C).

4. *A. platensis* (Nordst.) Gomont: This exhibits bright blue-green, multicellular trichomes that are helically coiled, forming open spirals. The cells are cylindrical, isodiametric, and lack heterocysts or akinetes, with distinct cross walls separating each cell.

References: (Desikachary, 1959).

5. *Nostoc linckia* Bornet and Flahault: Thallus blue green, densely entangled filaments. A diffusible gelatinous sheath is present at the periphery. The vegetative cells are short and barrel-shaped, about 3.5-4 μm in width. The heterocysts have a spherical shape, while the Akinetes are subspherical, measuring 6-7 μm in width and 7-8 μm in length (Figure 2 D).

Locality: Kot Radha Kishan roadside.

6. *Oscillatoria vaucher*: They have a single, flat or spongy free-floating thallus. Sheath is rarely present.

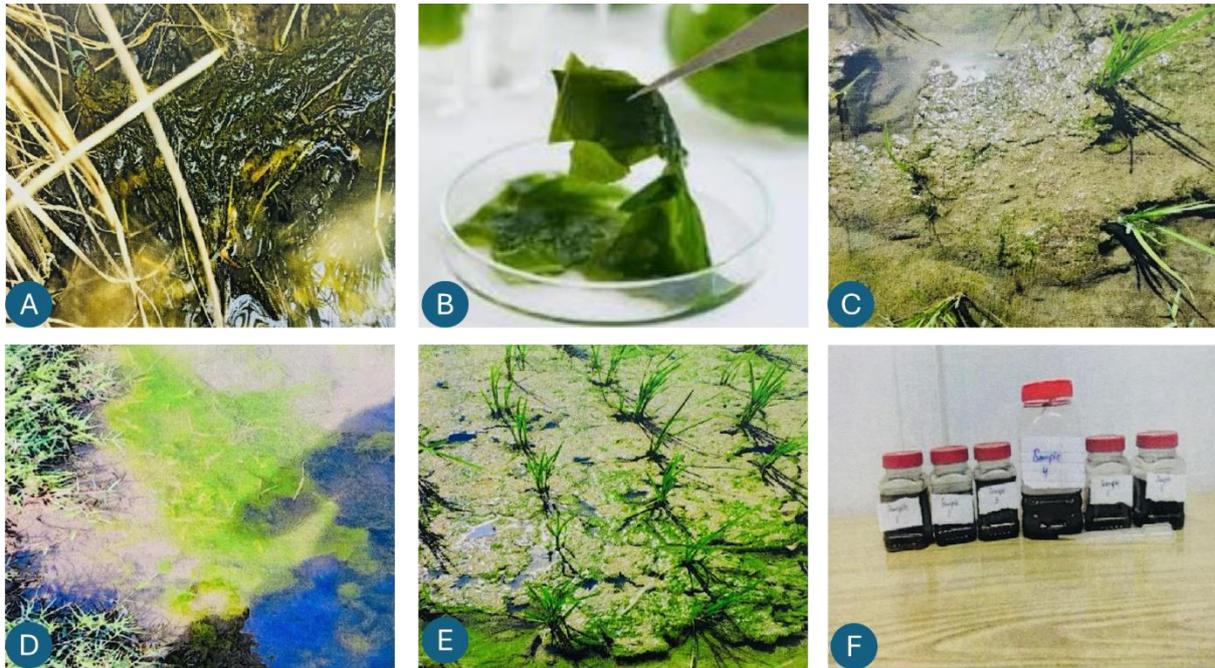


Figure 1. Collections of algae from different sites and areas of district Kasur. **A)** Kot Radha Kishan roadside, **B)** Slide making, **C)** Phool Nagar paddy field area, **D)** Waterways, **E)** Paddy field village Hussain Kahan Wala, **F)** Samples collection.

7. *O. subbrevis* Schmidle: Freshwater, marine, brackish species. They have been identified on the basis of a single trichome, straight. The diameter of cells is comprised of 5-6 μm and 1-2 μm long. Cross walls are without granules, with the end cell rounded.

