Five hundred seventeen samples of Oscillatoriales were collected from different localities of nine districts viz. Allahabad, Varanasi, Jaunpur, Pratapgarh, Mirzapur, Chitrakoot, Raebareli, Fatehpur and Kaushambi of Uttar Pradesh (India) during 2003-2013. On the basis of frequent occurrence and enough growth, ten species of Oscillatoria viz. *O. anguina*, *O. limosa*, *O. tenuis*, *O. subbrevis*, *O. nigro-viridis*, *O. sancta*, *O. margaratifera*, *O. princeps*, *O. vizagapatensis* and *O. proboscidea* were selected. A key to all the ten species and their morphological description with line diagrams and photographs are given. A brief account of cultural and seasonal observations is also included. The most common five species found in Uttar Pradesh (India) include: *O. sancta*, *O. limosa*, *O. subbrevis*, *O. vizagapatensis* and *O. nigro-viridis*.

**Keywords:** Cultural observations, Frequent occurrence, Oscillatoria

Morpho-taxonomy of cyanobacteria has always been on the melting pot. We have been identifying species of Oscillatoriales on the basis of colour, sheath, cell measurement, constriction, granulation and end cell. Most of the classical descriptions were created long back usually on the basis of a single collection. Many workers have identified varieties and forma and designated as: variety major forma minor or variety minor and forma major. As in *Anabaena iyengarii*, based on minor or major range of magnification, three varieties and two forma have been described (See Desikachary, 1959, p. 406-409). In *Gloeotrichia raciborskii*, in the same way, five varieties have been identified (See Desikachary, 1959, p. 563-564). In this way, the range of measurement was extrapolated on either side of the range. The scientists did not consider about their ecological niches, and terrestrial species were recorded as aquatic, bloom forming, benthic, metaphytic or periphytic. Fresh water species have been identified as marine, thermal, cryophytes, lithophytes, subaerial or endophytic in occurrence. All such amalgamation made the morpho-taxonomy most confusing. Now the so called polyphasic approach is the only alternative to identify a cyanobacterium. In polyphasic approach the most reliable is DNA sequencing. But every time you collect the specimen from the nature and going for DNA sequencings may not be an easy task and the facility may not be available with every worker.

For day to day use, we identify the organisms on the basis of morphological and ecological features. Morpho-taxonomic description of each taxon is important, because in nature different species have different requirements and have specific behavior towards their source habitat. In culture, we give optimum nutrients and physical conditions but the organism undergoes stress and leads to such physiological and morphological adaptations which are rarely seen in nature. Morpho-taxonomy is helpful for routine identification or for biodiversity programmes, however if one finds difficulty or involved in biotechnological exploitation one has to go certainly for the polyphasic approach upto the gene level. Keeping this in view, we attempted to segregate our known species on the basis of some practical features of morphology and ecology etc.

There are many taxonomic accounts on Oscillatoriales of India including Anand (1989), Tiwari (1975), Adhikary (2007) and many other floristic papers. However, exclusive details on Oscillatoriales have been given by Komarek and Anagnostidis (2005) and McGregor (2007). Most Indian accounts...
are based on criteria of classical description and classification. Komarek and Anagnostidis (2005) reinvestigated the taxa and several new genera have been segregated and they are Geitlerinema, Pseudanabaena, Leptolyngbya, Tychonema, Jaaginema, Komvophoron, Limnothrix, Planktothrix, Planktothricoides, Phormidium and Trichodesmium etc. The new concept of Oscillatoria as defined by Komarek (2005) includes the following features: trichome straight or bent, without distinct sheath, gliding movement present; cells short discoid; tips are usually characteristic; reproduce by hormogonia.

The present communication is to distinguish different species of Oscillatoria clearly on the basis of morphological features. We found that ten taxa that we are reporting here can be clearly identified on the basis of measurement, terminal tip and cell features, as also indicated in key of the species. It appears that there is some overlapping in measurements, but it is supported by other features like constriction, colour and tip characteristics. Presence of constrictions at the cross walls is quite supportive in identification. However, formation of characteristic tips like attenuation, calyptras or thickening may not be seen all the time in a population or present only in certain trichomes due to fragmentation of trichomes or in young hormogonia.

