

## ULOTHRIX IN PAKISTAN

M.A.F. FARIDI, GHAZALA ANJUM AND IMTIAZUL HAQ

*Department of Botany, University of Peshawar, Peshawar, Pakistan.*

### Abstract

This paper comprises 11 species of *Ulothrix* collected from Pakistan: *U. aequalis*, *U. confervicola*, *U. idiospora*, *U. oscillarina*, *U. shameelii* sp. nov., *U. subtilissima*, *U. tenerrima*, *U. tenuissima*, *U. terrestre* comb. nov., *U. variabilis* and, *U. zonata*. The concept of the genus has also been discussed.

### Introduction

The taxonomy of *Ulothrix* is in a state of confusion. The classical concept of the genus has undergone many changes lately. Forest (1945) included *Uronema*, *Chlorohormidium* (= *Hormidium*) and *Stichococcus* in *Ulothrix*. Mattox & Bold (1962) on the other hand, amalgamated *Uronema* in *Ulothrix*, keeping all the other related genera as separate entities. Ramanathan (1964) has taken purely a classical view, rejecting the concept of Forest. He was not aware of the work of Mattox & Bold. *Uronema* has pointed apical end unlike *Ulothrix* which has a broad one, according to the classical concept. Mattox & Bold (1962) have pointed out the *Uronema* does not have a pointed tip in all cases. Some of the filaments do have rounded tips, therefore, they placed *Uronema* in *Ulothrix*. *Chlorohormidium* has at least two distinct characters, the absence of holdfast and biflagellate zoospores (Fott, 1960). *Stichococcus* has never given much trouble in identification, because it is quite distinct from others.

Mattox & Bold (1962) have emended the description of *Ulothrix* to include those ulotrichean organisms which have more than one pyrenoid and the plastid covering the whole (or a part ?) of the cell circumference. This concept breaks down in some taxa like *U. rorida* which has only one pyrenoid yet a complete plastid. The number of pyrenoids may be a physiological phenomenon and can not be made a generic character.

The occurrence of *Ulothrix* had long been reported from Pakistan (Shameel, 1963). Recently Shameel, (1978) has described five taxa of the genus including a new taxon, from Swat, Pakistan. He has also followed the classical view.

Unless the entire Ulotrichaceae is studied in detail afresh, the riddle will remain and the taxonomist will be depending on conjectures. It was decided to include *Uronema* in *Ulothrix* tentatively. Here *Ulothrix* means those taxa which have quadriflagellate zoospores, holdfast, plastid covering the whole or part of the cell circumference, unbranched filaments of unlimited growth, cells uninucleate with rounded or acuminate apex, pyrenoids mostly 2 or more, sometimes one. This concept is closer to the old one except acuminate tip.

### Materials and Methods

Collections were obtained from different parts of the country by the writers and other Botanists. Some species were put to cultures (soil extract: Faridi, 1971) to examine the plant and its behaviour in detail. All the diagrams except Fig. 1 are original, Fig. 1 is a modified version of Shameel (1978).

### Key to the Species

1. Filaments tapering towards apex ..... *U. shameelii*
1. Filaments uniform in thickness ..... 2
  2. Apex acuminate ..... 3
  2. Apex rounded ..... 4
3. Filaments constricted at septa ..... *U. terrestre*
3. Filaments unconstricted at septa ..... *U. confervicola*
  4. Plastid covering almost the whole cell circumference ..... 5
  4. Plastid covering less than 3/4 of cell circumference ..... 6
5. Cells 8-12  $\mu\text{m}$  thick ..... *U. subtilissima*
5. Cells 15-25  $\mu\text{m}$  thick ..... *U. tenuissima*
5. Cells 25-45  $\mu\text{m}$  thick ..... *U. zonata*
  6. Cells 12-25  $\mu\text{m}$  thick ..... *U. aequalis*
  6. Cells 4.5-7  $\mu\text{m}$  thick ..... *U. variabilis*
  6. Cells 7-11  $\mu\text{m}$  thick ..... 7
7. Cells less than 1/2 as long as broad ..... *U. oscillarina*
7. Cells more than 3/4 as long as broad ..... 8
  8. Plastid a plate, akinetes in chain ..... *U. idiospora*
  8. Plastid a girdle, akinetes single ..... *U. tenerrima*

1. *Ulothrix aequalis* Kutz., 1845.