Locality: Kot Radha Kishan roadside

8. *O. curviceps* Agardh: Expanded blue-green algal-like mass formed by trichome. Twisted and entangled, scarcely tapering to the apex. Broadly rounded apical cell. Not capitate, without calyptra, no constrictions at the cross walls, which may be granulated (Figure 2 E, F).

Locality: Phool Nagar field area

3.2 KINGDOM PROTISTA

The following species have been found.

1. *Closteridium reinsch*: Cells are cylindrical to crescent-shaped with a spine from each end.

2. *C. lunula* Reinsch: Cell's lunate bearing a stout spine at either end, single parietal chloroplast terminal vacuoles absent (Figure 3 A).

Locality: Phool Nagar field area

3. *Cosmarium* Cord: Cell has clear contraction in the centre with a single isthmus nucleus. One or two

chloroplasts are present in each semi-cell and have a prominent pyrenoid.

4. *Cosmarium pseudopyramidatum* Lund: Moderate-sized cells, sinus linearly narrow, intensely confined cells, semi cells truncate-pyramidate or truncate-semi-elliptical (Figure 3 B).

Locality: phool Nagar field area

5. *C. formosulum* Hoffman: It was slightly longer than wide, deeply constricted, linear sinus with 34-40 x 40-50 x 22-25 μm thick. Isthmus 10-15.5 μm . Subsemicircular or subpyramidate semicells with round basal angles. The apex is slightly dilated; apex is truncate, and 4 or 6-7 crenations and minute granules occur. Sides convex with 6-7 crenate, upper 3 crenations, 2 granules, lower crenations entire, and obtuse apical angles.

In the center, a broad tumour with 5-7 granules exists vertically. Semicells, vertically appear as elliptically containing poles, rounded. Chromatophores are axial, and pyrenoids are 2 in number (Figure 3 C).

Locality: Phool Nagar field area

6. *C. obtusatum* (Schmidle) Schmidle: Semi cells broadly triangular with flat apices; cell wall granular and undulate; chloroplast 2 in a semi-cell, each with a

pyrenoid; length 58-60 μm and width 46-48 μm ; isthmus 14-16 μm wide (Figure 3 D).

