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SHORT COMMUCATION

The first occurrence of halophyte *Oryza coarctata* in the mid-southern coast of Bangladesh

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Abstract. Salt marshes and other coastal habitats are essential for preserving ecological balance because they provide a habitat for a variety of species, prevent erosion, and mitigate climate change. The salt-tolerant wild species of rice *Oryza coarctata* is highly valuable because it may be used to develop crops that can withstand salt. It is a species that is well suited to coastal areas. This study documents the first recorded occurrence of *O. coarctata* along the mid-southern coast of Bangladesh, specifically in the intertidal zone of the Andharmanik River, Patuakhali, Bangladesh. The distribution and features of the species were evaluated by morphological studies and field surveys. The results show considerable variability of *O. coarctata* in shoot density (300 to 830 shoots m^{-2}), plant height (5 to 152 cm), leaf length (2.7 to 29 cm), and biomass (48 to 71 g dry weight m^{-2}), indicating the species' phenotypic plasticity in response to environmental conditions. This finding highlights the potential expansion of *O. coarctata*'s known distribution area.

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Introduction

Coastal ecosystems are dynamic environments that serve as critical habitats for various species and play key roles in maintaining ecological balance (Bij de Vaate et al. 2020). Salt marshes are highly productive ecosystems and salt marsh species are vital for maintaining the health and stability of coastal ecosystems (Fan et al. 2020). Their dense root systems help prevent coastal erosion by binding soil and sediments, while their vegetation acts as a natural buffer against storm surges and flooding, protecting coastal communities from extreme weather events (Kearney and Fagherazzi 2016, Schwarz et al. 2016). These plants also support high biodiversity, providing crucial habitats and breeding grounds for fish, birds, and invertebrates. In addition, by capturing sediments and filtering contaminants, salt marshes contribute significantly to the improvement of water quality. Their ability to sequester carbon further contributes to climate change mitigation efforts (Banerjee et al. 2021, Mishra and Farooq 2022).

Oryza coarctata, a member of the Poaceae family, is a perennial wild species of rice predominantly found in

coastal regions (Jagtap et al. 2006, Chowrasia et al. 2018, Chowrasia et al. 2021). It is well-adapted to high salinity and tidal inundation, making it a valuable candidate for studying mechanisms of salt tolerance (Bal and Dutt 1986). The species exhibits unique physiological and morphological traits, such as salt-secreting glands, which enable it to thrive in saline environments. These characteristics have drawn considerable interest from plant breeders and geneticists who aim to transfer salt-tolerant traits to cultivated rice (*Oryza sativa*) through hybridization and genetic engineering (Mondal et al. 2015, Chowrasia et al. 2023). The existence of *O. coarctata* in the coastal habitats of Bangladesh is particularly noteworthy, considering the nation's susceptibility to both increasing sea levels and climate change (Ashrafuzzaman et al. 2022). Bangladesh, with its extensive coastline and deltaic plains, is highly susceptible to salinity intrusion from both natural processes and anthropogenic factors such as upstream river water diversion. As salinity levels increase, traditional rice cultivation faces severe challenges, threatening food security for millions of people (Ashrafuzzaman et al. 2022). In this context, the discovery of salt-tolerant species like *O. coarctata* along the mid-southern coast opens up new avenues for research, particularly in the development of salt-tolerant rice varieties that could be crucial for sustaining agriculture in coastal areas under stress.

The present study aims to contribute to our understanding by documenting the first record of any salt marsh species (*Oryza coarctata*) from the mid-southern coast of Bangladesh, Bay of Bengal. The record of *O. coarctata* in this region, therefore, represents a significant addition to the botanical records of Bangladesh and expands the known distribution range of this species. This information can be used to inform conservation efforts and to promote the sustainable management of this species and its surrounding ecosystem.

