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Diversity and distribution of seaweeds at Digha coast, West Bengal, India

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ABSTRACT

'Seaweeds' are the marine macro algae, and constitute an important component of the marine biodiversity. The coastline of Digha is an important tourist destination and located in the southern part of the West Bengal coastal stretches. The present study deals with the preliminary study on the diversity and distribution of seaweeds at Digha coast. During the present survey, 5 taxa of green seaweeds have been documented and described in detail.

Key words: Digha, Marine macro algae, Seaweeds, Taxonomy.

INTRODUCTION

'Seaweeds' is a popular term and refer to the *marine macro algae*, growing in the marine ecosystems. Characteristically, it grows on rocks, pebbles, mollusc shells, coastal wastes like ropes, nets, and also as epiphytes on other plants like mangroves, seagrasses etc. Physiologically, seaweeds can grow in shallow, intertidal and sub–tidal zones and deep waters of sea, even up to a depth of 150 m or up to a depth that can receive more than 0.12% of the incident light (Markager & Sand–Jensen, 1992). Seaweeds are one of the important components of the marine flora and ecologically play a significant role in the sustainability of the marine ecosystems, by providing food and shelter to the marine fauna and maintaining the level of *Dissolved Oxygen* (DO) in the water bodies. Therefore, its proper taxonomic study and documentation are prerequisite for understanding its importance and also for effective conservation.

Digha is one of the important coastlines located in the southern part of *ca* 220 km long coastal stretches of the West Bengal (GPS: 21° 37' 33.5" N and 87° 31' 43.4" E). Geographically, it is situated in Purba Medinipur district of West Bengal **(Fig. 1)**. It is one of the important tourist destinations along the coastline in Bay of Bengal and attracts large number of tourists every year. Naturally, the coastline is sandy, shallow and endowed with few scattered natural rocks. Besides, the artificial cement blocks / constructions laid along the coast also act as substrata for the growth and diversity of marine algae **(Plate 1)**.

Taxonomic study and documentation of all forms of biodiversity of any geographic area is essential for conservation of such biodiversity. Considering the importance of seaweeds in food chain of marine ecosystems, the proper observation and documentation of such marine resources become prerequisite for further study. The pioneer workers on the seaweed resources of India are Iyengar (1927), *the father of Indian Algology* (1886–1966), Boergesen (1930, 1931), Dixit (1940), Misra (1966) etc. Perusal of relevant literature reveals that significant works have been done on the seaweed resources of southern parts of the East coast of India such as Tamil Nadu (Thivy, 1964); Chennubhotla, 1977, 1992; Kaliaperumal & al., 1989, 1995), Andhra Pradesh (Rao & Sriramulu, 1964, 1970) and and Orissa (Adhikary & Sahu, 1992; Rath & Adhikary, 2005, 2006). However, the information on the seaweed resources of the West Bengal coast is very sporadic (Naskar & Santra, 1985; Pal & al., 1988; Chattapadhyaya & Pal., 1995; Pal, 2000; Sen & al., 2000, 2002; Mukhopadhyay & Pal, 2002). Satpati & al. (2012, 2013) reported the morphotaxonomic account of few algal taxa from the Sundarban Mangrove forest area. Recently, Sinha & al., (2016) reported a green alga *Enteromorpha compressa* from Bakkhali coast. Das & al. (2017) studied the coastal dunes ecology and role of vegetation in coastal stability along the southern coastal stretches of West Bengal. However, there is lack of any comprehensive report on the seaweed diversity at Digha coast. Therefore, as a part of the comprehensive study on taxonomic aspects of the seaweed resources of the West Bengal coast, we have tried to document the preliminary information on seaweed resources of Digha coast.

Plate 1: Coastal landscapes - A. Luxuriant growth of seaweeds forming slippery green seaweed bed at Digha coast; **B.** Mixed growth of seaweeds on rocky habitats; **C.** Artificial cement blocks supporting algal vegetation along the coast; **D.** A panoramic view of Digha coast with influx of tourists during evening.

