

Biodiversity of Oscillatoria (Nostophyceae, Cyanophyta) from Lakes and Ponds of Sindh.

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Abstract: The 32 taxa of phytoplanktonic algal species belonging genus *Oscillatoria* Vaucher have been collected from various fresh water habitats from the numerous districts of Sindh (Dadu, Badin, Sanghar, Keenjhar and Chilla fish hatchery, Thatta).

Key words: Biodiversity; *Oscillatoria* and Sindh.

INTRODUCTION

Oscillatoria Vaucher is a commonly occurring cyanophycean alga *Oscillatoriaceae*, *Nostocales* and *Nostophyceae*,^[1].

A few studies of this genus have been made from Pakistan for taxonomic point of view^[2,3,4,5,6,7,8,9] as well as from the point of view of its occurrence^[10,11,12,23,14,15,16,17] but no detailed taxonomic investigation has been made so far.

A broad collection of Bluegreen algae (*Cyanophyceae*) was made from various districts of province Sindh. The present work was concerned with the diversity of *Oscillatoria* in different districts of Sindh, and seasonal variation in different aquatic ecosystems.

MATERIAL AND METHODS

The qualitative phytoplanktonic samples were collected from various fresh water habitats from the districts of Sindh, Dadu, Badin, Sanghar, Keenjhar Lake and fish hatchery Chilla Thatta during 2000-2005. All the samples were collected using plankton net (mesh size 25 μ m). All the samples were pooled in one sample and were preserved in 4 % formalin (Merck KG aA, 64271 Darmstadt, Germany). All the samples were observed completely under a microscope, (M 3300 D Swift Instrument International S.A. microscope). The specimens were taxonomically determined with the help of standard literature^[18,19,20,21,22,23,24].

Oscillatoria Vaucher: Trichomes single and forming a flat or spongy free swimming thallus, sheath absent, rarely more or less very delicate sheath, motile, mostly by creeping movement causing rotation on the longitudinal axis, ends of trichomes distinctly marked,

pointed bent like a sickle or coiled more or less like a screw, harmogones formed by the distinction of the trichome. It is represented by the following species in ponds and lakes of the Sindh, which may be distinguished as follows.

1. *Oscillatoria amoena* (Kutz)

Gomont:^[19,20,22,23,24,25,26,27].

General Characters: Thallus more or less bluegreen, trichomes straight, slightly curved, constricted at the septa, end gradually attenuated, cells 2.5-4.2 μ m long, 2.5-5 μ m broad, dull bluegreen cells, septa plane, end cell capitate, broadly conical with calyptra and necridia present, (fig.1).

Geographical Distribution: Myanmar, India and Pakistan.

Localities: Keenjhar Lake, Manchar Lake and Bakar Lake.

Remarks: It has been reported for the first time from Sindh, It was collected from Thatta, Dadu and Sanghar Lakes in the months of April to June 2002-2005, in free floating condition.

2. *Oscillatoria agardhii* Var. *Acquicressa* (Elenk): ^[19,22,28].

General Characters: Trichomes straight or some what curved, not constricted at the cross walls, 4-6 μ m (4.5 μ m) broad, free swimming, cells mostly shorter than long, quadrate 2.5-4 μ m (3-6 μ m) long, end cells concave, without Calyptra. Planktonic in fresh water pools, (fig. 2).

Geographical Distribution: India: Calcutta Biswas^[29], Biswas^[30] and Pakistan.

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Localities: Fish hatchery pond at Chillia, Phoosna Lake and Keenjhar Lake.

Remarks: Collection was made in different months of 2002 and 2005, such as March, April, October and November. Its abundant growth occurred during October as compared to the other month of the year because in this month temperature and light intensity remain favorable for the growth of blue green algae.

3. *Oscillatoria aanguina* (Bory) Gomont:^[19,20,22,31,32,33,34,35]

General Characters: Plant mass dark blue green, trichome straight having convex and expended at the end cells. 5.6-7.5 μm broad 1.5-2.5 μm long, granulated, (fig. 3).

Geographical Distribution: India: Andhra^[36], Orissa^[37], Bihar^[38], Sri Lanka^[39] and Pakistan.

Locality: Fish hatchery pond at Chillia district: Thatta.

Remarks: It was collected from fish hatchery pond during March 2001-2003. It occurred in free floating state being mixed with Spirogyra spp. due to low temperature and un favorable condition it was found in low quantity.