Locality: Grand Jamia Mosque fountain

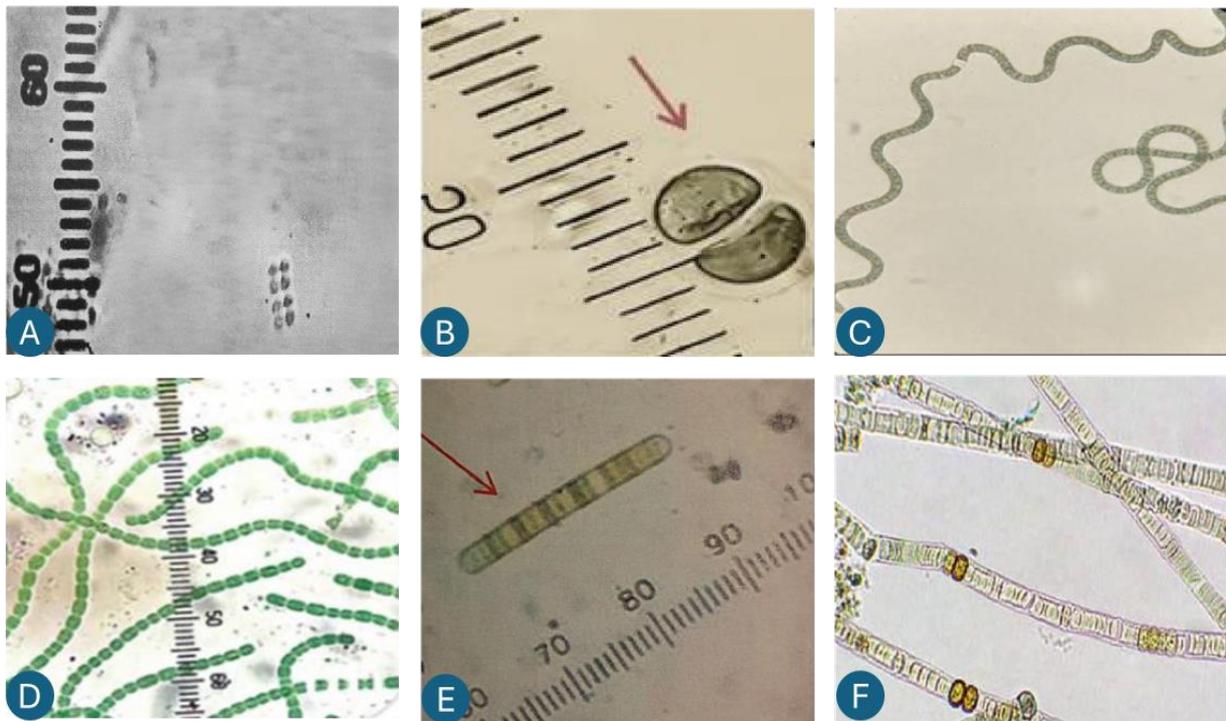


Figure 2. Algal species. **A)** *Chroococcus minor*, **B)** *C. minutus*, **C)** *Arthrospira platensis*, **D)** *Nostoc linckia*, **E)** *Oscillatoria subbrevis*, **F)** *Oscillatoria curviceps*

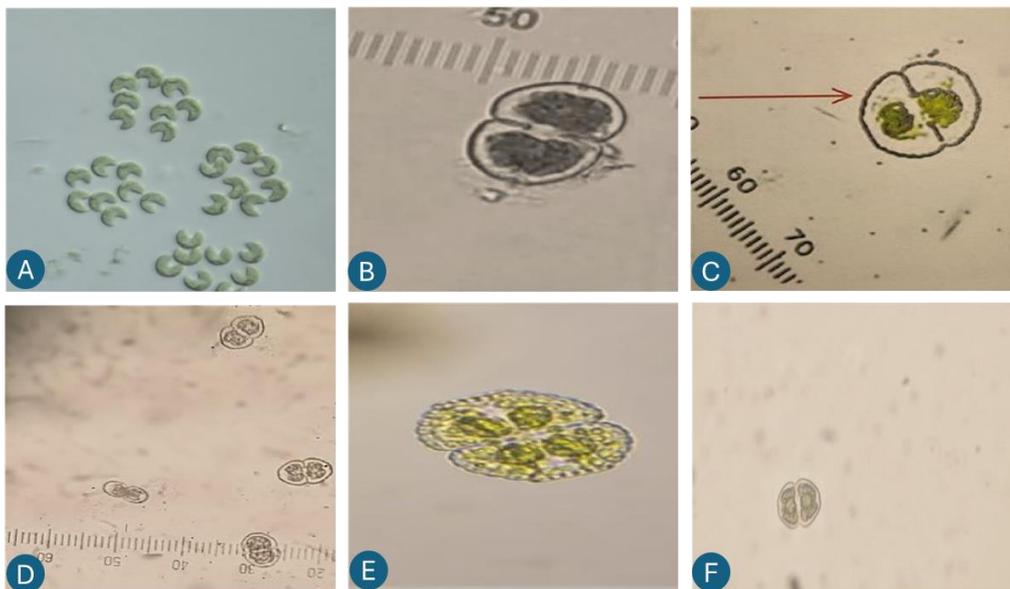


Figure 3. **A)** *Closteridium lunula* Reinsch, **B)** *C. pseudopyramidatum*, **C)** *C. formosulum* Hoffman, **D)** *C. obtusatum*, **E)** *C. botrytis*, **F)** *C. contractum*

7. *C. contractum*: Cosmarium cells are symmetrical and often elliptical or elongated in shape, with a prominent median constriction dividing the cell into two distinct semi-cells. The cell wall is composed of cellulose and is often ornamented with intricate

patterns, sometimes surrounded by a mucilage layer. Cosmarium primarily reproduces asexually through cell division, although sexual reproduction via conjugation also occurs (Figure 3 F).
Locality: Waterway 2

8. *C. botrytis* Meneghini ex Ralfs in Nordstedt: Deeply constricted medium-size cells; the sinus is narrowly linear and dilated extremities; ovate semi-cells, base of cells is pyramidal, and angle is rounded, covered with many papillae. Apex is complex, rather than narrowly truncate or subtruncate. Broadly punctate cell wall, flat at the apices. There are many pyrenoids in each semi-cell of 66-88 μm in length and 40-50 μm in width (Figure 3 E).

