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Research article

First report of *Ellobium incrassatum* (Mollusca: Gastropoda) from India and another moluscan new record from the Indian Sundarban

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Abstract: Sundarban Biosphere Reserve is the largest tidal halophytic mangrove forest in the world, and it houses 173 species of Mollusca. The present study reports the occurrence of two snails from the mangrove ecosystem, viz., *Ellobium incrassatum* and *Littoraria pallescens*, from the Indian part of the Sundarban. This is the first time *E. incrassatum* has been reported from India, and *L. pallescens* has been recorded from the eastern Indian coastline.

Keywords: *Ellobium*, Heterobranchia, *Littoraria*, Pulmonata, Winkles

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Introduction

Mollusca are the second-largest animal phylum on Earth after arthropods. Worldwide molluscan diversity is estimated at around 50000 to 55000 marine species, 25000 to 30000 terrestrial species, and 5000 to 7000 freshwater species (Apte, 2012; Rosenberg, 2014; Mollusca Base, 2022a). They are the soft-bodied, large, and most important group of invertebrates that occupies all the possible habitats except the aerial. The total diversity of mollusca recorded from India is 5249 species, which constitutes around 6.14% of the total global molluscan diversity (Banerjee et al., 2022). The first comprehensive data on Indian molluscan species was given by Subba Rao and Surya Rao (1991), who recorded 5100 species of molluscs from freshwater (22 families, 53 genera, and 183 species), land (26 families, 140 genera, and 1487 species), and marine habitats (242 families, 591 genera, and 3400 species) in India. As per the last updated compiled work by Mitra & Dey (2010), India has 1129 land molluscan species, of which 943 are endemic to the region. A total of 196 species of freshwater molluscs can be found in India, of which 47 are endemic to the country, as given in the compilation work by Tripathy and Mukhopadhayay (2015). A comprehensive work on marine and estuarine mollusc species by Mondal (2018), Dixit and Raghunathan (2018), and Rajendra and Raghunathan (2020) gave a list of 1196 species of Mollusca from the Andaman and Nicober Islands and 2379 species of Mollusca from the Indian main land coast and Lakshadweeps. There are several ambiguities in reports among various authors on the total number of molluscs from India, as the diversity is very rich in the Indian context.

The majestic Sunderban harbors about 173 species of molluscs classified into 135 genera and 80 families (Ramakrishna & Dey, 2003, 2010). There are three categories of species found in the Sunderban, differentiated by their habitat distribution: a) 14 terrestrial

species; b) 30 freshwater species; and c) 133 marine and estuarine species (Chandra et al., 2017).

Molluscs exhibit significant diversity in shell shape, sculpture, and colouration. Littorinidae have a wide distribution in tropical and sub-tropical areas, with only a few species occurring in temperate latitudes. Several species of this family live in intertidal mangrove and saltmarsh areas. Littorinid snails are the most common snails in supralittoral fauna throughout the coastline. However, there are some variations in species habitat and zonation in different regions, but they are seen almost all over the coastal regions of the world. On tropical coasts, a group of species is characteristically found on mangrove trees, and some are found in mudflats or rocky substrates. *Littoraria* is a genus of marine snails in the family Littorinidae commonly termed winkles or periwinkles and can be found in most of the marine habitats like mangroves, estuaries, rocky or sandy beaches and intertidal, reef-associated etc. There are more than 50 species in the genus, of which more than 20 are believed to be synonyms of *Littoraria scabra*, a very variable species (Reid, 1985). Six species of *Littoraria* are reported from the Indian mainland, and three species have been recorded from the Indian island habitat, of which five species are recorded from the Sundarban, *viz.*, *L. melanostoma* (Gray, 1839), *L. delicatula* (Nevill, 1885), *L. undulata* (Gray, 1839), *L. carinifera* (Menke, 1830), and *L. scabra* (Linnaeus, 1758) (Mondal, 2018; Rajendra & Raghunathan, 2020; Ramakrishna & Dey, 2003; Dey, 2016).

The family Ellobiidae, or air-breathing snails is characterized by the presence of several apertural teeth. There are many species under in this family, particularly the larger tropical species, which possess a complex series of apertural columellar teeth and lip callosities (Raven & Vermeulen 2007). The genus *Ellobium*, under the family Ellobiidae, is represented by 17 species worldwide, of which the taxonomic status of six species is uncertain as per WoRMS (2022). The Indian mainland has been represented by three species of *Ellobium*, *viz.*, *E. aurisjudae* (Linnaeus, 1758), *E. gangeticum* (L. Pfeiffer, 1855), and *E. translucens* Annandale & Prasad, 1919, but *E. translucens* is not registered in Worms 2022, and the genus has not been recorded from Indian Islands (Mondal, 2018; Rajendra & Raghunathan, 2020).

