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Fresh water algae of gulbahar, district Peshawar, Pakistan

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Abstract

Thirty nine species were identified from Gulbahar-Peshawar, City. These included Cyanophyceae (12 Spp.), Chlorophyceae (4 Spp.) and Bacillariophyceae (23 Spp.), The important genera were *Oscillatoria* (7 Spp), *Navicula* (4 spp), *Nitzschia* (4 spp), *Pinnularia* (3 spp), *Lyngbya* (3 Spp.), *Amphora* (3 spp), *Epithemia* (2 spp), and *Ulothrix* (2 Spp.). *Microcystis*, *Cosmarium*, *Microspora*, *Oocystis*, *Frustulia*, *Mastoglia*, *Surirella*, *Stauroneis*, *Diploneis*, *Achnanthes* and *Cymbella* had one species each. The present study will help others to know the ecological distribution of different flora of fresh water algea in gulbahar, Peshawar. Further work is needed to evaluate its medicinal value and other essential aspects.

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Introduction

Although many species of freshwater algae proliferate quite intensively in eutrophic waters, they do not accumulate to form dense surface scums (often termed blooms) of extremely high cell density, as do some Cyanobacteria. The toxins that freshwater algae may contain are therefore not accumulated to concentrations likely to become hazardous to human health or livestock. For these reasons, this chapter will focus primarily on the health impacts of Cyanobacteria. Almost any fresh water or brackish water site will contain one or more than one species of algae. Freshwater algae constitute a very diverse group of organisms. They have an enormous range of size from less than one micrometer to several centimeters. In lakes and rivers algae generate biomass which is the foundation of diverse food chain. Algae in freshwater are also harmful as they produce biomass which generate bed smell causing deoxidation and damage to aquatic life (Bellinger & Sigee, 2010).

Peshawar according to Koppen's climate classification comes under a semi-arid climate with very hot summers and mild winters. Winters start in mid November and end in late March. The mean maximum temperature in summer is over 40 °C and the mean minimum summer temperature is 25 °C. The mean minimum temperature during winter is 4°C and maximum may be upto 18 °C. Peshawar is out of monsoon region. Algal flora of fresh water bodies and aquatic habitats of Pakistan have been done by many to know the ecological distribution and role in environment (Khalid, Mustafa and Saleem,2009; Lashari, Korai and Sahato, 2009; Ungsethaphand, Peerapornpisal and Whangchai, 2009).

Algal flora of fresh water bodies and aquatic habitats of Peshawar Valley has been explored from time to time by many workers (Sarim & Ayaz, 2000; Nawaz & Sarim, 2004; Zaman & Sarim, 2005; Sarim & Zaman, 2005; Khair-un-Nisa, & Sarim, 2006; Sarim *et al*., 2009, 2010; Zaman *et al*., 2009; Hussain *et al*., 2009, 2010 a,b). The present report is further contribution to the algal flora of Peshawar that will help others to know the ecological distribution of different flora of fresh water algea Write the aim of the study here.

Materials and methods

Algal was specimen were collected with the help of forceps, hands picking direct taking water in the bottle for the floating algal flora, picking by hand with soil the clean with the help of tape water for preparation of microscopic slides. These collected algal specimens were preserved in 3% formalin. These specimens were identified following Desikachary (1959), Prescott (1951), Tiffany & Britton (1952) and Faridi (1971). For identification a drop of algal specimen was placed on slide for micro algae i.e Cyanophyceae and diatom flora. while for filamentous algae filament was separated with forceps and place on slide and put cover slip on it for microscopic examination. By comparing the figures given in literatures with the specimen as observed under microscope and by finding the structural details of the specimens. The diagrams were drawn with the help of camera Lucida (Prescott, 1951).