MATERIALS AND METHODS

The present study is exclusively based on the field observation, study of fresh algal specimens and comprehensive study of literature. The field survey was conducted for 5 days during low tides in the month of January, 2020. All the algal substrata such as rocks (natural and artificially laid), pebbles, coastal wastes like ropes, nets, decayed wooden pieces etc. along the coastline were observed and samples were collected by hand picking. All the collected samples were carefully washed and kept in the plastic containers and zipped covers. While making collection, important field details such as habit, habitats, nature of the locality and its GPS position (using Garmin 12 channel XL), vegetation patterns etc. were recorded and photographed using digital camera (Nikon COOLPIX L120). All the collected seaweeds were assigned a field number and preserved in the form of herbarium sheets and also in wet form **(Plate 3)** following the standard herbarium techniques (Srinivasan, 1969; Dhargalkar & Kavlekar, 2004). Identifications of the algal samples were confirmed based on the field observation, study of morphological and anatomical characters and following the standard references namely *Phycologia Indica: The Icons of Indian Seaweeds* (Srinivasan 1969, 1973); *Catalogue of the Benthic Marine Algae of the Indian Ocean* (Silva & al., 1996), *Algae of India and neighboring countries: Chlorophycota* (Krishnamurthy, 2000) and few recent publications (Kraft, 2017; Jha & al., 2009).

Fig 1 Map of West Bengal Showing the coast line and Digha coast

RESULTS

During the present study, 5 taxa of seaweeds have been recorded. All the recorded algal taxa belong to the class Chlorophyceae *i.e.* green seaweeds. All the enumerated taxa have been dealt in details with specific notes.

Family: Ulvaceae

This family is represented by 2 genera in India i.e. *Enteromorpha* and *Ulva*. Hayden & al (2003) based on the molecular study reported that these genera are paraphyletic in origin and transferred the genus *Enteromorpha* under *Ulva*. However, both these taxa exhibit remarkable variations in their morphological and anatomical characters (like tubular, membranous, foliose thallus, number of layer(s) of cells such as mono- or dia-stromatic nature etc. Therefore, *Enteromorpha* has been treated here, like most of the Indian literature, as a distinct genus for easy identification.

Enteromorpha Link

Key to the species

1a.	Fronds proliferated, hairy, tubular; surface cells polygonal	**4. E. prolifera**
1b.	Fronds simple, tubular-flattened; surface cells polygonal, rectangular or elongate	**2**
2a.	Thallus large, up to 25 cm long, flexuous in nature	**2. E. flexuosa**
2b.	Thallus small, up to 10 cm long, flattened and compressed in nature	**3**
3a.	Fronds compressed below and gradually expanded above, straight, small; surface cells polygonal to rectangular	**1. E. compressa**
3b.	Fronds distinctly tubular below and broadly flattened towards apex, slightly twisted or irregular, large; surface cells polygonal to elongate	**3. E. linza**

1. Enteromorpha compressa (L.) Nees, Horae Phys. Berol. Index 2: 123. 1820.
Ulva compressa L., Sp. Pl. 2: 1163. 1753. **(Plate 2A)**

Thallus light green in colour, 1-8 cm long (young stage), branched, lithophilic. Holdfast small, discoid, firmly attached on rocky substrata. Stipe small, tubular. Fronds compressed below and gradually expanded upward, surface smooth, margins entire, apex obtuse. *Microscopic*: Cells in surface view squarish-elongate or irregular, 12-30 µm across, 6-15 µm across in basal region, irregularly arranged, cell wall thin; cells in cross section 12-29 × 8-15 µm, sheath up to 2 µm thick.

Notes: This is a common and an edible seaweed in many parts of the world. Therapeutically, it has *anti allergic* properties (Venkataraman & al., 2004). It is mostly found growing in association with the species of *Enteromorpha* on surf-exposed rocks and exhibits maximum biomass during the monsoon and post monsoon seasons.

