

## ***Borzia* (Cyanophyta) in West Bengal, India, with the description of *B. indica* sp. nov.**

Sudip CHATTERJEE & Jai Prakash KESHRI\*

Department of Botany, The University of Burdwan, Golapbag, Burdwan-713104,  
West Bengal, India.

(Received 14 October 2003, accepted 10 September 2004)

**Abstract** – Three species of *Borzia* (Cyanophyta): *B. trilocularis*, *B. susedana* and *B. indica* sp. nov. are described and illustrated. The materials studied were collected from different locations of the Burdwan district of West Bengal. The taxonomic validity of the genus is discussed. With the exception of a listing by Kamat (1972), this genus has not been previously reported from India.

***Borzia* / Cyanobacteria / new records / new species / India**

**Résumé** – *Borzia* (Cyanophyta) au Bengale occidental, Inde, avec la description de *Borzia indica* sp. nov. Trois espèces de *Borzia* (Cyanophyta), *B. trilocularis*, *B. susedana* et *B. indica* sp. nov. sont décrites et illustrées. Le matériel étudié a été récolté dans différentes localités du district de Burdwan au Bengale occidental. La validité taxinomique du genre est discutée. Le genre n'avait encore été signalé de l'Inde que de l'Etat de Mysore, par Kamat en 1972.

### INTRODUCTION

*Borzia* Cohn ex Gomont is an interesting genus of Cyanophyta that is believed to exist in a permanent hormogonial condition. Due to this unusual habit, questions have been posed regarding the validity of the genus (Geitler, 1925; 1932; 1942; Elenkin, 1949; Hollerbach *et al.*, 1953; Drouet, 1968; Bourrelly, 1970a, b) and it is often confused with the hormogonia of cyanobacterial taxa such as *Tolypothrix*, *Stigonema* and *Calothrix* (Bourrelly, 1970a; Anagnostidis & Komárek, 1988). Geitler (1932) included *Borzia*, with its then two species *B. trilocularis* Cohn ex Gomont and *B. susedana* Ercegovič, in his monographic account on Cyanophyceae, suggesting that it is believed that the species might not represent separate entities and many mistake them as hormogonia of other genera. He was, however, impressed by the permanent hormogonial condition and believed the genus to occur only in this form. Based on observations in culture of the morphology and life history of several species of the *Borzia*, Pringsheim (1968), Anagnostidis (1977), Anagnostidis *et al.* (1983), Bicudo (1985) and Ribier *et al.* (1993) supported recognition of the genus.

---

\* Correspondence and reprints: keshrijp@sancharnet.in  
Communicating editor: Pierre Compère

Castenholz *et al.* (2001) have therefore included it in Bergey's Manual of Systemic Bacteriology (2<sup>nd</sup> Edition Volume I, p. 543).

The following list includes the main species of *Borzia* as recognized by Anagnostidis & Komárek (1988), Baker *et al.* (1997), Anagnostidis (2001) and Komárek *et al.* (2003):

1. *Borzia austriaca* (Claus) Anagnostidis et Komárek 1988
2. *B. brevis* (Kufferath) Anagnostidis 2001
3. *B. curta* (Lemm.) Anagnostidis et Komárek 1988
4. *B. elongata* Baker, Patterson et Ikagawa 1997
5. *B. endophytica* (West & G.S. West) Anagnostidis et Komárek 1988
6. *B. hollerbachii* Anagnostidis et Komárek 1988
7. *B. perikleii* Anagnostidis 1988
8. *B. susedana* Ercegovič 1925
9. *B. trilocularis* Cohn ex Gomont 1892

It has been suggested that several of these species be transferred to *Pseudoanabaena* (*B. endophytica*, *B. hollerbachii* and *B. starkii*) or to *Hormoscilla* (*B. endophytica* Li, *B. spongelliae* (Schulze) Feldm. and *B. xishaensis* Hua) by Anagnostidis & Komárek (1988) and Anagnostidis (2001), as they do not fit perfectly into the criteria set by the above mentioned workers. Two more unnamed species have been reported from marine epiphytic environments by Silva & Pienaar (2001).