Materials and Methods

The study was conducted in the mid-southern coastal region of Bangladesh, specifically in the intertidal zone of the Andharmanik River, Patuakhali, Bangladesh (21°96'65"N and 90°23'95"E; Fig. 1). The Andharmanik River is distinct since it empties into Bangladesh's Bay of Bengal on both sides. The site included a brackish water zone with varying levels of salinity, and tidal influences. The area is characterized by a semi-diurnal tidal regime and a subtropical monsoon climate.

Field surveys were carried out in September 2024 to locate and document the occurrence of different salt marsh species. Sampling was performed using a stratified random sampling method. A transect survey was established within the habitats to assess the distribution and abundance of salt marsh species. Transects were laid out perpendicular to the shoreline, extending from the high-tide line to the low-tide line. Along each transect, quadrats (0.5×0.5 m^2) were randomly placed to sample vegetation. Within each quadrat, the presence and abundance of salt marsh species were recorded. *Oryza coarctata* specimens were identified based on morphological characteristics following the description by Lu and Ge (2003), Jagtap et al. (2006), Abu Hena et al. (2007), and Roy and Chowdhury (2021), which include features such as leaf shape, size, texture, inflorescence type, and seed morphology. The morphological characteristics of each sample, including plant height, leaf length, breadth, etc., were measured for at least 150 samples at the laboratory of the Bangladesh Fisheries Research Institute, Patuakhali. Seasonal variability data was not obtained due to technological issues. The specimens collected were pressed and dried for herbarium deposition.

To check the parameters of water quality, pore water salinity and water salinity measurements were taken on-site with a digital Refractometer (HI96822, HANNA, Romania). A pocket pH meter (HANNA HI98107, Romania) was used to measure the temperature and pH of the water. Salinity, dissolved oxygen (DO), total dissolved solids (TDS), and soil electrical conductivity were measured with a multiparameter water quality meter (HANNA HI19894, Romania).

