

**New Records of some species of the Genus *Coleochaete* De Bréb .
(Chlorophyceae; Chaetophorales) from Bihar, India and a note on its
evolutionary significance.**

A.N. Kargupta* and Shipra Kumari

P.G. Dept. of Botany, Lalit Narayan Mithila University, Kameshwarnagar, Darbhanga, Bihar – 846008.

* E-mail: an.kargupta@gmail.com

ABSTRACT

During survey of the members of Chaetophorales of North Bihar, the present authors came across four species of the genus *Coleochaete* [*C. soluta* (De Bréb.) Pringsh., *C. irregularis* Pringsh., *C. orbicularis* Pringsh., *C. scutata* De Bréb.] growing over some aquatic angiosperms as epiphytes. Of these three species: *C. soluta* Pringsh., *C. irregularis* Pringsh., *C. orbicularis* Pringsh. form the first record from the state of Bihar.

Key words: Chaetophorales, *Coleochaete*, New Record, Phylogeny, Taxonomy

INTRODUCTION

The taxonomic status of the genus *Coleochaete* is debatable. Fritch (1935) placed this genus in the order Chaetophorales but later based on the features related to cell division and ultrastructure, it was put under Charophyceae at par with Chlorophyceae. Again some evolutionary biologists prefer to elevate the order Coleochaetales of Charophyceae to the rank of a class Coleochaetophyceae at par with Chlorophyceae (An et al., 1999).

The genus *Coleochaete* was studied by a number of workers in the past from different parts of the world. Sarma and Khan (1980) in their monograph recorded only six species of *Coleochaete* from India. P. Sarma (1985) in his book reviewed this genus and recorded altogether nine species, five varieties and four formae. Kargupta (1991) described twelve species of this genus including three taxa: *C. conchata* Moeb. var. *brevicellularis* (Schmidle) Printz, *C. divergens* Pringsh. and *C. pulvinata* A.Br. var. *baileyi* (Moeb.) Printz as new record to Indian flora. Keshri (2010) reviewed this genus including his own work and mentioned altogether eleven species reported from India in which *C. andreae* Szymanska, *C. disjuncta* Tiffany and *C. sampsonii* Transeau are additions to the Indian flora. Addition of these species to Indian flora (Gupta 2012) has been somehow overlooked in the recent monograph on - Algae of India, (Gupta 2012). He mentioned altogether ten species, five varieties and two formae of *Coleochaete* recorded from India. The present communication however deals with the description of four epiphytic species of this genus collected from fresh water bodies of Darbhanga, of which three species are additions to algal flora of Bihar. The following are the descriptions of this taxa communicated in the present paper.

MATERIAL AND METHODS

Algal samples were collected from different wetlands of North Bihar including submerged Leaves, twigs, grasses. The pH and temperature in this habitat were recorded at the time of collection. The samples were preserved in FAA with glycerine (50 ml/L of the preservative). Camera-lucida drawings were made from preserved materials.

RESULTS AND DISCUSSION

1. *Coleochaete soluta* (De Bréb.) Pringsheim
(Gauthier-Lievre 1956, p.41, p1.2, f.34-35; Printz 1964, p.354, p1.110, f.9-12, pl.111, f.1-2; Islam 1974, p.37, f.19-20; Sarma 1986, p.74, f.147-148, p1.25, f.149)

Thallus epiphytic, loosely branched filamentous, radiating from a common centre, fan shaped; cells usually elongate, cylindrical, rectangular, apical cells rounded, showing bifurcations; cells 8.32-21µm long, 8.32µm wide; spermocarp not observed.

Collection no. . SC4a-c, November 16, 2013, Darbhanga, growing as an epiphyte on submerged angiospermic plants and other aquatic grasses in a river (pH-5.0, temp. 25°C)

DISTRIBUTION IN INDIA: Andaman and Nicobar islands (Prasad and Misra 1984), Gujarat (Patel 1968), Maharashtra (Kamat 1975), Punjab (Randhawa and Venkatraman 1962), U.P (Saxena 1962), West Bengal (Kargupta and Sarma 1991).

This is the first record of the species from Bihar

2. *Coleochaete irregularis* Pringsh.

(Gauthier-Lievre 1950, p.38, p1.2, f.28-33; Printz 1964, P.358, P1.112, f.2; Nishihama 1970, p.529, p1.4, f.E-F; Starmach 1972, p.534, f.546; Sarma 1986, p.69, p1.21, f.134-135)

Thallus epiphytic, consisting of irregularly arranged cells, not radiating from a common centre but spread in various directions forming a loose monostromatic expansion; cells rectangular, polygonal, globose in shape; few setae, projecting laterally; cells:- 12-25µm long, 4-9µm broad, 12-16µm in diameter; spermocarp 50µm.in diameter showing the formation of 8 haploid zoomeiospores. This is probably the first record in this species.

