Taxonomic studies of family Oscillatoriaceae from Tehsil Landikotal, District Khyber, Khyber Pakhtunkhwa, Pakistan

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Abstract
Landikotal is an area mostly consists of hilly tracks, mountains and narrow strips of valleys. It is the meeting place of high ranges of mountain such as the Koh-e-Safaid, and outcome of the mighty Hindukush Mountains. The taxonomic studies of family Oscillatoriaceae from tehsil Landikotal, District Khyber, Khyber Pakhtunkhwa, Pakistan was carried out to find out the diversity of family Oscillatoriaceae which contains 2 Genera and 9 Species that includes Oscillatoria terebriformis, Oscillatoria tenuis, Oscillatoria splendid, Oscillatoria Formosa, Oscillatoria prolifica, Oscillatoria amoena, Oscillatoria saneta, Lyngbya kasyapii and Lyngbya martensian.

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Introduction

District Khyber is on the way across the mountains to the city of Peshawar and consists of three major tehsils including Barra, Jamrud and Landi Kotal. LandiKotal tehsil consist four major territories viz. Tirah, Khyber, LandiKotal and Shalmans while the Shalmans include Loy Shalman and Kam Shalman. Tehsil LandiKotal has a barren and rocky mountainous landscape. The area is mostly consists of hilly tracks, mountains and narrow strips of valleys. It is the meeting place of high ranges of mountain viz. Koh-e-Safaid and Hindukush Mountains. Amongst these mountains ranges natural water stream are flowing throughout the year. In Pakistan few studies have been conducted in the field of algae viz. studies on fresh water cyanophytes of Karachi, Sindh, Pakistan (Farzan a & Niazmuddin, 1979) and other areas of Sindh Province (Shameel & Butt, 1984) and Khyber Pakhtunkhwa Province (Leghari & Arbani, 1984). But little attention has been paid on the study of blue green algae of the Punjab Province and Azad Kashmir. Ghose was the first phycologist to start a systematic study of blue green algae from this area and reported fifty nine species including nine new species and three new varieties (Leghari et al., 2000). Randhawa mainly worked on Chlorophycota and added twenty-three species of blue-green algae to the list of this region (Faridi, 1971). Twenty five species of blue green algae growing in the culture of rice field soils of Kashmir were isolated by (Khan,1957). About ninety five species were reported by Ali and Sandhu in which seventy eight species were recorded for the first time from this area (Ali et al., 1972). Later (Masud-ul-Hasan, 1978) reported some freshwater algae including Cyanophycota which were collected from ponds around Lahore and study of pinnate diatoms from tehsil Landilotal, district Khyber, Khyber Pakhtunkhwa Pakistan were previously reported by (Irfan et al., 2018).

It appeared that vast areas of the north eastern regions of Pakistan were however not studied. Therefore the current study was undertaken to make a detailed survey of these algae from these areas.

Materials and method

The algal species were collected from fresh water streams of six major locations from tehsil landikotal, district Khyber, Khyber Pakhtunkhwa, Pakistan. The collected specimens were kept in glass bottles and preserved by adding 3% formalin solution. The preserved specimens were then examined under microscope and identified with the help literature (Ghose, 1919).

Results and discussion

A total of 9 species having 2 genera belongs to family Oscillatoriaceae were reported and identified. The taxonomic descriptions of all the species is given below.

**Fig. 1. Oscillatoria Amoena.**

**Key to family**

Filaments unbranched cylindrical, sheath generally hyaline usually
Trichomes ....................................Oscillatoriaceae

**Family Oscillatoriaceae**

**Taxonomic description**

Filaments un branched, cylindrical, straight, curved or twisted, solitary or densely inter wired into floccose masses or epiphytic; sheath firm, generally hyaline but sometimes brownish or with age, often
yellowish lamellose usually extending beyond the trichomes, trichomes solitary sometime appearing otherwise when hormogonia form within tenacious sheath, obtuse or sometime apically attenuate, sometime constricted at cross-wall, cell contents, homogenous, granulose and variously colored.

Trichome crooked or spirally twisted at the apex cross wall granular.........Oscillatoria terebriformis
End cell not globular..........................Oscillatoria prolifica
End cell almost globular......................Oscillatoria splendid
Cell diameter 2.3-4.3 µ or 4-10 µ.........Oscillatoria Tenuis
End cell conical, end cell capitates, end cell not capitates..........Oscillatoria Formosa

Key to genera
Plant irregularly spiral or straight..........................................Oscillatoria
Trichomes generally single within sheath.........................
Sheath hyaline or yellow brown.......................Lyngbya

Oscillatoria
Trichomes un branched, cylindrical, without evident sheath or amorphous jelly, solitary or in floccose masses, straight or variously curved and contorted, sometime apically narrowed, terminal cell rounded or calyptrate, cell contents homogenous or granular, color variable; plants often exhibiting oscillating or gliding movement; end cells often obscure in fragment material.

