

## A new species of heterocystous cyanoprokaryota from Sikkim, Eastern Himalayas (India).

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Short running title: *Scytonema (Myochrotes) adhkarii* sp. nov.

Total number of figures: 02

### Abstract

'*Myochrotes*' Bornet & Flahault 1887, is a section or subgenus of *Scytonema*, with morphological differentiation in the structure of trichome and sheath. A new species, i.e *Scytonema (Myochrotes) adhkarii* has been described for the first time from the Sikkim Himalayas based on morphological analysis. The taxon is distinguished from all existing species and closely looking taxa through morphological characterization of trichomes and the sheath.

**Key words** – *Scytonema (Myochrotes) adhkarii* sp. nov., Sikkim, Eastern Himalayas

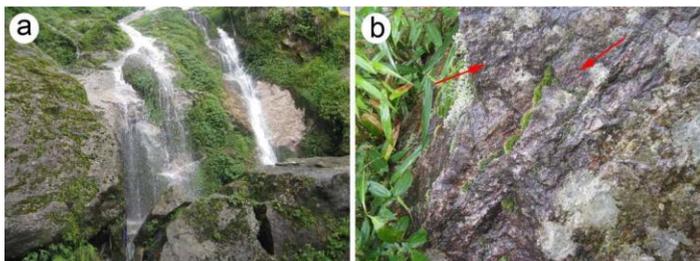
### Introduction

Eastern Himalayas are pretty landscapes with scenic range of snow-clad mountains to lush-green forests interlaced with bountiful of freshwater bodies like alpine to subalpine lakes, mountain rivers and streams with numerous waterfalls. These freshwater bodies are mostly oligotrophic and house an interesting phycobiota. Epilithic substratum near the streams and waterfalls (including both core zone and spray zone) are generally colonized by cyanobacteria, which cause the slippery appearance of the rocks.

Sikkim is a small state in Eastern Himalayas sharing its political boundary with West Bengal, Bhutan, Nepal and south-east Tibet in China. The complex topography and a wide altitudinal variation from 244 m to 8598 m a.s.l. create a favorable microclimatic ambience for its unique biodiversity. Santra (1984) studied the Cyanophycean flora of Sikkim Himalaya for the first time. Prasad & Khanna (1987) reported Cyanophytes specially Oscillatoriaceae from different parts of Sikkim. After that there are several sporadic documentations of blue green algae of the region during the phycological exploration of Sikkim (Suseela & Toppo 2004, 2005, 2006; Bhakta et al 2010; Das & Keshri 2013). Forty three cyanobacterial taxa from different regions of Sikkim were recorded by Das & Adhkary (2014). But, there is no novel cyanobacterial documentation from the state so far. In the present work, a new species is being described for the first time from the Sikkim Himalayas based on morphological analysis. The taxon is distinguished from all existing species and closely looking taxa through morphological characterization of trichomes and the sheath.

### Materials and methods

Cyanobacteria were collected from sub-alpine mountain streams of Eastern Himalayas in Sikkim, India, sampled during September, 2014 (Fig. 1). The collected samples were preserved with 4% formaldehyde solution and deposited in Central National Herbarium of Botanical Survey of India, Howrah (CAL). Microscopic observations and morphological study was made with Nikon microscope Ni-11 fitted with Nikon Digital Camera DS-Ri1-U3 and operated by Nikon Imaging Software NIS-D+EDF.



**FIGURE 1:** a. Stream at Samdung, East Sikkim, b. occurrence of *Scytonema (Myochrotes) adhkarii* sp. nov. as blackish brown biofilm on rock surface

## Results and discussion

Family – Scytonemataceae

Genus – *Scytonema* sect. *Myochrotes* Bornet & Flahault 1887

### *Scytonema (Myochrotes) adhkarii* Sudipta K. Das sp. nov. (Fig. 2 a – i)

Thallus flat, slightly slimy, blackish brown; trichomes cylindrical; of uniform width throughout, not narrowed or widened towards end, faintly constricted at the crosswalls in the middle and distinctly constricted towards the end; filaments straight, (18) 20 – 27.5 (32)  $\mu\text{m}$  wide, with frequent pseudo-branching; sheath thick, lamellated, transparent to grayish in young filaments, yellowish brown in mature filaments, sheath layers parallel, sometimes divergent towards the end of matured filaments, bursting of sheath at filament tip with emerging trichome commonly seen; trichomes narrowed in the middle portion of the filament, 10.5 – 14  $\mu\text{m}$  width; cells cylindrical, pale blue green, quadratic shape in mature filaments and short barrel shaped towards the tip, end cells distinctly hemispherical; heterocysts intercalary, elongated elliptical, 10 – 18.5  $\mu\text{m}$  long and 6.5 – 10  $\mu\text{m}$  wide.

Type: INDIA, Sikkim, East Sikkim, Samdung stream, 62884, 1873 m a.s.l., 27°22.123' N and 88°32.308' E, S.K. Das, 4 September 2014 (Holotype CAL!, Alg. 054)

Etymology: The species has been named as *Scytonema adhkarii* after Prof. S.P. Adhkary as a tribute to his invaluable contribution to the study of cyanobacteria of Eastern regions of India.

