PLANKTONIC CYANOPHYCEAE (OSCILLATORIACEAE) IN FISH PONDS OF LOWER SINDH (PAKISTAN) - I

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Abstract

The 22 taxa of phytoplankton algal species belonging to the genra, Spirulina Arthospira and Oscillatoria of Oscillatoriaceae constitute the subject of this paper.The species of these sheath less genra were collected from fresh water ponds of district Thatta, Sindh, Pakistan.

The species develop profusly in fish ponds and lakes , damage the quality of water , and impare the use of water. Some of the species of Oscillatoria has been reported to cause water blooms.

Out of 22 species reported here 4 species belong to the genra Spirulina, 2 species to Arthospira and 16 species to Oscillatoria. The paper is based on original material collected from these ponds.

Most of the species are new records.

Introduction

Inspite of the fact that certain species of Oscillatoriaceae change the quality of water , form water blooms and cause death of fishes and animals , the algal flora of this region is still unexplored and only few species have been reported.

The comparative morphology of the members of Oscillatoriaceae was treated critically by Thuret (1857) and were followed by Bornet (1872), Thuret (1875), Gomont (1892), Geitler (1932), Biswas (1932), Donret (1938), Rao (1938,1940), Bharadwaja (1940) Nelson (1948, 1954), Madison(1950) and Gupta (1950).

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The present study concerns with the taxonomical studies of the Oscillatorias. The aim has been to obtain as many data as possible in order to increase our knowledge about fresh water algal flora of Sindh.

Material and Method

Algal samples were collected with plankton nets from fresh water resources and also by squeezing and scraping the aquatic vegetation. The examination of taxonomical and morphological characters were conducted on living organism and formalin (5 ml of 35 % (w/v) formaldehyde per 100 ml) preserved samples under optical microscope.

The microscopic examination of the species belonging to Oscillatoriaceae, is based on the criteria given by Geitler (1932) i.e trichome type , cell size, cell shape and cellular inclusion. The general appearance and morphology of the organism as studied with optical microscope give a basis for taxonomical criterion of these species belonging to variuos genra of Oscillatoriaceae.

Diagrams are original and were drawn with the help of Camera lucida.. The isolates are deposited in the culture collection of algae at Sindh University.

List of the species observed in the collection from these waters

Spirulina

1.	*S. laxa*	Smith G.M
2.	*S. laxissima*	West . G.S
3.	*S. meneghiniana*	Zonard ex Gomont
4.	*S. sublissima*	Küetz ex Gomont

Arthospira

1.	*A. jenneri*	(Küetz) Stizenb ex Gomont
2.	*A. massurtii*	Kuffareth

Oscillatoria

1.	*O. acumata*	Gomont
2.	*O. agardhii var.*	aequicrassa (Elenk)
3.	*O. amphibia*	Agard. ex Gomont
4.	*O. anguina*	(Bory) Gomont
5.	*O. calcu tensis*	Biswas
6.	*O. chlorina*	Küetz (after Fremy)

7.	*O. formosa*	Bory ex. Gomont
8.	*O. jasorvensis*	Vouk
9.	*O. jenesis*	G. Schmid
10.	*O. lemmermannii*	
11.	*O. limosa*	A.G ex Gomont
12.	*O. okeni*	A.G Gomont
13.	*O. princeps*	Vaucher ex. Gomont var. pseudolimpsa
14.	*O. okeni*	A.G ex. Gomont
15.	*O. subbrevis*	chmidle
16.	*O. willei*	Gardner ex Drouet

1. *Spirulina laxa* Smith

Smith G.M , New or intresting alg. from lakes of Wisconsin , Bull. Torr. Bot. club. 43: p. 481, 24 - 26. 1916; Prescott, Alg. of the W. Great lake Area, 479, pl. 1o8, f. 10, 1951; Gollerbax et al., Guide to Fresh -w. Alg. U.S.S.R, Blue green alg.Vol. 2, f. 250- 3, 1953

Pl. 1 Fig. 1

Trchomes loosly spiralled , forming a dark blue green mass, 2 - 2.5 μ (3 μ) in diameter , snirals 4 - 6 μ wide; distance between spirals 15 - 20 μ wide; cell content blue green Tychoplankter

2. *Spirulina laxissima* West G. S.