4. *Oscillatoria amphibia* Agardh ex Gomont:^[18,20, 23]

General Characters: Thallus deep green, plant mass thin trichomes 3-4.5 μm in diameter, straight or curved fragile, not constricted at joints, curved gradually at the ends, apex of the trichome neither tapering nor capitate, apical cells rounded above, cells 4.5-7.5 μm in length, (fig. 4).

Geographical Distribution: India: Calcutta salt lakes Biswas^[32], Berhampur, Burdwan, Farid Pur, Bruhal and Biswas^[40] and Pakistan.

Locality: Keenjhar Lake and Bakar Lake.

Remarks: Collection was made from surface water during summer season of 2002, where it occurred in large quantity, apparently formed in summer mostly at surface water.

5. *Oscillatoria acuminata* Gomont:^[19,21,22,23,41]

General Character: Thallus blue green more or less straight, not constricted at the cross walls, 3-5 μm (6 μm) broad, at the end briefly tapering, sharply pointed, bent cells longer than broad, 5.5-8 μm (9 μm) long

some time granulated at the cross walls, (fig. 5).

Geographical Distribution: Myanmar: India; Calcutta Biswas^[29,42] Pakistan.

Localities: Fish ponds of Chillia district: thatta, Manchar Lake, Haleji Lake and Phoosna Lake.

Remakes: The collection work was done from different Lakes of Sindh, during 2000 only once it could be collected during autumn but was usually found in summer and winter season. It occurred in free floating, its variability of habitat preference. Its dominant growth was observed in summer season. Some morphological changes were found in different lakes.

6. *Oscillatoria angusta* Koppe:^[22,23,24,43]

General Characters: Trichomes colorless, 1.2-1.4 μm broad, not constricted at the cross-walls, straight, end cells rounded, cells 3.5-4 μm long, without vacuoles, (fig. 6).

Geographical Distribution: India: Madras and Pakistan.

Locality: Manchar Lake District Dadu.

Remarks: Collection was carried out from Manchar Lake during summer season of 2001-2002. It occurred in free floating state, due to favorable environmental condition it was found in large quantity.

7. *Oscillatoria calcuttensis* Biswas:^[22,23,36]

General Characters: Thallus leathery brown, trichomes parallel straight, not constricted at the cross wall, 2-3 μm broad, at the ends briefly attenuated, curved or bent, cells 2-5 times as long as broad, 10-15 μm long, septa with 2-3 granules on either side, blue green, end cells conical, pointed, not capitates, (fig. 7).

Geographical Distribution: India: Madras and Pakistan.

Localities: Keenjhar Lake, Haleji Lake and Phoosna Lake.

Remarks: Collection has been made from different lakes of Sindh during April 2001. It occurred in free floating condition. The summer season appears favorable for its growth.

8. *Oscillatoria chlorina* Kutz. (After Fremy):^[4,18,19,21,22,23,24]

General Characters: Thallus very thin, yellowish green, curved or straight, slightly constricted at cross walls 3-4.5 μm long, 6 μm broad, gas vacuoles absent, cells longer than broad, cross walls not granulated, calyptra absent, (fig. 8).

Geographical Distribution: India: Assam Bruhal and Biswas^[40], Myanmar: Kamyut Skuja^[44]; Allahabad Gupta^[45]; Sri Lanka Crow^[46] and Pakistan.

Localities: Keenjhar Lake, Bakar Lake, Phoosna Lake, Haleji Lake and fish ponds of Chillia district: Thatta.

Remarks: The collection work was done from different lakes of Sindh region during 2000. It was obtained in Planktonic state: It occurred in free floating, epiphytic and epizoic condition.

9. *Oscillatoria chalybea* (Mertens) Gomont:^[18,19,20,21,22,23,24]

General Characters: Thallus dark blue green, trichome nearly straight, constricted at cross walls, attenuated at the apex end bent, living trichomes show forward and rotatory movement, 3-12 μm broad cells, 1/2-1/3 times as long as broad or nearly quadrate (4.5-5.5 μm broad), 2-8 μm long, septa not granulated, end cells obtuse not capitates, with out calyptra, gas vacuoles present, (fig. 9).

Geographical Distribution: India: Calcutta, Sri Lanka: Malaya, Biswas^[29], Andhra, Rao^[36], Orissa, Rao^[37] and Pakistan.

Localities: Fish hatchery pond at Chillia district: Thatta, Keenjhar Lake and Hamal Lake near Faridabad.