Results and discussion

There were thirty-nine species representing classes Cyanophyceae, Chlorophyceae and Bacillariophyceae. Class Cyanophyceae was represented by *Oscillatoria* (7 spp), and *Lyngbya* by 3 species. While *Microcystis* and *Oocystis* had one species each. The lowest number of genera and species were recorded for Chlorophyceae. It included *Ulothrix* with 2 species; and *Comarium* and *Microspora* contained one species. The well represented class was Bacillariophyceae. It had 12 genera and 23 species. *Navicula & Nitzschia* had 4 species; *Amphora* and *Pinnularia* had 3 species; and *Epithemia* was represented by 2 species. There was one species in each of the remaining species including *Achnanthes, Cymbella, Diploneis, Frustularia, Mastogolia, Surrirella* and *Stauronies*.

The poor representation of blue green and green algae might be due to the polluted habitats within the city. Diatoms occur everywhere in almost all the season due to their siliceous nature and wide range of adaptability. Some of these species have been invariably identified from fresh water bodies, soil and polluted habitats of different parts of Peshawar Valley (Hussain *et al.*, 2009, 2010, 2011; Sarim & Zaman, 2005; Sarim *et al.*, 2010, Zaman & Sarim, 2005) and the present findings are supported by the above workers.

The taxonomic description and camera lucida diagrams are given below.

A. Class CYANOPHYCEAE

1. *Lyngbya* C. A. Agardh

Filaments unbranched, cylindric, straight, curved or twisted, solitary or densely intertwined into floccose masses, or epiphytic; sheaths firm, generally hyaline but sometimes brownish or yellowish with age, often lamellose, usually extending beyond the trichomes, trichomes solitary, obtuse or sometimes apically attenuate, sometimes constricted at cross-walls; cells contents homogeneous, granulose, variously colored.

Key to species

1. Trichome constricted at the cross wall..... *L. corticola*

1. Trichome not constricted at the cross wall..... 2

2. Trichomes 12-17 µm broad.....*L. connectens*

2. Trichome 3-4 µm broad.....*L. kashyapii*

i. Lyngbya connectens Bruhl et Biswas

Stratum extensive, about 1mm thick, when dry shinning and dark green; filaments straight or nearly so, lying parallel to each other, the trichomes often creeping out of their entire sheath, sheath at first delicate and colorless, but later when old, becomes firm and brownish, 1.5-2 thick, nearly lamellate with 2-3 lamellae. Trichomes 12-17 µm broad, not constricted at the cross walls, slightly thickened at the apex, cells about 1/6 as long as broad,2-2.5 µm long, dissepiments granulated (Fig. 1).

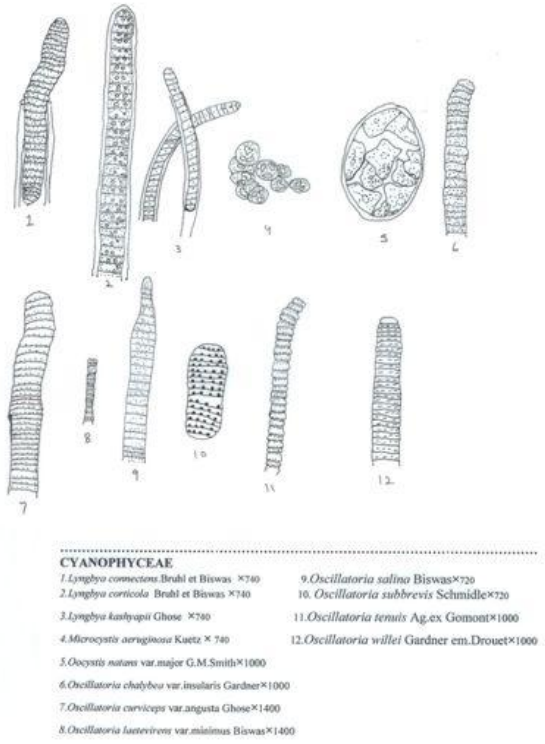

Fig. 1. Cyanophyceae.

ii. Lyngbya corticola Bruhl et Biswas

Thallus a thin tomentose dark or yellowish brown layer; filaments somewhat fragile, moderately flexuous, more or less densely intricate, 12-26 µm thick, sheath at first hyaline, but later becoming brown, 2 µm thick; scarcely or not at all lamellated surface uneven, not wrinkled. Tricomes 8-12 µm broad, slightly constricted at the joints, cells about ½-1/3 as long as wide dissepiments not granulated (Fig. 2).

iii. Lyngbya kashyapii Ghose

Thallus expanded, dull purple; filament curved, densely intricate, sheath firm, thick, dull blue or purple, smooth, chitinous; trichome 3-4 µm broad, not constricted at the cross wall, non granulated often oblique or curved, end cell rounded, not capitate and no calyptera (Fig. 3).