Ecology: Blackish brown coloured slimy mat on rock in a stream of Samdung, East Sikkim, Sikkim.

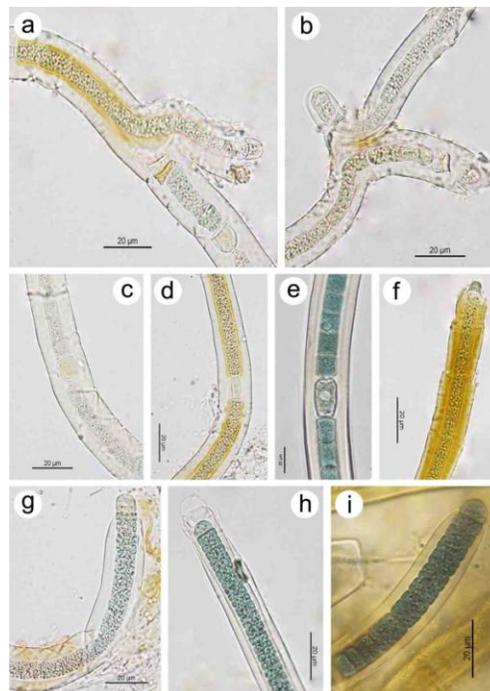


FIGURE 2: Cellular morphology of *Scytonema (Myochrotes) adhkarii* sp. nov., a-b. pseudo-branching, c-e. trichomes with lamellated sheath, f-i. bursting of the tip and emerging of filaments

*Myochrotes* is a subgenus or section of the genus *Scytonema* sensu lato, established by Bornet & Flahault (1887). In recent years, the view was thoroughly supported by taxonomists (Komárek 2013, Komárek et al 2013) though was validated through morphological studies only due to lack of any supporting molecular data. The subgenus is characterized by open, upwardly divergent sheath layers resembling to that of the genus *Petalonema*, with consecutive bursting and opening of sheath at filament tips producing significant funnel shaped collars. Narrowing of trichome at the medial (mature) portions is another characteristic feature of the subgenus.

The present taxon showed some phenotypic resemblances with *Scytonema (Myochrotes) mirabile* (Dillwyn) Bornet and *Scytonema (Myochrotes) myochorus* (Dillwyn) C. Aagrhdh ex Bornet & Flahault. A comparison between their morphological features is presented in Table 1.

**Table 1 – Phenotypic comparison of the *Scytonema (Myochrotes) adhikarii* sp. nov. with the closely look alike taxa.**

Morphological features	<i>Scytonema (Myochrotes) mirabile</i>	<i>Scytonema (Myochrotes) myochorus</i>	<i>Scytonema (Myochrotes) adhikarii</i> sp. nov.
Trichome texture	Cylindrical; slightly narrowed or widened towards ends; Not or very slightly constricted at the crosswalls in the middle and distinctly constricted towards the end	Cylindrical; slightly wider at the ends; Not constricted at the crosswalls; may be slightly at the ends	Cylindrical; uniform width throughout, not narrowed or widened towards end; Faintly constricted at the crosswalls in the middle and distinctly constricted towards the end
Sheath structure	Yellow or yellow brown, mostly parallel, less (at the ends) with divergent layers, outer layers colourless and slightly gelatinizing	Dark yellow or yellow brown, with divergent layers,	Yellow to yellow brown, parallel but rarely with divergent layers towards the end in matured filaments.
Filament width	(7.6) 12 – 21 (30) µm	(14) 18 – 36 (40) µm	(18) 20 – 27.5 (32)
Cell morphology	Blue-green or olive-green; Cylindrical, towards end barrel shaped	Blue-green or olive-green; Cylindrical, in older parts of trichomes quadratic, slightly short barrel shaped towards the end	Pale blue-green; Cylindrical, quadratic in mature trichomes, slightly short barrel shaped towards the end
End cells	Usually hemispherical, rounded	Rounded	Distinctly hemispherical
Heterocysts	Quadratic or longer than wide, rarely almost spherical	Cylindrical, rarely spherical or shortly obliquely elliptic	Elongated elliptical

Unlike both the closely look alike taxa, the present taxon had uniform trichome width throughout, though a variable trichome width is commonly observed in most of the species of *Myochrotes*. The sheath structure in both *S. (M.) mirabile* and *S. (M.) adhikarii* is similar, but the occurrence of divergent sheath layers in the apical area is more in the former and almost rare in the newly described species except a few mature filaments. Unlike both the species, the present taxon had elongated elliptical heterocysts.

Based on the distinct morphological features, *Scytonema (Myochrotes) adhikarii* Sudipta K. Das can be considered as a novel species and can be treated as a significant addition to the cyanobacterial flora of India.

#### Acknowledgements

The author is grateful to the Director, Botanical Survey of India for facilities and encouragement and also thankful to the Department of Forests, Environment and Wildlife Management, Govt. of Sikkim for providing necessary help during sample collection.

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