Remarks: Its collection was done from different lakes in month February, October and November 2000-2001. It occurred in different habitat such as standing water and deep water. Large growth was observed in Keenjhar Lake as compared to another water bodies due to suitable ecological condition.

10. *Oscillatoria cortiana* Meneghini ex Gomont:^[7,20,23]

General Characters: Thallus dull blue green, trichomes straight, slightly constricted at the joint, 3.5-5.5 μm broad, gradually tapering at the ends, sometimes bent, not capitate, blue green, cells as long as broad or longer or shorter than broad, 3-8 μm long, septa not granulated, end cell obtuse, without calyptra, gas vacuoles observed, (fig. 10).

Geographical Distribution: India, Bengal and Pakistan.

Locality: Manchar Lake, Keenjhar Lake and Bakar Lake.

Remarks: It was collected during the summer season of 2004 from the different lakes of Sindh. It was obtained in planktonic state. Bakar Lake appeared most suitable for its growth because environmental condition of this lake is most suitable.

11. *Oscillatoria curviceps* C.A. Agardh:^[4,18,19,20,22,23,24,25,47]

General Characters: Cells 10-17 μm broad, cells 1/3 – 1/6 as long as broad 2-5 μm long, often granulate at cross walls, trichomes generally straight terminally curved, hooked or somewhat spiral, end cell broadly rounded often with lightly thickened outer membrane, not capitate, not constricted at cross walls becoming bright or dark blue green, often steel blue (when dry) in aggregate, (fig. 11).

Geographical Distribution: India: Orissa; Sri Lanka: Gregory and Colombo Lakes Lemmermann^[39] and Pakistan.

Localities: Keenjhar Lake, Manchar Lake, Bakar Lake, Haleji Lake, Phoosna Lake and Fish hatchery ponds at district: Thatta.

Remarks: It was collected both in summer and winter season at 2003 occurring mostly in standing water, once it was also found in bloom condition mostly in free floating state. Its maximum growth was observed in Keenjhar Lake and medium growth ponds. Its minimum growth was found in month of March. It appears that high temperature is favorable condition for its growth.

12. *Oscillatoria coeruleascens* Gickhorn:^[20,21,22,23,42]

General Characters: Thallus dull blue green, trichome straight slightly constricted at the joint, 2-6 μm broad, gradually tapering at the ends, bent not capitate, blue green, cells as long as broad or long or shorter than broad, 2.5-4.5 μm long, at the ends up to 14 μm long septa not granulated, end cells obtuse without calyptra, (fig. 12).

Geographical Distribution: Sweden; India: Orissa Biswas,^[42] and Pakistan.

Localities: Phoosna Lake and Bakar Lake.

Plate number 1



1



2



3



4

15µm



5



6



7



8



9



10



11



12

Remarks: The collection has been carried out in both lakes, during the winter season 2004. This species occurred in small quantity due to un favorable temperature condition.

13. *Oscillatoria formosa* Bory ex Gomont:^[18,19,22,23,25].

General Characters: Plant mass dark blue green, trichomes 4-6 μm in diameters, straight to flexuous, usually slightly constricted at the cross walls, apex of the trichome slightly tapering and bent end cells blunt conical, nearly obtuse, not capitate without calyptra, cells nearly quadrate up to 1/2 is long as broad, 2-5 μm long septa some time granulated, cell content bright blue green, (fig. 12).

Geographical Distribution: India: Madras Fremy^[25], Cuttack Rao^[36], Myanmar, Kyauktan, Rangoon, Skuja,^[44] Allahabad Gupta,^[45] and Pakistan.

Locality: Bakar Lake.

Remarks: It was collected from eutrophic lake during summer 2004. It high growth at surface water as compared to varying depth of the lake. High temperature appears to be favorable for its growth.

14. *Oscillatoria jasorvensis* Vouk:^[22,23].

General Characters: Thallus pale blue green, straight 2.5-3 μm broad bent at the ends, not attenuated, not capitate, cells as long as broad or nearly so, end cells rounded, without Calyptra, (fig. 14).

Geographical Distribution: Myanmar: Rangoon Skuja,^[44]; India, Mumbai and Pakistan.

Localities: Hamal Lake.

Remarks: It was collected during June 2001 in high quantity. It occurred on epiphytic and epizoic condition in the water body.

15. *Oscillatoria jenesis* G. Schmid:^[18,19,22,23,25,49].

