

***DICTYOTA ADNATA ZANARDINI (PHAEOPHYCEAE) - A NEW RECORD
FROM THE SUNDARBANS MANGROVE FORESTS, BANGLADESH***

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Keywords: Brown algae, Epiphyte, Phycology, Taxonomy, A new record

Abstract

Samples were collected from Arpangasia and Kholpetua rivers within the Sundarbans in Bangladesh during February to March and December 2018. Among several forms was found a tightly prostrate brown alga occurring on moist parts of mangrove plants and clayey soil. Flattened brownish thalli tightly attached to pneumatophores and lower parts of mangrove trunks, spreading and branching dichotomously, sometimes overlapping and attached by means of unbranched marginal and sub-marginal rhizoids were collected. Distinct marginal sori are well developed in fertile specimens. On the basis of these characters, the sample has been identified as *Dictyota adnata* Zanardini which is herein reported as a new record for Bangladesh.

The Sundarbans is the world's largest mangrove ecosystem that is shared by India and Bangladesh fronting the vast Bay of Bengal to the south representing a unique ecosystem showcasing an astounding floral and faunal assemblage that is constantly exposed to various anthropogenic and natural threats (Aziz and Paul 2015). The rich biodiversity and largest contiguous forests of the Sundarbans were recognized when large portions of it were designated as a UNESCO World Heritage Site as well as a Ramsar site. The algal flora within the Sundarbans was first studied by Islam (1973) who documented 35 species, most of them belonging to the "Bostrychietum" group. Only one brown algal species was recorded in that study, the ubiquitous *Colpomenia sinuosa* (Mertens ex Roth) Derbès & Solier, which was also encountered in this study growing on the muddy river banks.

This report deals with the discovery of an apparently uncommon species of brown alga that is different from its congeners in many aspects. *Dictyota adnata* Zanardini is a member of a genus that is commonly found in most tropical and subtropical coral reef habitats occurring in truly marine conditions (>32 ppt salinity). This species is perhaps the only member of *Dictyota* that occurs in estuarine conditions and is herein reported from the mangrove forests of Bangladesh for the first time, and likewise a new addition to the algal flora of Bangladesh.

Specimens were collected during the low tide from the mangrove stands along the banks of the Arpangasia river (22°9'9.53" N and 89°16'34.84" E), the Kholpetua River (22° 16' 7.77" N and 89° 14' 58.70" E) and nearby areas within the Sundarbans mangrove forest, Bangladesh in February and March, and December 2018. Samples were collected by scraping mangrove trunks and pneumatophores with a small knife and field-preserving in ethanol and by air drying for carrying to the Aquatic Botany Laboratory, Graduate School of Biosphere Science, Hiroshima University, Japan. In the first sampling only 10 specimens were collected, however in second sampling around 200 specimens were collected with revisiting the same sampling stations. For proper identification the distinct features of external and internal morphologies of both vegetative

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and reproductive structures were used and compared with descriptions in the literature. Hand sections using double-edged razor blades were mounted without staining and examined by stereo dissecting and compound light microscopes (Nikon SMZ1500 and Nikon ECLIPSE E400) and pictures were taken by a digital camera mounted on the microscope (Nikon DS-Fi1 and Inohara INOCAM-30U2CM). A total of 20 examined specimens were collected from both seasons to confirm the identity of the species *D. adnata*. Voucher specimens are yet to be deposited in the Bangladesh National Herbarium, Dhaka.

Dictyota adnata Zanardini 1878: 34.

(Figs 1-12)

Type locality: Originally collected by Oduardo Beccari from Irian Jaya, western New Guinea, now part of Indonesia and described by Zanardini (1878) and later neotypified by De Clerck and Coppejans (1997) using a sample from Kei Archipelago (Kepulauan Kei), also in Indonesia and which was collected by Anna Weber-van Bosse.

Specimens examined: Arpangasia river (AHC 001), Kholpetua river (AHC 001-002), 2627/02/2018; Kolagachia river (AHC 111-113), 04-05/12/2018.

