

TAXONOMIC STUDIES OF THE GENUS *ZYGNEMA* FROM NORTH-EASTERN AREAS OF PAKISTAN

A. ZARINA¹, MASUD-UL-HASAN* AND MUSTAFA SHAMEEL**

¹Department of Botany,
Federal Urdu University of Arts, Science & Technology,
Gulshan-e-Iqbal Campus, Karachi-75300

Abstract

Ten species of *Zygnema* C. A. Agardh (Zygnemophyceae, Chlorophyta) were collected during December 2003-December 2004 from different freshwater habitats of Gujranwala, Kasur, Lahore, Sheikhupura, Sialkot and Pasrur districts of the Punjab, Attock and Swat in N.W. F. P. of Pakistan and Neelum Valley of Azad Kashmir. They were taxonomically determined and have been described for the first time from these areas. Their reproduction was observed to occur mostly in winter and spring. They were usually found abundant in permanent water habitats.

Introduction

The occurrence of *Zygnema* C. A. Agardh in Pakistan and Kashmir was reported earlier by Faridi (1971). Later on, Khan & Faridi (1977) carried out its detailed taxonomic investigation and reported 14 species from Peshawar Valley (N. W. F. P.) of Pakistan including a new species, *Z. pakistanica* Khan *et al.* Faridi. Since then no composite study was made on this genus from any other area of Pakistan. During a research program, which started in December 2003, a large collection of green algae was made from freshwater habitats of various districts of the Punjab, certain areas of N. W. F. P. and Azad Kashmir (Zarina *et al.*, 2005a, b, 2006). In this program 10 species of *Zygnema* (Zygnemaceae, Zygnemales, Zygnemophyceae Shameel, Chlorophyta; *fide* Shameel, 2001, 2006) have been collected and taxonomically determined. All of them were found to be different from those described by Khan & Faridi (1977).

Materials and Methods

Collections were made during December 2003-December 2004 from different freshwater habitats of Gujranwala, Kasur, Lahore, Sheikhupura, Sialkot and Pasrur districts of the Punjab, Attock and Swat in N. W. F. P. of Pakistan and Neelum Valley of Azad Kashmir. They were taxonomically investigated as described earlier (Zarina *et al.*, 2005a) and were identified with the help of authentic literature (West, 1904; Transeau, 1951; Randhawa, 1959; Prescott, 1962). The voucher specimens are kept in the Phycology & Phycochemistry Lab., MAH Qadri Biological Research Centre, University of Karachi.

Results and Discussion

In the present collection 10 species have been identified. They are taxonomically described for the first time from their area of collection. They were usually abundant in permanent water habitat and were observed to reproduce mostly in winter and spring. Their taxonomic enumerations are as follows:

*Haleema Sheikh Street No. 12, Shahgoharabad, P. O. Baghbanpura, Lahore-54920

**Department of Botany, University of Karachi, Karachi-75270, Pakistan

Zygnema C. A. Agardh 1824

Filaments unbranched, up to 10 mm long; with short, cylindric, uninucleate cells; each cell with two stellate chloroplasts, with a central prominent pyrenoid; sometimes chloroplast connected by a cytoplasmic isthmus; single nucleus lying in between the two chloroplasts; reproduction scalariform or chain conjugation; zygospores mostly spherical; mesosporium may be smooth or variously ornamented; parthenospores (aplanospores) may also be formed. The collected species may be distinguished as follows:

1. Vegetative cells less than 38 μm broad 2
Vegetative cells more than 38 μm broad 3
2. Conjugation only scalariform 4
Conjugation both lateral and scalariform 5
3. Vegetative cells up to 60 μm long *Z. kashmirens* (7)
Vegetative cells more than 60 μm long *Z. czurdae* (2)
4. Vegetative cells up to 35 μm long *Z. khannae* (8)
Vegetative cells more than 35 μm long 6
5. Vegetative cells up to 52 μm long *Z. insigne* (6)
Vegetative cells more than 52 μm long 7
6. Zygospores more than 34 μm broad *Z. normani* (9)
Zygospores up to 34 μm broad 8
7. Zygospores up to 39 μm long *Z. gangeticum* (4)
Zygospores more than 39 μm long *Z. fanaticum* (3)
8. Zygospores more than 37 μm long *Z. cyaneum* (1)
Zygospores up to 37 μm long 9
9. Vegetative cells 43 μm long *Z. subcruciatum* (10)
Vegetative cells 70 μm long *Z. himalayense* (5)

1. *Z. cyaneum* Czurda 1932: 127

(Czurda, 1932: 127; Transeau, 1951: 38; Randhawa, 1959: 246)

Cytological features: Vegetative cells 30-32 μm broad and 55-60 μm long.