General Characters: Aggregate mass of trichome dark brown, trichomes 19.8-24.9 μm wide not constricted at the cross walls, grey brown somewhat spiraled at the ends, cells short end, walls asymmetric convex, not knobbed or thickened, no granulation at the cross walls, (fig. 15).

Geographical Distribution: India, Madras and Pakistan.

Localities: Keenjhar Lake.

Remarks: Collection has been made from eutrophic lake during May 2003. It occurred in free floating condition and also high quantity in the summer season appears favorable for its growth.

16. *Oscillatoria lemmermanii* Wolosz after. Fremy:^[21,22,23].

General Characters: Trichomes pale blue green, straight or slightly bent, constricted at the cross walls, 2-2.5 μm (3-4.5 μm) broad, cell 2-3 times as long as broad, 12-18 μm long, (fig. 16).

Geographical Distribution: Kamyut, Burma Skuja^[44] and Pakistan.

Localities: Manchar Lake and Haleji Lake.

Remarks: It was collected from two lakes of Sindh region during May 2004. It occurred in free floating state being mixed with spirogyra spp. Due to low temperature and another un favorable condition it was found in low quantity.

17. *Oscillatoria limosa* Ag. ex Gomont:^[2,4,5,6,7,18,19,20,21,22,23,24,49].

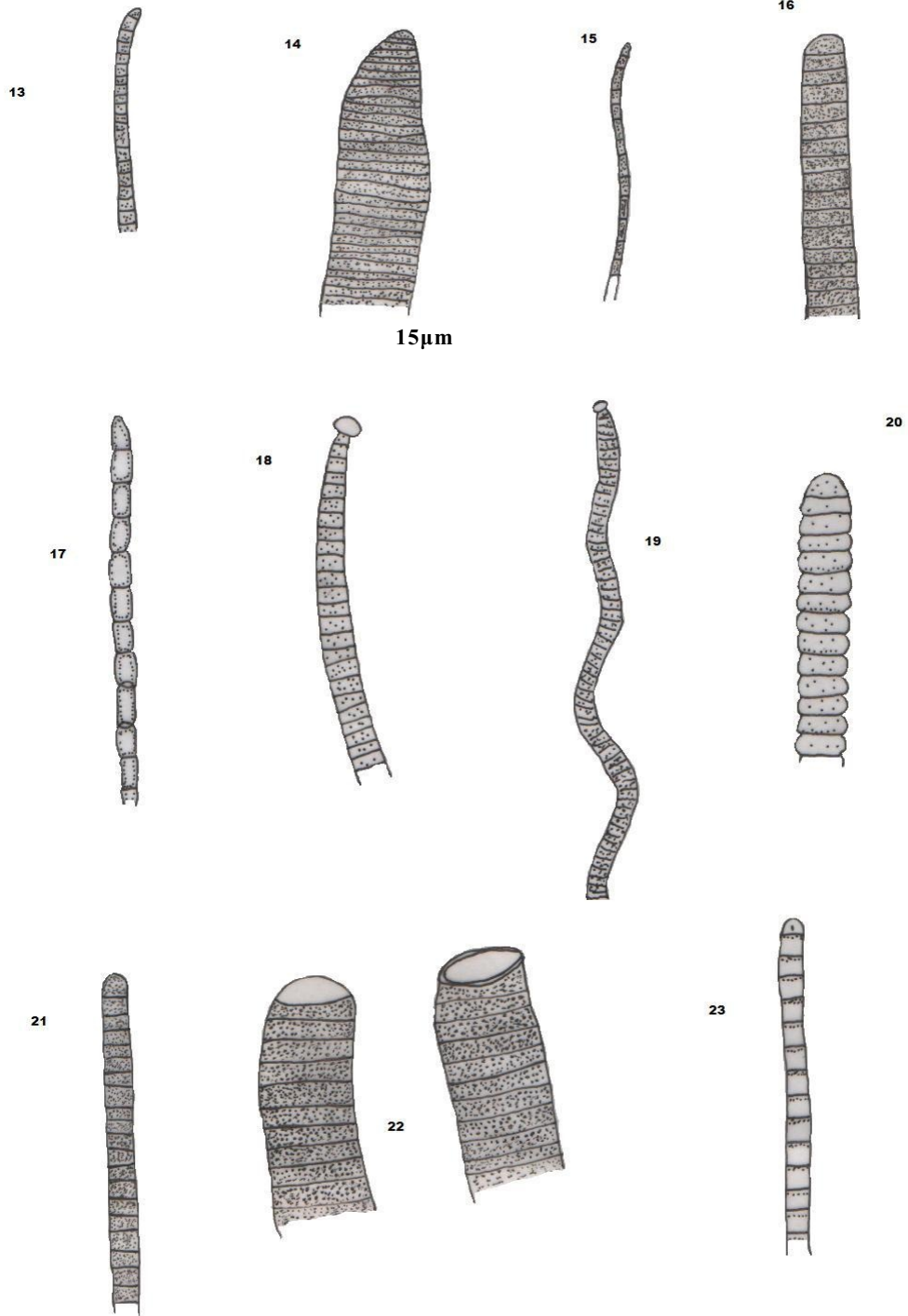
General Characters: Thallus dark blue green to brown, trichomes more or less straight 11-20 μm (15 μm) broad commonly 16 μm broad, not constricted at cross walls or joints, apex of the trichome straight, not at all or scarcely tapering, not capitate, cell 1/3 -1/6 times as long as broad, transverse walls usually granulated, cells content blue green, to brown or olive green. Apical convex with somewhat thickened outer wall, (fig. 17).

