

## 96. RECORD OF THE MARINE CYANOBACTERIA FROM THE ROCKY SHORES OF BET-DWARKA AND OKHA, INDIA

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*Citas de cianobacterias marinas del litoral rocoso de Bet-Dwarka y Okha, India*

Keywords. Cyanobacteria, Sea Shore, Flora, Bet-Dwarka, Okha, India

Palabras clave. Cianobacteria, litoral marino, flora, Bet-Dwarka, Okha, India

Cyanobacteria – the largest group of phototropic prokaryotes have been in the corner stone of biology for long. They are oxygenic, photosynthetic, microorganisms and are widely distributed over a diverse range of habitats (Nagarkar, 1998). Remaining in the oblivion, uncared and unrecognized, it has shot into fame and popularity owing to a host of their innate properties that make them ideal organisms for use in a variety of ways to meet our needs and to promise us a bright future. Presently the biotechnological exploitations range from its use in production of biofuel such as hydrogen (Bagai & Madamwar, 1999); wastewater treatment (Shah *et al.*, 1999); production of antimicrobial compounds (Smith & Doan, 1999); exopolysaccharides (Shah *et al.*, 2000) and other various applications in fertilizer and food industry. At this juncture of expansion of cyanobacterial biology it is essential to explore new species of cyanobacteria existing in the nature, isolate and purify it and subsequently establish a collection, which then could be a door for the biotechnological exploitation (Shah *et al.*, 2000). Komarek, & Anagnostidis (1986) reported the new approach for the classification of cyanophytes.

As described in detail (Thajjudin & Subramanian, 1992) very little work has been carried out on the cyanobacterial flora of marine areas of India. Also, with the exceptionally high rate of species getting extinct, the study

on the distribution of types of species across different distributions is necessary. The regular study on such lines will help us to know the effect of anthropogenic activities on the colonization and decolonization of the species at particular locus.

Extensive literature survey has shown no records of cyanobacteria from the shores of Bet-Dwarka and Okha, India. Therefore an attempt has been made in this direction.

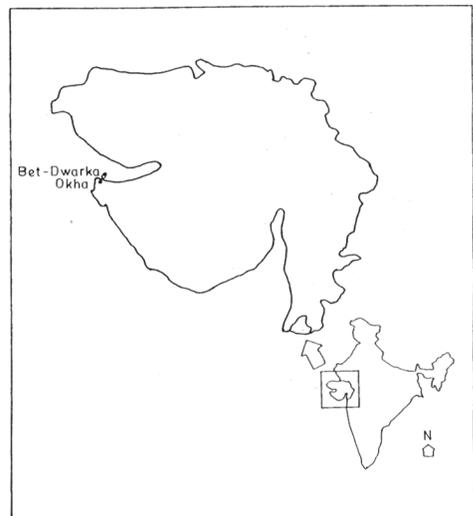


Figure 1. Location of the study area at Gujarat, India.

Samples of cyanobacteria were collected from the rocky shores of Bet-Dwarka and Okha ports, Gujarat, India (located between 20' and 25' latitude and 65' and 70' longitude) (fig. 1). The cultures were collected from shore sand, stones, floating biomass and other substrates along the sea. The cyanobacteria specimens were collected in polythene bags and plastic vials and were later transferred to sterile seawater media having 100 mg NaNO<sub>3</sub>, 100 mg CaCl<sub>2</sub> and 100 mg KH<sub>2</sub>PO<sub>4</sub> per litre of sea water. Cyanobacteria were isolated by dilution plate and surface plating techniques. Cyanobacteria were made free of diatoms and green algae by adding 0.16 mM of cyclohexamide final concentration for 24 hours with incubation in light. Antibiotic combination of ampicillin and streptomycin was used at a final concentration of 40mg/ml and 100mg/ml respectively to make it free of the bacterial flora. The cultures were maintained in the modified sea water as mentioned earlier at 25°C with dark/light cycle of 8/16 hours. The light intensity was of 3,000 lux.

Identification of the taxa was done with the help of classical manuals (Geitler 1932; Desikachary, 1959 and Freymy 1929, 1933) and observing under light microscope (40 X magnification).

## CYANOBACTERIA

### CHROOCOCCALES

#### Chroococcaceae Nageli

##### *Microcystis* Kutzing

*M. litoralis* (Hansg) Forti (fig. 2.a) (= *Aphanocapsa litoralis* Hausg.)

