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Contributed Paper

# Estuarine Macrophytes at Bakkhali, Cox's Bazar, Bangladesh with Reference to Mangrove Diversity

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## ABSTRACT

The diversity and ecosystem significance of macrophyte communities was studied, with emphasis on the mangrove species in the Bakkhali estuary of Cox's Bazar, Bangladesh. Macrophytes of the Bakkhali river estuary were mainly mangroves (*Avicennia marina* Forssk Vierh and *A. alba* Blume and *Acanthus ilicifolius* Linnaeus) of inundation Class-IV; i.e., the mangroves are inundated 2-20 times per month (Watson, 1928), a wild rice variety of salt marsh (*Porteresia coarctata* Tateoka), Congon grass (*Imperata cylindrica* P. Beauv.), seagrass (*Halophila beccarii* Ascherson), macro-algae (*Ulva intestinalis* Linnaeus, *Catenella nipae* Zanardini and *Hypnea* sp.) and mangrove associates *Suaeda maritima*. Only two individual plants of mangrove, *Sonneratia apetala* and *Aegialitis rotundifolia*, were found growing in the inter-tidal area of this estuary. On the eastern side of the estuary, almost 100% of the intertidal area is covered by the salt marsh plant *P. coarctata*, with patches of seagrass *Halophila beccarii*. The western portion of the estuary is covered by mangroves, mixed with patchy salt marsh and seagrass in and sheltered by a sand bar. Salt marsh and seagrass grow in mangrove dominated sites as 2<sup>nd</sup> pioneer species in the newly accreted land at the mouth of Bakkhali estuary. These estuarine macrophytes are of both economic and ecological significance and the macrophyte community plays a principal role directly or indirectly in supporting the local communities as source of food, cash and energy.

**Keywords:** mangroves, biodiversity, estuary, Cox's Bazar, Bangladesh

## 1. INTRODUCTION

Coastal inter-tidal macrophytes are aquatic plants large enough to be visible to the naked eye. Characteristically, they grow in wet areas and are quite diverse group. This group of plants may be native to an area or

they may have been imported. Macrophytes in the inter-tidal area serve as a nursery ground, nutrient source and primary food source of fish, invertebrates and coastal birds. The coastal macrophytes play a vital role in the life history

development of many coastal organisms [1].

The estuarine and coastal area of Bangladesh is mostly covered by living resources such as mangroves, salt marshes, seagrasses and macro-algae [2]. It is also well established that the coastal environment of Bangladesh is highly productive in terms of nutrients input from diverse sources and support to the other living resources in the surrounding area of coastal environment. These diverse living resources play a vital role in the economy of the nation as well as promoting the socio-economic and food security of the coastal population by increasing fishery resources [3].

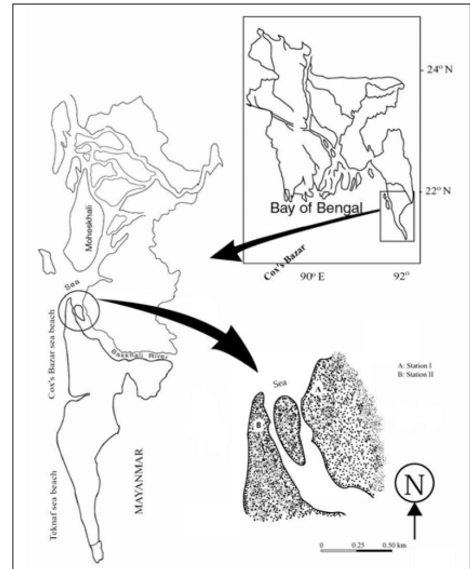
Although these coastal resources play a fundamental role in the ecosystem and have a great importance in economic aspect [4, 5], studies of coastal plant resources and their usefulness are scarce. To date, except the studies by Das and Siddiqi [6] and Abu Hena et al. [3], no systematic research has been conducted on the diversity of the coastal macrophytes resources in the country. Few scientific data on macrophyte species are available for the coastal waters of Bangladesh [7-15]. Therefore, this study on coastal macrophyte resources can be considered as important, dealing as it does with the diversity and ecological significance of the macrophytes growing in the intertidal area of Bakkhali estuary channel system, Cox's Bazar, Bangladesh.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Study Area

The study area is situated in the Bakkhali river estuary, Cox's Bazar, in the southern region of Bangladesh. The approximate geographical location of this estuary is between  $20^{\circ}85'40''$  to  $21^{\circ}46'92''$  N latitude and  $91^{\circ}96'60''$  to  $92^{\circ}34'37''$  E longitude (Figure 1). The estuary of the Bakkhali river is directly influenced by semi-diurnal tides and

climatology impacted by monsoon winds. Its bottom consists mostly of muddy and sandy particles [16]. This estuarine zone is characterized by long intertidal mudflat where the salt marsh plant *Porteresia coarctata* grows, along with mangroves and seagrass.