MATERIALS AND METHODS

While surveying the taxa of Oscillatoriales from different localities and habitat of Uttar Pradesh (India) during last one decade (2003-2013) total 517 samples were collected. We found 30 species of Oscillatoria out of which some were rare and therefore, we selected ten species which were found atleast twenty times in different collections and in sufficient quantity. Various districts of Uttar Pradesh (India) included Allahabad, Varanasi, Jaunpur, Pratapgarh, Mirzapur, Chitrakoot, Raebareli, Fatehpur and Kaushambi. The collections were made once in a year in different localities of each district of Uttar Pradesh subsequently representing the different month and year to cover all the months. The aim was to cover all the localities of each district during all the months in duration of one decade (2003-2013). The morphological observations were made under Leica DMLB trinocular microscope and photomicrographs were taken with the help of Leica DC 300. The material brought from natural habitat was first grown in sterilized petridishes and BG-11 medium (Stanier et al. 1971) was used as enrichment cultures for observations. Unispecies cultures were maintained in agar culture tubes, liquid culture tubes and flasks and also in soil water cultures. (In a culture tube, for soil-water cultures: first a pinch of calcium carbonate, then garden soil upto 1.5 inches from bottom was added and then filled with tap water upto more than a half of culture tube, then steamed in autoclave for one hour consecutively for three days; the organism was inoculated after one day settlement, and maintained in culture room).

OBSERVATION

Growth in culture: Cultures were grown in BG-11 medium on solid agar plates as well as in liquid cultures. Broader species of Oscillatoria formed radiating, fibrous and anastomosing growth patterns of filaments in solid medium and many of them grew penetrating the agar substratum. Narrower species formed dense bright coloured expanded mass. In liquid cultures, narrower species formed mucilaginous and membranous growth attached to glass wall or on the surface of medium. All forms growing in culture appeared bright coloured but later as nutrients depleted they became yellow-brown. When grown in nitrogen rich medium (double concentration of NO₃ in medium) they were highly granulated and when grown in nitrogen deficient medium (half of NO₃ dose) they produced yellow-green filaments depleted with granules and often produced sheath around trichome and making them look like species of Lyngbya.

Perennation: When dried samples of Oscillatoria collected from natural habitat were grown as enrichment culture narrower forms revived and soon they were dominated by other
Plate 1: Figures 1-10 Oscillatoria Vaucher
8: O. limosa 9: O. maragaritifera 10: O. princeps
Plate 2: Figures 11-24 Oscillatoria Vaucher

Plate 3: Figures 25-34 Oscillatoria Vaucher
members of Oscillatoriaceae which were too narrow (less than 4 µm) in diameter. However, dried growth of unispecies cultures in liquid medium or agar medium did not revive at all. But those grown in soil-water cultures did revive even after one year of stored shelf life.

**Taxa of Oscillatoria Vaucher:** On the basis of classical description, a total of 128 species, 80 variety and forma of Oscillatoria were recorded from all habitats of India (Tiwari et al. 2001). When the records were scrutinized in the light of Komarek and Anagnostidis (2005) and McGregor (2007) we found that only 30 species are really Oscillatoria and the rest had been either transferred to other genera (as mentioned in introduction) or considered as doubtful or naked names (*nomen nudum*; where only new names have been given but not details; Vashistha, 1968).

