



## Occurrences of Mosses in Indian Mangrove Forests

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### Abstract

For the first reporting mosses in salt water provisions like estuaries. In our recent field survey on the mosses in mangrove forests at Krishna, Godavari and Brahmani-Baitarani estuaries, India have brought to light two new records in mosses at Brahmani-Baitarani estuary and none at Krishna, Godavari estuaries. The two new recorded mosses are identified as *Octoblepharum albidum* Hedwig and *Taxithelium nepalense* Brotherus on the trunks of *Cocos* and *Rhizophora* species respectively at Brahmani-Baitarani estuary, Odisha, India. Both the species are very scarcely exists and identified on stressed conditions.

**Key words:** New records, Mangroves, Brahmani-Baitarani estuary and India.

### 1. Introduction

The mosses are highly evolved group of bryophytes and bio-monitors (Karr, 1981; Tingey, 1989) with around (ca.) 17,000 species falling in 3 subclass, 4 order, 89 families and ca. 898 genera across the world (Kumar et al., 2011). Among bryophytes mosses are small flowerless plants, typically composed of simple, one-cell thick leaves, attached to a stem that may be branched or unbranched and lack of vascular tissue for water transport but they need damp, fresh water and shady locations to survive or reproduce (Ligrone et al., 2000; Kimmerer, 2003). In India, 355 genera with 1786 species were recorded around Assam, Sikkim, Darjeeling, Manipur, Kashmir, Shimla, Arunachal Pradesh, Tamil Nadu, Kerala, Mussoorie, Khasia, Palni, Nilgiri and Naga Hills, Eastern and Western Himalaya (Van der Velde et al., 2001; Dandotiya et al., 2011). The shade and water tolerance varies from species to species, till now the maximum mosses were recorded from fresh water province around the world and India and there were no mosses recorded around salt tolerant regions of the south coastal line of Andhra Pradesh and Odisha, India as well as other regions of world. Moreover, till now there are no records of mosses in and around salt water regions like oceans, coral reefs and estuaries. So, our main objective is to investigate whether or not mosses occur in and around mangrove forest regions. Hence, we have

done field survey on mosses in Krishna and Godavari estuaries at Andhra Pradesh along with Brahmani-Baitarani estuary, Odisha, India.

### 2. Materials and Methods

#### 2.1 Collection of specimens

The fresh materials of mosses were collected from the Bhitarkanika Island at Brahmani-Baitarani estuary area, India during March 2016 (Fig 1). The specimens were stored in paper packets prepared according to Schofield's method (Schofield, 1985). The collected species were analysed by Dr. Ankita Srivastava using Olympus BX-50 microscope and compared with relevant literature available on the collected species. The herbariums were prepared using collected species with label number having collection date, locality, habit, habitats and collector's name and deposited at Bryophyte Herbarium, National Botanical Research Institute (NBRI), Lucknow, India.

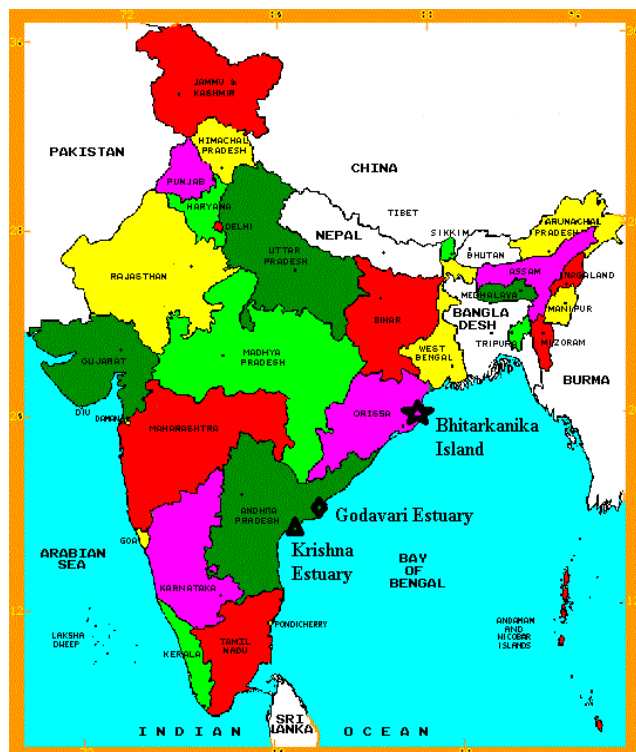
#### 2.2 Details of coordinates and elevation

2.2.1 About 5 km from the banks of Brahmani-Baitarani estuaries into the Bhitarkanika Island, Rajnagar, Odisha, 20°65'23''N and 86°86'91''E, alt. 0 m.