Heering, 1914:35; Ramanathan, 1964:36; Shameel, 1978:380.

Filaments light green, long, cylindrical; cells 12-25 x 12-40  $\mu\text{m}$ ; cell-wall striated, 5.5-8  $\mu\text{m}$  thick; plastid girdle-shaped, uniform in appearance, covering 1/2 to 3/4 of cell

circumference; pyrenoids 1-3; gametes pyriform, biflagellate, with 1 stigma, 2.3-5 x 3.5-5  $\mu\text{m}$  escaping through a pore; zoospore quadriflagellate; aplanospores present (Fig. 11).

Locality: Bahrain (Leg. Shameel), Marghazar (Leg. Shameel), Saidu (Leg. Shameel).

This species has been collected from Swat district only, but it is most certainly likely to occur elsewhere as well.

2. *U. confervicola* (Lagerh.) Mattox & Bold, 1962.

= *Uronema confervicolum* Lagerh., 1887.

Mattox & Bold, 1962:29; Ramanathan, 1964:50 (= *Uronema confervicolum*).

Filaments indefinite, sometimes constricted at the cross-walls, fragmentation almost absent; holdfast discoid; cells cylindrical, 3.5-9  $\mu\text{m}$   $\frac{1}{2}$ -4 times as long as broad; terminal cell acuminate; plastid parietal band covering almost the whole cell circumference; pyrenoids 2-3; quadriflagellate zoospores, 6-7 x 9-10  $\mu\text{m}$  one or two from a cell; aplanospores one or few from a cell; gametes not yet observed (Fig. 9).

3. *U. idiospora* G. W. West, 1908.

Ramanathan, 1964:40.

Filaments attached or free-floating, subflexuous; cells 8-10  $\mu\text{m}$  thick,  $\frac{3}{4}$  to  $2\frac{1}{2}$  times as long as broad; plastid thin, plate covering more than half the cell circumference; pyrenoid 1; akinetes in chains, ellipsoidal or doliform with thick scrobiculate wall, 10-13 x 18-36  $\mu\text{m}$ ; zoospores and gametes not observed (Fig. 8).

Locality: Peshawar.

This is the second report of the species after the original from Australia.

4. *U. oscillarina* Kütz., 1845.

Ramanathan, 1964:34; Shameel, 1978:382.

Filaments long, attached, later free, shining green; cells 8-11 (-14)  $\mu\text{m}$  thick,  $\frac{1}{4}$  to  $\frac{1}{2}$  long as broad; cell-wall thin, easily gelatinizing; plastid broad girdle-shaped band, covering more than half the cell circumference; pyrenoids 2-3; akinetes common; zoospores and gametes not observed so far (Fig. 4).

Locality: Kohat, from a stagnant pond (Leg. Zafar Iqbal), Marghazar (Leg. Shameel).

5. *U. shameelii* Faridi sp. nov.

= *Ulothrix zonata* var *faridii* Shameel, 1978:378 (Basionym)

Filia obscura, non ramosa, cylindrica, sursum tenuiora (18-39  $\mu\text{m}$ ), apice inflexo, compluribus affixa. Apice cellula convexa-quadrata, 12-18  $\mu\text{m}$  longa, 12-18  $\mu\text{m}$  diametro, cum fragmine chloroplastae ad laterem infra. Cellulis adultis rectangularibus, 9-30  $\mu\text{m}$  longitudine, 39-54  $\mu\text{m}$  diametro, cellulae membrana 2.5-4.0  $\mu\text{m}$  lata (rariusve 8  $\mu\text{m}$ ). Uno chloroplasto cingulo simile, ut circino altissima cellula, cingulum aperiante in cellulis infra versus, tanto ut  $3/4$  usque ad totam magnitudinem cellulae, cum 2-6 pyrenoidibus. Inferiora cellula fili separata, longitudine minora quam aliae cellulae (9-20); radix sine colore, 12-15  $\mu\text{m}$  diametro, 190-205  $\mu\text{m}$  longitudine.