J . Linn. Soc. (Lond) Bot. , 38, 78, pl. 9, fig. 6, 1907; Fremy , Myxo . d' Afr. equat. franc., 234, fig. 207, 1929 ; Geitler , Kryptogamenflora , 929, 1932; Gollerbax et al., Guide to Fresh-w. Alg. U.S.S.R, Blue Gr. Alg.Vol. 2 , f. 250 - 8, p. 464, 1953; Decikachary in Cyanophyta pl. 36, fig. 5 , p. 1986, 1959.

Pl. 1 Fig. 2

Trichomes 0.7 - 0.8 μ (1.0 μ) broad , blue green , spirals very loose , but regular 4.5 – 5.3 μ broad ; 17 - 22 μdistant from each other end cells rounded obtuse.

In flowing and standing waters.

3. *Spirulina meneghiniana* Zanard and Gomont

Zanardini , Not. intorno alle Cellal . marinede elitor di Venezia, Atti .R. Inst. veneto, 6; 80, 1847; Gomont , Monogr. Oscillaries , 250 . pl. 7, f. 28 . 1892; Forti in De Toni , Syll. Alg., 5 : 209, 1907 ; Geitler . Kryptogamenflora928 , f. 593 d, 1932; Fremy , Cyano cotes d' Eur.,131 , pl. 31 , f. 11 , 1933. Gollerbax et al. Guide to Fresh-w.Alg. U.S.S.R . Blue gr. Alg.Vol. 2, f. 250 10, p. 464 , 1'953; Desikachary , in Cyanophyta pl. 36, f. 8 , p.195 , 1959.

Pl. 1 Fig. 3

Trichomes 1.2 - 1.8 μ (1.5 μ) broad , flexible irregularly spirally coiled , bright blue green, forming a thick blue green thallus ; spirals 3.2 - 5 μ broad and 3 - 5 μ distant from each other. Planktonic in ponds.

4. *Spirulina subtilissima* Kutz ex Gomont

Kutzing. Phyc. gene ., 183 ; Gomont , Monogr. Oscillariees , 252 , pl. 7, f. 30 , 1892; Forti in De Toni , Syll. Alg. 5 : 212, 1907; Fremy , Myxo. d' Afr. equat. franc. ,233, f.206, 1930; Geitler , Kryptogamenflora, 929, 1932; Gollerbax et al. Guide to Fresh-w.Alg. U.S.S.R ,Blue Gr. Alg.,Vol. 2, f. 250 -3, p. 465, 1953;Desikachary in Cyanophyta , pl. 36, f.10, p.196, 1959.

Pl. 1 Fig. 4

Trichomes 0.6 - 0.9 μ broad , regularly spiraly coiled, bright blure green or yellowish , spirals 1.5 - 2.5 μ broad , distance between the spirals 1.35 - 2 μ. In lakes among other algae.

5. *Arthrospira jenneri* Stizbenb ex Gomont

Stizenberger , Spirulina and Arthospira ,Hedwigia 1 : 32 , 1852 ; Gomont , Monogr. Oscilariees , 247 , pl. 7, f. 26, 1892 ; Desikachary in Cyanophyta , pl. 35, fig. 3 , p.192, 1959; Prescott , Alg. of the West Gt. lake Area , pl. 108 , f. 22, 23, p. 481, 1951;

Syn = *Spirulina jenneri* (Stizenb) . Geitler in Paschers Susswaserflora , 12 : 344, 1925; Kryptogamenoflora , 924 , f. 590 c, 1932;Tiffany and Britton , The Alg. of Illinois , pl. 97, f. 1123, p. 354, 1952; Gollerbax et al. Guide to Fresh-w. Alg. U.S.S.R, Blue Green Alg. Vol .2, f. 248 -4, p. 460, 1953.

Pl. 1 Fig. 5

Trichomes blue green unconstricted at the cross walls, 5 – 8 μ (7.5 μ) broad, not attenuated at the ends , more or less regularly coiled , spirals 10 – 15 μ wide distance between the spirals 12 - 15 μ. Cells as long as broad or some what shorter. End cells broadly rounded.

Planktonic in lakes and ponds

6. *Arthrospira massartii* Kuffareth

Contribution a letude Flora Algologique de luxembourg meridional , 11 , Ann. biol. Lacuster, 7 : 264 , fig 16, 1914.

Spirulina massartii (Kuff) Geitler in Pascher's Susswasserflora , 12 : 346 , 1925; Kryptogamenflora, 925 , fig. 590 b , 1932 ; Descikachary in Cyanophyta , pl. 35, fig. 9 – 10 , p.191, 1958.