Geographical Distribution: Malaysia: Kualalampur, Malaya Biswas^[30], Myanmar: Royal Lakes, Rangoon and Tanuggyi canal, Maymyo and Myoingam Skuja^[44], Ghose^[50], India and Pakistan.

Localities: Fish hatchery pond, Chillia district: Thatta. Keenjhar Lake, Bakar Lake and Hamal Lake.

Remarks: The collection was made in different season of 2001-2002 from different localities. It occurred in free floating state in Chillia pond and different lakes of Sindh. It was found growing in summer, winter, autumn and spring seasons. During summer it showed a high growth in Keenjhar Lake but minimum growth was observed in winter season. It appears that this species can survive in different season in different rates.

Plate number 2



18. *Oscillatoria limnetica* Lemmermann:^[5,19,21,22,23,24,25]

General Characters: Thallus blue green, trichomes straight or slightly bent, constricted at the cross walls, pale blue green, 1-2 μm broad, filaments not attenuated, not capitate, cells 1.5 μm broad, 3-11 μm long, usually 2 1/2 -6 times as long as broad, (fig. 18).

Geographical Distribution: India: Madras Ganapati^[51] and Pakistan.

Localities: Manchar Lake and Hamal Lake.

Remarks: The collection was made from two different localities during April and November 2003. It occurred in slow standing water at Manchar Lake during April in limited quantity, other specimens were collected from Hamal Lake during November in large amount showing some morphological difference. It appears that Hamal Lake is favorable for its growth as compared to the Manchar Lake.

19. *Oscillatoria martini* Frey:^[5,21,22,23,27]

General Characters: Trichome single attenuated, loosely spirally coiled through its length, un constricted at cross walls, 6 μm broad, at the end short and clearly attenuated, end cells straight or slightly curved, capitate, cells 1/3 as long as broad 2-3 μm (6 μm) long, not granulated at the cross walls, end cells with flat convex distinctly thick and broad out membrane, (fig. 19).

Geographical Distribution: India: Delhi and Pakistan.

Locality: Manchar Lake, Keenjhar Lake and Bakar Lake.

Remarks: It was collected from three lakes of Sindh region during May 2003. It occurred in free floating state being mixed with spirogyra sp. Due to low temperature and another un favorable condition it was found in low quantity.

20. *Oscillatoria minnesotensis* Tilden:^[18,19,20]

General Characters: Thallus thin, dark blue green, trichome 2-5 μm broad, more or less curved, especially constricted at the joints, apex of the trichome straight, or slightly bent, neither tapering nor capitates, apical cells rotund, calyptra none, cells 2-4 μm in length transverse walls pellucid, cell contents homogenous, (fig. 20).

Geographical Distribution: Calcutta: Biswas^[29] and Pakistan.

Localities: Keenjhar Lake and Bakar Lake.

Remarks: Collection was made from two lakes during summer season 2003. Due to low temperature it occurred only in vegetative state probably it survives in winter season with low growth rate.

21. *Oscillatoria ornata* Kutz ex Gomont:^[18,19,20,21,22,23,24,52]

General Characters: Thallus dark blue green, trichomes straight, uniform in thickness, 9.0-12.6 μm broad, constricted at the cross walls, granulated, cells shorter than broad, 3-5.6 μm long, end cells convex, without calyptra, not capitate, (fig. 21).