Filaments dark green, unbranched, cylindrical, attached in clusters; tip tapering, curved; apical cell convexo-quadrata, 12-18 x 12-18  $\mu\text{m}$ , with a fragment of plastid at the upper side; apical region 18-39  $\mu\text{m}$  thick; mature cells rectangular, 9-30 x 39-54  $\mu\text{m}$ ; cell-wall 2.5-8  $\mu\text{m}$  thick; plastid girdle-shaped, forming a close ring in the uppermost cell, gradually opening downwards, extending  $3/4$  to full length of cell; pyrenoids 2-6 with a distinct starch sheath; lowest cell of filament 9-20  $\mu\text{m}$  long, smaller in length than other cells; holdfast colourless, prolonged, rhizoid-like, 12-15 x 190-205  $\mu\text{m}$  (Fig. 1).

Type locality: Madyan, Swat (Shameel 14, 8.11.1963).

Holotype: NO. IMB 6, Herbarium, Institute of Marine Biology, Karachi University.

Shameel (1978) described this plant as a new variety, *Ulothrix zonata* var. *faridii* but it differs from *U. zonata* in prolonged rhizoid-like holdfast, tapering and curved tips, short lowest cell and convexo-quadrata apical cell. Therefore, it has been raised to the status of species because these characters are not varietal but represent a species. A new name is proposed because the varietal name was after the new author. It has been named after Dr. Mustafa Shameel of Karachi University, the original discoverer of the taxon.

#### 6. *U. subtilissima* Rabenh., 1863.

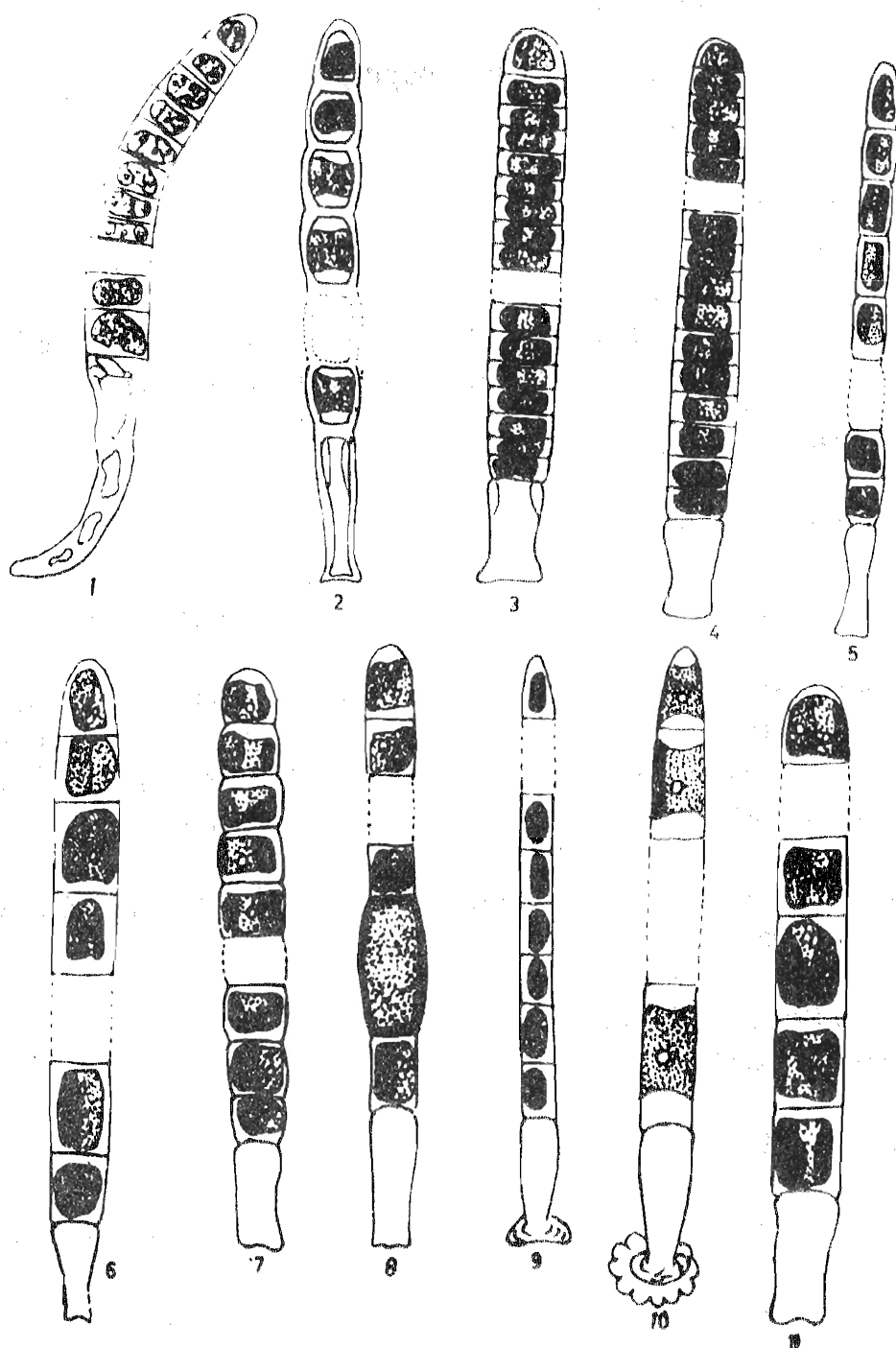
Heering, 1914:31; Mattox & Bold, 1962:32 (= *Hormidium subtilissima*);