Pl. 1 Fig. 6

Trichomes loosly coiled , spirals 28 U broad , cells 4 - 6 μ (4.5 μ) broad and 2 - 4 μ (3 μ) long, greyish blue green; end cells rounded conical , cross walls not granulated, no gas vacoules.

In fish ponds of Chillia dist. Thatta.

7. *Oscillatoria acuminata* Gomont

Monogr. Oscillariees , 227, pl.7, f.12, 1892;West & West , A cont. to the fresh-w. of Cylon, Trans. Linn. Soc. Bot. Der. 3,6.p.204, 1902; Forti in De Toni , Sylloge Algarum, 5: 177, 1907; Fremy , Myxo.d'Afr.equat. franc., 222, f.192, 1929;Geitler , Kryptogamenflora , 978, f.603 d, 1932; Dixit , The Myx. of Bombay Presidency , India,l. Proc. Ind. Acad. Sci ., B.3: p.103, 1936; Rao , The Myx, of Unit. Prov. India, III . Proc. Ind. Acad. sci. B,6(6) , p.368,1937b; Parukuty, Collection of Alg. from Asam, Proc. Ind. Acad. Sci. B. 9(5) , p.234, 1939; Gollerbax et al., Guide to Fresh-w. Alg. U.S.S.R, Vol. 2, Blue green Alg. f.246, p.452, 1953; Desikachary in Cyanophyta, pl.38, f.7, pl.40,f.13, p.240, 1959.

Pl. 1 Fig. 7

Thallus blue green more or less straight , not constricted or slightly constricted at the cross walls, 3 - 5 μ (6 μ) broad, at the end briefly tappering , sharply pointed , bent; cells longer than broad, rarely subquadrate, 5.5 - 8. μ (9 μ) long, sometimes granulated at the cross walls; end cells mucronate , without calyptra.

In fish ponds of dist. Thatta.

8. *Oscillatoria agardhii var. aequicressa* (Elenk)

Monogr. Oscillariees , 2o5 ; 1892 ; Forti, In De Toni , Sylloge Algarum , 5 : 149 , 1907 ; Geitler, Kryptogamenflora , 974 , f.. 621 , 1932 ; Fremy , Cyano. Cotes d' Eur ; 123 , pl. 31 , f. 1, 1933, Gollerbax et al., Guide to fresh-w. Alg. U.S.S.R , Blue Green Algae , Vol.2 ,f. 244 , 15 - 16, p. 446 , 1953.

Pl. 1 Fig. 8

Trichomes straight or some what curved , not constricted at the cross walls , 4 - 6 μ (4.5 μ) broad , free swiming , cells mostly shorter than long , quadrate 2.5 - 4 μ (3 -6 μ) long , end cells concave , without calyptra. Planktonic in fresh water pools.

9. *O. amphibia Agardh* ex Gomont

Aufgahling einiger in den osteichenschien Landern gefundenen reuen Gattengen und. Asten von Algen . Flora 10:632. 1827; Gomont .Monogr . Oscill 241, pl.7, f.415,1893; De Toni Syll. Algae 5: 169,1907; Fremy, Myxo.d. Afr.equat Franc,213,f.180,1929; Geitler,Kryptogumenflora ,966,1932;

Fremy , Cyano . Cotes d' Eur.,122,pl.31,f.2,193;Buchanan,Notes on Algae of Iowa.Proc. Iowa Acad. Sci. 14:14 1908;Tilden American Algae , Cent.VII . Fasc.1.No. 46,1909;Tilden Minnosota Algae , Myxophyceae, Pl.. IV , f. 19 & 20 , p. 74 , 1910; Desikachary in Cyanophyta . pl.37 , f. 6, p.229, 1959.

Pl. 1 Fig. 9

Thallus deep green , plant mass thin , trichomes 3 - 4.5 μ in diam. straight or curved , fragile ,not constricted at joints, cerved gradually at the ends , apex of the trichome neither tappering nor capitate, apical cells rotund above, cells 4.5 - 7.5 μ in length, transverse walls commonly marked by two protoplasmic granules , cell content pale blue green.

Planktonic in fresh water tanks , lakes and ponds.