2. Microcystis aeruginosa Kuetz
Colonies when young round or slightly longer than broad, solid, when old becoming clathrate, with distinct hyaline, colonial mucilage. Cells 3-4 µm in diameter, cell contents blue-green, highly granular and with conspicuous pseudovacoules (Fig. 4).

3. Oocystis natans var.*major* G.M.Smith
Colony of 2 or 4 ovate cells enclosed in the much expanded old mother cell wall; poles of the cells rather sharply rounded but without polar nodules; Chloroplast 4-8 in number, parietal lobed or star shaped plates, cells 16-25 µm in diameter, 31-38 µm long; families about 90 µm in diameter, 120 µm long (Fig. 5).

4. Oscillatoria Vaucher
Trichomes unbranched, cylindric, without evident sheaths or amorphous jelly, solitary or in floccose masses, straight or variously curved and contorted, sometimes apically narrowed, terminal cell rounded or calypterate; cell contents homogeneous or granular, color variable; plants often exhibiting oscillating or gliding movements; end cells often obscure in fragmented material.

i. Oscillatoria chalybea var.*insularis* Gardner
Thallus dark blue green, cells 8-13×3.6-8 µm, cross-walls little or not at all granulate; trichomes straight or sometimes twisted, slightly constricted at cross-walls, gradually tapering for a long distance from the hooked or curved apex, terminal cell somewhat elongate and broadly rounded, blue-green to dark blue-green becoming blackish green in mass; trichome ends bent and sickle-shaped, 6.4-7.2 µm broad as long as or shorter than broad (Fig. 6).

ii. Oscillatoria curviceps var.*angusta* Ghose
Thallus blue-green, trichomes straight but bent at the ends, very slightly attenuated, not constricted at cross-walls, 10-17 µm broad, cells 1/3-1/6 times as long as broad, 2-5 µm long, cross-walls granulated, end walls rounded, not capitate (Fig. 7).

iii. Oscillatoria laetevirens var.*minimus* Biswas
2.5-3 µm in dia, a pex slightly tapering, more or less curved, slightly constriction at the cross wall, not capitate, calyptera absent, cells 1.5-2 µm in length, granulated cross wall (Fig. 8).

iv. Oscillatoria salina Biswas
Cells shorter than broad, 1.5-2 µm long, sometime filament may be interrupted by infated reifringent cells, transverse septa indistinct not granulated cell content finally uniformly granular, almost homogenous blue-green (Fig. 9).

v. Oscillatoria subbrevis Schmidle
Trichome 5-6 µ broad, straight, not attenuate at the apices, cells 1-2 µm long; not granulated at the cross-walls, cell wall ends are rounded, calyptera absent (Fig. 10).

vi. Oscillatoria tenuis Ag.ex Gomont
Trichome straight, slightly constriction at the cross wall, 4-10 µm broad, 2.6-5 µm long, not attenuated at the apices, not capitate, end cell more or less hemispherical (Fig. 11).

vii. Oscillatoria willei Gardner ex. Drouet
Trichome pale blue green to grey blue green, bent at the ends or screw like, 2.4-3.6 µm broad, unconstructed at the cross walls, ends not attenuated, not capitate; cells 1.3 upto twice as long as broad, not granulated at the cross walls, and cell rounded without a thickened membrane (Fig. 12).

B. Class CHLOROPHYCEAE

1. Cosmarium supraspeciosum Wolle
Ovate, longer than wide, deeply constricted, sinus narrowly linear, margin crenate, semicells phyramidate semicircular, basal angle rounded, side convex, apex truncate, crenation usually about 16 on each side and 5-6 on the apex, wall ornamented with large undivided granules arranged in concentric and radiating series, extending from the margin nearly half way to the centre, central area bearing vertical series of smaller granules, lateral view of semicells ovate-oblong with a granulate inflation near the

base, ventral view with a prominent central granulate inflation (Fig. 13).