(Desikachary, 1959 p. 85, Geitler, 1932 p. 134; Freymy, 1933 p. 11)

Colony round or ellipsoidal, with colonial mucilage that is not homogenous, cells spherical or ellipsoidal, many in single colony, with distinct individual sheaths, up to twice as long as broad, closely arranged, pale blue-green.

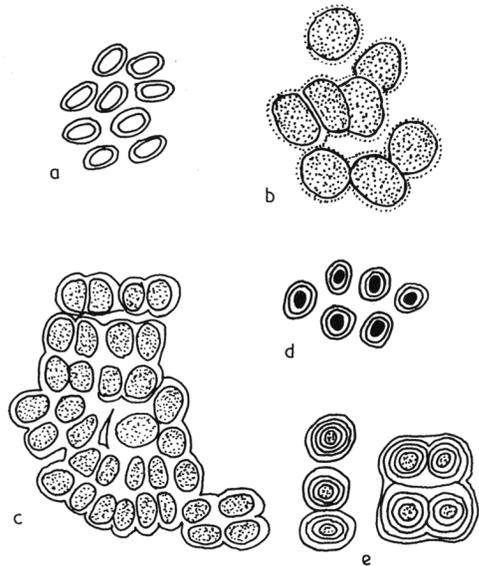


Figure 2. (a) *Microcystis litoralis* (Hansg) Forti (b) *Chroococcus minutus* (Kutz) Nag (c) *Chroococcus cohaerens* (Breb). Nag (d) *Chroococcus westii* (W. West) Boye-Petersen (e) *Gleocapsa decorticans* (A. Br.) Richter.

#### *Chroococcus* Nag

*Ch. minutus* (Kutz) Nag (fig. 2. b)

(Desikachary, 1959 p.102, pl. 24, fig. 4 & pl. 26, figs. 4, 15; Geitler 1932, p. 232, fig. 112a, 113c; Freymy 1933, p.24, pl. 4, fig. 6)

Cells are spherical; single rarely in groups of 2-4, diameter of 4-6 µm (with out sheath); cell content homogenous; colonies 10-12µm X 15-17 µm; light blue green.

*Ch. cohaerens* (Breb). Nag (fig. 2.c)

(Desikachary 1959, p. 111, pl. 26, fig. 3.9; Geitler 1932, p. 238, fig. 116 c; Freymy 1929, p. 44, fig. 47)

Thallus slimy, gelatinous, blue or dark-green; cells single or up to 2 – 8 in group, without envelope 4-7µm diameter, with sheath 5-7µm diameter; sheath thin, colorless, unlamellated.

*Ch. westii* (W. West) Boye-Petersen (fig. 2.d)

(Desikachary 1959, p. 103; Geitler 1932, p. 230, fig. 108d)

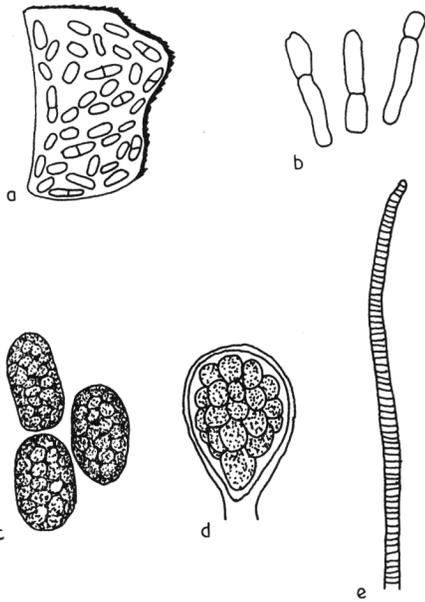


Figure 3. (a) *Aphanothece microscopica* Nag. (b) *Synechococcus elongatus* Nag (c) *Synechococcus aeruginosus* Nag. (d) *Dermocarpa leibleiniae* (Reubscg) Bornet et Thuret (e) *Oscillatoria laetevirens* (Crouan) Gomont Var. *minimus* Biswas.

Cells single or in groups of 2-4, without sheath 13-27 $\mu$ m diameter, with sheath 18-32  $\mu$ m diameter, violet; sheath colourless, distinctly lamellated.