10. *Oscillatoria anguina* (Boty) Gom

Bory, Dict, class , d' hist . nat .13 , p. 407 , 1927. Monogr. Oscill. p.214, pl.6, f.16, 1892; Tilden, in Minn. Bot. stud . 1 , p.235 , 1895;De Toni , Syll. Algar .5, p.159, 1907; Tilden , Myx in Minn Alg . 1,p.68,pl.4,f.9,1910; Lemm.,Krypt. Fl. Brand . III , p.110, 1910; Geitler , Cyan in Pascher, , Sussw . Fl.12, p.359, f.424, 1925; Skovortov, in Journ . Bot. 65, p. 196, 1927; Geitler , Cyan. in Rabenn , Krypt . Fl. 14, p. 948, f. 599 b, 1932; Drouet, in Bull. Torr. Bot. cl. 59, p. 296,1932; LI , Contr . Biol. . Lab. Sc. Soc. China 8, p. 2, 248, f..16 E , 1933; Petersen, in Dansk . Bot. Ark. 8, p. 134, 1935 ; Copeland in Ann. N.Y. Acad. Sci. 36, p.144, 1936; Yoneda, Cyan. of Japan. III in Acta . Phytotax . Geobot. (9), 7, p.161, f.17, 1938.

Pl. 1 Fig. 10

Plant mass dark blue green , trichomes 6 - 8 μ in diam. straight below , above tuberiform , gradually tappering , apex of the trichome capitate , rounded or obtusely flattened . Outer wall of the apical cell slightly thickened , 1.5 - 2.5 μ long, cross walls some times granulated , cells content blue green. In standing waters and small streams.

In fish hatchery ponds at Chillia dist. Thatta.

11. *Oscillatoria calcuttensis* Biswas

J. Dept. Sci. Calcutta Univ. , 7: 5 , 1925; Geitler , Kryptogamenflora, 976 , 1932 . Desikachary, in Cyanophyta , p.237, pl. 42 , f. 20 - 21 , 1959. Rao,. Myx. Madras Presy. I , J . Indian Bot. Sci. , 17, 92 , 1938 a.

Pl. 2 Fig. 11

Thallus leathery brown ; trichomes parallel straight , not constricted at the cross wall , 2 - 3 U broad , at the ends breifly attenuated , curved or bent ; cells 2

– 5 times as long as broad , 10 15 U long , septa with 2 -3 granules on either side, blue green , blue green , end cells conical, pointed, not capitate.

In fish ponds of dist. Thatta.

12. *Oscillatoria chlorina* Kutz. (after Fremy)

Kutzing , Phyc. gene., 185, 1843; Gomont, Monogr. Oscillariees , 223, 1892; Forti in De Toni, Sylloge Algarum ,5 : 172, 1907; Fremy , Myxo. d' Afr , equat franc., 215, f.183, 1929; Geitler Kryptogamenflora , 951, f. 611 c, 1932; Desikachary in Cyanophyta , Pl. 40, f.4 p. 215, 1959.

Pl. 2 Fig. 12

Thallus very thin , yellowish green ; trichomes straight or curved , constricted or slightly constricted at cross walls; 3 - 4.5 μ (6 μ) broad. Gas vacoules absent . Cells longer than broad, cross walls not granulated ; calyptra absent.

Planktonic in number of lakes.

13. *Oscillatroria formosa* Bory ex Gomont.

Bory, Dict. class. d' hist . nat ., 12: 474 , 1827; Gomont , Monogr. Oscillariees, 230, pl.7, f.16, 1892; Forti in De toni Sylloge Algarum 5 : 182 , 1907; Fremy , Myxo.d' Afr. equat franc., 225, f.197, 1929; Geitler Kryptogamenflora , 970, f.619 b , 1932; Smith , Fresh-w Alg. Y.S. p.79, f. 38 A, 1933; Fremy ,Cano cotes d' Eur ., 126, pl.31, f.11, 1933; El. Nayal , Egypt , Fresh-w Alg. p. 87, f. 127, 1935; Youneda , Cyanophyceae of Japan II, Acta Phylotax. Geobot 1938 (9) , 7 p.167, 1938; Desikachary in Cyanophyta, pl.40, f.15, p. 232, 1959.

Pl. 2 Fig. 13

Plant mass dark blue green. Trichomes 4 - 6 μ in diameter, straight to flexous , usually slightly constricted at the cross walls; apex of the trichome slightly tappering and bent, end cells blunt conical , nearly obtuse , not capitate without calyptra . Cells nearly quadrate upto 1/2 as long as broad,2 - 5 μ long, septa sometimes granulated, cell content bright blue green.