Reproductive structures: Conjugation scalariform, zygospores in one of the gametangia; receptive gametangia cylindric; zygospores globose, 30-34 μm broad and 38-45 μm long; wide, median spore wall thick and smooth (Fig. 1).

Locality: Azad Kashmir: Neelum Valley (20-3-2004).

Geographical distribution: U.S.A., India.

Remarks: It was collected in free floating state during spring season. It was found in slow running water of stagnant ponds at Azad Kashmir in low quantity.

2. *Z. czurdae* Randhawa 1936: 239

(Transeau, 1951: 27; Randhawa, 1959: 217; Ghazala *et al.*, 2004: 336)

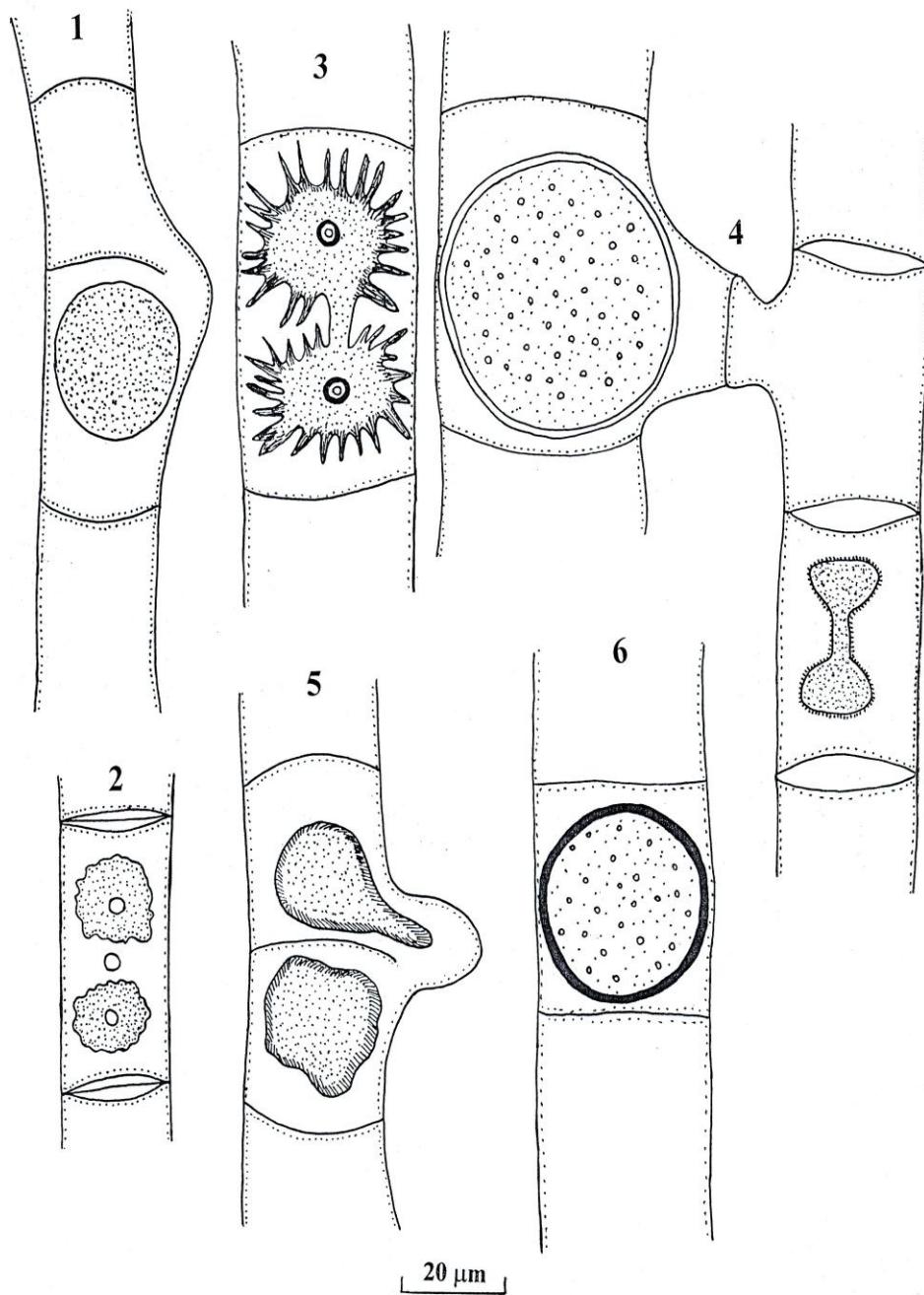
Cytological features: Vegetative cells 32-38 μm broad and 132-136 μm long; chloroplasts showing tiny protuberances (Fig. 2).