**Figure 1** Study area location showing the Bakkhali river estuary at Cox's Bazar.

### 2.2 Period of Study and Collection of Sample

This study was carried out from June to December, 2008 with several field visits. Samples were collected during the period of low tide from the Bakkhali estuary at two stations. The stations were selected based on the availability of macrophytes on both sides of the inter-tidal area of channel. Samples were collected along a transect perpendicular to the shore at each station [17]. The different types of macrophyte specimens were collected manually by hand or using a knife. All samples were collected in pre-labeled plastic bags while macro-algae were collected in plastic pots containing 5% formalin. All the collected samples were brought back to the Laboratory of Estuarine, Coastal and Aquaculture Research (LECAR), Institute of Marine Sciences and Fisheries, University of

Chittagong and washed under tap water. The identification of the specimens was done following the literature described by Singh and Garge [18] for mangroves, Lewmanomont and Ogawa [19] and Islam [7] for macro-algae followed by Chapman [20] and Flowers et al. [21] for salt marsh.

### 2.3 Ecosystem Functions and Zonation Study of Macrophytes

Ecosystem functions of mangrove species in this area were measured following the procedure described by English et al. [17]. The zonation of inter-tidal macrophytes, especially mangrove, salt marsh and seagrass growing in the Bakkhali estuary, was detected following the procedure described by Chapman [20]. For this study, the macrophytes growing within the lower tidal edge to the higher tidal edge were counted along the transect. The mangrove species were recorded and identified.

## 3. RESULTS AND DISCUSSION

### 3.1 Vegetation Types

Five species of mangroves, two species of salt marsh plants, one species of seagrass, three species of macro-algae and one species of mangrove associate were recorded from the intertidal area of Bakkhali river estuary (Table 1). A higher number of aquatic macrophytes was recorded in the western side of the Bakkhali estuary compared to eastern side. The western part of the estuarine area is protected from the direct wave energy of the sea or other high-energy forces. Mangroves grow along the upper and middle zone of inter-tidal area on the riverbank especially in the mouth and accreted land of the estuary.

The diversity and distribution pattern of different type of macrophytes varied greatly at different geographical locations and topography of the coastal land. The higher diversity of macrophytes in the inter-tidal

area may be due to rich nutritional status of the sediment, greater penetration of light and slow water current. The higher diversity of macrophytes on west side of the estuary revealed that generally the protected area with sandy muddy substrates in the coastal area is suitable for the production and regeneration of macrophytes. The fringe type of macrophytes plays an important ecological role while providing a variety of services for human welfare elsewhere in subtropical coast [22] and some of the functions and values of mangroves are given in Table 2. The benefits obtained from these macrophyte ecosystems are quite broad and encompass a variety of economic, environmental and social aspects, including carbon sequestration for combating global warming [23] and protection from erosion, flooding, cyclones, typhoons and tidal waves [2].

**Table 1.** The macrophytes recorded from the inter-tidal area of Bakkhali river estuary Cox's Bazar.

Group	Species
Mangroves	<i>Avicennia alba</i>
	<i>A. marina</i>
	<i>Acanthus ilicifolius</i>
	<i>Aegialitis rotundifolia</i>
	<i>Sonneratia apetala</i>
Mangroves associates	<i>Suaeda maritima</i>
Salt marsh	<i>Imperata cylindrica</i>
	<i>Porteresia coarctata</i>
Seagrass	<i>Halophila beccarii</i>
Macro algae	<i>Ulva intestinalis</i>
	<i>Hypnea</i> sp.
	<i>Catenella nipae</i>

**Table 2.** Functions and values of coastal aquatic macrophytes (including mangroves) in the Bakkhali river estuary, Cox's Bazar.

Function	Value
Primary production	Support estuarine and offshore food webs
Soil organic matter accumulation	Support estuarine and offshore food webs Counter effects of sea level rise
Production export	Support estuarine and offshore food webs
Nutrient regeneration and recycling	Support estuarine and offshore food webs
Maintenance of plant communities	Provide habitat for animals, provide high biodiversity
Maintenance of animal communities	Support shellfish, finfish production Provide high biodiversity
Provision of habitat for fish, birds (as nesting, shelter, foraging, and/or nursery areas)	Support of finfish production, recreational resources (observation and photography)
Nutrient and contaminant filtration	Improve water quality
Sediment filtration, trapping and binding	Counter effects of sea level rise Improve water quality
Dissipation of physical forces of waves and currents	Protect upland from erosion Reduce flood-related damage
Maintenance of self sustaining system	Recreation, Aesthetics, Open space, Landscape level biodiversity, history, culture and education

The salt marsh *Porteresia coarctata* and *Imperata cylindrica* grows next to the mangroves. Salt marsh *P. coarctata* was common in over almost all the inter-tidal area of the Bakkhali estuary. Sometime, *P. coarctata* grows patchily with the mangroves and colonizes through vegetative reproduction. However, the salt marsh usually grows next to the upper area of the muddy zone; between the mangroves and muddy lower intertidal zone. The salt marsh plant *I. cylindrica* grows in patchily in

the upper tidal area of the estuarine mouth and sometime associated with mangroves and *Suaeda maritima* in hard soil substrates; sometime it forms meadows. Three species of macro-algae were found in this estuarine system. The species *Catenella nipa* grows very commonly on the mangroves pneumatophores. The dominant species of macro-algae in the salt marsh and seagrass habitat are *Ulva intestinalis* and *Hypnea* sp. in this estuarine system. Similar

observations have been made in Pakistan [24].