Planktonic in lakes and ponds.

14. *Oscillatoria jasorvensis* Vouk.

Jugost . Akad. Zagreb , 14 : 133, f.1, 1919; Geitler , Kryptogamenflora Burmas. Nova Acta Reg. Soc. Sci.. Uppsal. ser. IV, 14 (5), p. 46, 1949; Desikacharty in Cyanophyta p. 221, 1959.

Pl. 2 Fig. 14

Thallus pale blue green, straight 2.5 - 3 μ broad bent at the ends , not attenuated , not caspitate, cells as long as broad or nearly so, end cells rounded , without calyptra. Planktonic in ponds and lakes.

15. *Oscillatoria jenesis* G. Schmid

Uber Organization und Schleimildung bei Oscillatoria jenesis und das Bewegunsverhatten Teilslucke , etc Jahrb wiss Bot. 60 : 572 - 627, 1921; Reizverhalten kunstlicher Teilslucke , die kontrantilitat und das osmotische Vehalten der Oscillatoria jenesis Jahrb wiss . Bot. 62 , 328 - 419 , 1923.

Pl. 2 Fig. 15

Aggregate mas of trichome dark brown .. Trichomes 19.8 - 24..9 μ wide not constricted at thecross walls , grey brown some what spiraled at the ends . Cells short , end walls asymteric - convex, not knobbed or thickened , no granulation at the cross walls.

In temporary ponds dist. Thatta.

16. *Oscillatoria lemmermannii* Wolosz aft. Fremy

Bul. Acad. Sc. Cracovie, 6: Ser. B., 687., pl.34, f.26, 1912; Geitler, Kryptogamenflora,975, f..618i, 1932; Desikachary in Cyanophyta.237, pl.40,f.10,1959. Gollerbax et al., Guide to Fresh-w. Alg. U.S.S.R,Blue Green Alg ,Vol.2, , f.24-5,p. 449.1953.

Pl. 2 Fig. 16

Trichomes pale blue green , straight, slightly bent, constricted at the cross walls, 2-2.5U (3 - 4.5 U) broad, cells 2 -3 times as long as broad , 12 - 18 U long. Planktonic in lakes and ponds

17. *Oscillatoria limosa* Ag. ex · Gomont

Agarth, Disposi to Algarumum suecire , 35, 1812, Gomont, Monogr, Oscillariees , 210, pl..6, fig.13, 1892; Forti, in De toni , Sylloge Algarum 5 ; 154, 1907; Fremy , Myxo. d ' Afr. equat. franc; 212, fig, 178, 1927; Geitler , Kryptogamenflora , 944, fig. 598 d, 1932: Tilden, Myxoophyceae . Minn. . Alg. 1, p.6, 1910; Higashi in Okamura,, synopt. Lst Jap. Alg. 305, 1916; Skuja, in Act. Hort. Bot. Univ.Latv. 1. p. 172, 1926, West, and Fritsch , Brit. Freshw Alg. p. 470, f. 191 B, 1927; Skvortzow in Journ. Bot. 65, p.196, 1927; Drouet in Bull. Torr. Bot. Cl. 59, p. 296, 1932; Smith , Freshw. Alg. U.S. p. 79, f. 36 B. 1933; Wang, in Contr. Biol. Lab. Sc. Soc. China 8, p. 249, 6. 17 A, 1933; Cedercreutz in Act. Bot. Feun. 15, pl. 114, 1934; L I in Bull . Fan Mem. Inst. Biol. 6, p.142, 1935; in Ling . Sc. Jour. 14, p. 47, 1935; Wang in Contr. Biol. Lab. Sc. Soc. China 10, p. 158, 1936; Yoneda in Cyanophyceae of Japan, I , Acta Phytolax . Geobot. vol. VI, fig. 34, p.201, 1937; Desikachar in Cyanophyta, pl., 42, fig.11, p. 206, 1958.

O. *Frelichii* Kutz . Phyc. gener. p. 189, 1843.

O. *Grateloupii* Kutz. Tab. Phyc. I, p. 31, pl.43, fig. 9, 1845 - 49.

Pl. 2 Fig. 17

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

In ponds and pools or slowly flowing water.

In fish hatchery Ponds, Chillia dist. Thatta.