Key to species
End cell capitates.......................Oscillatoria amoena
Diameter of cell 10-20 µ ......Oscillatoria saneta

Oscillatoria amoena (kuetzing) Gomont 1892 Fig. 1
Cell 2.5-5.0 x 2.7 - 4.3 µ granulate in cross wall; trichome vertical, a little constricted at cross wall steadily attenuated at the apex with or without capitates, broadly outwardly-rounded thick calyptras end at cell, spread or form blue green masses.

Distribution
North America, Europe and Asia/

Oscillatoria saneta ( kuetzing) Gomant 1892 Fig 2
Cell 10-20 x2.5-6.0 µ granulate at cross wall with half-rounded, slightly capitate end cell with thick outer membrane, trichomes straight or twisted, slightly constricted at cross-walls, slightly narrowed apically, deep blue-green to dirty olive-green; masses steel-blue, shiny thin, slimy.
Fig. 4. Ooscillatoria Prolifica.

**Fig. 5. Ooscillatoria Tenuis.**

**Fig. 6. Ooscillatoria splendida.**

**Distribution**
North America, Europe and Asia

*Oscillatoria terebriformis* C.A.Agardh 1892 Fig. 1
Trichome forming a plant mass, dark steel-blue in color; spirally twisted, especially at the apex, slightly tapering in the apical region.

Apical cell round or pointed, not capitates, and without a calyptras. Cell 4-6µ in diameter, 2.5-6 long; not constricted at cross wall.

**Distribution**
Europe, North America, Asia and Australia

*Oscillatoria prolifica* (Greville) Gomont 1892 Fig. 4
Cell 2-5 x4-6 µ with pseudo vacuoles, cross wall granulate; trichomes bent-straight, not tapered at or near cross walls gradually become narrow at apex, spread or make red to purple-violet asymmetrical masses; capitates, calyptras present or absent.

**Distribution**
Europe, North America, Asia and Australia

*Oscillatoria tenuis*
C.A.Agardh 1892 Fig. 5.

Cell 4-10 x 2.5-5.0 µ with more or less protoplasm granulose, frequently crush at cross wall; trichome are blue or bright green in colored, wall are straight or slightly constricted, gradually curved at the apex, end cell convex and with thick outer membrane, hemispherical, forming thin blue green, oily masses, attached or free floating.
Fig. 7. *Oscillatoria formosa*.

**Distribution**
Europe, North America, South America, Africa and Asia.

*Oscillatoria splendid*  
Greville 1892-1893 Fig. 6.

Cell 2-3 x 3.9 µ homogenous, blue green; trichome straight or bent, not constricted but somewhat granulate at cross wall gradually tapering at apex (often bent or twisted) and cell capitates, nearly rounded, forming dark blue green thin masses, or scattered.

**Distribution**
North America, Asia

*Oscillatoria formosa* Bory 1892 Fig. 7

Cell 4-6 x 2.5 - 5.7µ sometime slightly granulate near cross wall clear blue- green; trichome are slightly striate or tapered at cross walls, apically tapering bluntly rounded end of cell or it may neither capitates nor calyptrate with dark blue to green masses.

Fig. 8. *Lyngbya martensian*.

**Distribution**
Caribbean island, South America, Antarctic and sub Antarctic island and Asia.

*Lyngbya*
Filaments unbranched, cylindrical, straight, curved or twisted, solitary or densely intertwined into floccose masses, or epiphytes; sheath firm generally hyaline but sometime brownish or yellowish with age, often lamelllose, usually extending beyond the trichomes; trichomes solitary, obtuse or sometime apically attenuate, sometime apically attenuate, sometime constricted at cross walls, cell contents homogeneous, granulose, variously colored.

**Key to species**
Sheath firm....................*Lyngbya Kashyaphii*
Filment 6-10 µin diameter; apical cell rotund; sheath thick........*Lyngbya Martensian*

*Lyngbya martensian* Meneghini 1892 Fig. 8 Plant greatly knotted and interwoven to form an extended, dark blue or green mass; trichome 10-20.9µ in diameter, not narrowing near the apices which are
generally convex; cell about \( \frac{1}{4} \) as long as broad, 2.6-2.9µ length, not constricted at or near cross wall, contents homogeneous excluding for 1 or 2 conspicuous granule near cross wall; sheath firm, fairly broad (1.5-2µ); filament mostly 6-10 µ (upto 14µ) in diameter.

**Conclusion**
The taxonomic studies of family Oscillatoriae from Tehsil Landikotal, District Khyber, Khyber Pakhtunkhwa, Pakistan was carried out to find out the diversity of family Oscillatoriae which contains 2 Genera and 9 Species viz. *Oscillatoria terebriformis*, *Oscillatoria tenuis*, *Oscillatoria splendid*, *Oscillatoria Formosa*, *Oscillatoria prolifica*, *Oscillatoria amoena*, *Oscillatoria saneta*, *Lyngbya kashyapii* and *lyngbya martensian*. Keys at generic and specie level were presented. Based on our findings it is concluded that this area need more research to determine the diatoms flora.

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**Author’s contribution**
HK, MI & N conducted the experiment and MK, ZU & FW carried out the statistical analysis and HU& RK designed the experiment and SIU & MF structured and wrote the manuscript.

**Conflict of interest**
The authors declare that they have no conflict of interest.

**References**