Locality: Phool Nagar field area

Phylum Bacillariophyta

They are freshwater and marine, comprising phytoplankton with cell walls with two valves impregnated with silica. Reproduction of mostly diatoms (plankton) is by fission. They lack flagella (except the male gametes) with frustules that overlap and are made of opaline silica.

Class Bacillariophyceae

In class, mostly diatoms are freshwater and marine algae. The flagellum is present on sperm with a bipartite cell wall with sculptured frustules and outer epitheca and inner hypotheca.

Order Bacillariales

Individual cells of this order are pennate/trellisoid with one or two chloroplasts. They show raphe with gliding manner and with flagellated spermatozooids reproduce by conjugation.

Family: Naviculaceae

Organisms of this family are free-floating. The solitary cells have elliptic valves and lanceolate raphe with distinct central and polar nodules with two laminate chromatophores.

Navicula Bory: The frustules are free floating form solitary or colonies. The girdlea are straight with rectangular lanceolate or fusiform linear valves. The ends of the cells are capitate, prostrate, or rounded. Raphe is straight with central and polar nodules with striae or costae transverse, parallel, or radiate narrow axial area. This has 2 chromatophores with lamination on both sides of the valve that form a bridge and connection in the middle. This splits up into numerous small, rounded granules sometimes (Figure 4).

N. tripunctata (O.F. Müll.) Bory: Cells of this species are small and oblong shells with pointed ends; a thin

line in the center and middle is wide with visible, faint lines of 50 μm long.

Locality: Grand Jamia mosque, Fountain

N. salinarum (Grunow) Cleve: Prostrate 21.6 μm long cells with 6.6 μm in diameter and striations are strongly radiate with parallel and convergent. Valves are broad and lanceolate with rostrate ends. The axial area is narrow, and the central part is large and circular (Figure 4 B).

Locality: phool Nagar field area

N. bacillum Ehrenberg: Cells have linear valves with straight or slightly convex sides and broadly rounded ends. The central area is round (Figure 4 C).

Locality: Grand Jamia Mosque.

Family Nitzschiaceae

Cells of this family are solitary, free-floating, or epiphytic. The valves are straight/sigmoid, with transversely symmetric and longitudinally asymmetric formation. The raphe is present on one lateral margin in each valve, with two chromatophores separated at the girdle.

Nitzschia Hassall: The solitary cells float or form a cluster in unbranched gummy tubes. They are long, diversely attenuated poles. Valves are longitudinal and asymmetrical. One valve has a keeled margin and another unkeeled. In the keel, the raphe has small central and polar nodules. Transverse striae. Two axial chromatophores on the girdle face.

N. vermicularis (Kutzing) Majeed: The girdle is sigmoid with truncated ends and has separate frustules. Sigmoid and linear, the valves narrow at the ends. The valve keel is punctate. The valve measures 67.2 μm long and 9.6 μm broad. It is frequently present in freshwater and marine environments, including those with colder temperatures, and is associated with sea ice (Figure 4 D).

Locality: Grand Jamia mosque Fountain

Nitzschia hungarica Gurnow: Narrowly linear valves with parallel and somewhat concave sides & slightly rostrate poles. striations interrupted by wide folk; keel punctate.

Locality: Kot Radha Kishan roadside (Figure 4 E).