During systematic investigations on the cyanobacterial flora of the Burdwan district of West Bengal, the authors recorded three species of *Borzia*; these not only add new information to the algal diversity of Indian sub-continent but also a species new to science.

## MATERIAL AND METHODS

Specimens were collected from soil samples from different locations in the Burdwan district. Some materials were grown in culture and others were preserved in 5% formalin. For culture, the specimens were inoculated in slants using medium [Modified BG-11 without N<sub>2</sub>- source (Stanier *et al.*, 1971)] solidified with 3% agar. The pH of the medium was recorded as 7.5, without using any buffer solution. The slants were then kept in aseptic conditions to obtain optimum growth, under the illumination of two standard Philips tube lights (IS-2418) of 40-Watt capacity for 8 hrs: 4 hrs in normal shady condition: 12 hrs of dark intervals. Temperature was maintained at 27°C. Growth was observed under light microscopy (Olympus GB model) at two week intervals to enable a complete understanding of its life cycle pattern. Camera lucida drawings were made from both field-collected and cultured specimens.

## RESULTS AND DISCUSSION

Key to the species of *Borzia* described:

1. Cells greater than 13 µm broad ..... *B. indica* Chatterjee et Keshri sp. nov.
1. Cells less than 7 µm broad ..... 2
  2. Cells 3.5 - 4.5 µm broad and 2.1 - 4 µm long ..... *B. susedana* Ercegovič
  2. Cells 6-7 µm broad and 5-6 µm long ..... *B. trilocularis* Cohn ex Gomont

***Borzia trilocularis* Cohn ex Gomont 1892** (Figs 1, 2)

Gomont, 1892: 198, pl. VI, f. 5; Geitler, 1932: 914, f. 587; Anagnostidis *et al.*, 1983: 237, f. 8; Bicudo, 1985: 489-493, figs. 1-11; Anagnostidis & Komárek, 1988: 370, f. 3; Ribier *et al.*, 1993: 3, f. 1-15; Castenholz *et al.*, 2001: 443.

Trichomes blue green in colour, composed of 3-6 cells without a sheath, conspicuously constricted at cross walls, cells 6-7  $\mu\text{m}$  broad and 5-6  $\mu\text{m}$  long, terminal cells of the trichome hemispherical with broadly rounded apex, other cells barrel-shaped.

**Habitat:** Specimens were found growing on the moist surface of soil near lime heaps at Anandapally, Burdwan. The pH recorded at the site was 7.5 and temperature 22°C at the time of collection.

Apart from a listing by Kamat (1972), this taxon has not been reported from India.

***Borzia susedana* Ercegovič 1925** (Figs 3, 4, 5)

Geitler 1932: 914; Anagnostidis & Komárek 1988: 370, f. 5.

Trichomes blue-green in colour, short, 3-6 celled, cells about 3.5-4.5  $\mu\text{m}$  broad and 2.1-4  $\mu\text{m}$  long, calcareous; trichomes without sheaths, with distinct constrictions between the cells.

**Habitat:** The alga was found growing in calcareous and shady situations near a drain on the wet soil. The pH recorded was distinctly alkaline, approximately 8. Associated taxa were *Lyngbya* sp. and *Scytonema* sp.

This is the first report of this species from India.

***Borzia indica* Chatterjee et Keshri, sp. nov.** (Figs 6, 7, 8)

*Trichomata 3-7 cellularia, distincte caeruleo-viridia, sine vagina et distincte constricta ad septa; cellulae 13-15  $\mu\text{m}$  latae et 7-9  $\mu\text{m}$  longae; cellulae extremae distincte rotundatae et cellulae ceterae inflato-orcyliformes.*

**Holotypus:** No. SC 4, die 14/11/2002, Specimina lecta ad locum Anandapalli, Burdwan, ad locos humidos calcareos prope canales, pH 7.5, temp. ca 22°C, et positus in herbario algarum, Sectionis Botanices, Universitatis Burdwanensis (BURD), Burdwan, Benghala occ., India.