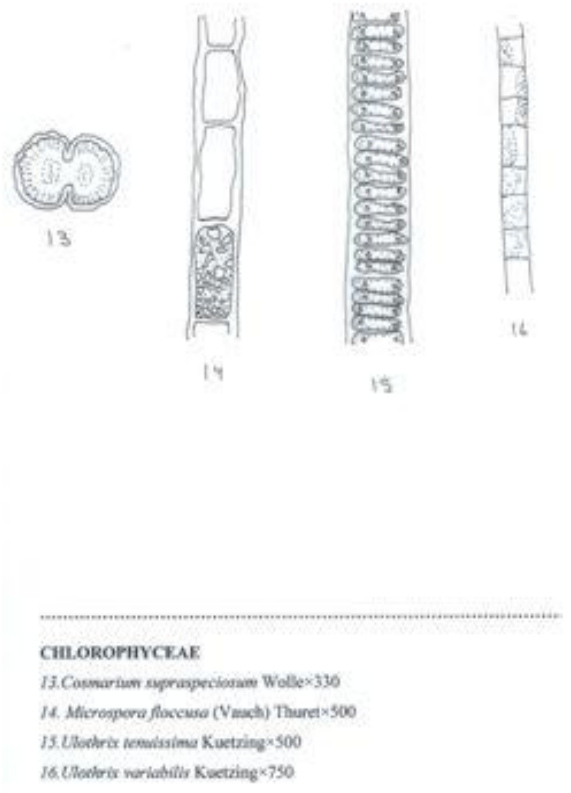

Fig. 1. Chlorophyceae.

2. *Microspora floccusa* (Vauch) Thuret
Walls relatively thin, sections not always evident in the mid region of the cell. Cells cylindrical or slightly swollen; 14-17 µm in dia, 22-29 µm long. Chloroplast usually reticulate (Fig. 14).

3. *Ulothrix* Kuetzing
Filament unbranched, not apically attenuated, frequently attached basally; vegetative cell uninucleate, cylindric or sometimes barrel-shaped; chromatophores band-shaped, occupying part or the whole of cell circumference, with 1 or more pyrenoids.

Formation of quadriflagellate and biflagellate zoospores and of akinetes; biflagellate gametes; zygotes germinating into daughter protoplasts producing aplanospores or zoospores.

Key to species
+ Cells 16-20 µm in diameter..... *U. tenuissima*
- Cells 4.5-6 µm in diameter ..... *U. variabilis*

i. Ulothrix tenuissima Kuetzing
Filaments long, composed of cylindrical cells. Cells shorter than wide, 16-20 µm in dia, thin walled and not constricted at the cross walls. Chloroplast a broad band encircling about 2/3 of the circumference of the cell, with 2 or several pyrenoids (Fig. 15).

ii. Ulothrix variabilis Kuetzing
Filaments long, slender and entangled forming cottony masses. Cells cylindrical, without constrictions at the cross walls. Chloroplast a folded, parietal plate, ½ to 2/3 the length of the cell, with 1 pyrenoid (or 2 pyrenoids).Cells 4.5-6 µm in dia and upto 15 µm long (Fig. 16).

C. Class BACILARIOPHYCEAE
1. Achnanthes minutissima Kuetzing
Cells 2-4 × 5-40 µm, Valves linear-elliptic, slightly narrowed to rounded poles; Transverse striations 33-35 in 10 µm; hypovalve with delicate thread-like raphe, central area small; epivalve with very narrow pseudoraphe, central area absent (Fig. 17).