Collection no: SC7, March 23, 2014 Darbhanga, growing as an epiphyte on aquatic angiosperms in a pond situated in university campus (pH-5, temp-27°C)

Distribution in India :- Jharkhand (Sinha and Das 1963-64), Maharashtra (Kamat 1963, 1975), West Bengal (Kargupta and Sarma 1991).

This is the first record of the species from Bihar.

3. *Coleochaete orbicularis* Pringsh.

(Gauthier-Lievre, 1956, p.40, p1.3, f.39-41, 43; Printz 1964, p.360, p1.112, f.12; Starmach 1972, p.534, f.549; Islam 1974, p.37, f.21; Sarma 1986, p.71, f.288-289).

Thallus epiphytic, radiating from a common centre, forming a regular, circular or lobed monostromatic disc of branching filaments, laterally coalescent; cells rectangular, orbicular; cells 20-36µm long and 12-21µm broad; spermocarp not observed.

Collection no: SC6a, November 11, 2013. Sahila, Darbhanga growing as epiphytes on aquatic plants and grasses in a pond (pH 5, temp -27°C)

DISTRIBUTION IN INDIA : Gujarat (Patel, 1968), Jharkhand (Sinha and Noor, 1962), Maharashtra (Kamat 1963, 1968, 1974, 1975), Manipur (Bharadwaja 1963), U.P. (Kamat 1973), West Bengal (Saxena 1962).

This is the first record from the state of Bihar.

4. *Coleochaete scutata* De Bréb.

(Gauthier-Lievre 1956, p.39, p1.3, f.42, 45-46; Printz 1964, p.360, p1.112, f.3-11; Starmach 1972, p.532, f.548; Sarma 1986, p.72, p1.23, f.143-144, p.24., f.145, 146, p1.74, f.351)

Thallus epiphytic forming a parenchymatous or pseudo- parenchymatous monostromatic disc of branched filaments radiating from a common centre and laterally coalescent; circular in outline; vegetative cells; rectangular, quadrangular, 8-30µm long, sometimes upto 42µm; 8-21µm broad; thick walled, few setae towards the margin of the thallus; spermocarp spherical, 50-75µm in diameter, corticated, with warts on the oospore wall.

Collection No. SC3, November 15, 2013, Ekmi ghat, Darbhanga, growing in a flooded field (pH- 5-6, temp- 20°C). attached on aquatic weeds and grasses. **DISTRIBUTION IN INDIA :** Bihar (Kargupta 1987), Gujarat (Kamat 1962, Patel 1968), Maharashtra (Gonzalves and Joshi 1946, Kamat 1963, 1975), North India (Turner 1892), Punjab (Randhawa and Venkatraman 1962), U.P. (Randhawa 1936, Singh 1941, Venkatraman 1957), West Bengal (Kargupta and Sarma 1991)

Evolutionary significance of Coleochaete

The genus *Coleochaete* possesses some typical chlorophytean features such as presence of photosynthetic pigments- chl a and b, starch as a reserved food material, non-jacketed unicellular sex organs and haplontic type of life cycle. Its cellular structure and heterotrichous thallus organization show resemblance with the members of this order Chaetophorales. Later some advanced characters also have been observed in this genus like oogamous type of sexual reproduction, retention of zygote on the maternal plant, mature zygote surrounded by vegetative cells and development of spermocarp.

The discoid thallus organization of one of the species of the genus *Coleochaete*- *C.scutata* (described in present communication) looks like the flat thalloid gametophyte of *Riccia*. The more recent studies of Frederick et al. (1973) Pickett Heaps (1975), Graham and McBride (1979) have pointed out that *Coleochaete* possesses certain features like the presence of phragmoplast during cell-division, presence of glycolate oxidase and peroxisomes enzymes and parenchyma in some species, which indicates its affinities with early land plants.

The view that the genus *Coleochaete* might have been the ancestors of land plants proposed earlier by Stewart and Mattox (1975) have been supported by several findings as above including the latest report of Leliaert et al.(2012).

On the basis of morphological, ultrastructural and molecular data (Graham 1984, An et al.1999) focus was laid to Coleochaetophyceae as the closest living relative of the land plants besides Charophyceae and Zygnematophyceae.