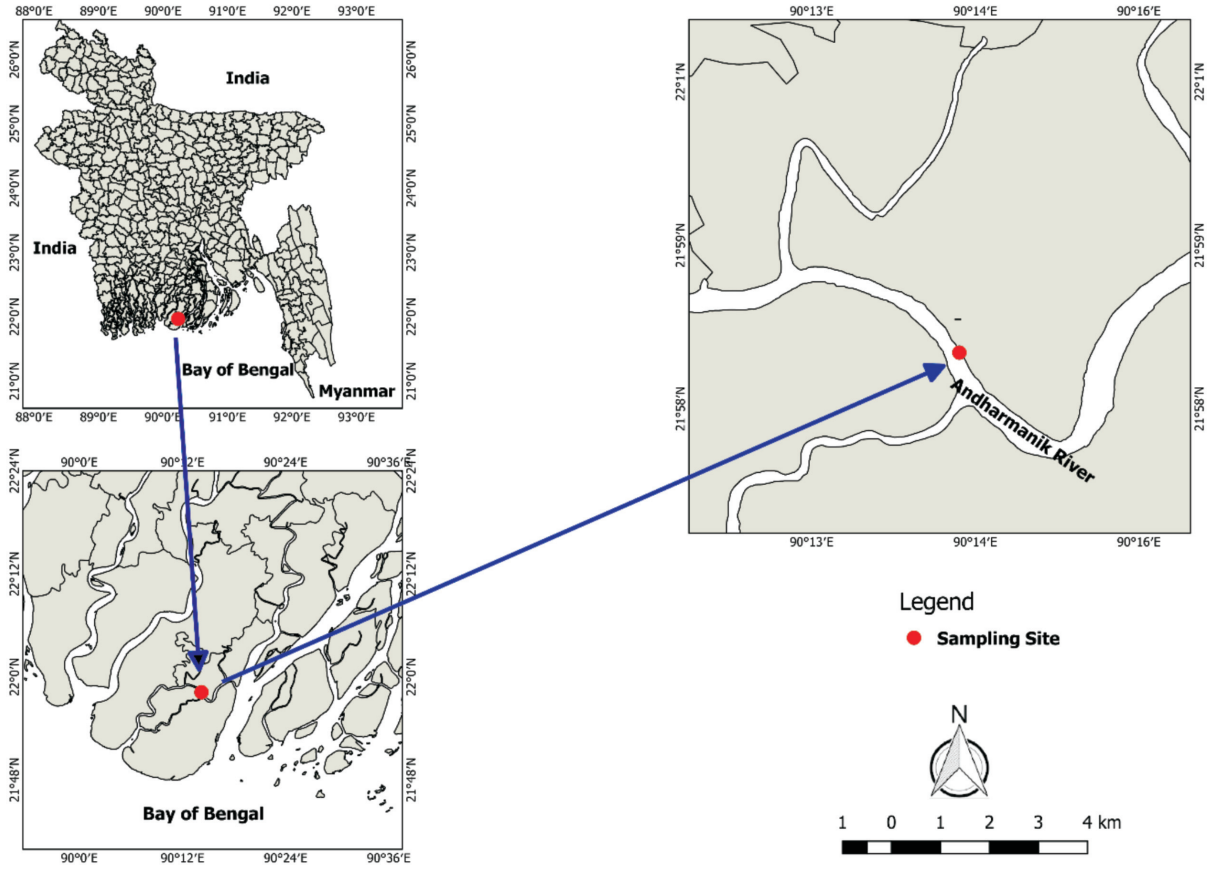

Figure 1. Map of the Andharmanik River, Patuakhali, Bangladesh presenting the sampling area.

Results

The morphological characteristics of *Oryza coarctata* from the mid-southern coast of Bangladesh were recorded. Fig. 2 displays the habitat, mature shoot, young shoot, and seed of *O. coarctata* on the mid-southern coast of Bangladesh. The average total number of shoots per square meter ranged from 300 to 830, with a mean of 580 ± 261 shoots m^{-2}. Plant height exhibited variability, with heights ranging from 5 to 152 cm. The number of leaves per shoot was relatively consistent, ranging between 3 and 5. The average leaf length varied considerably across the samples, ranging from 2.7 to 29 cm. Similarly, the leaf breadth ranged from 0.10 to 0.90 cm, with a mean value of 0.45 ± 0.21 cm. The internode length was found to be quite small, ranging from 0.25 to 2.10 cm, with an average length of 1.07 ± 0.19 cm. Biomass was measured as dry weight per square meter and exhibited a range of 48 g to 71 g DW m^{-2}, with an average biomass of 60 ± 9.0 g DW m^{-2}.

Comparisons of the average shooting density (m^2) and total biomass (g DW m^{-2}) with previous studies of *O. coarctata* are presented in Table 1. Bangladesh's Andharmanik River is considered an estuary with significant seasonal salinity fluctuations. At the time of sample collection, the water temperature was 28.3°C, its pH was 8.1, total dissolved solids content was 1,284 mg L^{-1}, and its pore water and water salinities were 1.02 ppt and 0.78 ppt, respectively. The electrical conductivity of the soil was 1790 µS cm^{-1}.

Discussion

The environments in which salt marshes thrive vary greatly from muddy intertidal bottoms to coarse sand to sandy clay. The coastal areas of subtropical and