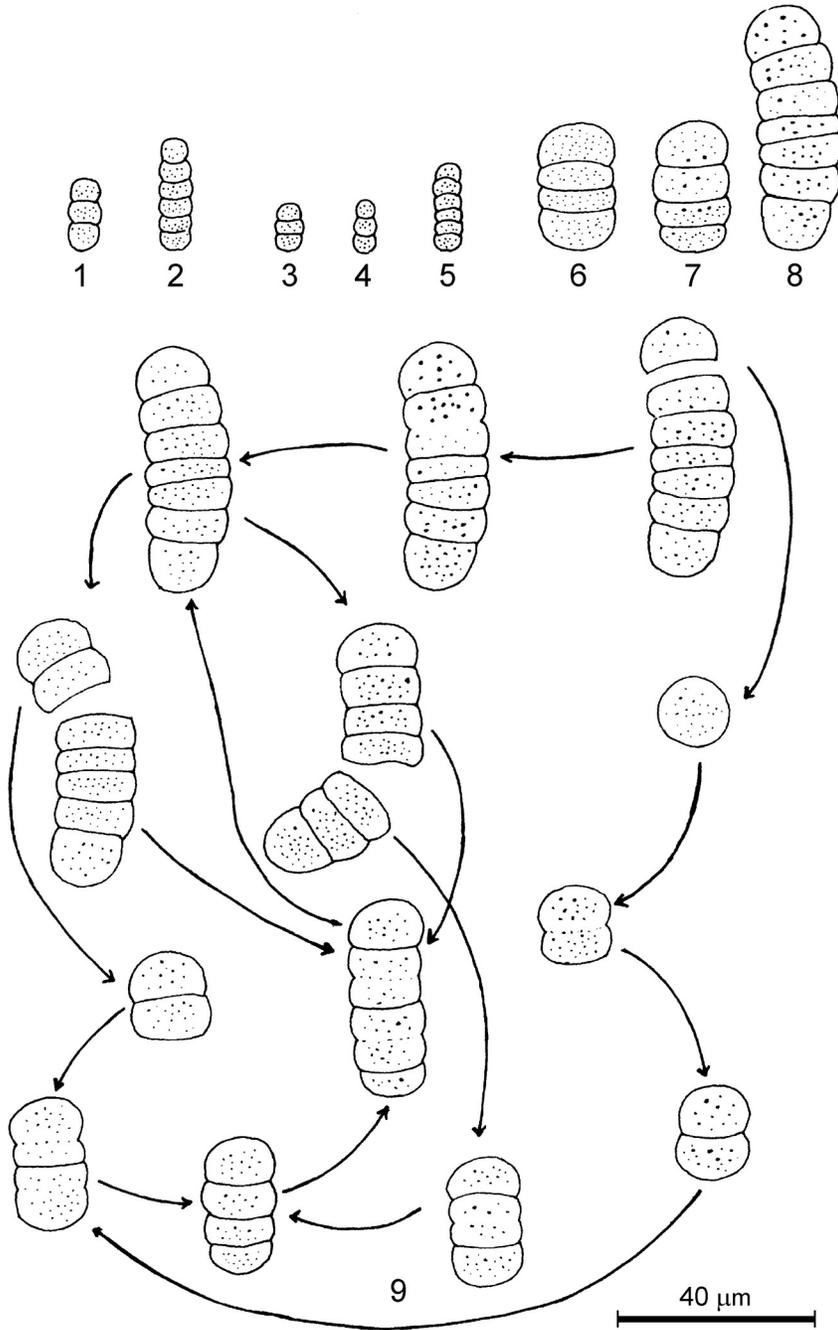
Trichomes 3-7 celled, distinctly bluegreen in colour, without a sheath and distinctly constricted at the cross walls; cells 13  $\mu\text{m}$ -15  $\mu\text{m}$  broad and 7  $\mu\text{m}$ -9  $\mu\text{m}$  long, end cells distinctly rounded and other cells inflated and barrel shaped.

**Holotype:** No.- SC 4 dated 14/11/2002. The specimens were collected from damp and wet calcareous situations near drains from Anandapalli, Burdwan, pH was 7.5, temperature around 22°C at the time of collection; deposited in the algae herbarium, Department of Botany, The University of Burdwan (BURD), Burdwan, West Bengal, India.