Prescott, 1915:96; Ramanathan, 1964:37.

Filaments attached or free-floating, long, slender; cells 4-5  $\mu\text{m}$  broad, 8-12 (-15)  $\mu\text{m}$  long, constricted at the cross-walls; plastid covering the whole cell circumference; pyrenoid mostly 1, rarely 2; akinetes common; zoospores and gametes not yet observed (Fig. 5).

Locality: Lahore, Rawalpindi, Sibi.

This species occurs as epiphytes on *Lyngbya* also, but in our collection it was obtained free-floating and attached to stones. This is a remarkable plant as regards the tolerance of temperature.



Figs. 1-11. Various species of *Ulothrix* from Pakistan.

1. *U. shameelii* x 200. 2. *U. zonata* x 200. 3. *U. tenuissima* x 450. 4. *U. oscillarina* x 900. 5. *U. subtilissima* x 1000. 6. *U. variabilis* x 1600. 7. *U. tenerrima* x 1000. 8. *U. idiospora* x 875. 9. *U. confervicola* x 1000. 10. *U. terrestre* x 1400. 11. *U. aequalis* x 700.

Broken lines indicate the large number of cells in continuation.

7. *U. tenerrima* (Kutz.) Kutz., 1843.

Heering, 1914:32; Prescott, 1951:96; Tiffany & Britton, 1952:26; Ramanathan, 1964:37; Shameel, 1978:382.

Filaments attached or free-floating; cells 7-10  $\mu\text{m}$  thick, 2/3 to 1½ times as long as broad; cell-wall thin, often mucilaginous; plastid girdle-shaped, covering more than half the cell circumference, often in mid-region, sometimes on one side of the cell; pyrenoid 1; one quadriflagellate zoospore from a cell; palmella-stage common and individual cells transformed into aplanospores or zoospores; akinetes single, gametes not observed (Fig. 7).

Locality: Peshawar, Kalam (Leg. Shameel).

8. *U. tenuissima* Kutz., 1843.

Heering, 1914:32; Prescott, 1952:97; Ramanathan, 1964:34; Shameel, 1978:381.

Filaments long, attached by means of broad and short holdfast; later free; cells cylindrical, unstricted at the cross-walls, 15-22  $\mu\text{m}$  thick, 1/4 to 1/2 as long as broad; cell wall thin, unstratified; plastid a broad band encircling the whole cell circumference, rarely up to 2/3; pyrenoids 2 to several; zoospores from somewhat swollen cells (Fig. 3).

Locality: Abbottabad, Peshawar, Madyan (Leg. Shameel), Kalam (Leg. Shameel), Mingora (Leg. Shameel).

9. *U. terrestre* (Mithra) Faridi comb. nov.  
= *Uronema terrestre* Mithra, 1947.

Mithra, 1947:349; Ramanathan, 1964:53.