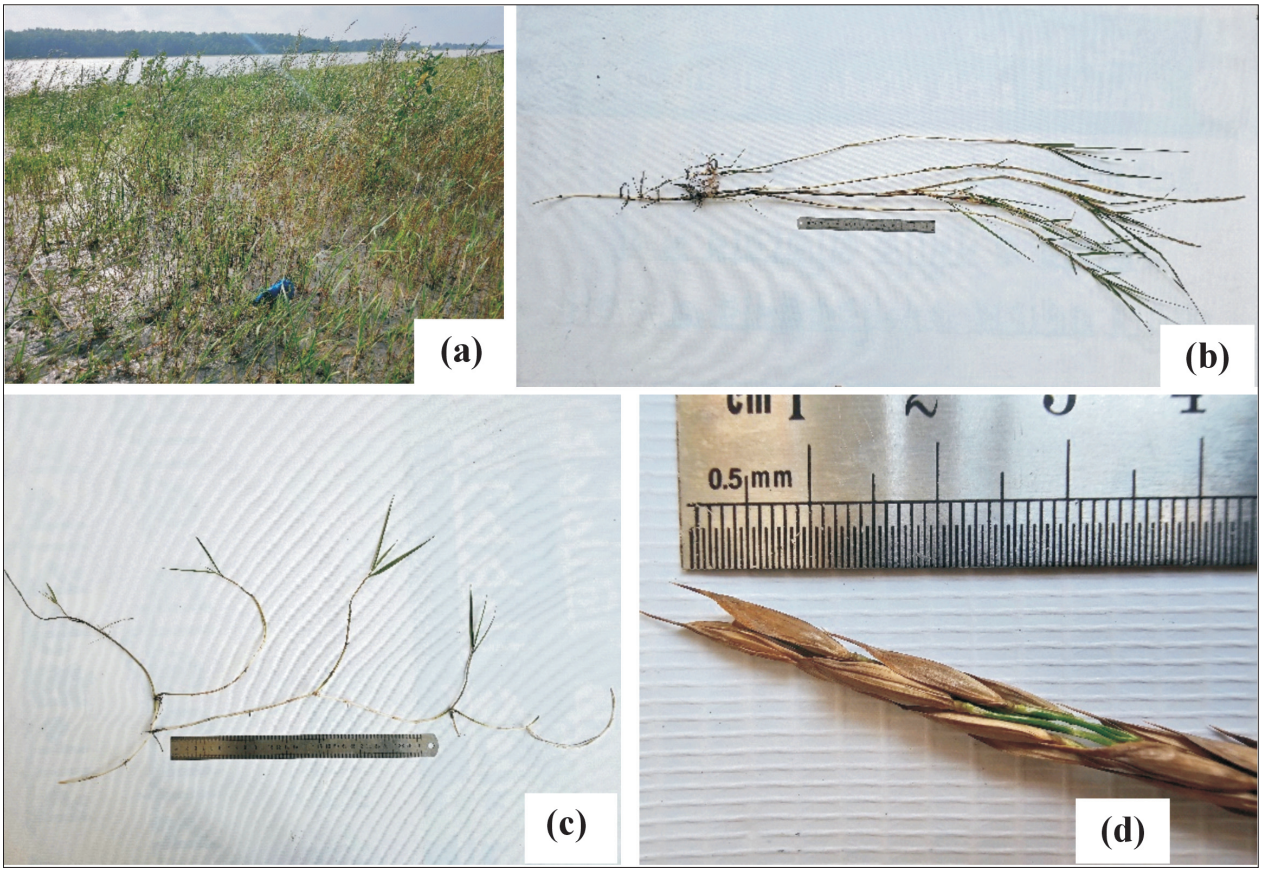

Figure 2. (a) Habitat of *Oryza coarctata* on the mid-southern coast of Bangladesh, Bay of Bengal. (b) Mature shoot of *Oryza coarctata*. (c) Young shoot of *Oryza coarctata*. (d) Seed of *Oryza coarctata*.

Table 1
Comparison of shooting density and biomass (above and below ground biomass) of *Oryza coarctata* with previous studies

Location	Shooting density (m^2)	Biomass (g DW m^{-2})	References
Sundarbans mangrove swamps, India		426	Jana et al. 1993
Goa coast, India	39 to 50	39.3 to 145.2	Jagtap et al. 2006
Southeast coast, Bangladesh	400 to 2875	36.8 to 199	Abu Hena et al. 2007
Southeast coast, Bangladesh	400 to 3375	2.20 to 165	Abu Hena 2013
Mid-Southern Coast, Bangladesh	300 to 860	48 to 71	This study

temperate nations are home to the majority of tidal salt marshes (Wang et al. 2021, Haque et al. 2023). The salt marsh zone along the banks of the Andharmanik River hosts brackish water tidal marshes with diverse and complex plant distribution patterns. There is no known record of any type of salt marsh species on Bangladesh's mid-southern coast. *Oryza coarctata* was previously identified in the southeast coastal region of Bangladesh by Abu Hena et al. (2007). However, the discovery presented in this paper is the very first from Bangladesh's mid-southern Bay of Bengal coast.