2.2.2 About 2 km from Vainateya Island, Godavari estuary, Andhra Pradesh, 16°48'59''N and 81°98'19''E with 0 m.

2.2.3 About 15 km from Gullalamodha village towards Nagayalanka lighthouse, Krishna estuary,

Andhra Pradesh, wet black soil, 15°77'34''N and 80°96'29''E with 10 m.



**Fig 1.** Location of Krishna and Godavari estuaries at Andhra Pradesh along with Brahmani-Baitarani estuary, Odisha, India.

### 3. Results

The collected specimens during the field were identified as *Octoblepharum albidum* Hedwig belong to family *Leucobryaceae* (Fig 2-3) and *Taxithelium nepalense* Brotherus belong to family *Sematophyllaceae* (Fig 4-5). For the first time we are reporting them from Orissa state, India on mangrove forest region.

#### 3.1 *Octoblepharum albidum* Hedwig

##### 3.1.1 Identified Location:

Specimen was recognised and collected on 25 March, 2016 at Bhitarkanika Island (20° 72' N and 86° 81' E), Brahmani-Baitarani estuary, Orissa, India on the trunks of *Cocos* species. The species was identified by Mr. Vinay Bharadwaj and it was determined by Dr. Ankita Srivastava, NBRI, Lucknow, India as *Octoblepharum albidum* Hedwig (Fig 2-3).

##### 3.1.2 Accession No.:

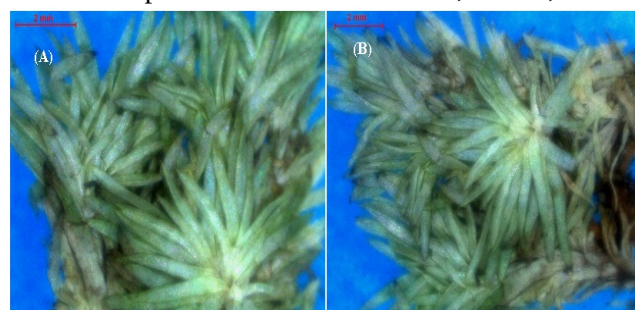
LWG-6/VB-ORISSA-2016, deposited at the Bryophyte Herbarium, NBRI, herbarium, Lucknow, India.

#### 3.1.3 Taxonomy

Kingdom: Plantae,  
Phylum: Bryophyta,  
Class: Bryopsida,  
Order: Dicranales,  
Family: Leucobryaceae,  
Genus: *Octoblepharum*,  
Species: *albidum*.



**Fig 2.** *Octoblepharum albidum* Hedwig on the trunk of *Cocos* sp. in Bhitarkanika Island, Orissa, India.



**Fig 3.** Microscopic pictures (2 mm) of *Octoblepharum albidum* Hedwig.

3.1.4 Synonyms: *Octoblepharum albidum* var. *cuspidatum* Müll. Hal, *Octoblepharum cuspidatum* Müll. Hal, *Octoblepharum ekmanii* Thér, *Octoblepharum longifolium* Lindb, *Octoblepharum minus* Hampe.

3.1.5 Habitat: *O. albidum* is a weedy and conspicuous moss that is distributed worldwide in forest regions, often in the tropical areas. It was recognised North, Central and South America, China, India, Myanmar, Thailand, Australia, Philippines, Indonesia and Vietnam.

3.1.6 Description: *O. albidum* grows on palms, often forming deep soft cushions similar to *Leucobryum*, which has erect or spreading, pointed subtubulose leaves and glossy. But the *O. albidum* has flat, glossy, ligulate, spreading-recurved leaves with glaucous-green, densely cespitose, axillary

hairs 3 per axil, 5-celled and older leaves with rhizoids on tips (Reese, 2007).

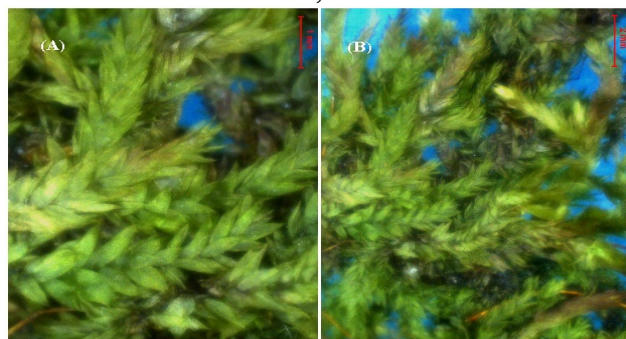
### 3.2 *Taxithelium nepalense* Brotherus

#### 3.2.1 Identified Location:

Specimen was recognised and collected on 25 March, 2016 at Bhitarkanika Island (20° 72' N latitude and 86° 87' E Longitude), Brahmani-Baitarani estuary, Orissa, India on the trunks of mangrove, *Rhizophora* species. The species was identified by Mr. Vinay Bharadwaj and it was determined by Dr. Ankita Srivastava, NBRI, Lucknow, India as *Taxithelium nepalense* (Fig 4-5).