Filaments short but in culture indefinitely long; holdfast tapering towards lower end, 20  $\mu\text{m}$  broad, with a circular disc at the lower end, green; cells cylindrical, 3-5  $\mu\text{m}$  broad, 22-35  $\mu\text{m}$  long, often swollen at the septa; plastid a parietal plate covering almost the whole cell circumference; pyrenoid 1; terminal cell often acuminate but sometimes especially in culture may be with rounded apex; zoospores 1 from a cell, 5-8 x 6-15  $\mu\text{m}$ , oval, posterior end pointed, with one pyrenoid; plastid cup-like, eye-spot, two contractile vacuoles; 1-2 rounded aplanospores from a cell; akinetes often in chain with thick walls (Fig. 10).

Locality: Peshawar, moist and dry soil.

This species was first described from India and this is the second time it has been collected.

10. *U. variabilis* (Kütz.) Kütz., 1849.

Prescott, 1951:97; Tiffany & Britton, 1952:26; Ramanathan, 1964:39.

Filaments attached or free-floating; holdfast somewhat pointed; filaments not constricted; cells 4.5-7  $\mu\text{m}$  thick;  $\frac{1}{2}$  to  $1\frac{1}{2}$  times as long as broad, cylindrical; cell-wall thin; plastid a parietal folded plate covering  $\frac{1}{2}$  to  $\frac{2}{3}$  cell circumference; pyrenoid 1; one quadriflagellate macrozoospore from a cell; microzoospores 2-4 from a cell; akinetes solitary (Fig. 6).

Locality: Peshawar University.

This is a remarkable species in being a good soil binder.

11. *U. zonata* (Weber & Mohr) Kütz., 1833.

Heering, 1914:35; Prescott, 1951:97; Tiffany & Britton, 1952:26; Ramanathan, 1964:30.

Filaments long, attached by means of a broad and long holdfast, later free; apical end rounded; cells mostly 25-45  $\mu\text{m}$  rarely 20-70  $\mu\text{m}$  broad,  $\frac{1}{2}$  to  $1\frac{1}{2}$  as long as broad, sometimes slightly swollen and constricted at the cross-walls, cell-wall thin but up to 7  $\mu\text{m}$  thick in old filaments; plastid a band, covering the whole cell circumference in the mid region of the cell; pyrenoids 2 to several; nucleus one; macrozoospores 10-15  $\mu\text{m}$  long; microzoospores 8-11  $\mu\text{m}$  long; zoospores quadriflagellate; gametes biflagellate; zygote becomes zygospores, produces zoospores or aplanospores; heterothallic (Fig. 2).

Locality: Peshawar, Kalam, Abbottabad, Wah, Rawalpindi, Lahore, Multan, Quetta, Hyderabad.

### Acknowledgements

Thanks are due to Drs. Mustafa Shameel, S.N. Arbani, Phool B. Zahid and M. Nizamuddin and to Mr. F.M. Sarim, Mr. Zafar Iqbal and Miss Tahira Jabeen for loan of their collections and literature.

### REFERENCES

- Faridi, M.A.F. 1971. The genera of fresh water algae of Pakistan and Kashmir. *Biologia*, 17:123-142.
- Forest, H.S. 1954. Discussion of a portion of the Ulotrichaceae. *Castanea*, 19:61-75.
- Fott, B. 1960. Taxonomische Übertragungen und Namensänderungen unter den Algen. *Prestia*, 32: 142-154.

- Heering, W. 1914. Ulotrichales. *In*: Pascher, A.: Die Susswasserflora Deutschlands, Osterreichs und der Schweiz. 6:1-250.
- Mattox, K.R. and H.C. Bold. 1962. The taxonomy of certain ulotrichean algae. Phycological Studies. III. Austin, Texas.
- Mitra, A.K. 1947. On the strcuture and reproduction of *Uronema terrestre* n. sp. Ann. Bot. N.S., 11:349-361.
- Prescott, G.W. 1951. Algae of the Western Great Lakes Area. Cranbrook Inst. Sci. Bull., 31:1-977.
- Ramanathan, K.R. 1964. Ulotrichales. Ind. Council Agr. Res., New Delhi, pp. 188.
- Shameel, M. 1963. Studies on the genus *Ulothrix* from Swat State. Sci. Soc. Pak., Ann. Conf., Biol. Sec., 5:13-14.
- Shameel, M. 1978. Contribution to *Ulothrix* from Swat, Pakistan. Nova Hedw., 30:377-384.
- Tiffany, L.H. and M.E. Britton. 1952. The Algae of Illinois. Chicago Univ. Press, pp. 407.