2. *Amphora* Ehrenberg
Cells usually sessile with concave faces attached in girdle view, broadly elliptic in outline, with truncate ends, girdles usually separated by several punctuate or striate intercalary bands valves lunate, longitudinally asymmetric, transversely striate; axial field strongly excentric, nearer the concave side of the valve; raphe gibbous, with its central nodule close to the concave margin; chromatophores, single or 2-4.
Key to species
1. Striae 6-8 in 10 µm..... *A. bacillaris*
1. Striae more.....2
2. Striae 10 –13 µm in 10 µm..... *A.ovalis*
2. Striae 18-19 in 10 µm..... *A.mexicana*

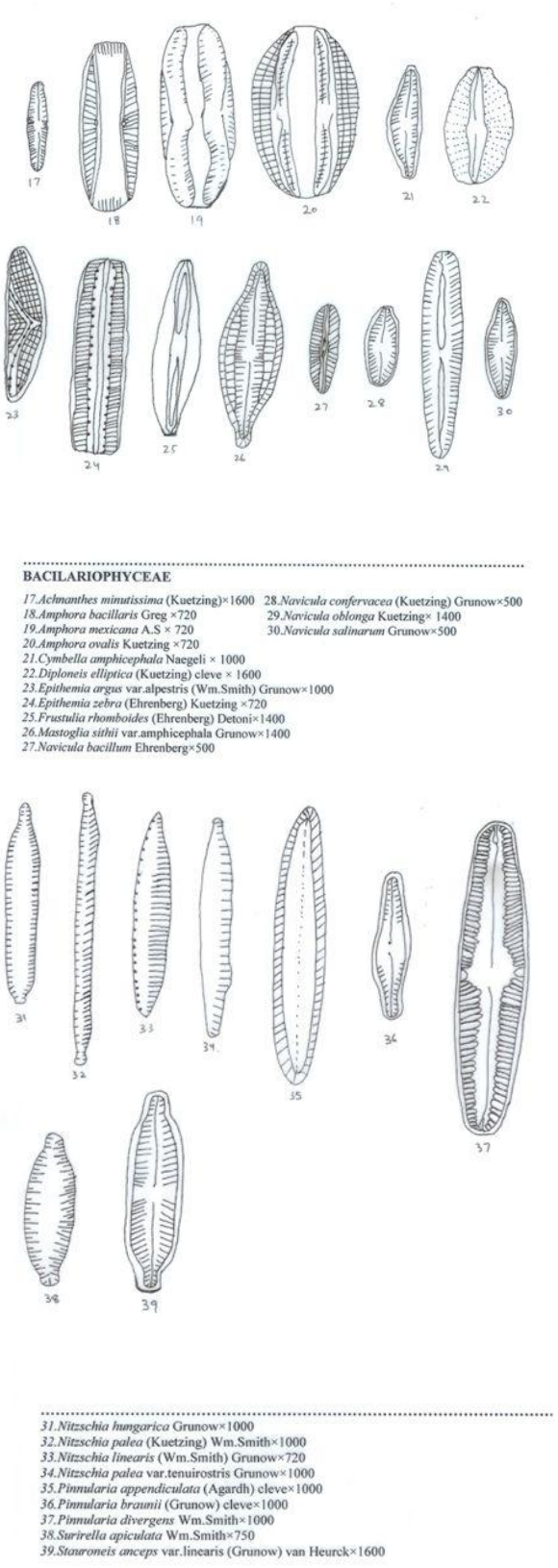

Fig. 3. Bacilariophyceae.

i. Amphora bacillaris Greg

Frustule almost rectangular. Valves narrow, central nodule not dilated into a stauros. Striation radiate 18 –19 µm in 0.01mm not crossed by a longitudinal line (Fig. 18).

ii. Amphora mexicana A.S

Valve lunate with arcuate dorsal and straight ventral margin. Median line more or less biarcuate. Axial area not distinct, central area small and rounded on the dorsal side. Dorsal side with a longitudinal line more or less approximate to the median line. Striae 6-8 in 0.01mm, coarsely punctuate; punctae 6-7 in 0.01mm.Ventral side entirely covered with somewhat radiate striae (Fig. 19).

iii. Amphora ovalis Kuetzing

Cells in girdle view broadly elliptic with truncate ends, 17-63 × 20-110 µm, Valve lunate, with rather blunt poles, ventrally concave, dorsally convex; raphe gibbous; axial area narrow, central area develop only on the ventral side; Transverse striations 10-13 in 10µ, convent into ventrally at the poles, radial elsewhere (Fig. 20).