A first analysis of 77 nuclear ribosomal proteins genes suggested that *Coleochaete* represents the closest relative of land plants (Finet et al.2010) which agrees with earlier morphology based hypothesis (Graham 1984). *Coleochaete* ranges in morphology from filamentous to relatively complex discoid parenchymatous thalli. In some species the zygote is retained on the maternal plant and corticated after fertilization by a layer of sterile cells and receives nourishment via placental transfer cells with wall ingrowths. The zygote wall possesses sporopollenin, a highly resistant substance found in the outer wall of pollen. Cytokinesis and phragmoplast formation in the genus is typical of land plants.(Graham et al.,2003).Two genes associated with asymmetric cell division (WUSHEL and GNOM) were only found in *Coleochaete*.In addition,several ethylene pathway genes, long thought to be unique to land plant, have also been identified in *Coleochaete* (Leliaert,F.,Smith,D.R., Morean,H. and Herron,M.D.-2012).

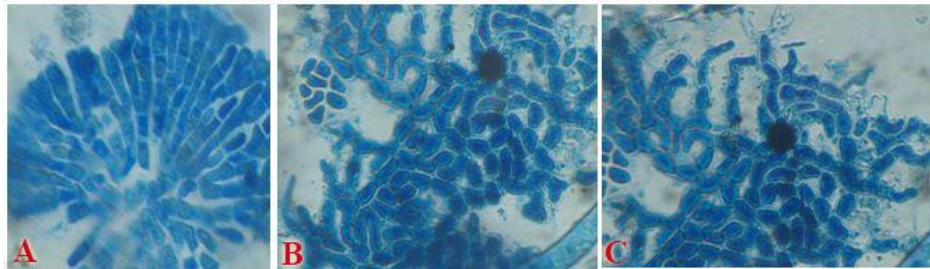


PLATE 1

Fig. A-*Coleochaete soluta* Pringsh. (General habit), A-*Coleochaete soluta* Pringsh. (General habit), B-C;*Coleochate irregularis* Pringsh (General habit showing 8 zoomeiospores.)

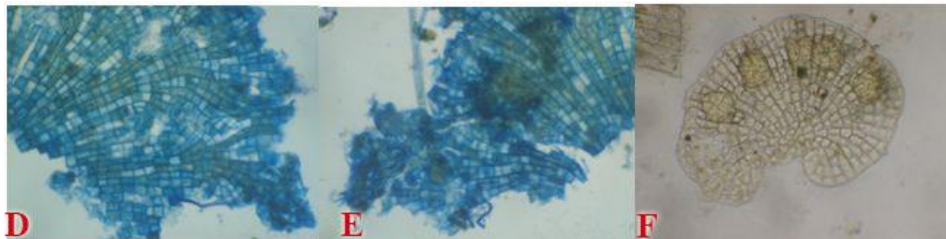


PLATE 2

Fig. D- E : *Coleochaete orbicularis* Pringsh.(General habit)
Fig. F: *Coleochaete scutata* De Brèb. (General habit showing spermocarps)

ACKNOWLEDGEMENTS

The present authors are grateful to Professor and Head of the Department of Botany, L.N.Mithila university, Darbhanga for providing laboratory facilities.

BIBLIOGRAPHY

- An,S.S.,Mopps,B.,Weber,K.and Bhattacharya,D.C1999. The origin and evolution of green algae and plant actins, *Molecular Biology and Evolution*. 16:275-285
- Bharadwaja, Y. 1963. The freshwater algae of Manipur, India. I *Proceedings of Indian Academy of Science*. Section B 57 : 239-258
- Finet,C.,Timme, R.E., Delwiche, C.F.and Marletaz, F.2010. Multigene phylogeny of the green lineage reveals the origin and diversification of land plants. *Current Biology*. 20: 2217-2222
- Frederick, S. E.,Gruber, P. J.and Tolbert, N.E. 1973. The occurrence of glycolate dehydrogenase and glycolate oxidase in green plants. An evolutionary survey. *Plant physiology*. 52: 318-323
- Fritsch, F. E. 1935. The structure and reproduction of the algae I. *Cambridge University press*, London. 791pp.
- Gauthier-Lievre, I. 1956. Ulotrichales africaines 1. Genres '*Aphanochaete*' et '*Coleochaete*'. *Bull. Soc. Hist. Natur. Afrique Nord* 47: 31-49
- Gonzalves, E.A. and Joshi, D.B. 1943. The algal flora of temporary waters around Bombay II. A study of the algae in some rainwater puddles at Jogeswari. *J.University Bombay*. 11: 120-128.
- Graham,L.E. 1984. *Coleochaete* and the origin of land plants. *American journal of Botany*.71: 603-608.
- Graham,L.E. and McBride, G.E. 1979. The occurrence and phylogenetic significance of a multilayered structure in *Coleochaete* spermatozoids , *American journal of Botany*. 66: 887- 894
- Graham ,L.E. and Wilcox, L.W. 2000. *Algae*. Prentice-Hall , upper saddle river, New Jersey.640pp.
- Gupta, R.K. 2012. Algae of India- A check list of chlorophyceae, Xanthophyceae, Chrysophyceae and Euglenophyceae. Volume 2, *Botanical Survey of India*, Kolkata, India 428pp.
- Islam, A. K. M. N. 1974. Freshwater algae of Bangladesh IV, (*Aphanochaete*, *Coleochaete* and *Chaetosphaeridium*).- *Bangladesh Journal of Botany*. 3: 35-43
- John, D. M., Whitton, B. A. & Brook, A. J. 2008. The freshwater algal flora of the British Isles, *Cambridge University press* 702pp.
- Kamat, N. D. 1962. Chlorophyceae of Ahmedabad, India. *Hydrobiologia*. 20 : 248-279
- Kamat, N. D. 1963. The algae of Kolhapur, India. *Hydrobiologia*. 22: 209-305.
- Kamat,N.D. 1968. Algae of Alibag, Maharashtra. *journal of Bombay Natural history society* 65: 88-104
- Kamat,N.D. 1974. Algae of Marthwada, Maharashtra, *Phykos* 13: 22-32
- Kamat, N. D. 1975. Algae of Vidarbha, Maharashtra. *J. Bombay Natural History Society*. 72 : 450-476
- Kargupta, A. N. 1987. New reports of some members of Chaetophorales from Bihar, India, *Advances in Bioscience*. 6: 155-172
- Kargupta, A.N. & Sarma, P. 1991. New records of *Coleochaete* species from West Bengal, India. *Bangladesh Journal of Botany*. 20 : 149-156