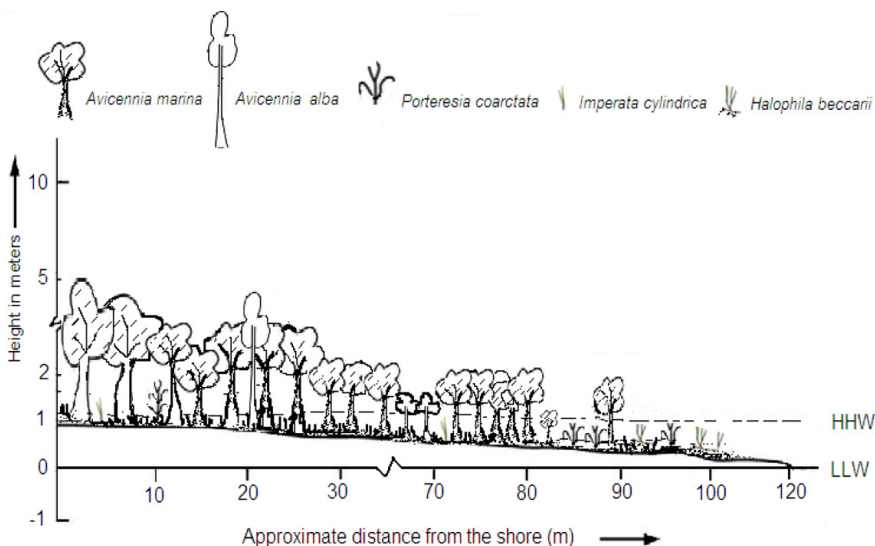
The seagrass *H. beccarii* grows both as an annual and a perennial. It may grow to form dense mono-specific meadows or may grow with other coastal aquatic plants like salt marsh (*P. coarctata*) and seaweed (*U. intestinalis*) in the estuarine intertidal habitat. Sometimes it grows in mangrove (*A. alba* and *A. marina*) dominated sites. The geographical distribution of this seagrass is most interesting. The species is widely distributed in the Indo-West Pacific region between Tropic of Cancer and the Equator, including India, Sri Lanka, Myanmar, Vietnam, Philippines, Singapore, Hong Kong and Malaysia [25-27]. On sandy bottoms with an admixture of mud, the species is often accompanied by *H. ovalis*, or elsewhere by *H. minor* or *Halodule*

*uninervis* [25].

### 3.2 Zonation of Mangroves

The predominant species of mangrove in this estuary is *A. marina* followed by *A. alba* and *Acanthus ilicifolius*. Flowering and fruiting of the mangroves *A. marina* and *A. alba* in this estuarine ecosystem was found from April to September. Flowers starts blooming in April and fruits are present until September on the mangrove trees.

Studies have shown that the distribution of mangrove species within a mangrove area depends mainly on accessibility and allocation of seeds or seedlings, as well as tolerance of species to flooding and soil salinity, creating zonation of species. Two distinct zones can be identified in mangrove areas of Bakkhali river estuary, Cox's Bazar (Figure 2), i.e.,



**Figure 2.** Zonation profile of mangroves and other macrophytes in the Bakkhali river estuary, Cox's Bazar, Bangladesh (© Abu Hena).

I) Water-front zone or lower inter-tidal zone that consists of *Avicennia marina* and *A. alba*. The height varies from a few meters to 2 m together with salt marsh and seagrass.

II) Mixed species zone - These mangrove forests mostly consist of mixed species including *Avicennia marina*, *A. alba* and *Acanthus* sp. situated behind the water-front zones or middle inter-tidal zone.

#### 4. CONCLUSION

Five species of mangroves, three species of seaweeds, two species of salt marsh plants, one species of seagrass and one species of mangrove associate were recorded from the mouth of Bakkhali estuary, Cox's Bazar. The mangrove *A. marina* is the dominant species in this estuarine ecosystem, growing in the lower through upper inter-tidal area. The mangroves and their associates in the intertidal area of Bakkhali estuarine system are affected environmentally by both biotic and abiotic factors. This study observed that overgrazing by cattle and extension of shrimp farms by cutting mangroves are the main biotic factors that affect the diversity of mangroves in this estuarine ecosystem. Among the abiotic factors, heavy discharge during the rainy season brings high sediment, which covers the mangroves pneumatophores and whole plant of salt marsh, seagrass and macro-algae. Also, die-back diseases of mangroves were noted during the study period in this area probably due to the drought condition, which increases the salinity level in this estuarine area that could probably be related to climate change issues. This process affects the physiological processes of intertidal macrophytes like water stresses and internal salt balance, which needed further study.

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