### *Gleocapsa* Kutzing

*G. decorticans* (A. Br.) Richter (fig. 2.e)

(Desikachary 1959, p. 114, pl. 24, fig. 9; Geitler 1932, p.184, fig. 83b)

Cells spherical or sometimes oval, blue-green, single or up to 2-4 together; single cells with 19 X 21  $\mu$ m, without sheath 6 X 8  $\mu$ m, in a two celled stage with sheath 22 X 30  $\mu$ m, without sheath up to 12  $\mu$ m long; sheath colorless, thick, distinctly lamellated.

### *Aphanothece* Nag.

*A. microscopica* Nag. (fig. 3.a)

(Desikachary 1959, p. 142, pl. 22, fig. 4,5,9; Freymy 1929, p 28, fig. 30; Geitler 1932, p. 172, fig. 79).

Thallus small gelatinous, amorphous, up to 2

mm diameter; cells oblong, cylindrical, more or less 4.5  $\mu$ m broad, 1 1/2 - 2 times as long as broad, with sometimes distinct, individual sheath, blue-green, colorless, nannocytes present.

### *Synechococcus* Nag.

*S. elongatus* Nag. (fig. 3.b)

(Desikachary 1959, p. 143, pl. 25, fig. 7,8; Geitler 1932, p. 273, fig. 133a-c)

Cells cylindrical, 1.4 -2  $\mu$ m broad, 1 1/2 - 3 times as long as broad, single or 2-4 cells together; contents homogenous and light blue green.

*S. aeruginosus* Nag. (fig. 3.c) (= *Cyanothece aeruginosus*)

(Desikachary 1959, p. 143, pl. 25, fig. 6,12; Geitler 1932, p. 274, fig. 133d)

Cells cylindrical, 5-16  $\mu$ m broad, up to 30  $\mu$ m long, single, or 2-4 together, pale blue-green.

## CHAMAESIPHONALES

### Dermocarpaceae

#### *Dermocarpa* Crouan

*D. leibleiniae* (Reinsch) Bornet et Thuret (fig. 3.d)

(Desikachary 1959, p. 173, pl.33, fig. 20-21; Geitler 1932, p. 399, fig. 224; Freymy 1933, p. 161, pl. 17, fig. 3)

The sporangia is olive-green or brownish, mostly single, elongate, oval or spherical, 7-9  $\mu$ m broad, with a thick dark brown membrane. The entire protoplasm is divided successively to form 6 - 19 endospores which are 1-2  $\mu$ m in diameter.

## OSCILLATORIALES

### Oscillatoriaceae

#### *Oscillatoria* Vaucher

*O. laetevirens* (Crouan) Gomont var. *minimus* Biswas (fig. 3.e)

(Desikachary 1959, p. 213, pl. 39, fig. 2,3)

Trichomes 2.5-3 $\mu$ m in diameter, somewhat fragile, slightly constricted at the cross walls, apex of the trichome slightly tapering, more or less curved, not distinctly hooked, apical cell acute and

somewhat pointed, calyptra absent; cells 1.5-2  $\mu\text{m}$  in length; cross walls granulated, 3 granules on either side; cell contents uniformly granular, blue-green.

### *Trichodesmium* Ehrenb.

*T. erythraeum* Ehrenberg ex Gomont (fig. 4.a)

(Desikachary 1959, p. 245, pl. 42, fig. 1,2; Geitler 1932, p.968, figs. 617a,d)

Trichomes in free swimming bundles, straight, parallel, constricted at the cross-walls, the ends gradually attenuated, 7-11  $\mu\text{m}$  broad, rarely upto 21 mm; cells as long as broad or up to 1/2 as long as broad, 5.4 – 11  $\mu\text{m}$  long; apex with a depressed conical or convex calyptra.

### *Phormidium* Kutz.

*Ph. corium* (Ag.) Gomont (fig. 4.b)

(Desikachary 1959, p.269, pl.44, fig. 10-11; Geitler 1932, p. 1018, fig. 649; Frey 1929, p. 150, fig. 133)

Thallus expanded, membranous, leathery; filaments are olive green, straight, densely entangled; sheath is diffluent, hyaline and very thin; trichomes are 1-3  $\mu\text{m}$  wide with slightly constricted cross walls; cells are barrel shaped; slightly shorter than wide; cross walls not granulated; the end cells are obtuse conical.