Geographical Distribution: India, Mysore and Pakistan.

Localities: Keenjhar Lake.

Remarks: The collections were made from lentic water in the month of February, June and October 2002. It was found during summer season in the large quantity in vegetative as well as reproductive phase especially in lentic water. It also occurred in abundance in gently flowing portion of fountain in vegetative but rarely in reproductive condition. Specimens were also collected during winter season but in low quantity. It appeared that temperature plays the most important role in the growth of this alga.

22. *Oscillatoria okeni* Agardh ex Gomont:^[5,18,19,20,21,22,23,24,28,53]

General Characters: Plant mass dark blue green, trichome 5.5-9 μm (7.5 μm) in diameter, straight, distinctly constricted at joints, apical cell somewhat pointed, not capitate, Calyptra none, cells 3-4.5 μm in length, apical cell somewhat quadrate up to 8 μm in length, cell content finely granular. Probably cosmopolitan, known from Europe, America and Africa, (fig. 22).

Geographical Distribution: India: Orissa Rao^[36], Banaras Rao^[37], Delhi Rao^[38] and Pakistan.

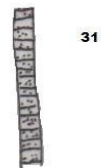
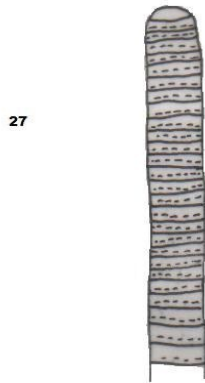
Localities: Bakar Lake, Haleji Lake, Hamal Lake and Keenjhar Lake.

Remarks: It has been collected during June 2002. It occurred in small quantity in standing water under Noori spot and Helaya spot at Keenjhar Lake. It was also collected in high quantity from Haleji and Hamal Lake during October 2002, because temperature and light intensity were high and favorable for its growth.

Plate number 3



15µm



1. Cells smaller in length than breath	2
1. Cells longer in length than breath	3
2. Trichomes constricted	4
2. Trichomes unconstricted	5
3. Trichomes yellow colored	6
3. Trichomes blue-green	7
4. Trichomes straight	8
4. Trichomes spirally coiled not capitate	9
5. Trichomes straight	10
5. Trichomes bent or spirally coiled	11
6. Trichomes attenuated	<i>O. subliformis</i>
6. Trichomes unconstricted	12
7. Apices of trichomes spirally coiled	13
7. Apices not so coiled, only bent	14
8. Trichomes constricted	<i>O. sancta</i>
8. Trichomes unconstricted	15
9. Trichomes slightly constricted	<i>O. cortiana</i>
9. Trichomes constricted at cross wall	<i>O. ornata</i>
10. End cell with thickened outer walls	<i>O. limosa</i>
10. End cell capitate	<i>O. perornata</i>
11. End cell rounded	<i>O. curviceps</i>
11. End cell slightly capitate	<i>O. prinnceps</i>
12. Trichomes less than 3µm broad	<i>O. puesdogennata</i>
12. Trichomes more than 3µm broad	16
13. Trichomes capitate	17
13. Trichomes not capitate	18
14. Apices distinctly attenuated	19
14. Apices not distinctly attenuated	20
15. Trichomes up to 5-6µm broad	<i>O. subbrevis</i>
15. Trichomes more than 4µm broad	<i>O. agardhii</i>
16. Cells up to 2µm long	<i>O. formosa</i>
16. Cells more than 2µm long	<i>O. chlorina</i>
17. Cells as long broad	<i>O. martina</i>
17. Cells longer than broad	<i>O. willei</i>
18. Cells constricted at cross walls	21
18. Cells constricted at cross- walls	<i>O. minnesotensis</i>
19. End cells capitate	<i>O. amoena</i>
19. End cells not capitate	22
20. Trichomes constricted at cross-wall	23
20. Trichomes not so constricted	24
21. Septa granulated up to 2.2-3µm many granules	<i>O. lemmermanii</i>
21. Septa granulated up to 2 or granules on septa	<i>O. jensis</i>
22. Trichomes more than 8µm broad	<i>O. chalybea</i>
22. Trichomes less than 5µm broad	25
23. Trichomes less than 5 µm broad	<i>O. jasorvensis</i>
23. Trichomes more than 5µm broad	26
24. Cells as long as broad	<i>O. okeni</i>
24. Cells longer	27
25. Trichomes up to 3-4µm broad	<i>O. amphibia</i>
25. Trichomes 5 to 8µm broad	<i>O. acuminata</i>
26. Trichomes constricted at cross-walls	28
26 Trichomes not constricted at cross- walls.....	29
27. Trichomes 4-5µm broad	<i>O. tenuis</i>
27. Trichomes 5µm broad	<i>O. anguina</i>
28. Trichomes up to 1-1.5µm broad	<i>O. angusta</i>