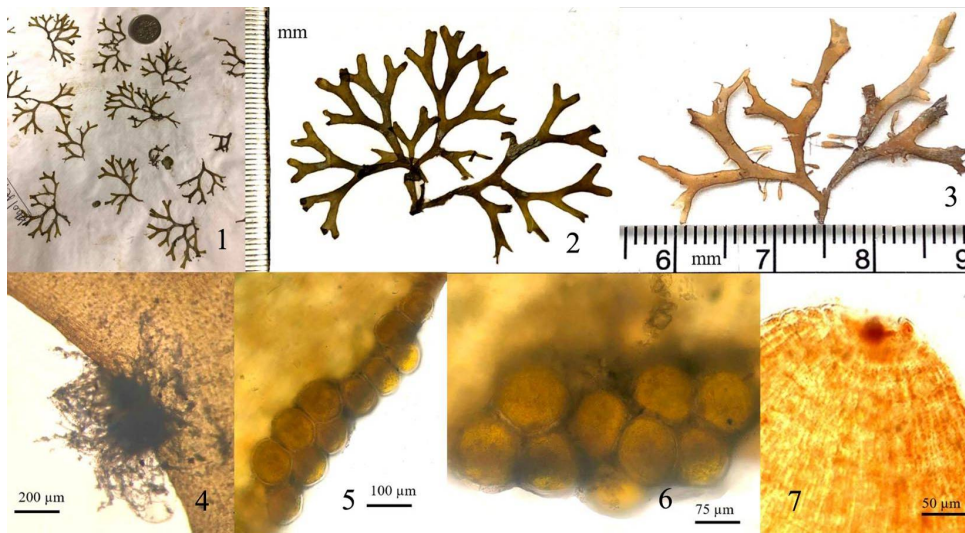
References: De Clerck 2003: 32-36, figs. 7A-F, 8A-E; Kyaw & Soe-Htun 2012: 6, figs. 2-9; Coppejans 1990: 373, figs. 1-15.

Fronds are yellowish or dark brown in colour and prostrate on mangrove trunks and pneumatophores, sub-dichotomously branched with 65 - 100° angle (Figs 1 - 3). Thallus is around 3.0 - 4.5 cm long and about 2.5 - 4.0 cm high. The length of interdichotomics is shorter (2.5 - 3.0 mm) and the average blades width is 0.8 - 2.5 mm. Internodal segments are 0.16 - 1.0 cm long (the lower value for proximal and higher value for distal ones) and 1.0 - 2.5 mm broad, smaller value is again for proximal portions). Rhizoidal filaments unbranched, occurring largely from the undersurface margins (both marginal and sub-marginal) of the thallus for secondary attachment (Fig. 4). The thallus consists of three layers (Figs 11, 12,): the upper and lower epidermal layers of small, rectangular cells with one to three chromatophores, and the central medulla, composed of large, rectangular cells with/without chromatophores. The plants from mangroves along Arpangasia river do not contain chromatophores (Fig. 11) but some samples (AHC002) from Kholpetua river possess chromatophores (Fig. 12, indicated with asterisks) in the medulla. However, these might be artifacts of the sectioning process. In general medulla cells contain fewer plastids than the epidermis because of the cell position.

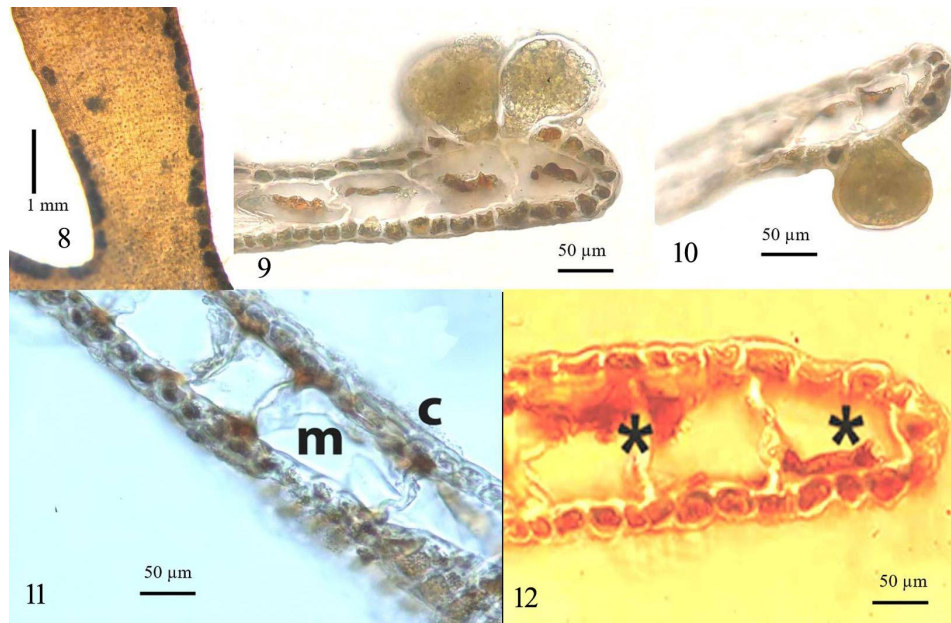
Tetrasporangia are formed singly or in groups from the upper marginal cells and attached by stalk cells (Figs 9, 10), sub-spherical to pear-shaped, 45 - 95 µm long, 30 - 65 µm broad, surrounded by an indusium.