Reproductive structures: In the present specimens reproductive stages were not found.

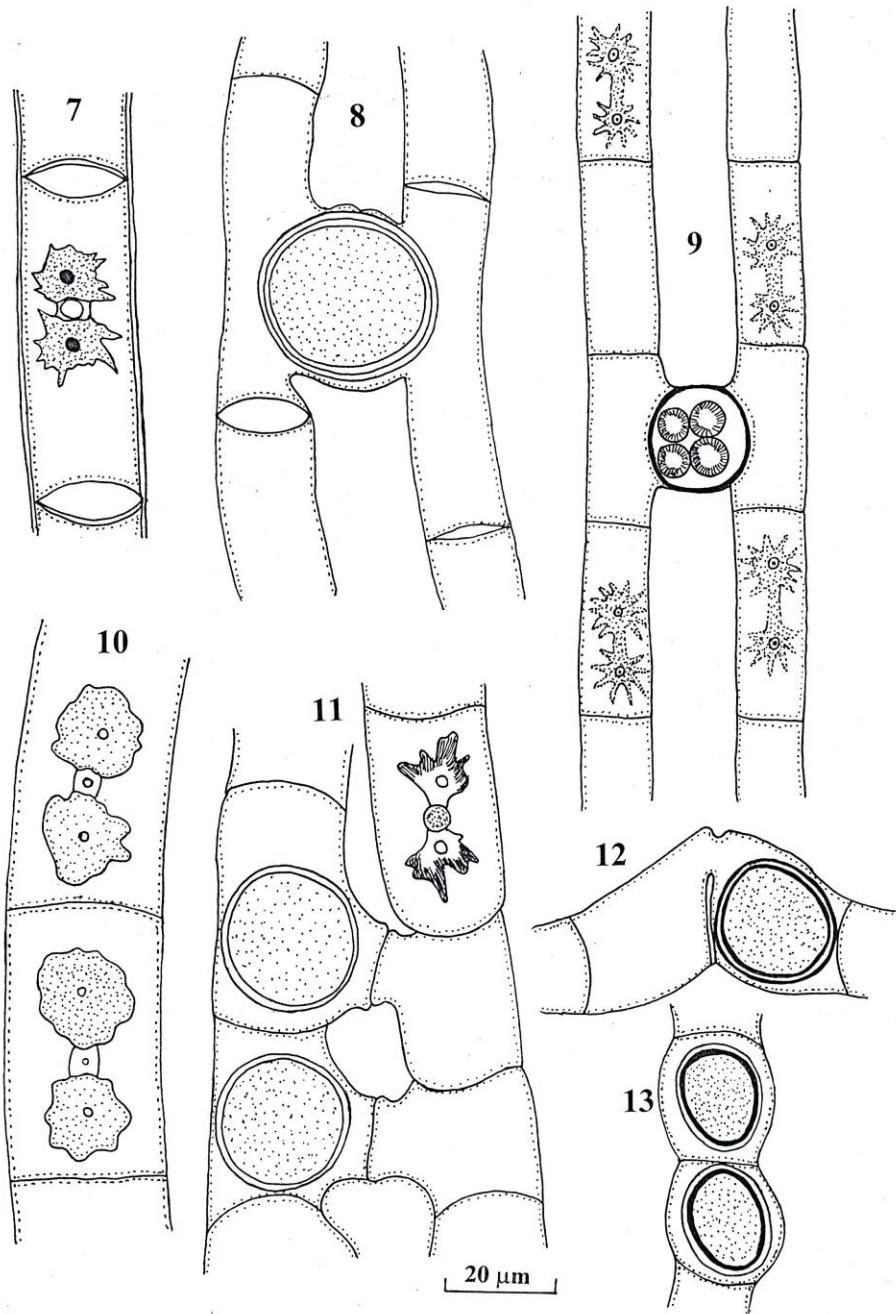
Locality: N.W.F.P.: Swat: between Bahrain and Kalam (13-8-2004).