The specimens have been cultured using BG – 11 medium at 3000 Lux, and temperature between 26°C and 28°C at Phycology Laboratory, The University of Burdwan (Strain No. B.U.C.B.50-II).

The vegetative structure of *Borzia indica* resembles *B. trilocularis* Cohn ex Gomont in its gross morphology, but the new species differs in being much wider and more inflated. Apical cells of the trichome are sub-spherical with rounded apices. There are also very prominent constrictions between the junctions. Trichomes are short, normally only 3-7 cells long, but 8 to 12 celled trichomes were infrequently encountered.

Vegetative division by fragmentation appeared to be the only mode of reproduction under standard culture conditions (Fig. 9). The new fragments were of varied lengths, with three very common types observed: i) single-celled frag-



Figs 1-9. **1-2.** *Borzia trilocularis* Cohn ex Gomont. **3-5.** *Borzia susedana* Ercegovič. **6-8.** *Borzia indica* Chatterjee et Keshri sp. nov. **9.** Life cycle of *B. indica* Chatterjee et Keshri sp. nov.

ments; ii) two-celled fragments; iii) three-celled or rarely more (4-5) long fragments. After inoculation the trichomes generally break into large fragments until two months of growth under optimal growth conditions. During this period the fragment lengths remain at 3-4 celled. Interestingly, the fragments gradually diminish to two-celled and then single-celled after two months and when the medium becomes overcrowded. The tip cells of the trichomes generally do not divide except under low nutrient conditions due to overcrowding. Under such conditions they may produce new mature trichomes through repeated divisions. The nutrient level of the medium thus seems to play an important role in determining the length of the fragments.

The life history and general morphology of the new species match in all respects that of the type species, *B. trilocularis*, with the exception of the large differences in dimensions. Thus we have no hesitation in proposing *B. indica* Chatterjee *et* Keshri sp. nov. as new to science. The present species differs from all other species of *Borzia* in having broader and more inflated cells (Anagnostidis & Komarek, 1988; Baker *et al.*, 1997; Anagnostidis, 2001; Silva & Pienaar, 2000).

The new species described herein, along with the descriptions of Indian specimens of two well-established species of *Borzia*, represent a new contribution to the cyanobacterial diversity of the Indian sub-continent. While *Borzia* exhibits some similarities with the hormogonia of *Tolypothrix* or *Scytonema*, the existence of an independent life history pattern, as shown from the observations in culture, supports the autonomy of the genus. This conclusion is in agreement with those of previous workers such as Pringsheim (1968), Anagnostidis (1977, 1983), Bicudo (1985), Ribier *et al.* (1993) and Castenholz (2001).

**Acknowledgements.** Thanks are due to the Head of the Department of Botany, The University of Burdwan, for laboratory facilities; the government of West Bengal for awarding the fellowship to Sudip Chatterjee; Prof. Jiří Komárek and Prof. G.L. Tiwari for providing valuable literature. The constant encouragement of Prof. Pranjit Sarma throughout this work and Prof. Sadashib Rao of Foreign language Department of the University of Burdwan for translation of some literature from German to English are all gratefully acknowledged.