As for as thirty taxa that could be recognized as valid species of Oscillatoria as recorded from India include *O. anguina*, *O. annae*, *O. bharadwajae*, *O. bonnemaisonii*, *O. chilkensis*, *O. corakiana*, *O. curviceps*, *O. fracta*, *O. jenensis*, *O. koettlitzi*, *O. limosa*, *O. lutea*, *O. maharashtrensis*, *O. margaritifera*, *O. miniata*, *O. mitrae*, *O. nigro-viridis*, *O. obtusa*, *O. ornata*, *O. perornata*, *O. princeps*, *O. proboscidea*, *O. rupicola*, *O. sancta*, *O. simplissima*, *O. subbrevis*, *O. subproboscidea*, *O. tenuis*, *O. vizagapatensis* and *O. yamadae*.

**Seasonal distribution:** In general, members of Oscillatoria grow in all types of fresh-water and polluted water bodies. Oscillatoria occur abundantly during rains wherever, there is water logging for more than 15 days, it starts growing and as water recedes or evaporates it may form bright blue-green expanded stratum on moist soil. Many species are common in rice-fields. In rains it shows luxuriant growth in all types of places including building walls, tree trunks, water outlets, ponds, puddles, ditches and other small or large water bodies. In winters it remains in sewage drains, water channels and other water bodies. During winter rains Oscillatoria may appear for a short while, wherever water is retained for sometime. In summer season most of the habitats are dried and Oscillatoria can be seen only in perennial drains, channels or water reservoirs or other shady places with limited growth and appearance. Repeated collections of the ten species reported in the present investigation indicated the following trend of their occurrence in decreasing order:

*O. sancta*, *O. limosa*, *O. subbrevis*, *O. vizagapatensis*, *O. nigro-viridis*, *O. tenuis*, *O. princeps*, *O. margaritifera*, *O. anguina*, *O. proboscidea*.

**OSCILLATORIA VAUCHER**

Trichomes isopolar, without sheath, straight or slightly irregularly undulating, cylindrical sometimes screw like coiled at ends, mostly present in mats rarely solitary, 4-50µm wide. Cells are always shorter than wide and disc like. Cells are blue-green, olive or almost blackish, yellow-green or greenish-blue in colour. Sheath usually absent, although they may occur under suboptimal conditions. Trichomes exhibit gliding motility by left or right handed rotations, rates of movement range from 1 to 11µm/s. Division occur in a rapid sequence transversely to the trichomes axis. Trichomes are disintegrated into short motile hormogonia and separate with the help of necridic cells.

**Morpho-taxonomic characteristics:** The following parameters have been used as characteristic features for distinguishing different species:

1. Fresh water or marine.
2. Benthic, sub-aerophytic, terrestrial, aquatic, periphytic or metaphytic.
3. Colour of mats: reddish, greenish, black, olive-green or blue-green.
4. Trichome straight, arcuated, pale blue-green, dark blue-green, brownish or violet coloured.
5. Trichome ends are cylindrical, narrowed, bent or coiled.
6. Cell diameter, constricted or not constricted at the crosswalls, intensity of pseudo-vacuoles and granulations.
7. End cells with or without calyptras.

**Key to the species included in the present study:**

1. Trichome upto 10µm wide.........................2
2. Trichome more than 10µm wide..............5
2. End cells capitate, distinctly attenuated with thickened outer wall.......O. anguina
3. End cells not capitate, not attenuated without thickened outer wall.........O. nigro-viridis
3. Cells quadratic, 4-8µm long...............O. tenuis
3. Cells not quadratic..........................4
4. Trichome ends straight, but not narrowed...............O. subbrevis
4. Trichome 7-11µm wide and constricted ....O. nigro-viridis
5. End cells with calyptra......................6
6. Trichome less than 12µm broad, never constricted at cross wall......O. vizagapatensis
7. Trichome 10-22µm wide...O. sancta
8. Trichome 17-29µm wide....O. margaratifera
8. Trichome up to 20µm (-22µm) wide, end-cells with slightly thickened outer wall.................O. limosa
9. Trichome 20-60µm wide, ends of trichome cylindrical, not narrow........O. princeps
9. Trichome 12-15µm broad with distinctly attenuated at apex...........O. proboscidea
9. Trichome 9-22µm broad, end of trichome straight or slightly arcuate.......O. limosa

1. **O. anguina (Bory) Gomont**
   (Pl. 1, Fig. 1; Pl. 3, Fig. 34)
   Geitler, 1932, *Kryptogamenflora*, P. 948, Fig. 599 b.
   Desikachary, 1959, *Cyanophyta*, P. 210, Pl. 38, Fig. 11.
   Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 592, Figs. 885 a, b, c, d, e, f, g.