Geographical distribution: India.

Remarks: The collection was carried out during summer. It was obtained in planktonic state from slow running water of stagnant ponds somewhere in between Bahrain and Kalam.



Figs. 1-6. Species of *Zygnema* from Pakistan: 1. *Z. cyaneum*, 2. *Z. czurda*, 3. *Z. fanicum*: vegetative cell, 4. *Z. fanicum*: scalariform conjugation, 5. *Z. fanicum*: lateral conjugation, 6. *Z. fanicum*: aplanospore.



Figs. 7-13. Species of *Zygnuma* from Pakistan: 7. *Z. gangeticum*: vegetative cell, 8. *Z. gangeticum*: zygospore, 9. *Z. himalayense*, 10. *Z. insigne*: vegetative cells, 11. *Z. insigne*: scalariform conjugation, 12. *Z. insigne*: lateral conjugation, 13. *Z. insigne*: aplanospores.

3. *Z. fanicum* Li 1934: 212
 (Transeau, 1951: 35; Randhawa, 1959: 239)

Cytological features: Vegetative cells 30-34 μm broad and 51-69 μm long; cells contain stellate chloroplasts with several long lobes (Fig. 3).

Reproductive structures: Conjugation scalariform (Fig. 4) and lateral (Fig. 5); receptive gametangia slightly enlarged; zygospores globose, 44-45 μm in diameter; mesosporium yellow and sharply pitted, pits 2-3 μm apart; aplanospores globose 33-35 μm broad and 36-38 μm long (Fig. 6).

Localities: Sheikhupura District: near Sheikhamwala (15-3-2004); Azad Kashmir: Neelum Valley (5-4-2004).

Geographical distribution: China: Hupeh, Kiangsi, Anhwei, Szechwan, Shantung (Transeau, 1951); India.

Remarks: Collection was made from stagnant water ponds and roadside puddles during spring where specimens occurred in free floating state and also mixed with other planktonic algae.

4. *Z. gangeticum* Rao 1937: 270
 (Transeau, 1951: 43; Randhawa, 1959: 216; Masud-ul-Hasan, 1978b: 93)

Cytological features: Vegetative cells 17-25 μm broad and 50-65 μm long (Fig. 7).

Reproductive structures: Conjugation scalariform and lateral; zygospores formed in conjugation tubes and extending into gametangia; zygospores globose to ovoid, 32-39 μm broad and 30-46 μm long; median spore wall yellow-brown and smooth (Fig. 8).

Localities: Kasur District: Kamal Chishti Village (22-12-2003); Sialkot District: Jamkay Village (25-5-2004).

Geographical distribution: India: U. P., River Ganges (Randhawa, 1959).

Remarks: Although specimens were collected from two different areas of the Punjab in summer and winter seasons, slight size differences were found among them. In Sialkot it was found in temporary puddles near residential areas. The temperature was high, pH of water was nearly 8.0 *i.e.* slightly alkaline and water remained stagnant. Such conditions were favourable, therefore, it occurred abundantly as compared to those found in Kasur. In both areas it was found in vegetative as well as in reproductive states.