Family: Pleurosigmataceae Pleurosigmataceae is a family of pennate diatoms typically characterized by

sigmoid (S-shaped) or curved frustules and well-developed raphe systems. The frustule patterning often includes fine striae (lines) and pores that assist in species identification. Members of this family are

commonly benthic, living attached to sediments or surfaces in freshwater and marine habitats. *Gyrosigma*, with its distinct raphe and striae pattern, is a classic representative of this family.

Table 2 Contribution of algal classes with their percentage.

Kingdom	Phylum	Class	O	F	G	Spp.	Contribution (%)
Monera	Cyanophyta	Chroocophyceae	1	1	1	2	06.40
		Nostocophyceae	2	2	3	4	17.50
Protista	Volvocophycota	Volvophyceae	1	1	1	1	03.70
		Desmidiophyceae	1	1	1	5	08.40
	Bacillariophycota	Bacillariophyceae	2	5	6	9	30.60
Protoctista	Chlorophycota	Zygnematophyceae	1	1	1	1	03.70
Total			8	11	13	22	100

Gyrosigma

The genus *Gyrosigma* includes elongated, sigmoid (curved) diatoms with prominent raphe systems and striae arranged in a unique, often diagonal or helical pattern. These diatoms exhibit a gliding movement along substrates and are commonly found in benthic freshwater and marine environments. The genus is closely studied in diatom taxonomy due to its distinct morphology and importance in ecological surveys. The curvature and striation patterns of *Gyrosigma* species make them relatively easy to identify under a microscope.

Gyrosigma scalproides (rabenhorst) Cleve: The valves of cells are slightly sigmoid and linear. More than half of the length of the diatoms is gradually attenuated to a bluntly rounded form with slightly constricted ends. The axial area and raphe are eccentric, diagonal, and weakly sigmoid. The end is scalpelliform but sometimes nearly symmetrical in shape. The outer proximal raphe ends are somewhat T-shaped, with the terminal area eccentric. The central area is small and longitudinally striate. Cells are slightly coarser at the center. Longitudinal striae curving outward on both sides of the central area. The dimension of transverse striae 20 is 10 µm at the center, then 24 in 10 µm. The length of striae ranges from 28-31 in 10 µm. Length 50-75 µ, breadth 8-12 µ (Figure 4 F).

Locality: Waterway 2

Family: Gomphonemataceae

The family Gomphonemataceae consists of unicellular or loosely colonial diatoms characterized by asymmetrical, heteropolar, and generally clavate (club-shaped) valves. Members of this family possess a raphe system that is typically located on one side of the valve and aids in gliding motility. Cells are siliceous and exhibit distinctive valve patterns with fine striations and central or eccentric raphe structures.

Genus: *Gomphonema* Ehrenberg

Gomphonema is a well-known genus of freshwater diatoms characterized by asymmetrical, heteropolar frustules with valves that are typically clavate (club-shaped) or wedge-shaped. The raphe system is unilateral and located along the ventral margin of the valve. Valves exhibit distinct striae (lines or punctate) and a prominent central area. *Gomphonema* species are widely distributed in freshwater lakes, rivers, and ponds, often found attached to submerged substrates. They play a key ecological role in primary production and are bioindicators of water quality (Figure 5 A).

G. ghosea: Epiphytic striae punctate, axial region narrow; length 31-40 µm, breadth 10-16 µm; striae 10-12 within 10 µm; two chromatophores, elongated

with irregular lobes. Valve clavate, attenuated towards the base.

Locality: Grand Jamia mosque Fountain
Order: Fragilariales

Table 3 Distribution of algal species in Kasur.