**Thallus:** Mucilaginous, thin, dark blue-green.

**Trichome:** Bright blue-green, 6-8µm broad, straight, at the ends distinctly attenuated and bent.

**Cell:** Discoid, 6-8µm broad, 1.3-2.6µm long, apical cell capitate, with slightly thickened membrane.

**Cultural Study:** Growth on agar plates appear as thin stratum on the surface as well as trichomes may penetrate inside the agar medium. In liquid medium trichomes creep on the wall of flask.

**Previous record:** Paddy field soils, Karjat, Maharashtra and from paddy fields, Aduturai, Madras, Desikachary, 1959; Allahabad, Uttar Pradesh, Tiwari, 1975.

**Habitat and Occurrence:** It was found growing in irrigation channels mixed with other species of Oscillatoria and other algae; Allahabad, Jaunpur, Mirzapur and Kaushambi.

2. **O. tenuis Ag. ex Gomont**
   (Pl. 1, Fig. 2; Pl. 2, Figs. 23, 24)
   Geitler, 1932, *Kryptogamenflora*, P. 959, Fig. 611 f, g.
   Desikachary, *Cyanophyta*, 1959, P. 222, Pl. 42, Fig. 15.
   Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 587, Figs. 878 a, b, c, d.
   McGregor, *Australian biological Resources Study*, 2007, P.79, Pl.13 e, f; Fig.16 d.

**Thallus:** Thin, blue-green.

**Trichome:** Free, straight, 6-11µm broad, indistinctly constricted at the cross walls.

**Cell:** Quadratic, 6-11µm broad, 2-3µm long, apical cell with broadly rounded apex without thickened outer membrane.

**Cultural Study:** Growth on agar plate appears as anastomosing wiry growth of long filaments on the surface as well as inside the agar medium. In liquid medium flask growth is always attached to the bottom and side walls of flask.
**Previous record:** From paddy field soils, Nagpur, Maharashtra and Mahabalipuram, Madras Desikachary, 1959; Allahabad, Uttar Pradesh; Tiwari, 1975.

**Habitat and Occurrence:** It was growing on cemented wall of buildings or water tanks where water leaks and also in ponds and ditches; Varanasi, Pratapgarh, Raebareli, and Chitrakoot.

3. *O. subbrevis* Schmidle

(Pl. 1, Fig. 3; Pl. 3, Fig. 33)

Geitler, 1932. *Kryptogamenflora*, 949, Fig. 601 b.

Desikachary, *Cyanophyta*, 1959, P. 207, Pl. 37, Fig. 2 & Pl. 40, Fig. 1.

Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 587, Fig. 877.

McGregor, *Australian biological Resources Study*, 2007, P. 79, Figs. 15 g, 16 c.

**Thallus:** Thin, olive-green.

**Trichome:** Free, 5-8μm broad, nearly straight, not attenuated at the apex.

**Cell:** Short, 1/3-1/6 as long as broad, 1-2μm long, apical cell rounded, calyptra absent.

**Cultural Study:** Growth in liquid medium shows solitary trichomes attached to the bottom and side wall of flask. On agar plates trichomes creep and form thin layer.

**Previous record:** On the moist banks of River Ravi, Panjab, Singh V.P., 1941; in temporary rainwater pools at Borivli, Bombay, Gonzalves and Joshi, 1943; from paddy field soil, Kerla, Bihar, Mysore, West Bengal, Lalaraya and Mitra, 1974; West Bengal, Roy and Keshri, 2014.