3. Cymbella amphicephala Naegeli

Cells 9-10 × 25-40 µm; Valves lanceolate, somewhat asymetrica, with convex sides and evident constrictions below the rostrate-capitate poles; raphe straight, slightly excentric; axial; Transverse striations radiate, 12-16 in 10 µm (Fig. 21) .

4. Diploneis elliptica (Kuetzing) Cleve

Cells 10-30 × 20-65 µm; Valves broadly elliptic, with large roundly quadrate central nodule with distinct horns, furrow slender, medianly somewhat widened; Transverse costae somewhat radial, 9-13 in 10µ,crossed by numerous irregular longitudinal costae, forming areola 9-14 in 10 µm (Fig. 22).

5. *Epithemia* Brebisson

Cells solitary, usually epiphytic upon submerged aquatics, attached at the girdle, rectangular valves slightly to strongly curved dorsally convex, ventrally

straight to concave, with broadly rounded to capitate and sometimes recurved poles; axial field near ventral side except for v-shaped median extension toward dorsal side; raphe with polar and central nodules, with inner fissure containing circular pores; transverse septa appearing as costae and alternating with two or more rows of punctuate; single chromatophore with irregular projections.

Key to species

+ Walls with rounded ends.....***E. argus* var. *alpestris***

- Walls with not rounded ends.....E. zebra

i. Epithemia argus var. *alpestris* (Wm.Smith) Grunow

Valves gradually attenuated to rounded ends, not capitate (Fig. 23).

ii. Epithemia zebra (Ehrenberg) Kuetzing

Cells 7-14 × 30-150 µm; Valves lanceolate, gently curved with nearly parallel sides, gradually attenuated to rounded poles; costae radial, 2-4 in 10, alternating with 4-8 rows of striations 12-14 in 10 µm (Fig. 24).

6. Frustulia rhomboides (Ehrenberg) Detoni

Cells 15-30 × 70-160 µm with rhombo-lanceolate valves, transverse striations, 23-30 in 10 µm and longitudinal lines 20-30 in 10 µm (Fig. 25).

7. Mastoglia sithii var. *amphicephala* Grunow

Valves elliptic with pronounced rostrate ends (Fig. 26).

8. *Navicula* Bory 1822

Cells generally solitary and free-floating, sometimes aggregated into irregularly radiating clusters rectangular in girdle view, with smooth girdles and without intercalary bands; valves elongate, usually attenuated toward capitate, rounded or rostrate poles; axial field narrow with distinct, straight raphe and poles and central expansions, nodules small; transverse striations, sometimes somewhat medianly radial; two laminate chromatophores, rarely 4 to 8, infrequently with one or more pyrenoids.

Key to species

1. Valves linear..... *N.bacillum*

1. Valves lanceolate.....2

2. Valves 6-8 µm broad..... *N.confervacea*

2. Valves otherwise.....3

3. Stiation 6-8 in 10 µm..... *N.oblonga*

3. Striation 14-16 in 10 µm..... *N.salinarum*

i. Navicula bacillum Ehrenberg

Cells 10-20 × 30-80µ, values linear, with straight or convex sides and broadly rounded ends, transverse striations, 12-14 in 10µ at the middle, 18-20 in 10µ at the poles, central area rounded (Fig. 27).

ii. Navicula confervacea (Kuetzing) Grunow.

Cells 6-8 × 17-25 µm; valves lanceolate, axial area lanceolate and medianly broad; transverse striations often weak, radial, 20-22 in 10 µm (Fig. 28).

iii. Navicula oblonga Kuetzing

Cells 13-24 × 70-220 µm, valves linear to lanceolate with broadly rounded ends; transverse striations in polar and sub polar area bent, generally radial, 6-8 in 10 µm; central area large, round (Fig. 29).

iv. Navicula salinarum Grunow

Cells 8-12 × 23-41 µm; valves lanceolate, with more or less rostrate, often lightly capitate ends central area round; transverse striations, medianly alternately long and short, radial, 14-16 in 10 µm (Fig. 30).