## REFERENCES

- ANAGNOSTIDIS K., 1977 — Some remarks on the taxonomy of the genus *Borzia* Cohn ex Gom. from Greece. *Schweizerische Zeitschrift für Hydrologie* 39: 121-122.
- ANAGNOSTIDIS K., 2001 — Nomenclatural changes in the cyanoprokaryotic order Oscillatoriales. *Preslia, Praha* 73: 359-375.
- ANAGNOSTIDIS K., ECONOMOU-AMILLI A. & ROUSSOMOUSTAKAKI M., 1983 — Epilithic and chasmolithic microflora (Cyanophyta, Bacillariophyta) from marbles of Parthenon (Acropolis-Athens, Greece). *Nova Hedwigia* 38: 227-287.
- ANAGNOSTIDIS K. & KOMÁREK J., 1988 — Modern approach to the classification system of cyanophytes.3. Oscillatoriales. *Archiv für Hydrobiologie/Algological Studies* 50/53: 327-472.
- BAKER K.K., PATTERSON G.M.L. & IKAGAWA M., 1997 — Preliminary description of *Borzia elongata* sp. nov., a representative of a valid genus in Oscillatoriales. *Archiv für Hydrobiologie* 118: 1-12.
- BICUDO C.E.M., 1985 — *Borzia* Chon ex Gomont: Only a hormogonal or a true genus of blue-green algae?. *Archiv für Hydrobiologie/Algological Studies* 41: 489-493.
- BOURRELLY P., 1970a — *Les algues d'eau douce. III. Les algues bleues et rouges. Les Eugléniens, Peridiniens et Cryptomonadines*. Paris, Boubée, Cie., 512 p.

- BOURRELLY P., 1970b — Note sur la famille des Oscillatoriaceae. *Schweizerische Zeitschrift für Hydrologie* 32: 519-522.
- CASTENHOLZ R.W., RIPKA R. & HERDMAN M., 2001 — Form-genus II *Borzia* Cohn ex Gomont 1892. In: Boone D.R. & Castenholz R.W. (ed.), *Bergey's Manual of Systematic Bacteriology*. 2<sup>nd</sup> ed. New York, Springer, pp 443.
- DROUET F., 1968 — *Revision of the classification of the Oscillatoriaceae*. Monograph of the Academy of Natural Sciences, Philadelphia 15, 370 p.
- ELENKIN A.A., 1949 — *Monographia Algarum Cyanophycearum aquidulcium et terrestrium in finibus URSS inventarum*. II. Izdat Acad. Nauk SSSR, Moskva — Leningrad, pp. 985-1908.
- GEITLER L., 1925 — *Cyanophyceae*. In: Pascher A. (ed.), *Süßwasserflora* 12. G. Fischer, Jena, 450 p.
- GEITLER L., 1932 — *Cyanophyceae*. In: Rabenhorst L. (ed.), *Kryptogamenflora von Deutschland, Österreich und der Schweiz*. 14. Leipzig, Acad. Verlagsges., 1196 p.
- GEITLER L., 1942 — *Schizophyta (Klasse Schizophyceae)*. In: Engler & Prantl (eds), *Natürliche Pflanzenfamilien* 1b. Berlin, 232 p.
- GOMONT M.M., 1892 — Monographie des Oscillariées (Nostocacées homocystées). *Annales des Sciences Naturelles, Botanique, série 7*. Paris 16: 91-264.
- HOLLERBACH M.M., KOSINSKAJA E.K. & POLJANSKIJ V.I., 1953 — *Sinezeleye vodorosli (Blue-green algae)*. In: *Opredelitel presnovodnykh vodoroslej SSSR*. 2. Moskva, Nauka, 652 p.
- KAMAT N.D., 1972 — Oscillatoriaceae of Mysore state. *Phykos* 11: 59-63.
- KOMÁREK J., KOMÁRKOVÁ J. & KLING H., 2003 — 4. Filamentous Cyanobacteria. In: Wehr J.D. & Sheath R.G. (ed.), *Freshwater Algae of North America: Ecology and Classification*. New York, Academic Press, pp. 117-196.
- PRINGSHEIM E.G., 1968 — Cyanophycean - Probleme. *Planta* 79: 1-9.
- RIBIER J., PATILLON M. & FALXA M.J., 1993 — *Borzia trilocularis* Très rare cyanobactérie d'eau douce, isolé d'un sol aride (Negev, Israël). *Cryptogamie, Algologie* 14: 1-9.
- SILVA S.M.F. & PIENAAR R.N., 2000 — Bethnic Marine Cyanophyceae from Kwa-Zulu Natal, South Africa. *Bibliotheca Phycologica Band 107*, 456 p.
- STANIER R.Y., KUNISAWA R., MANDEL M. & COHEN-BAZIRE G., 1971 — Purification and properties of unicellular blue-green algae (Order Chroococcales). *Bacteriological Review* 35: 171-205.