Sr. No.	Specimen	1	2	3	4	5	6
1	<i>Chroococcus minor</i>	-	-	+	-	-	+
2	<i>Chroococcus minutus</i>	-	+	-	-	+	-
3	<i>Arthrospira platensis</i>	+	-	-	+	-	-
4	<i>Oscillatoria subbrevis</i>	-	-	+	-	-	+
5	<i>Nostoc linckia</i>	-	+	-	-	+	-
6	<i>Oscillatoria curviceps</i>	+	-	-	+	-	-
7	<i>Closteridium lunula</i>	-	-	+	-	-	+
8	<i>Cosmarium pseudopyramidatum</i>	-	+	-	-	+	-
9	<i>Cosmarium formosulum</i>	+	-	-	+	-	-
10	<i>Navicula tripunctata</i>	-	-	+	-	-	+
11	<i>Nitzschia vermicularis</i>	-	+	-	-	+	-
12	<i>Gomphonema ghosea</i>	+	-	-	+	-	-
13	<i>Navicula salinarum</i>	-	-	+	-	-	+
14	<i>Navicula bacillum</i>	-	+	-	-	+	-
15	<i>Nitzschia hungarica</i>	+	-	-	+	-	-
16	<i>Gyrosigma scalproides</i>	-	-	+	-	-	+
17	<i>Fragilaria ulna</i>	-	+	-	-	+	-
18	<i>Fragilariforma virescens</i>	+	-	-	+	-	-
19	<i>Spirogyra nitida</i>	-	-	+	-	-	+
20	<i>Cosmarium botrytis</i>	-	+	-	-	+	-
21	<i>Cosmarium obtusatum</i>	+	-	-	+	-	-
22	<i>Cosmarium contractum</i>	-	-	+	-	-	+

The order Fragilariales is composed of pennate diatoms that typically have elongated or rectangular cells arranged in chains. Members of this order often lack a central raphe but may show slight cell-to-cell adhesion, forming long colonies or filaments. These diatoms are commonly found in freshwater habitats, and their ability to tolerate varying environmental

conditions makes them valuable bioindicators. Fragilaria species are often abundant in eutrophic waters and may form blooms under nutrient-rich conditions.

Family: Fragilariaceae is a family of diatoms known for their linear or ribbon-like colony structures and the

absence or rudimentary presence of a raphe. Their frustules are often elongated and show fine, parallel striae. Members of this family thrive in both planktonic and benthic zones and are frequently observed attached to substrates or forming floating colonies. The family includes several ecologically important genera, including *Fragilaria*, which are sensitive to changes in nutrient levels and water quality.

Genus *Fragilaria*

The genus *Fragilaria* comprises filamentous, pennate diatoms that usually form colonies in zig-zag or ribbon-like chains. The cells are elongate and flattened, often with a narrow central area and finely striated valves. Unlike some other pennate diatoms, most *Fragilaria* species lack a raphe and rely on

passive movement or colonial structure for stability in water columns. *Fragilaria* species are widespread in freshwater and brackish systems and are frequently used in diatom-based environmental assessments due to their sensitivity to nutrient enrichment and organic pollution.

F. ulna (Nitzsch) Ehrenberg: Cells 5-9 x 50-350, linear in girdle view, with widened extremities, solitary; valves linear to linear-lanceolate, gradually narrowed toward the ends, with broadly rounded poles; transverse striations 8-12 (mostly 10) in 10, finely but plainly punctate; pseudoraphe narrowly linear, with central area varying, often absent (Figure 5 B).

Locality: Waterway 1



Figure 4. A) *Navicula tripunctata*, B) *N. salinarum*, C) *N. bacillum*, D) *N. Vermicularis*, E) *Nitzschia hungarica* Gurnow, F) *Gyrosigma scalproides*

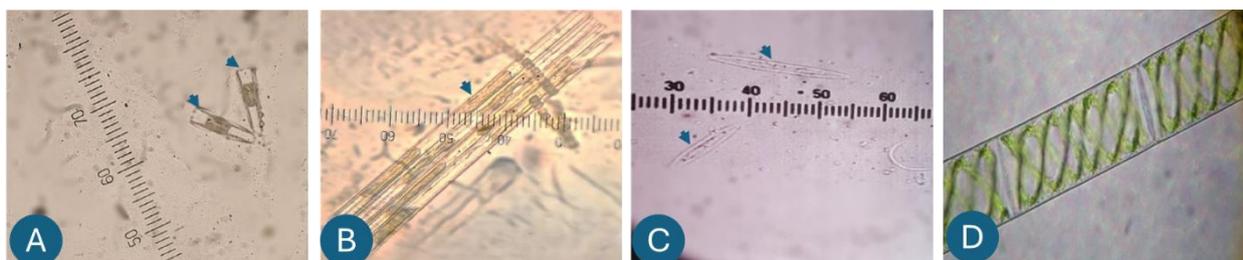


Figure 5. A) *Gomphonema ghosea*, B) *Fragilaria ulna*, C) *F. virescens*, D) *S. nitida*