28. Trichomes up to 1-2µm broad.....	<i>O. limnetica</i>
29. Trichomes more than 5µm broad	30
29. Trichomes up to 5µm broad	31
30. Trichomes 4-6 µm broad	<i>O. coerulescens</i>
30. Trichomes 4-6µm broad	<i>O. late-virens</i>
31. Trichomes 3-4µm broad	<i>O. animalis</i>
31. Trichomes 2-3µm broad	<i>O. calcuttensis</i>

23. *Oscillatoria princeps* Vaucher ex Gomont:^[5,18,19,20,21,22,23,24]

General Characters: Thallus blue green, trichomes straight, rigid and fragile, un constricted at cross walls, cross walls not granulated, 30-35 µm broad, cells short protoplasm granular, apices straight, apical cell slightly convex, calyptra absent, (fig. 23).

Geographical Distribution: Myanmar, India, Sri Lanka and Pakistan.

Localities: Bakar Lake, Haleji Lake and fish hatchery ponds at Chillia district: Thatta.

Remarks: The collection was made from fish hatchery pond at Chillia. Specimens were obtained both in summer and winter season of 2003. In summer it occurred in vegetative and reproductive stage but in winter it was found in small quantity and only in vegetative condition. It appears that winter season is not favorable for its growth but in survive in this season only in vegetative state.

24. *Oscillatoria pseudogeminata* G. Schmid:^[22,23,48]

General Characters: Trichomes 2-2.6 µm in diameter, tenuous, straight or somewhat curved, not constricted at the cross walls, not attenuated at the apices, obtusely rounded or truncate, not capitate, calyptra none, cells 1.3-2.5 µm in length, cell wall thick, distinct with one large granule situated at the center of the partition walls either side, cell contents finally uniformly granular, blue green, (fig. 24).

Geographical Distribution: India: Banaras Rao^[27], Bihar Rao^[38] Assam Biswas^[42], Myanmar; Rangoon Skuja^[44] and Pakistan.

Localities: Manchar Lake, Keenjhar Lake, Hamal Lake and Haleji Lake.

Remarks: The collection has been made during winter and spring season of 2003. Specimens were collected from different lakes of Sindh. It dense growth occurred

in standing water during spring season because temperature was relatively high.

25. *Oscillatoria subbrevis* Schmid:^[19,48,55]

General Characters: Filaments solitary, not occurring in the plant mass, straight and tapering towards the apices, apical cell rounded, not capitate and without calyptra, cell short 5-6 µm in diameter, 1-2 µm long, with frequent necridia in evidence cross walls not granular, cell content, pale grey green, (fig. 25).

Geographical Distribution: Worldwide Myanmar; India: Mumbai, Madras and Pakistan: Lahore Masud-ul-Hasan^[3].

Localities: Haleji Lake, Manchar Lake, Keenjhar Lake, Hamal Lake and Bakar Lake.

Remarks: The collections have been made from different lakes of Sindh. Large collection was made during summer season of 2002, from Keenjhar Lake, but few collections were also made from Hamal Lake during winter season of 2003. Species was found in different habitat, sometimes it occurred as a soil banding alga, as a component of algal bloom and in planktonic state. It appears that type of locality, temperature, light intensity and other factors may affect it form, kind distribution and growth.

26. *Oscillatoria sancta* (Kutz) Gomont:^[4,18,19,20,21,22,23,24]

General Characters: Thallus dark blue, trichomes straight, constricted at the cross walls, end broadly attenuated, cell 1.5-5.6 µm long, 8-13 µm broad, granulated at the cross walls, end cells flattened, hemispherical, slightly capitate, with a thickened membrane, (fig. 26).

Geographical Distribution: Myanmar: Rangoon Skuja^[44], India: Cuttack Rao^[36], Banaras Rao^[37], Mumbai Schmid^[48] and Pakistan.

Localities: Keenjhar Lake: Noori spot and Manchar Lake: Ural Wah.