5. *Z. himalayense* Randhawa 1940: 129
 (Transeau, 1951: 23; Randhawa, 1959: 218)

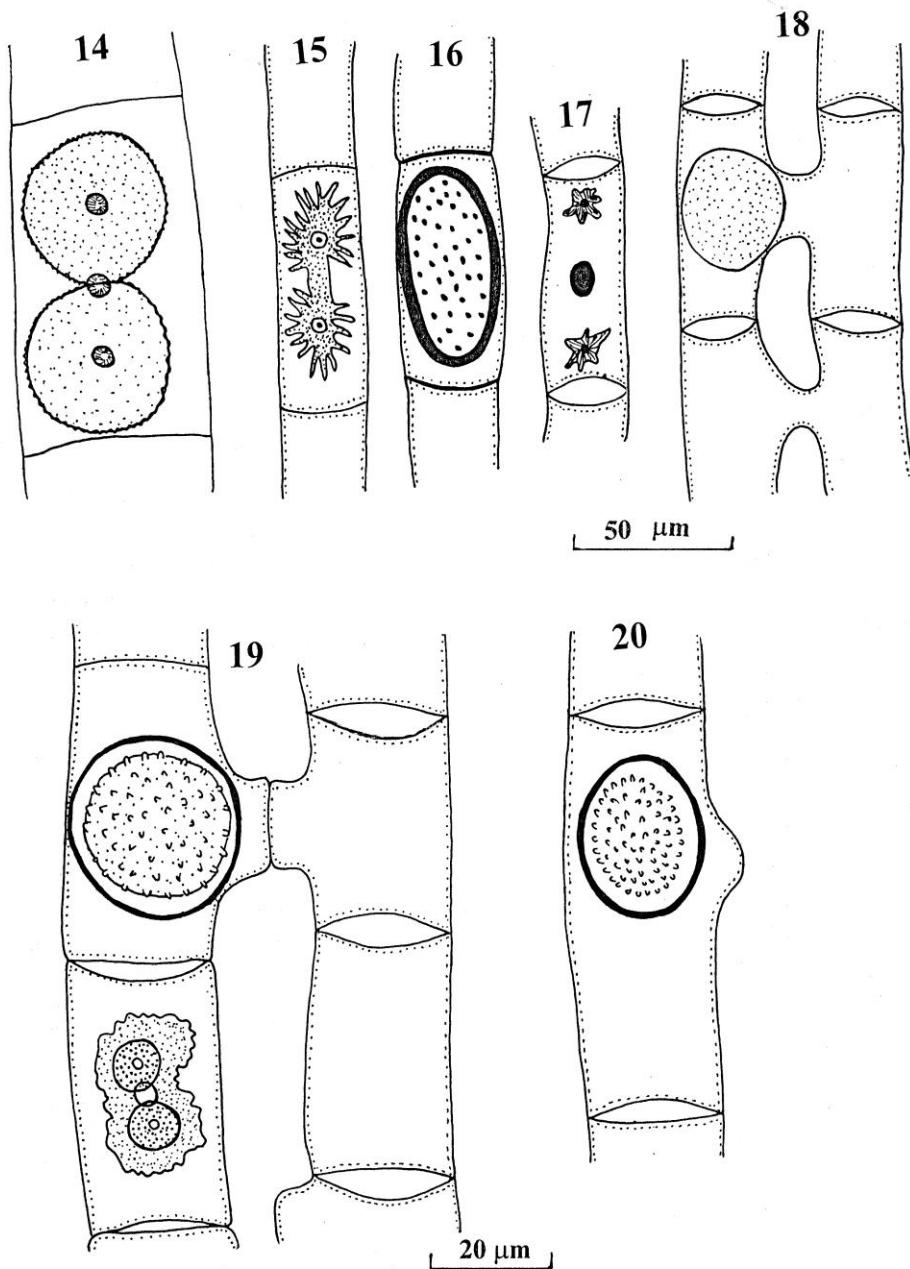
Cytological features: Vegetative cells 20.4- 22.4 μm broad and 68-70 μm long and have two stellate chloroplasts, which are connected by a cytoplasmic isthmus (Fig. 9).

Reproductive structures: Conjugation scalariform; zygospores bluish-green in colour, 35-37 μm long and 64-66 μm in diameter (Fig. 9).

Locality: Sheikhupura District: near Sheikhanwala (15-3-2004).

Geographical distribution: India: at the elevation of 5,750 feet in the Himalaya mountains (Transeau, 1951).

Remarks: Collections were made during spring. It was found in roadside puddles of Sheikhupura, where pH of water was 7.5 *i.e.* slightly alkaline.