Fragilariforma (J. Ralfs) D.M. Williams et F.E. Round: Frustules araphid, rectangular in linear or zig-zag colonies; valves elliptical, lanceolate or linear with

tapering rostrate to capitate apices, narrow sternum, labiate process and spines present; apical pore fields simple, extending on the valve face.

F. virescens (Ralfs) D.M. Williams et F.E. Round: General Characteristics: Frustules rectangular, valve lanceolate; length 65-67µm and width 10.5-12.5 µm; has 15 costae (Figure 5 C).

Locality: Waterway 2

3.3 Kingdom: Protoctista

It includes a wide variety of eukaryotic organisms that are mostly unicellular, though some are colonial or multicellular without specialized tissues. It serves as a grouping for algae, protozoa, and other organisms that do not fit into the plant, animal, or fungal kingdoms.

Family: Zygnemaceae

Plant cells of this family are long or somewhat small with a cylindrical, plane-folded end wall. They have a few large chloroplasts with very small, visible pyrenoids.

Spirogyra nistidia: Filaments are long and unbranched with or without basal-distal differentiation. Sometimes rhizoidal branches are developing laterally, and the filament comes in contact with the substrate. Cylindrical, short, or very long cells in some species. Ends are even and smooth. They replicate/colligate (exterior H-shaped piece) with their end walls. Chloroplasts are present in the form of a parietal band or ribbon-shaped. They are spirally twisted 14 to 3 turns, straight as present in genus *Sirogonium*, 1-16 chloroplasts in a cell. Conjugation is either lateral or scalariform. Genuiculate bending is rare. Conjugating cells are brought into juxtaposition (Prescott, 1948).

Taxonomic Features: Filaments are stout cells, 60-80 µm in diameter and 90-166 µm long, with the end wall plane. Chloroplast 3 to 5, making 1/2 to 11/2 turns. Gametangia of two cells are conjugated by a tube. Zoospore ovate to ovate ellipsoid, in which fertile cells are cylindrical. The medium-spore wall is irregularly reticulate and brown in colour.

Locality: Grand Jamia Mosque fountain

The present study revealed a diverse assemblage of freshwater algae from District Kasur, comprising 22 species across 20 genera distributed among the kingdoms Monera, Protista, and Protoctista, following the Shameelian classification system. The recorded taxa exhibit a wide range of morphological, cytological, and ecological adaptations, indicating the heterogeneity and productivity of the aquatic habitats sampled.

Cyanophyta, represented by genera such as *Chroococcus*, *Oscillatoria*, *Nostoc*, and *Arthrospira*, dominated the prokaryotic group, highlighting the role of nitrogen-fixing and bloom-forming cyanobacteria in nutrient cycling and water quality dynamics. Among eukaryotic algae, desmids like *Cosmarium* and *Closteridium* reflected cleaner, less disturbed environments, while the rich diversity of diatoms such as *Navicula*, *Nitzschia*, *Gyrosigma*, and *Fragilaria* pointed to a mixture of benthic and planktonic communities thriving under variable conditions of light, substrate, and nutrient availability. The presence of sensitive taxa like *Cosmarium botrytis* alongside more tolerant forms such as *Oscillatoria curviceps* suggests a gradient of ecological conditions across the sites, from oligotrophic to eutrophic states. Overall, the observed diversity underscores the ecological significance of the region's freshwater systems and offers a valuable baseline for future biomonitoring and conservation efforts.

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Data availability: All data supporting the findings of this study are available within the paper. We do not have any research data outside the submitted manuscript file.

Declarations

Consent for publication: Not applicable.

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