2. Enteromorpha flexuosa (Wulfen) J. Agardh, Algern. Syst. 3: 126. 1883.
Ulva flexuosa Wulfen, Crypt. Aquat. 3: 1. 1803. **(Plate 2B)**

Thallus light-dark green in colour, tubular, up to 25 cm long and 2-8 mm broad, lithophilic. Holdfast discoid, attached firmly on rocks and also on other coastal solid wastes like nets, cloths, ropes. Stipe small, tubular. Fronds hairy to flat and forming tubular structure, usually 3-25 cm long, tubular or hairy at base and flexuous towards apex, margins entire, apex obtuse to round. *Microscopic*: Cells in surface view polygonal to rectangular, 8-20 µm across; in cross section thallus 18-25 µm thick, cells usually rectangular, 14-20 × 12-18 µm wide; chloroplast with several spherical pyrenoids.

Notes: This is one of the common seaweeds and grows luxuriantly during the monsoon and post monsoon seasons, usually in the estuarine areas and forming thick greenery seaweed bed on substrata. Economically, it contains nourishing agents such as polysaturated fatty acids, minerals, vitamins, antioxidants and proteins (Jha & al., 2009).

3. Enteromorpha linza (L.) J. Agardh, Algern. Syst. 3: 134. 1883.
Ulva linza L., Sp. Pl. 2: 1163. 1753. **(Plate 2C)**

Thallus light-dark green in colour, flattened to tubular, 2-10 (-15) cm long, epilithic. Holdfast small, discoid, loosely attached to substratum, sometimes free floating. Stipe tubular, gradually flattened upwards, up to 1.5 cm long. Fronds tubular below and gradually flattened upwards, up to 10 cm long in mature stage, blades 0.4-1.5 cm wide in apical region, margins entire to undulate, apex obtuse to irregular. *Microscopic*: Cells in surface view polygonal to elongate, thin walled, irregularly arranged; in cross section cells usually rectangular, 6-10 × 12-18 µm wide, sheath up to 2 µm thick.

Notes: This is an economically important seaweed and used as aquafeed and livestock feed in several countries (Jha & al., 2009). In habitats, it shows similarity with *Enteromorpha compressa* in young stage as both exhibit flattened blades and create confusion in identification. However, *E. linza* can be identified by its tubular base and gradually more flattened fronds towards apex.

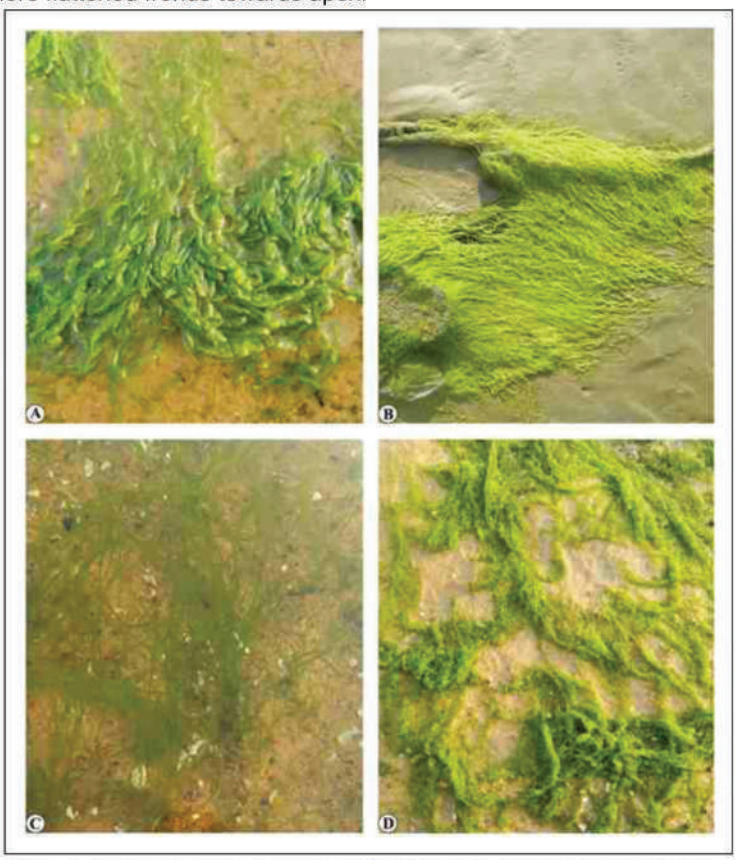

Plate 2: Seaweed diversity - A. Enteromorpha compressa (L.) Nees; **B. Enteromorpha flexuosa** (Wulfen) J. Agardh; **C. Enteromorpha linza** (L.) J. Agardh ; **D. Chaetomorpha crassa** (C. Agardh) Kuetz.