Distribution: (Data mainly from Guiry and Guiry 2018): **Atlantic Islands**: Azores; **Central America**: Costa Rica; **South America**: Venezuela; **Africa**: Kenya, Tanzania; **Asia**: Vietnam, Indonesia, Myanmar, Malaysia, Singapore; **Australasia**: Queensland, Papua New Guinea, New Zealand; **Pacific Islands**: American Samoa, Central Polynesia, Federated States of Micronesia, Fiji, Tonga, New Caledonia.

Dictyota adnata was originally described by Zanardini (1878: 34-35) who examined samples from Irian Jaya (Western New Guinea) in Indonesia and who first noted the distinctive features such as the smaller thallus, the prostrate growth form and the marginal group of spores. In the study area, the species grows on tree trunks, on rocks and rarely on the ground/substrate in the upper parts of the intertidal zone, usually covered by a thin film of mud making them inconspicuous to the inexperienced collector. This muddy layer can significantly block sunlight potentially causing reduced photosynthesis and possibly also nutrient exchange. On the other hand, it could also play a role in reducing water loss and desiccation stress although there are no



Figs 1-7. *Dictyota adnata*: 1. Several specimens on the herbarium sheet. 2. Close-up of a typical pressed plant sample (AHC 111). 3. Habit of pressed specimen (AHC 002) showing proliferations issued from the margins of the basal portions of the plant. These are likely *in situ* germinated spores still attached on the original thallus. 4. Cluster of rhizoidal filaments issued from the thallus margin. 5, 6. Clusters of marginal tetrasporangia. 7. Parenchymatous apical region showing a single, densely pigmented apical cell.



Figs 8-12. *Dictyota adnata*: 8. Rows of tetrasporangia arranged on both margins of the thallus. 9. X-S of thallus margin showing two tetrasporangia attached to the cortical layer by stalk cells. 10. X-S of thallus margin showing a tetrasporangium on the ventral margin. 11. X-S of thallus showing pigmented upper and lower cortical layers (c) and a single layered largely unpigmented medulla (m). 12. X-S of thallus showing chromatophores (asterisks) within the medullary cells.

Table 1. A morphometric comparison between the *Dictyota* species recorded from Bangladesh coast.

Characters	<i>D. adnata</i>	<i>D. bartayresiana</i>	<i>D. ciliolata</i>	<i>D. dichotoma</i>	<i>D. friabilis</i>	<i>D. hauckiana</i>	<i>D. implexa</i>
Habit of thallus	Prostrate	Prostrate	Erect	Erect	Procumbent	Erect	Erect
Colour of thallus	Yellowish to dark brown	Yellow-brown	Dark brown	Yellowish brown	Pale brown to purplish	Dark to golden brown	Light brown
Thallus height (cm)	3 - 4.5	3.5 - 20	4.5 - 20	3 - 18	3 - 5	5 - 75	3 - 10
blades width (mm)	0.8 - 2.5	3.3 - 3.9	3.8 - 5.1	3.2 - 7.3	2.3 - 4.0	28.8 - 38.5	0.8 - 1.5
Branching patterns	DSubdichotomous	Repeatedly dichotomous	Isotomous dichotomous	Dichotomous	Isotomous to anisotomous dichotomous or irregular	Dichotomous	Dichotomous
Interdichotomics (length (mm))	2.5 - 3.0	5.3 - 7.4	11.3 - 28.5	7.5 - 8.5	4.1 - 5.0	120.7 - 180.6	8.0 - 8.7
Thallus margin	Smooth	Smooth	Smooth or sparsely dentate	Smooth	Entirely smooth	Undulate	Smooth
Marginal proliferation	Frequent	Present	Frequent	Unknown	Present	Present	Unknown
Thallus surface	Smooth	Smooth	Smooth, Sometimes leaf-like proliferations	Smooth, Occasionally basal proliferations	Entirely Smooth	Smooth	Smooth
Rhizoids	Margin form bundles, basal	Scattered at margin, basal	Basal	Basal	Marginal form bundles, basal	Basal	Basal
Tetraspores position	Always Marginal	Unknown	Surface	Peripheral cells, surface	Surface	Peripheral cells	Unknown
Apices shape	Rounded, truncate, acute	Rounded	Rounded	Round, obtuse, acute	Rounded, obtuse or truncate	Elongate, obtuse	Rounded
Iridescence	Absent	Absent, blue, green	Absent, yellow-greenish	Blue-green	Bluish, often in broad bands	Absent	Green-yellow light
Branching angle (°)	65 - 100	60 - 70	40 - 80	58 - 61	70 - 80	unknown	42 - 49
References	Present work, Coppejans 1990, De Clerck 2003, Kyaw and Soe-Htun 2012	Islam 1976, Darakrai 2012, Lozano-Orozco <i>et al.</i> 2015	De Clerck and Coppejans 1999, Abbas 2010, Darakrai 2012, Lozano-Orozco <i>et al.</i> 2015	Islam 1976, Abbas 2010, Tronholm <i>et al.</i> 2010,	Islam 1976, De Clerck and Coppejans 1999, Darakrai 2012	De Clerck and Coppejans 1999, Abbas 2010,	Islam 1976, Abbas 2010, Tronholm <i>et al.</i> 2010