Figs. 14-20. Species of *Zygnema* from Pakistan: 14. *Z. kashmirensis*, 15. *Z. khannae*: vegetative cells, 16. *Z. khannae*: aplanospore, 17. *Z. normani*: vegetative cell, 18. *Z. normani*: conjugation, 19. *Z. subcruiciatum*: conjugation, 20. *Z. subcruiciatum*: zygospores.

6. *Z. insigne* (Hassall) Kützing 1849: 444

(West, 1904: 131; Czurda, 1932: 127; Transeau, 1951: 35; Randhawa, 1959: 234; Prescott, 1962: 325; Masud-ul-Hasan, 1978a: 29; Masud-ul-Hasan & Batool, 1987: 355; Masud-ul-Hasan & Yunus, 1989: 110)

Basionym: *Tyndaridea insignis* Hassall.

Cytological features: Vegetative cells 22-56 μm broad and 26-52 μm long (Fig. 10).

Reproductive structures: Conjugation scalariform (Fig. 11) and lateral (Fig. 12); two empty gametangia alternate with two zygospores in one of the gametangium, receptive gametangia cylindrical and enlarged; zygospores globose to sub-globose, 29-31 μm broad and 30-35 μm long; median spore wall yellow-brown and smooth; aplanospores ovoid, 22-24 μm broad and 32-34 μm long, otherwise like zygospores (Fig. 13).

Localities: Gujranwala District: Nandipur (4-4-2004); Lahore District: Batapur (27-9-2004), Salamatpura (11-3-2004); Sialkot District: (25-5-2004), Ravi-Marala link Submaral Road (6-4-2004); N.W.F.P.: Attock: (12-1-2004); Azad Kashmir: Neelum Valley (5-4-2004).

Geographical distribution: U.S.A., South America, Europe, China, Sikkim, India, Australia (Randhawa, 1959).

Remarks: The collection work was carried out in different areas of the Punjab, N.W.F.P. and Azad Kashmir during spring, summer and winter seasons. It was mainly obtained from rice fields, tube well houses near border areas, ponds and puddles, but some collections were also made from gently flowing portion of streams along the road side. It was found in vegetative as well as reproductive state, mixed with other free floating algae. Slight cytological differences were found among the same species.

7. *Z. kashmirensis* Misra 1937: 112

(Randhawa, 1959: 235)

Cytological features: Vegetative cells 39-41 μm broad and 57-60 μm long (Fig. 14).

Reproductive structures: Specimens were found only in vegetative state.

Locality: N.W.F.P.: Swat: Kalam (13-8-2004).

Geographical distribution: Kashmir: Srinagar (Randhawa, 1959).

Remarks: The species occurred in summer season of 2004, in flowing water of Kalam River during which temperature, light intensity, water quantity and pH conditions were suitable for its growth.

8. *Z. khannae* Skuja 1949: 99

(Transeau, 1951: 44; Randhawa, 1959: 255)

Cytological features: Vegetative cells 23-25 μm broad and 33-35 μm long; with two stellate chloroplasts, which are connected by a cytoplasmic isthmus (Fig. 15).

Reproductive structures: Conjugation scalariform; aplanospores 22-24 μm broad and 43-45 μm long (Fig. 16).

Locality: Sheikhupura District: near Sheikhanwala (15-3-2004).

Geographical distribution: Myanmar: near Rangoon.

Remarks: Collections were made during spring season. It was found in stagnant water ponds along the roadside puddles, where the pH of water was 7.5.

9. *Z. normani* Taft 1934: 213
 (Transeau, 1951: 34; Randhawa, 1959: 237; Shahida *et al.*, 2005: 112)

Cytological features: Vegetative cells 24-28 μm broad and 30-73 μm long (Fig. 17).

Reproductive structures: Conjugation scalariform; zygospores in one of the gametangia greatly inflated on conjugation side; zygospores globose or sub-globose, 36-46 μm broad and 35-45 μm long; median spore wall yellow-brown, scrobiculate; pits 3-4 μm in diameter 2.5-4 μm apart (Fig. 18).

Localities: Kasur District: Galwedah (9-12-2004), Raja Jung Village (21-12-2004).