4. Enteromorpha prolifera (O.F. Muell.) J. Agardh, Algern. Syst. 3: 129. 1883.
Ulva prolifera O.F. Muell., Fl. Dan. 5(13): 7, pl. 763 (1). 1778.

Thallus dark green in colour, tubular, hairy, usually 3-30 cm long, proliferated, growing in densely intricated masses, lithophilic. Holdfast small, discoid, attached firmly on surf exposed rocks and also on other coastal solid wastes like nets, ropes. Stipe slender, small, simple or branched. Fronds tubular, proliferated into several minute branches of up to 4 cm long, margins entire, apex obtuse. *Microscopic*: Cells in surface view

usually polygonal, thin walled, 7-15 µm across, linear - irregularly arranged; in cross section cells oblong, 8-20 × 5-11 µm wide, sheath 2-4 µm thick; chloroplast with one to many pyrenoids.

Notes: This is one of the common green seaweeds and found growing luxuriantly during the monsoon and post monsoon seasons. Economically, it is an edible seaweed and cultivated artificially in Japan and several other south east Asian countries (Jha & al., 2009).

Plate 3: Collection and processing of seaweed specimens - A. Collection of specimens in plastic zip cover; **B-D.** Various patches of seaweed vegetation at Digha coast; **E.** Processing of collected specimens in field; **F.** Preservation of specimen in wet forms; **G.** A seaweed herbarium specimen.

Family: Cladophoraceae
Chaetomorpha Kuetz.

Chaetomorpha crassa (C. Agardh) Kuetz., Phycol. Germ. 204. 1845.
Conferva crassa C. Agardh, Syst. Alg.: 99. 1824. **(Plate 2D)**

Thallus dark green in colour, 5-12 cm long, filamentous, unbranched, irregularly coiled and forming entangled mass. Holdfast small, discoid, loosely entangled with other seaweeds and waste materials etc. Fronds tufted, filamentous, divided into several nodes and internodes, irregularly coiled, tapering towards apex. *Microscopic*: Cells cylindrical to barrel shaped, slightly swollen in central part and constricted near nodes, 300-620 × 200-410 µm; cell wall up to 100 µm thick; chloroplast reticulately, with several pyrenoids.

Notes: This species of the genus *Chaetomorpha* is recognised with its irregularly coiled nature, and usually found entangled with other objects and forming loose mass. Also occasionally seen offshore.

DISCUSSION

The diversity and distribution of seaweeds depend on the availability on suitable substrata, besides many other factors. Seaweeds are usually lithophilic in nature and require rocky substrat for its occurrence. The coastline of Digha is mainly sandy and well recognised as a beach. Though, it is endowed with very few scattered natural rocks along its coast. However, it has also been observed that artificially laid cement blocks, stones and solid constructions have been made abundantly along the coasts at Digha, New Digha and Udaipur in order to prevent from the magnitude of coastal erosion. These newly laid stones, with the passage of time, accumulate the essential minerals and nutrients and act as substrata for the growth of seaweeds. Therefore, it is supposed that, though Digha coast presently harbours very limited diversity of seaweeds, however in future the diversity of seaweeds may increase rapidly with the adaptation of more seaweeds on suitable substrata. In

addition, Digha coast has also been reported to support significantly 55 species of crabs (Patra & al., 2017) and metal accumulating extracellular protease secreting Bacteria (Roy & al., 2008). The Digha-Sankarpur coastline is also known to the occurrence of two endangered species viz *Lepidochelys olivacea,* the marine turtle and *Carcinoscorepius rotundicauda,* the medicinal invertebrate the "Horse shoes" (ICZMWB, 2010). Therefore, this coast supports significant marine biodiversity.

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