**Habitat and Occurrence:** Common on moist soils with other Osillatoriales during rains. Frequently observed in rice-fields; Allahabad, Jaunpur, Raebareli, Kaushambi and Fatehpur.

4. *O. nigro-viridis* Thwaites in Harvey

(Pl. 1, Fig. 4; Pl. 2, Figs. 15, 16, 17, 18)

Geitler, *Kryptogamenflora*, 1932, P. 942, Fig. 597 c.

Desikachary, *Cyanophyta*, 1959, P. 202, Pl. 42, Fig. 6 & Pl. 49, Fig. 2.

Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 579, Figs. 861 a, b, c, d.

**Thallus:** Expanded, blackish-green or olive-green in colour.

**Trichome:** Blue-green or olive-green in colour, usually straight rarely coiled, irregularly flexuous, cylindrical, 7-11μm broad, slightly narrow towards ends, slightly constricted at the granulated cross-walls.

**Cell:** Blue-green or grey blue-green in colour, 2-4μm long, content granular, apical cell conical to widely rounded with slightly thickened outer cell wall, calyptra present.

**Cultural Study:** Growth pattern in liquid medium shows initially attached to walls of flask which later on float freely in submerged condition containing air bubble in biomass. In solid dish filaments are irregularly spread forming thin layer over solid agar surface.

**Previous record:** Usarland rice field, Udhin, Kaushambi; Allahabad, Uttar Pradesh; Tiwari, 1975; Kumawat and Jawale, 2006; Tiwari and Chauhan, 2006.

**Habitat and Occurrence:** Frequently observed in aquatic as well as in moist soils. It grows in slow flowing channels or building walls during rains and usarland rice fields; Kaushambi, Allahabad, Chitrakoot and Pratapgarh.

5. *O. vizagapatensis* Rao, C.B.

(Pl. 1, Fig. 5; Pl. 3, Fig. 32)

Desikachary, 1959, *Cyanophyta*, P. 203, Pl. 42, Fig. 10.

Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 602, Fig. 909.

McGregor, *Australian biological Resources Study*, 2007, P. 79, Pl. 12 g, h; Fig. 16 e.
Thallus: Bright blue-green.

Trichome: Mostly straight, rarely bent, 9-12µm broad, not attenuated and constricted at the cross-walls.

Cell: Shorter, 1-3µm long with finely granulated contents, apical cell broadly rounded with slightly thickened outer wall.

Cultural Study: In liquid medium trichomes float on the surface of medium in submerged condition. On solid agar plate trichomes creep and penetrate the agar substratum.

Previous record: From enrichment culture of paddy field soils, Aduturai, Madras, Rao, 1938; Katni, Madhya Pradesh; Allahabad, Uttar Pradesh, Tiwari, 1975.

Habitat and Occurrence: Frequently observed around shores or attached to side walls of small ditches, ponds and lakes. Often mixed with other genera of Oscillatoriales found in rice fields; Varanasi, Jaunpur, Fatehpur and Raebareli.

6. O. sancta Kutzing ex Gomont
(Pl. 1, Fig. 7; Pl. 3, Figs. 29, 30, 31)

Geitler, Kryptogamenflora, 1932, P. 943, Fig. 598 c.

Desikachary, Cyanophyta, 1959, P. 203, Pl. 42, Fig. 10.

Starmach, Cyanophyta sinice, 1966, P. 332, Figs. 433, 434.

Komarek and Anagnostidis, Cyanoprokaryota, 2005, P. 594, Figs. 890.

McGregor, Australian biological Resources Study, 2007, P. 78, Pl. 12 J; 13 c, d; Fig. 16 b.

Thallus: Light brown to dark brown to blackish in later phase of growth.

Trichome: Pale-brown in colour, 13-15µm broad, cylindrical, usually straight or rarely curved, slightly constricted at the granulated cross-walls.

Cell: 13-15µm broad and 3-5µm long, discoidal in shape, apical cell hemispherical or flattened with thickened calyptral outer cell wall.