*Ph. tenue* (Menegh) Gomont (fig. 4.c)

(Desikachary 1959, p 259, pl 43, fig. 13 – 15 & pl 44, fig. 7a; Geitler 1932, p 1004, fig. 642 d,e; Frey 1929, p. 146, fig. 131)

Thallus pale blue-green, thin, membranous, expanded; trichome straight or slightly bent, densely entangled, slightly constricted at cross walls, attenuated at the ends, 1-2  $\mu\text{m}$  broad, pale blue-green; sheath thin; cells up to 3 times longer than broad, end cells acute conical.

*Ph. fragile* (Meneghini) Gomont (fig. 4.d)

(Desikachary 1959, p 253, pl 44, fig. 1-3; Geitler 1932, p 999, fig. 636 b; Frey 1933, p. 86, pl. 22, fig. 6)

The filaments are dull blue green, more or less flexuous entangled or nearly parallel; sheath is hyaline and very thin; the trichomes are 1-2  $\mu\text{m}$  wide, constricted cell cross walls; cells are quadrate or longer than wide; 1-3  $\mu\text{m}$  long; cross walls are not granulated and the protoplasm is homogenous. The end cells are attenuated, acute conical without a calyptra.

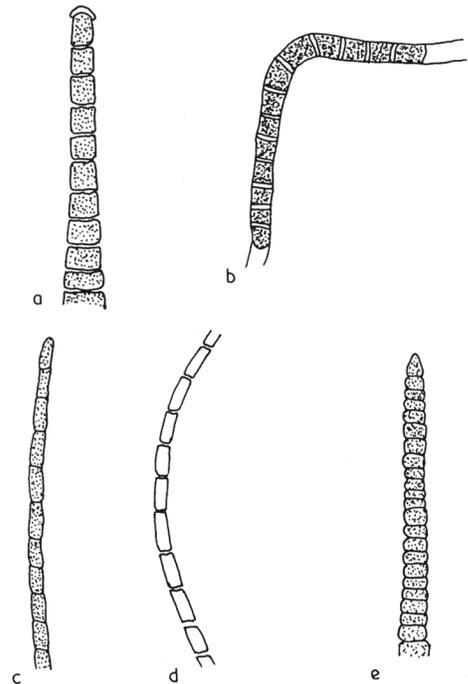


Figure 4. (a) *Trichodesmium erythraeum* Ehrenberg ex Gomont (b) *Phormidium corium* (Ag.) Gomont (c) *Phormidium tenue* (Menegh) Gomont (d) *Phormidium fragile* (Meneghini) Gomont (e) *Phormidium jadinianum* Gomont.

*Ph. jadinianum* Gomont (fig. 4.e)

(Desikachary 1959, p 256, pl 55, fig. 9; Geitler 1932, p 1002, fig. 640; Frey 1929, p. 136, fig. 118).

Thallus dark-green, thin, amorphous; filaments more or less parallel; sheath thin, diffluent; trichome olive-green, distinctly constricted at the cross-walls, with straight long acuminate ends, 4 – 6 mm broad; cells shorter than broad to nearly quadrate, 2 – 3.5 mm long, contents granulated with a hyaline central area, septa not granulated; end cell acute conical, calyptra absent.

### *Lyngbya* Ag.

*L. limnetica* Lemmermann (fig. 5.a)

(Desikachary 1959, p 294, pl 50, fig. 11; Geitler 1932, p 1046, fig. 661 a,b; Frey 1933, p.