Remarks: It was collected from two spot in Keenjhar Lake and Manchar Lake during summer season of 2002. It occurred in free floating state in large quantity, showing some morphological difference in specimens collected from different habitat.

27. *Oscillatoria willei* Gardner. em. Drouet:^[22,23,28,55]

General Characters: Trichomes pale blue green, bent at the ends or screw like, 2.4-3.6 μm (4.5 μm) broad, un constricted at the cross walls, ends not attenuated, not capitate at the cross walls, end cells rounded without a thickened membrane, (fig. 27).

Geographical Distribution: India: Orissa Rao^[36], UP Rao^[37] and Pakistan.

Locality: Fish ponds of Chillia district: Thatta.

Remarks: The specimens were collected from fish ponds of Chillia dist: Thatta, during summer of 2000-2002 in free floating state. It was found mixed with other blue green algae. The summer season appears to be suitable for its growth, due to rapid reproduction it occurred in massive quantity.

28. *Oscillatoria perornata* Skuja:^[23,44]

General Characters: Thallus blue green, trichomes straight, 8- 10 μm broad, without constriction at the cross- walls, cell much shorter than broad, 1.6- 2 μm long, contents granular, end cell broadly rounded forming a cap with a slightly thickened outer wall, (fig. 28).

Geographical Distribution: Sweden: India: Burma: Skuja^[44] and Pakistan.

Localities: Phoosna Lake and Bakar Lake

Remarks: The collection work has been carried out in both lakes, during the winter season 2004. This species occurred in small quantity due to the un favorable temperature condition.

29. *Oscillatoria animalis* Ag. ex Gomont:^[18,19,21,22,23]

General Characters: Thallus dark blue green, trichomes straight, not constricted at the crosswall, briefly attenuated at the ends and slightly bent, 3-4 μm broad, blue green, cells mostly up to 1- 2 μm ,as long as broad, seldom longer, 1.6-5 μm long, not granulated at the cross wall, not capitate, (fig. 29).

Geographical Distribution: Calcutta Biswas^[29] and Pakistan.

Localities: Keenjhar Lake and Bakar Lake.

Remarks: Collection was made from two lakes during summer season 2003, due to low temperature it occurs only in vegetative state probably it survives in winter season.

30. *Oscillatoria sublifformis* Kutz .ex Gomont:^[18, 22,23,25]

General characters: Trichomes yellow green, very long flexuous, and bent, not constricted at the cross walls, 4.7- 6.5 μm broad, at the ends gradually attenuated and bent, cells nearly quadrate, 4.7- 6.5 μm long, at the ends up to 10 μm long, obtuse, not capitate, calyptra absent, (fig. 30).

Geographical Distribution: Madras: India and Pakistan.

Localities: Haleji Lake and fish hatchery pond at Chillia.

Remarks: It was collected during the winter season of 2003. It occurred in different habitat such as standing water and deep water. Haleji Lake appeared most suitable for its growth because environment condition of this lake is most suitable.

31. *Oscillatoria laete-virens*. (Crouan) Gomont:^[19, 22,23,25,54,56]

General Characters: Thallus thin, membranous, green, trichome yellowish green, straight, fragile, slightly constricted at the cross wall, 3-5 μm broad, apices attenuated, undulate or bent, cells nearly as long as broad, 2.5-5 μm long, some time granulated at the cross walls, end cells not capitate more or less obtuse or conical, without calyptra, (fig. 31).

Geographical Distribution: Rangoon Skuja^[44] and Pakistan.

Localities: Manchar Lake and Hamal Lake.

Remarks: Collection was made from Manchar and Hamal Lake during 2005. This species occurred in low quantity in Manchar Lake due to un favorable environment factor.

32. *Oscillatoria tenuis* Gomont:^[18,19,21,22]

General Characters: Thallus thin blue green or olive green, slimy, trichome straight, fragile straightly constricted at the cross walls, 4- 10 μm broad, blue green, sometimes bent at the ends, not attenuated at the

apices, not capitate, cell up to 1/3 as long as broad, 2.6 µm long, at the septa mostly granulated, end cell more or less hemispherical with thick end outer membrane.

Geographical Distribution: India: Calcutta and Pakistan.

Localities: Keenjhar Lake and fish hatchery pond Chillia district: Thatta, Sindh.

Remarks: Collection has been made from Keenjhar Lake and fish hatchery pond at Chillia during 2002. It occurs in free floating state.

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