Cultural Study: Growth pattern in liquid medium shows initially trichomes attach to wall of flask and creep in upward direction but in later phase they float freely on the surface of liquid medium. Trichomes creep irregularly in all directions over solid agar surface.

Previous record: Soil, drain, marble tank of garden, Department of Botany, University of Allahabad and road side Shivrampur, Chitrakoot and Atarra, Banda; Tiwari and Chauhan, 2006; Hazarika, et al. 2001, 2002.

Habitat and Occurrence: Most common and grows all round the year in open domestic sewage drains. It forms membranous layer on the bottom and side walls of drains. It also grows mixed as metaphytes with other genera of Oscillatoriales in other water bodies; Allahabad, Jaunpur, Pratapgarh, Chitrakoot, Fatehpur and Kaushambi.

7. O. margaritifera Kutzing ex Gomont
(Pl. 1, Fig. 9; Pl. 2, Figs. 19, 20, 21, 22)

Geitler, Kryptogamenflora, 1932, P. 942, Fig. 597 b.

Desikachary, Cyanophyta, 1959, P. 202, Pl. 42, Fig. 8.

Komarek and Anagnostidis, Cyanoprokaryota, 2005, P. 581, Figs. 865 a, b.

Thallus: Expanded, initially light brown which turns dark brown to blackish in later phase.

Trichome: Straight or wavy, gradually arcuate towards ends, 15-22µm broad, constricted at the ± granulated cross-walls, usually parallelly arranged.

Cell: Pale-brown to blackish-brown in colour, 15-22µm broad and 3-5µm long, apical cell rounded with convex calyptra containing numerous large granules.

Cultural Study: Growth pattern in liquid medium shows growth attached to wall of flask. Trichomes initially creep over solid agar plate but in later stage they are tightly coiled.

**Habitat and Occurrence:** It grows in water channels, ditches and ponds forming mucilaginous layers in shady places. It was also found growing on tree trunks during rains with other of Oscillatoriales; Allahabad, Kaushambi, Varanasi, Jaunpur, Mirzapur and Fatehpur.

8. **O. princeps** Vaucher ex Gomont

(Pl. 1, Fig. 10; Pl. 2, Figs. 11, 12, 13, 14)

Geitler, *Kryptogamenflora*, 1932, P. 931, Fig. 593 d.

Desikachary, *Cyanophyta*, 1959, P. 197, Pl. 36, Fig. 7.

Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 590, Figs. 883 a, b, c, d, e, f, g.

McGregor, *Australian biological Resources Study*, 2007, P. 78, Pl. 12 d, e; Figs. 15 c, d.

**Thallus:** Clusters of floating trichomes appear blackish blue-green or dark blue-green in colour.

**Trichome:** Olive-green to dark blue-green in colour, 20-50µm broad, long, usually straight, terminal ends slightly attenuated, ± bent, truncate, sometimes fragmented part containing two thorn-like structures at terminal end.

**Cell:** Blue-green in colour, 20-50µm broad and 3.5-7.5µm long, content are finely granulated, apical cell rounded to spherical or truncate with or without sheath.

**Cultural Study:** Clusters of trichome attached to the side wall of the flask or free floating. Motility is rapid gliding, oscillating with left handed rotation.

**Previous record:** Drain near Paranubaba, Bargarh, Chitrakoot and near Siddhnath ki dari, Mirzapur; Vashishta, 1968; Kumar, 1970; from paddy field soils, Kerala, Madras, West Bengal, Laloraya and Mitra, 1974; Tiwari, 1975; Hazarika, 2001, 2002; Mishra and Srivastava, 2005; Kumawat and Jawale, 2006; Tiwari and Chauhan, 2006.

**Habitat and Occurrence:** It was found growing purely in slow flowing clear water often mixed with aquatic weeds; Mirzapur, Pratapgarh, Raebareli, Kaushambi and Chitrakoot.