**Fig 4.** *Taxithelium nepalense* Brotherus on the trunks of *Rhizophora* sp. in Bhitarkanika Island, Orissa, India.



**Fig 5.** Microscopic pictures (1 & 2 mm) of *Taxithelium nepalense* Brotherus.

#### 3.2.2 Accession No.:

LWG-5/VB-ORISSA-2016, deposited at the Bryophyte Herbarium, NBRI, Lucknow, India.

#### 3.2.3 Taxonomy

Kingdom: Plantae

Phylum: Bryophyta

Class: Bryopsida,

Order: Hypnales,

Family: Sematophyllaceae or Pylaisiadelphaceae

Genus: *Taxithelium*,

Species: *nepalense*

3.2.4 Synonyms: *Taxithelium nepalense* (Schwaerg) Brotherus, *Taxithelium nepalense* Broth

*Taxithelium trachaelophyllum* Dixon, *Hypnum punctulatum* Harv, *Hypnum turgidellum* Müll. Hal.

#### 3.2.5 Habitat:

*T. nepalense* grows on tree trunks, bark, dead logs, exposed roots and rocks, from sea level to 1,000 m in Nepal, Singapore, Indonesia, Malaysia, Borneo, Papua New Guinea, Thailand, Myanmar, Australia, Sri-Lanka, Madagascar, China, Comoros, New Zealand, India, Bhutan and Laos (Câmara, 2011).

#### 3.2.6 Description:

Plants are large, forming yellow-green mats. Stems creeping, short-ascending, branched. Stem and branch leaves slightly differentiated; stem leaves larger and longer, erect spreading, slightly concave, 0.75-1.15 mm long  $\times$  0.22-0.42 mm wide, ovate or lanceolate, margins entire below, serrulate above; apex serrulate, obtuse or blunt acute; costae short and double or absent; laminal cells linear, 40-80  $\times$  2-3  $\mu$ m, pluripapillose, thick-walled, basal cells smooth; alar cells several, small, rectangular to oval, not inflated, supra alar cells many, quadrate. Rhizoids clustered beneath the stem. Perichaetial leaves 0.70-1.75 mm long  $\times$  0.25-0.40 mm wide, lanceolate, margins entire at base and slightly serrulate at apex; apex long-acuminate; costae absent; laminal cells linear, 50-65  $\times$  ca. 2  $\mu$ m, thick-walled, pluripapillose at apex; alar cells poorly differentiated with 1 row, not inflated. Setae 0.8-1.5 cm long. Capsules inclined, asymmetric, ovoid, 0.6-2.0 mm long, constricted below mouth; exothelial cells subquadrate, not collenchymatous. Opercula short, conic or obliquely conicostate ca. 0.3 mm long. Spores 15-20  $\mu$ m finely papillose. (Câmara, 2011).

## 4. Discussion

Bhitarkanika has a luxuriant green, opulent and pulsating eco-system and an abode for the dynamic and salt tolerant species of trees (the Mangroves), located in the estuarial regions of Brahmani-Baitarani tidal rivers on the West, Dhamara estuary on the North, Maipura and Baungarh creek on the South and the Bay of Bengal on the East, in the north-eastern place of Kendrapara District of Odisha (Orissa tourism, web). The mangroves are acme of the area and 62



mangrove species out of 70 found all over the world exist in Bhitarakanika. The vegetation is adapted especially for the saline mud of the coastal delta (Envis Newsletters, 2008).

The Island is prone to cyclones and tidal waves that usually occur between April and May and at the beginning of winter, between October and December. The temperatures in winter and summer are ranging from 15-27°C, 17-35°C respectively and with an average rainfall of 1450mm during the year. During collection of specimens on March 2016, we observed the weather condition is moderately hot with minimum of 23°C to maximum of 35°C, with no rainfall.

Mangrove and its communities have been described by several authors from different perceptions and using different research tactics (Tomlinson, 1987). Mangroves are woody plants that propagate at the line between land and sea in tropical and sub-tropical latitudes where they exist in circumstances of high salinity, extreme tides, strong winds, high temperatures and muddy, anaerobic soils. There may be no other group of plants with such highly developed morphological and physiological adaptations to extreme conditions (Logesh et al., 2011; Kathiresan & Bingham, 2001). Because of the adaptive characteristics, the ecology of mangroves has been extensively studied (Chang, 1995). Mangroves create unique ecological environments that host rich assemblages of species. The muddy or sandy and loose sediments attract rich epifaunal communities including bacteria, fungi, macroalgae and invertebrates. The aerial roots, trunks, leaves and branches host other group of organisms and contribute to its unique characters (Kathiresan & Bingham, 2001).