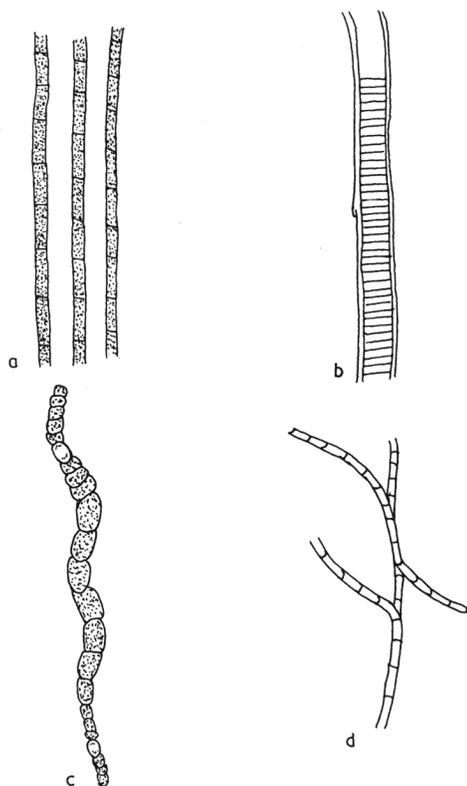


Figure 5. (a) *Lyngbya limnetica* Lemmermann (b) *Lyngbya martensiana* Menegh. ex Gomont (c) *Anabena variabilis* Kutzing ex Born. Et Flah (d) *Plectonema terebrans* Bornet ex Gomont.

110, pl. 29, fig. 3)

Filaments straight or slightly curved or coiled, single, free-floating, 1-2  $\mu\text{m}$  broad; sheath thin, colourless; cells 1 – 1.5  $\mu\text{m}$  broad, quadrate to 1/3 rarely 1/8 as long as broad, 1 – 3  $\mu\text{m}$  long, not constricted at the cross walls, with or without a granule at the cross-walls, pale blue-green; end cells not attenuated, rounded.

*L. martensiana* Menegh. ex Gomont (fig. 5.b)

(Desikachary 1959, p 318, pl 52, fig. 6; Geitler 1932, p 1064, fig. 676; Freymy 1933, p. 107, pl. 29, fig. 1).

Thallus caespitose, blue-green, when dried violet, filaments long more or less flexible; sheath colourless, thick; trichome 6-10 mm broad, not constricted at the cross walls, cross wall sometimes granulated, apices not attenuated, pale blue-green;

cells 1/2 - 1/4 times as long as broad, 1.75 – 3.3  $\mu\text{m}$  in length; end cell rounded, without calyptra.

#### *Plectonema* Thuret

*P. terebrans* Bornet ex Gomont (fig. 5.d)

(Desikachary 1959, p 435, pl 61, fig. 4,5; Geitler 1932, p 683, fig. 437 a; Freymy 1933, p. 99, pl. 25, fig. 5).

Filaments long, flexuous, with sparse false branching; false branches single, sheath very thin, trichomes blue-green, not constricted at the cross-walls; cells are 2-6 $\mu\text{m}$  long, granule on either side of the cross-walls, end cells rounded.

### NOSTOCALES

#### Nostocaceae

#### *Anabena* Bory

*A. variabilis* Kutzing ex Born. Et Flah (fig. 5.c) (= *Trichormus variabilis*)

(Desikachary 1959, p 410, pl 71, fig. 5; Geitler 1932, p 876, fig. 558; Freymy 1929, p. 360, fig. 294)

Thallus gelatinous, dark-green; trichome without any sheath, flexuous, 4 – 6  $\mu\text{m}$  broad, slightly constricted at the cross-walls, end cells conical, obtuse; cells barrel-shaped, sometimes with gas-vacuoles, 2.5 – 6  $\mu\text{m}$  long; heterocysts spherical or oval, 6  $\mu\text{m}$  broad, up to 8 mm long; akinetes formed centrifugally, not contiguous with the heterocysts, barrel-shaped, in series, 7 – 9  $\mu\text{m}$  broad, 8 – 14  $\mu\text{m}$  long, epispore smooth, or with fine needles, colourless.

**ACKNOWLEDGEMENT.** The work was sponsored by University Grants Commission, New Delhi.

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Acceptedo para su publicación en julio de 2001

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## 97. NOTAS COROLÓGICAS DEL MACROFITOBENTOS DE ANDALUCÍA (ESPAÑA). V

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*New records for the macrophytobenthos of Andalusia (Spain). V.*

Palabras clave. Andalucía, *Asparagopsis taxiformis*, *Desmarestia dresnayi*, Macroalgas marinas, *Spatoglossum solierii*.

Key words. Andalusia, *Asparagopsis taxiformis*, *Desmarestia dresnayi*, *Spatoglossum solierii*, seaweeds.

El listado de macroalgas marinas del litoral andaluz ha sido reseñado por Flores-Moya *et al.* (1995a, 1995b) y Conde *et al.* (1996a, 1996b). Este trabajo continua en esa línea, aportando 14 nuevas citas para las provincias de Almería, Cádiz, Granada y