9. **O. proboscidea** Gomont

(Pl. 1, Fig. 6; Pl. 3, Fig. 35)

Geitler, 1932, *Kryptogamenflora*, P. 948, Fig. 598 b.

Desikachary, 1959. *Cyanophyta*, P. 211, Pl. 38, Fig. 9.

Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 596, Figs. 891 a, b, c, d.

McGregor, *Australian biological Resources Study*, 2007, P. 78, Pl. 12 i, 13 a, b; Fig. 15 e, f.

**Trichome:** Free, straight or sometimes bent, bright blue-green, screw like coiled at the end, 12-15µm broad, 3-7µm broad at apex and bent at the apices.

**Cell:** short, 2-4µm long; end-cells flat rounded with a slightly thickened outer membrane.

**Cultural Study:** Trichomes form blue-green patches on solid agar plate. In liquid medium solitary trichomes float inside the medium.

**Previous record:** From enrichment cultures of paddy field soils, Nagpur, Maharashtra and Mahabalipuram, Madras, Rao, 1938; from paddy field soils of Ballia and Ghazipur, Kamat, 1965; Tiwari, 1975.

**Habitat and Occurrence:** It grows mixed with other species of *Oscillatoria*. Often characteristic tips are obscured and identified as other species of *Oscillatoria*; Allahabad, Kaushambi, Chitrakoot, Fatehpur, Raebareli and Varanasi.

10. **O. limosa** Agardh ex Gomont

(Pl. 1, Fig. 8; Pl. 3, Figs. 25, 26, 27, 28)

Geitler, *Kryptogamenflora*, 1932, P. 944, Fig. 598 d.

Desikachary, *Cyanophyta*, 1959, P. 206, Pl. 42,
Fig. 11.

Starmach, *Cyanophyta sinice*, 1966, P. 326, Fig. 443.

Komarek and Anagnostidis, *Cyanoprokaryota*, 2005, P. 593, Fig. 886.

McGregor, *Australian biological Resources Study*, 2007, P. 76, Pl. 12 b, c; Fig. 16 b.

**Thallus**: Expanded, dark blue-green, often layered.

**Trichome**: Dark blue-green or olive-green in colour, 10-14μm broad, free solitary, long, straight, not constricted at the prominent cross-walls, terminal end flatly rounded.

**Cell**: Blue-green in colour, 12-20μm broad and 2-4μm long, apical cell flat rounded or obtuse rounded without calyptra.

**Cultural Study**: Growth patterns in liquid medium shows initially solitary trichomes, free floating in submerged condition but in later stage attached to the wall and bottom of the flask. In solid dish trichomes radiate on solid agar surface and show fibrous growth.

**Previous record**: Low land rice field, Pratapgarh, Uttar Pradesh, Tiwari, 1975; Bengal, Martens, 1870; Hazarika, 2001, 2002; Mishra and Srivastava, 2005; Kumawat and Jawal, 2006; Tiwari and Chauhan, 2006.

**Habitat and Occurrence**: Common in larger water bodies mixed with other Oscillatoriales and also as a dominant species and also low land rice field; Pratapgarh, Allahabad, Fatehpur, Raebareli, Kaushambi and Mirzapur.

**DISCUSSION**

The species of *Oscillatoria* grow mostly in submerged condition and may remain viable in moist or dry soil for several months. In culture condition, when they are dried they do not revive on rewetting. In culture condition the bright colour and distinct granulation depend on enough nutrient condition. Characteristic tips are seen only in mature trichomes, not in fragmented pieces or hormogonia. The diameter of trichome, constrictions at the cross-walls, apical tips and measurements are quite helpful in identification of morphospecies. The grading of frequency during our study for the ten spices of different localities of Uttar Pradesh (India) in decreasing order (most frequent to least frequent) is *O. sancta*, *O. limosa*, *O. subbrevis*, *O. vizagapatensis*, *O. nigroviridis*, *O. tenuis*, *O. princeps*, *O. margaretifera*, *O. anguina*, *O. proboscidea*.

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