9. *Nizschia* Hassall

Cells solitary and free floating or densely clustered in simple or unbranched gelatinous tubes, elongate-rectangular or sigmoid in girdle view, with somewhat attenuated poles, rhombic in cross-section; valves longitudinally asymmetric, very variable in shape; straight, sigmoid, linear, elliptic, somewhat undulate, medianly constricted or not, poles acute or rostrate or capitate, often much attenuate; near one

margin is a keel with a raphe having small nodules and a row of circular pores opening toward the interior of the cell; transversely striate or punctuate; two chromatophores on the same girdle face.

Key to species

1. Walls with more acute ends..... *N. palea var. tenuirostris*
1. Walls without acute ends 2
2. Striations less than 30 in 10 µm..... *N. hungarica*
2. Striations more than 30 in 10 µm.....3
3. Keel punctae 10-15 in 10 µm..... *N. palea*
3. Keel punctae 11 in 10 µm..... *N. linearis*

i. Nitzschia hungarica Grunow

Cells 6-9 × 20-110 µm, valves narrowly linear, with parallel or somewhat concave sides and slightly rostrate poles; striations 16-20 in 10 µm, interrupted by a fairly wide fold; keel punctae 7-9 in 10 µm (Fig. 31).

ii. Nitzschia palea (Kuetzing) Wm.Smith

Cells 2.5-5 × 20-65µ;Valves linear-lanceolate with connate poles; Striations 35-40 in 10 µm, keel punctae 10-15 in 10 µm (Fig. 32).

iii. Nitzschia linearis (Wm.Smith) Grunow

Valves more slender, about 85 µm long; Striations more than 30 in 10 µm; keel punctae about 11 in 10 µm (Fig. 33).

iv. Nitzschia palea var. *tenuirostris* Grunow

Valves longer, with more acute ends (Fig. 34).

10. *Pinnularia* Ehrenberg

Cells solitary and free floating, rarely in short filaments, symmetric, rectangular in girdle view, girdles smooth, intercalary bands absent; valves usually with straight sides, sometimes medianly inflated or undulate, generally with broadly rounded poles; axial field usually broad, expanded both polarly and medianly, with complicated straight or sigmoid raphe; rostae, with internal openings smooth, radial or transverse with 2 longitudinal lines visible in costate part of the valve, chromatophores two, laminate usually with pyrenoids.

Key to species

1. Valves linear-lanceolate..... *P. appendiculata*
1. Valves elliptic-lanceolate.....2
2. Cells 8-12 × 30-60 µm..... *P. braunii*
2. Cells 13-20 × 50-140 µm..... *P. divergens*

i. Pinnularia appendiculata (Agardh) Cleve

Cells 4-6 × 18-36 µm, Valves linear-lanceolate with nearly straight sides scarcely tapering to broadly rounded ends; transverse striations, somewhat radial in the middle and convergent at the poles 16-18 in 10 µm (Fig. 35).

ii. Pinnularia braunii (Grunow) Cleve.

Cells 8-12 × 30-60 µm; valves elliptic-lanceolate, constricted toward the capitate poles; axial area widely lanceolate with a broadly central area; transverse striations short, medianly radial and polarly convergent, 11-12 in 10 µm (Fig. 36).

iii. Pinnularia divergens Wm.Smith

Cells 13-20 × 50-140 µm; Valves elliptic-lanceolate, with convex sides and broadly rounded ends; transverse striations medianly radial and polarly convergent, 10-12 in 10 µm (Fig. 37).

11. Surirella apiculata Wm. Smith

Cells isopolar, 15-18 × 50-70 µm; Valves rectangular with broadly cuneate to rectangularly narrowed poles, costae alternately long and short, mostly radiate, 9-10 in 10 µm; an imperfectly known species (Fig. 38).

12. Stauroneis anceps var. *linearis* (Grunow) van Heurck

Cells 6-8 × 25-130 µm, solitary, without polar septum, valves elliptic to linear lanceolate, with

rostate to capitate ends, raphe straight, usually narrow, axial area narrow (Fig. 39).

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