experimental data to support this assumption. In neighboring Myanmar, Kyaw and Soe-Htun (2012) also observed the marginal position of tetrasporangia, and vegetative features such as the epidermis and hypodermis and the large-celled medulla. The plants were found in the upper intertidal zone of river mouths, on the pneumatophores and trunks of mangrove plants in the Bay

of Bengal, quite similar to the present observations. Sundarbans material perfectly agreed with these descriptions and the environmental conditions observed there. Due to its unique habit, it is one of the easiest species to identify (De Clerck 2003). This species is likely widely distributed throughout the tropical regions as listed above but its muddy coating and tightly appressed habit may have rendered it inconspicuous to most collectors. Furthermore, there has been some confusion with the application of correct names to this species, a complicated nomenclatural issue addressed and resolved by Silva *et al.* (1996: 927-928). At least three species of *Dictyota* have now been relegated to the synonymy under *D. adnata* (De Clerck 2003, Guiry and Guiry 2018), namely *D. sibogae* Weber-van Bosse (an invalid name based on materials from Indonesia), *D. submaritima* Tanaka and Pham Hoang-Ho (type from Saigon River in Ho Chi-Minh City, Vietnam), and *D. marginispora* Coppejans (an invalid name based on materials from Kenya).

In Bangladesh, only six species of *Dictyota* [*D. hauckiana* Nizamuddin (recorded as *D. atomaria* Hauck), *D. bartayresiana* Lamouroux, *D. ciliotata* Sonder, *D. dichotoma* (Hudson) J.V. Lamouroux, *Dictyota implexa* (Desfontaines) J.V. Lamouroux (recorded as *D. divaricata* Lamouroux) and *D. friabilis* Setchell] were reported from St. Martin's Island and Cox's Bazaar district in southeastern Bangladesh (Islam 1976, Islam *et al.* 2004). Among all the species recorded from the Bangladesh coast they can be distinguished by their anatomic and reproductive traits such as in *D. adnata* and the type species *D. dichotoma* whose colour and branching pattern sometimes show resemblance (Table: 1). In addition it is difficult to separate by thallus height when they are young. However, the comparative examination of the thallus width, length of interdichotomies, rhizoidal arrangements, branching angles can help to distinguish species (Table 1). *D. bartayresiana*, *D. ciliotata*, *D. friabilis* and *D. hauckiana* and *D. implexa* are far different in morphology from *D. adnata* (Table 1).

In view of the recent monographic work on Indian Ocean species of *Dictyota* by De Clerck (2003) and the rapid progress in molecular systematics work on the family Dictyotaceae (De Clerck *et al.* 2006), it is very important to re-examine previous records of *Dictyota* from Bangladesh. Without any doubt, *D. adnata* is herein reported for the first time from the Sundarbans mangrove forest and is added to the algal flora of Bangladesh.

Acknowledgements

Microphotographic equipment was kindly provided by Dr. Koichiro Kawai and Mr. Shaharior Arnob (Graduate School of Biosphere Science, Hiroshima University). Field work in Bangladesh was supported by a travel grant from the Graduate School of Biosphere Science as well as the issuance of a permit from the Bangladesh Forests Department. Valuable field assistance was provided by Mr Chayan Biswas (Khulna University). Postgraduate research of the first author (MAI) is made possible by a grant from the Monbukagakusho [MEXT - Japan Ministry of Education, Culture, Sports, Science and Technology].

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(Manuscript received on 19 March, 2019; revised on 23 September, 2019)