- Keshri, J.P. 2010. Contribution to our knowledge of Coleochaetales (Charophyta) of West Bengal, India. *Algological Studies* 134: 41-54
- Krishnamurthy, V. 2000. Algae of India and neighbouring countries. I. Chlorophycota. *Oxford & IBH*, New Delhi, 210pp.
- Leliaert, F., Smith, D.R., Morean, H., Herron, M. D. 2012. Phylogeny and molecular evolution of the green algae. *Critical review in plant sciences* 31: 1-46
- Nishihama, Y. 1970. A preliminary note on some species of *Coleochaete* from Hokkaido, Japan. *Nova Hedwigia* 19: 523-534
- Patel, R. J. 1968. On *Coleochaete* from Gujarat (India). *Phykos* 7: 90-97
- Pickett-Heaps, J.D. 1975. Green algae. Structure reproduction and evolution in selected genera. Sinauer Associates Sunderland, Mass. 606 pp.A.
- Prasad, B. N. & Asthana, D. K. 1977. Observations on the genus *Coleochaete* De Bréb. *Geophytology* 7: 38-43
- Prasad, B. N. & Mishra, P. K. 1984. Some Chaetophorales from Andaman & Nicobar Islands. *Phykos* 23: 80-87
- Prescott, G. W. 1962. Algae of the western great lakes area. 2nd ed.- Brown Co., Iubaque, Iowa, 977 pp.
- Printz, H. 1964. Die Chaetophorales der Binnengewässer. *Hydrobiologia*. 24: 1-376
- Randhawa, M. S. 1936. Occurrence and distribution of the freshwater algae of North India. Proceedings of Indian Academy of Science. Section B. 4: 36-44
- Randhawa, M. S. & Venkataraman, G. S. 1962. Notes on some Chaetophorales from India. *Phykos* 1: 44-52.
- Sarma, P. 1986. The freshwater Chaetophorales of New Zealand. Beith. *Nova Hedwigia* 58 : 1-169
- Sarma, Y.S.R.K. and Khan, M. 1981. Algal taxonomy in India. *Today and Tomorrow's printers and publishers*, New Delhi 133pp.
- Saxena, P. N. 1962. Algae of India I. Chaetophorales. *Bulletin of Natural Botanical Garden*. 57: 1-59.
- Singh, V.P. 1941. The chlorophyceae of the Benaras District, U.P, India 1. proceedings of Indian Academy of Science. sec.B 14 : 256-260
- Sinha, J.P. & Das, R.N, 1963-64. A note on the occurrence of members of Chaetophorales of Chotanagar. *Journal of Ranchi university*. 2 & 3: 43-47
- Sinha, J. P. & Noor, M. N. 1962. A preliminary report on the occurrence of freshwater green algae of Chotanagpur plateau. *Journal of Ranchi University*. 1: 70-78.
- Starmach, K. 1972. Flora slodkowodna Polski , Tome 10. Chlorophyta III polska Akademia Nauk Instytut Botaniki, Krakow, 755pp.
- Turner, W.B. 1892. Algae aquae Dulcis Indiae orientalis. Fresh water algae (principale Desmidiaceae) of East India. *K.Svensk vet- Akad.Handle*. 25: 1-187
- Venkataramana, G.S. 1957. The algal flora of ponds and puddles inside the Banaras Hindu University grounds, India. *Journal of Bombay Natural History society*. 54: 908-919