18. *Osaillatoria okeni* Ag. ex Gomont

Agardth . Aufzahlung etc. Flora 10, p. 633, 1827; Gomont , Monogr. Oscill. p. 252 , pl. 7, f. 18, 1892; W est & West, in Journ. Bot. 35 , p. 300 , 1897; Setchell, and Garder , Algae of North West Am. Univ. Calif. Pub. Bot. 1 , 184, 1903; De Toni , Syll. Algae . 5 , p. 185,1907; Tilden , Myx. in Minn. Alg. 1, p. 81, pl. 4. f. 35. 1910; Geitler , Cyan. in Pascher . Sussw . Fl. 12, p. 372, f. 403, 1925; in Rabenh , Krypt. Fl., 14, p. 969, f. 608 a, 1932; Cedercreutz, in Act.Bot. Fenn. 15, p. 114, 1934; Copeland, in Ann.. N.Y. Acad. Sci. 36, p.155, 1936; Yoneda; Cyan. of Jap. III; Acta . Phytotax, Geobot. 9, 7, p.164, f.104, 1938.

Pl. 2 Fig. 18

Plant mass dark blue - green ; trichomes 5.5 - 9 μ (7.5 μ) in dieameter , straight , distinctlly constricted at joints. Apical cell some what pointed , not capitate ; calyptra none ; cells 3 - 4.5 μ in length , apical cell some what quadrate up to 8 μ in length , cell content finely granular. Probably cosmopolitan , known from Europe , America and Africa.

In fish ponds dist. Thatta

19. *Oscillatoria princeps* Vaucher ex Gomont var. pseudo limosa. Ghose

Vaucher , Historie des conferves d' eau dovce , 190 , pl.15, f. 2, 1803; Gomonty , Monogr. Oscillatorees 206, pl. 6, f.9. 1892; Forti in De Toni , Sylloge Alagarum , 5 : 150 1907; Fremy , Myxo.d' Afr. equat. franc. ,208, f.175, 1929; Geitler, Kryptogamenoflora, 947, f.598 a, 601 -cg, 1932; Biswas, L. Linn. Soc. (Lond.) Bot., 46: 337, pl.31, f.2, 1924; Desikachary in Cyanophyta , pl.39. f.15 -17, p. 210, 1959.

Pl. 2 Fig. 19

Thallus blue green , trichomes straight , rigid and fragile , unconstricted at cross walls, croos walls not granulated , 30 - 35 μ broad ; cells short protoplsm granular, apics straight , apical cell slightly convex , calyptra absent.

Attached to mud and free floating in ponds.

20. *Oscillatoria subtilissima* Kutz

Tab. Phycologicae,1: pl.38, f.7, 1846; Forti in De Toni , Sylloge Algarum 5 : 171, 1907, Geitler , Kryptogamenflora, 950, 1932; Gollerbax et al., Guide to Fres-w Alg. U.S.S.R, Blue green Alg. Vol. 2, .f.241-5, p.428, 1953; Desikachary in Cyanophyta p.215, 1959.

Pl. 2 Fig. 20

Trichomes single or a few together , seldom forming a thallus, yellowish green , 1 - 1.5 μ straight or curved , septa distinct , without gas vavoules.

Planktonic in fresh water ponds and lakes .

21. *Oscillatoria subbrevis* Schmidle 1901 b.

Algologische Notizen X - XIII, Allgm, Bot. Zeitschr., 5: 17 - 20, 1901. b; Prescott, Alg. of the West. Gt. lake Area, pl. 107, f.23, p.491., 1951.

Pl. 2 Fig. 21

Filaments solitary , not occuring in plant mass; straight and tappering towords the apics . Apical cell rounded , not capitate and without a calyptra. Cells short 5–6 μ in diameter , 1 - 2 μ long, , with frequent necridia in evidence ; cross walls not granular; cell content pale grey green.

Planktonic in lakes and ponds.

22. *Oscillatoria willei* Gardner em. Drouet

Brazilian Myxophyceae I. Amer. J. Bot. ,24 :606, f.4, 1937. O. Willei Gardner, Mem .N.Y. bot.. Gard., 7 : 86, pl.7, f.67, 1927; Geitler, Kryptogamenflora , 954, f. 6o6 b, 1932.incl. O.homogenea Fremy , Myxo.d'Afr equat . franc.,f.611 d.1932; Gollerbax, et al. Guide to Fresh-w. Alg Blue green Algae U.S.S.R. Vol.2, .f.241-1,p.430,1953;Desikachary in Cyanophyta, pl.38, f. 4,5 , pl.40, f.5, p.217, 1959.