According to reports, *O. coarctata* grows in the intertidal brackish water of river mudflat systems (Latha et al. 2004, Jagtap et al. 2006), much like other species of temperate salt marsh (*Imperata cylindrica*) and seagrass (*Halophila beccarii*) that thrive in estuaries and marine waters (Abu Hena

2013). It is the sole species in the halophyte-dominant genus *Oryza*. The branching stalks (culms), resistant leaves with a waxy, leathery feel, an unclear articulation under the top empty glumes, non-flattened spikelets, embryo shape, and other features are the primary morphological traits of this species. Perennial *O. coarctata* has an upright, branching stem in its natural environment. Its husk is yellow, while its kernel is black. The current discovery aligns with the findings of previous research (Jagtap et al. 2006, Abu Hena et al. 2007, Banerjee et al. 2021). The succulent, leathery, waxy leaves of *O. coarctata* aid in regulating the plant's rate of transpiration, preserving its relative water content (Sengupta and Majumder 2009, Chowrasia et al. 2019). However, due to their resilience, the plant's seeds dehisce early and have a short viability period (Schubauer and Hopkinson 1984, Banerjee et al. 2021).

Appropriate physicochemical and sediment qualities may be connected with the potential to efficiently colonize *O. coarctata*. It can withstand a wide range of salinities, from 0–35.65 ppt (Jagtap et al. 2006), which means that it might increase in population in estuary mangrove environments. For germination and early growth, pioneer species such as *Halophila beccarii* and *O. coarctata*, as well as seedlings of several mangrove species, require lower salinity (Jagtap 1985). *Oryza coarctata* is a saline-loving species of rice that uses a coordinated action of many genes to eliminate excess salt through salt glands (Bal and Dutt 1986, Mondal et al. 2017). Although it is a facultative halophyte, its early growth establishment needs a salty environment (Banerjee et al. 2021). As a result, it may be used as a valuable source of genes and alleles for resistance to salt and submersion (Wang et al. 2024). The beds of *O. coarctata*, which normally develop towards the shoreline, might be of relevance in decreasing erosive processes and boosting the rate of sedimentation (Zhao et al. 2022). The substratum's predominant sandy character demonstrated *O. coarctata*'s flexibility to construct recently deposited unsettled sediments and aids in the process of further enhancing land-building. Variation in the physical traits of *O. coarctata* populations throughout Bangladesh's mid-southern coast can be attributed to both genetic variety and environmental influences. This species has a high degree of phenotypic plasticity, enabling it to adapt to a wide variety of environmental circumstances, as evidenced by the observed variation in shoot density, plant height, and leaf dimensions (Jana et al. 2013, Yang et al. 2022).

Conclusion

This study documents the first recorded occurrence of *Oryza coarctata* along the mid-southern coast of Bangladesh, significantly expanding its known distribution range within the country. The observed variation in shoot density, plant height, leaf dimensions, and biomass of *O. coarctata* with previously documented areas can be attributed to differences in season, tidal influence, as well as potential genetic diversity among populations. Understanding this variation is crucial, as it provides insights into the species' adaptive mechanisms in different environments. This knowledge is valuable for developing salt-tolerant rice varieties, supporting conservation strategies, and enhancing coastal ecosystem resilience amid climate change. The findings of the present investigation highlight the need for more research to fully comprehend the spatiotemporal oscillations of *O. coarctata* in this area, as well as its interactions and positive impacts with mangroves.

Author contributions. Md. Rahamat Ullah: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. Mohammed Ashraful Haque: Project administration, Supervision, Funding acquisition, Writing – review & editing. Md. Amirul Islam: Visualization, Investigation, Supervision, Writing – review & editing. Anuradha Bhadra: Investigation, Supervision, Writing – review & editing.

Declaration of competing interest. The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Data availability. Data will be made available on request.

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