Mosses are phototrophic lives in damp areas (shade) on other plants, rocks, soils as epiphytic (Pojar and MacKinnon, 1994). They absorb water and nutrients mainly through their leaves and harvest carbon dioxide and sunlight to create food by photosynthesis and hence habituated in wet and fresh water soil (Kimmerer, 2003). The present study is survey on mosses, whether they can endure in and around salt water provinces mainly in mangrove forests, because till now the maximum identified mosses are habituated at fresh water areas,

but the mosses can change their habitat on hosts in wet areas (Haglund et al., 1981). Mangrove forest contains bipolar systems i.e., fresh and salt water systems to exist and it is very rare and special case to find out mosses in mangrove forest regions. During our in-deep survey, we identified two mosses in mangrove forests of Bhitharkanika Island, Mahanadi estuary, Orissa State, India and they are identified as *Octoblepharum albidum* Hedwig and *Taxithelium nepalense* Brotherus on *Cocos* and *Rhizophora* species respectively.

*O. albidum* was geographically widely distributed to Africa & Madagascar, Asia (Chagos Archipelago, China, India, Papua New Guinea, Philippines, Sabah, South-eastern Thailand and Srilanka), Caribbean-Jamaica, Mesoamerica, North and South America and reported as non-marine species at Interim Register of Marine and Nonmarine genera, Australia. In 1801, the *O. albidum* was identified on wet soil by Hedwig at North America (Sp. Musc. Frond., 1801). In 1822, N. Wallich collected the specimen on wet rocks at Singapore and deposited at Singapoer Herbarium 1822 with EICH number: 7563 [A] (Kew Royal Botanic Gardens). In September 1898, it was identified by P. Decoly & P. Schaul at Gotegaon, Jabalpur, Madhya Pradesh state, India on shallow black soils around tropical moist deciduous forest of rainfall around 1200-1400 mm and temperature ranges from 23-25°C and deposited at Natural History Museum (London) Collection Specimens with GBIF ID: 1055838133 (Indian Biodiversity Portal). In 2011, *O. albidum* was identified on the wet rocks by Eliana Calzadilla at Mapiri Departamento de La Paz, Bolivia (Tropicos, 442). In 2013, *O. albidum* was identified on the trunk of *Sabal palmetto*, Florida International University, Miami, Florida, USA by Scott Zona. After 1898, there were no reports on *O. albidum* around the Indian sub-continent.

*T. nepalense* was geographically distributed in Asia (China, India-Assam, Kerala, Karnataka, Orissa, Nepal, Tamil Nadu, Philippines and Thailand), Africa and Java and reported as non-marine species which is habituated in forests. As per the records, *T. nepalense* was first identified and determined by Brotherus in 1899 and reported that it

was an epiphyte grows on tree trunks, bark, dead logs, exposed roots and rocks, twigs and branches in semi evergreen forests. As per National Centre for Biotechnology Information (NCBI) records, a herbarium with Taxonomy ID: 246677 was deposited on 21 March 2013 in Missouri Botanical Garden, Missouri, USA (Tropicos, 2013). There was no proper data like favourable climatic conditions and about host type or genus on which *T. nepalense* is habituated. Now, we are reporting the *O. albidum* and *T. nepalense* at Bhitarkanika Island, Orissa state, India for the first time in recent times.

As previous stated, the regions of Bhitarkanika Island is a salt tolerant areas, it is special and rare case to find out *O. albidum* and *T. nepalense* species in these areas. New records of *O. albidum* and *T. nepalense* are identified on the trunks of *Cocos sp.* and *Rhizophora sp.* respectively, which are lives in mangrove forest conditions at high salinity at Bhitharkanika Island of Orissa state, India illustrates that the *O. albidum* and *T. nepalense* species are grown on stressed conditions and can also grows on salt water conditions.

The further work is going on to identify the bioactive molecules with biological activities on the collected species, because the mosses are having very bioactive molecules, may be due to their quick adaptation to the environmental changes. The chemical compounds nature modify as per plants requirements and they have been using traditionally in the treatment of diseases at different countries (Czeczuga, 1980; Asakawa, 2007; Decker and Reski, 2007). Moreover, as mosses are bio-monitors of nature, the areas of Bhitharkanika Island of Orissa are very less polluted and ecologically built.

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### Conflict of interest

None to declare.

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