Pl. 2 Fig. 22

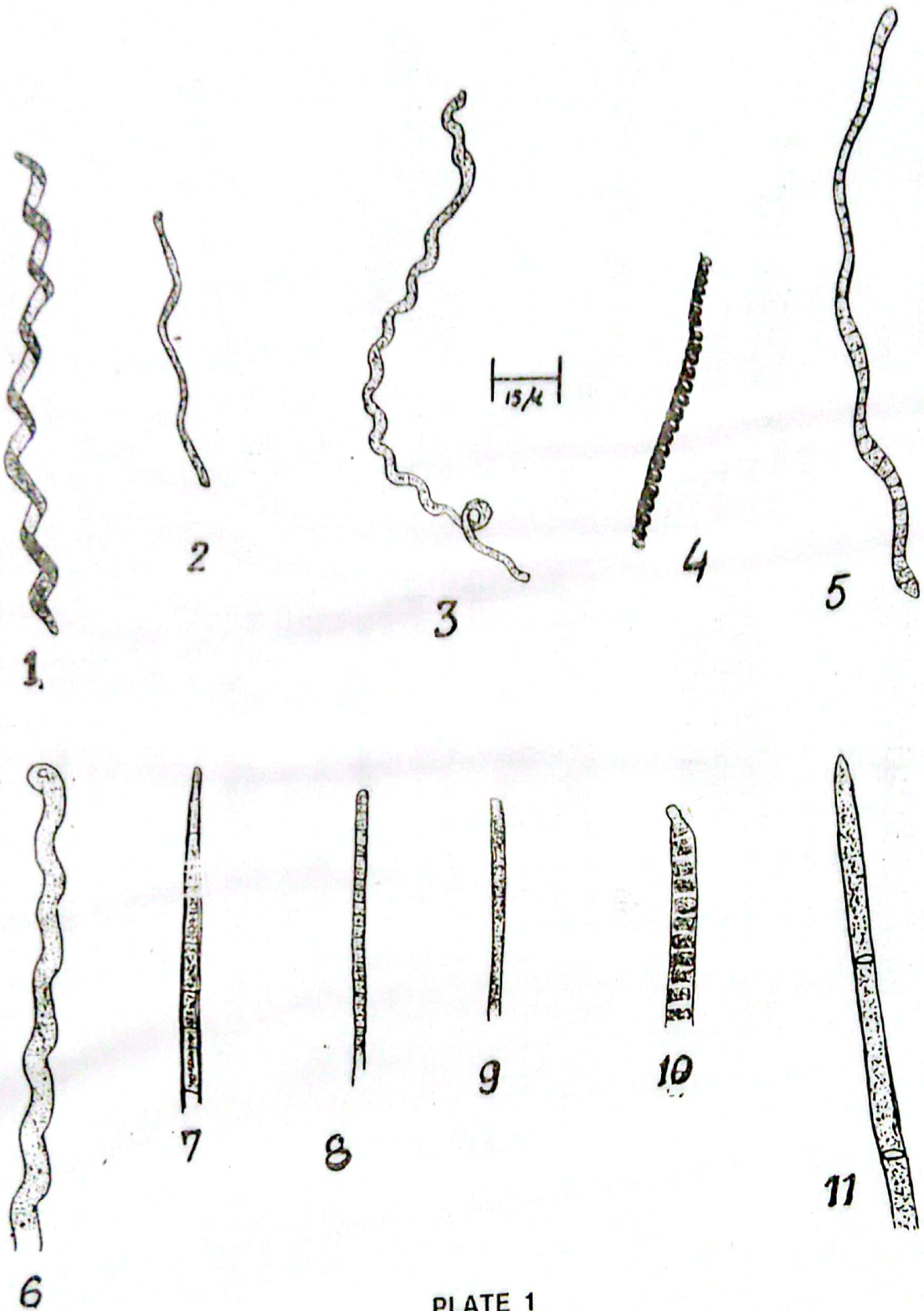

PLATE 1

Spirulina
1. S. laxa
2. S. laxissima
3. S. meneghiniana
4. S. subtilissima

Arthospira
5. A. jenneri
6. A. massurtii

Oscillatoria
7. O. acuminata
8. O. agardhii
9. O. amphibia
10. O. anguina
11. O. calcuttensis