Geographical distribution: U.S.A.: Oklahoma (Transeau, 1951), India.

Remarks: The collections were carried out from two different stagnant water ponds at two different areas of Kasur during winter seasons. Slight cytological and reproductive differences were noticed among these specimens, probably because they occurred in different ecological conditions.

10. *Z. subcruciatum* Transeau 1934: 212
 (Transeau, 1951: 34; Randhawa, 1959: 236)

Cytological features: Vegetative cells 25-26 μm broad and 42-43 μm long (Fig. 19).

Reproductive structures: Conjugation scalariform; zygospores in one of the gametangia (Fig. 19); receptive gametangia cylindrical or enlarged, mostly on the inner side; zygospores globose to ovoid, 24-33 μm broad and 31-37 μm long; median spore wall brown, finally scrobiculate (Fig. 20).

Locality: Pasrur District: Kot Libajuva Village (4-3-2004).

Geographical distribution: U.S.A. Oklahoma, Texas, Arkansas, Louisiana, Illinois, Ohio (Transeau, 1951); Sweden, Norway, France, China (Randhawa, 1959).

Remarks: The collection was carried out during spring, from surface of large ponds as free floating masses. It was found in vegetative as well as reproductive stages.

References

Czurda, V. 1932. Zygneales. In: *Die Süßwasser flora Mitteleuropas*. (Ed.): A. Pascher, Vol. 9, Gust. Fish. Verlag, Jena, 230 pp.

Faridi, M.A.F. 1971. The genera of freshwater algae of Pakistan and Kashmir. *Biologia*, 17: 123-142.

Ghazala, B., M. Shameel, M.I. Choudhary, S. Shahzad and S.M. Leghari. 2004. Phycochemistry and bioactivity of *Zygnema* (Zygnemophyceae) from Sindh. *Int. J. Biol. Biotech.*, 1: 335-342.

Khan, T.M. and M.A.F. Faridi. 1977. *Zygnema* and *Zygnemopsis* in Peshawar. *Pak. J. Bot.*, 9: 67-75.

Masud-ul-Hasan. 1978a. A contribution to the freshwater algae of the Punjab I. *Biologia*, 24: 25-30.

Masud-ul-Hasan 1978b. A contribution to the freshwater algae of the Punjab II. *Biologia*, 24: 81-96.

Masud-ul-Hasan and I. Batool. 1987. A taxonomic study of some freshwater algae from Attock and Sargodha districts. *Biologia*, 33(2): 345-366.

Masud-ul-Hasan and A. Yunus. 1989. An addition to the algal flora of Lahore. *Biologia*, 35: 99-131.

Prescott, G.W. 1962. *Algae of the Western Great Lakes Areas*. 2nd ed., Wm. C. Brown Co., Dubuque, Iowa, 977 pp.

Randhawa, M.S. 1959. *Zygnemaceae*. ICAR, New Delhi, 478 pp.

Shameel, M. 2001. An approach to the classification of algae in the new millennium. *Pak. J. Mar. Biol.*, 7: 233-250.

Shameel, M. 2006. New concept of the class Zygnemophyceae (Chlorophyta). *Int. J. Phycol. Phycochem.*, 2: 103-104.

Transeau, E.N. 1951. *The Zygnemataceae*. Ohio. State. Univ. Press, Columbus, 327 pp.

West, G.S. 1904. *A Treatise on the British Freshwater Algae*. Camb. Univ. Press, Cambridge, 372 pp.

Zarina, A., Masud-ul-Hasan and M. Shameel. 2005a. Taxonomic study of Vaucheriophyta Shameel from certain areas of the Punjab and NWFP, Pakistan. *Int. J. Phycol. Phycochem.*, 1: 159-166.

Zarina, A., Masud-ul-Hasan and M. Shameel. 2005b. Taxonomic study of the order Ulotrichales (Chlorophyta) from north-eastern areas of Pakistan. *Pak. J. Bot.*, 37: 797-806.

Zarina, A., Masud-ul-Hasan and M. Shameel. 2006. Taxonomic study of the class Siphonocladophyceae Shameel from north-eastern areas of Pakistan. *Pak. J. Bot.*, 38: 151-159.

(Received for publication 14 October 2005)