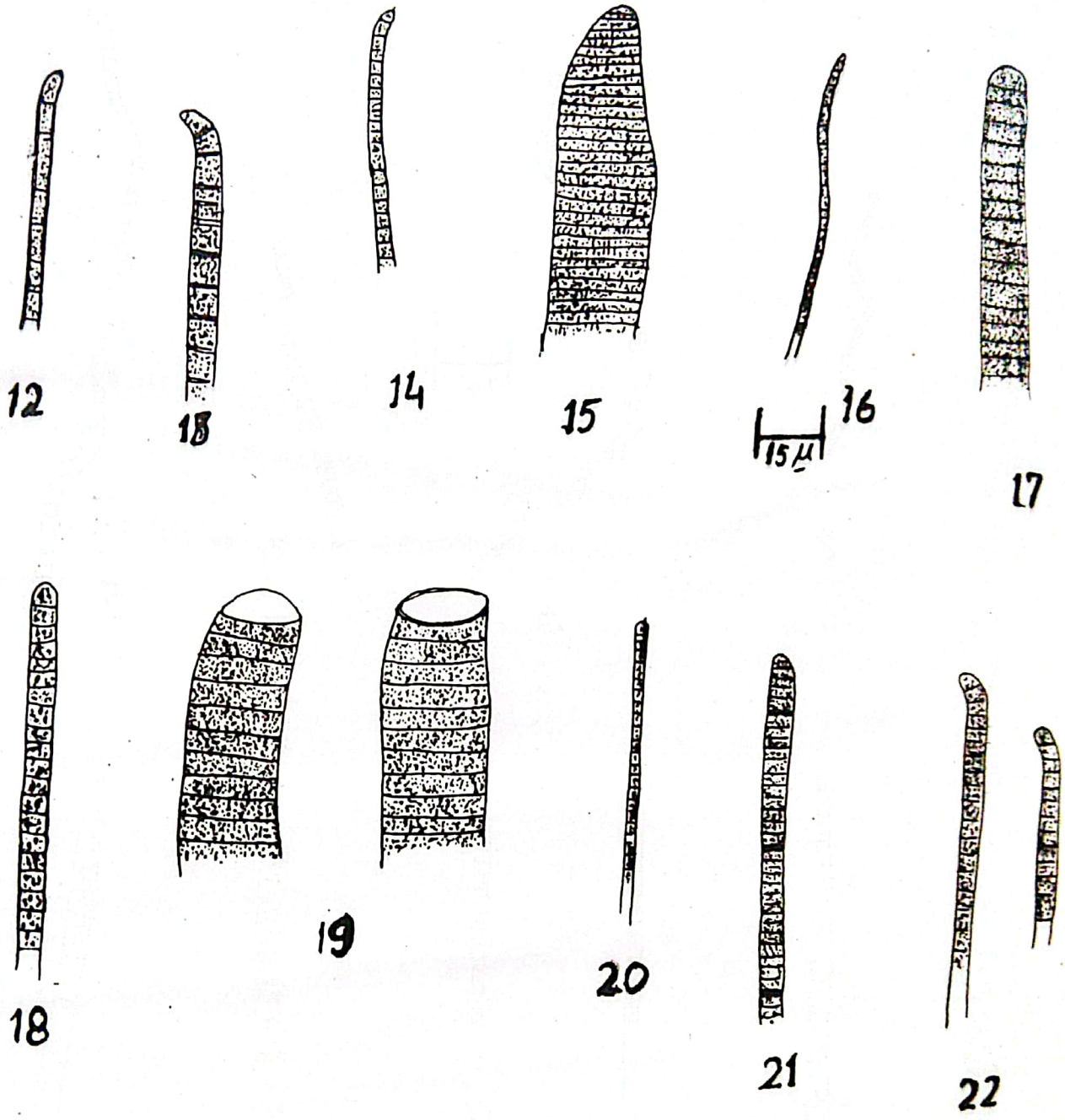

PLATE 2

Oscillatoria
12. O. chlorina
13. O. formosa
14. O. jasorvensis
15. O. jenesis
16. O. lemmermanii
17. O. limosa
18. O. okeni
19. O. princeps
20. O. subtilissima
21. O. subrevis
22. O. willie

Trichomes pale blue green, bent at the ends or screw like , 2.4–3.6 μ (4.5 μ) broad, unconstricted at the cross walls, ends not attenuated , not capitate at crosswalls, end cells rounded without a thickened membrane.

Drouet has correctly included *O.homogene* under *O.willei.*

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