This study documents *Littoraria pallescens* Philippi, 1846, and *Ellobium incrassatum* (Adams & Adams, 1854) for the first time from the Indian Sunderban.

Material and Methods

Surveys were carried out to study the diversity of mollusca in different regions of the Sunderban Biosphere Reserve (Figure 1). The specimens were collected manually by handpicking techniques and by using scrapers and forceps. Prior to collections, specimens were photographed *in situ* using a digital camera (Nikon 5300). The taxonomy followed in this manuscript is based on Rao (2003), Rao and Dey (2000). Two specimens of *Ellobium* were collected from the southwest beach of Jamboo Dwip, located in the southwest part.

Results

The details of the identified specimen are given below:

Taxonomic classification

Class : Gastropoda Cuvier, 1795
Subclass : Caenogastropoda Cox, 1960
Order : Littorinimorpha Golikov & Starobogatov, 1975
Superfamily : Littorinoidea Children, 1834
Family : Littorinidae Children, 1834
Subfamily : Littorininae Children, 1834
Genus : *Littoraria* Gray, 1833

***Littoraria pallescens* Philippi, 1846**

Conservation Status - Not Evaluated (IUCN 3.1) (IUCN Red List)

Material examined: 3 examples (2 live, 1 shell), ZSI/SbRC/KN3364, SL 11.8-18.7 mm, Dhanchi Island, southwestern side of Sundarban Biosphere Reserve (21°39'44.48"N, 88°12'8.24"E), 28.xii.2019, Coll: Somesh Banerjee; (Deposited in the National Zoological Collections of ZSI-Sunderban Regional Centre).

Description: The shell is attenuated, conical, imperforate, thin, and light with inflated spirals. Spire is free from any kind of ridge. The foot is of shield type and has a truncated, double-edged anterior. Umbilicus is a closed type. The aperture is semi-oval with a thickened columellar and thin outer lip. The operculum solid with a laterally placed nucleus. The colors of the shells are pinkish orange and light yellow. There are rhomboidal-shaped black or brown markings in every spiral striae. Those markings are only seen along the spiral, not along the whole body. Both the tentacles are pale whitish in color, and there are black stripes from top to bottom. Opercular color of both specimens is pale white (Figure 2a, b, c, d). Table 1 provides the length measurements of *L. pallescens*.

Table 1. Morphometric measurements of the collected specimens of *Littoraria pallescens* Philippi, 1846; *Ellobium incrassatum* (H Adams & A Adams, 1854) (length in mm)

	L. pallescens			*E. incrassatum*	
Characters	Sp. 1	Sp. 2	Sp. 3	Sp. 1	Sp. 2
Shell Length	18.7	15.8	11.8	28.4	21.1
Shell Width	15.1	13.1	8.8	20.3	14.6
Aperture Length	7.9	5.5	4.9	14.3	1.8
Aperture Width	5.5	5.2	3.6	5.6	5.6

Distribution: **India:** Kerala (Vishwanathan & Biju Kumar, 2023), West Bengal **-** Dhanchi Island, Sunderban (current report). **Elsewhere**: throughout the tropical Indo-Pacific, Indonesia (Boneka, 1994), the Indian Ocean, Kenya, Thailand (Cook, 1989), Mozambique, Madagaskar, the Ryukyu Islands, the Republic of Mauritius, and Tanzania (WoRMS, 2022).

Remarks: *Littoraria pallescens* prefers seaward and middle-levels mangroves. They are found mainly on the leaves of mangrove trees, but often they are seen in the tree bark with other species such as *L. scabra* or *L. intermedia* (Cook, 1989). However, these three specimens were found during the survey at Dumbar Chor. The area is a submerged mudflat and arises during low tide. There are three different colors. The most abundant colour morphs are dark and yellow.

The abundance of orange or pink-coloured morphs is relatively low (Boneka, 1996). Studies have shown that *L. scabra* and *L. pallescens* coexist all together. *L. scabra* occupied the lower level, 25-150 cm from the ground surface, and was restricted to the bark; conversely, *L. pallescens* occupied a wider altitude range, 50-380 cm above ground, and inhabited mainly on the leaves. The transplant experiment showed that both species tended to crawl down to the bottom when moved from one place to another. It looks like specialization in substrate use is the most likely reason why *L. scabra* and *L. pallescens* can live together when their distributions overlap (Boneka, 1994).

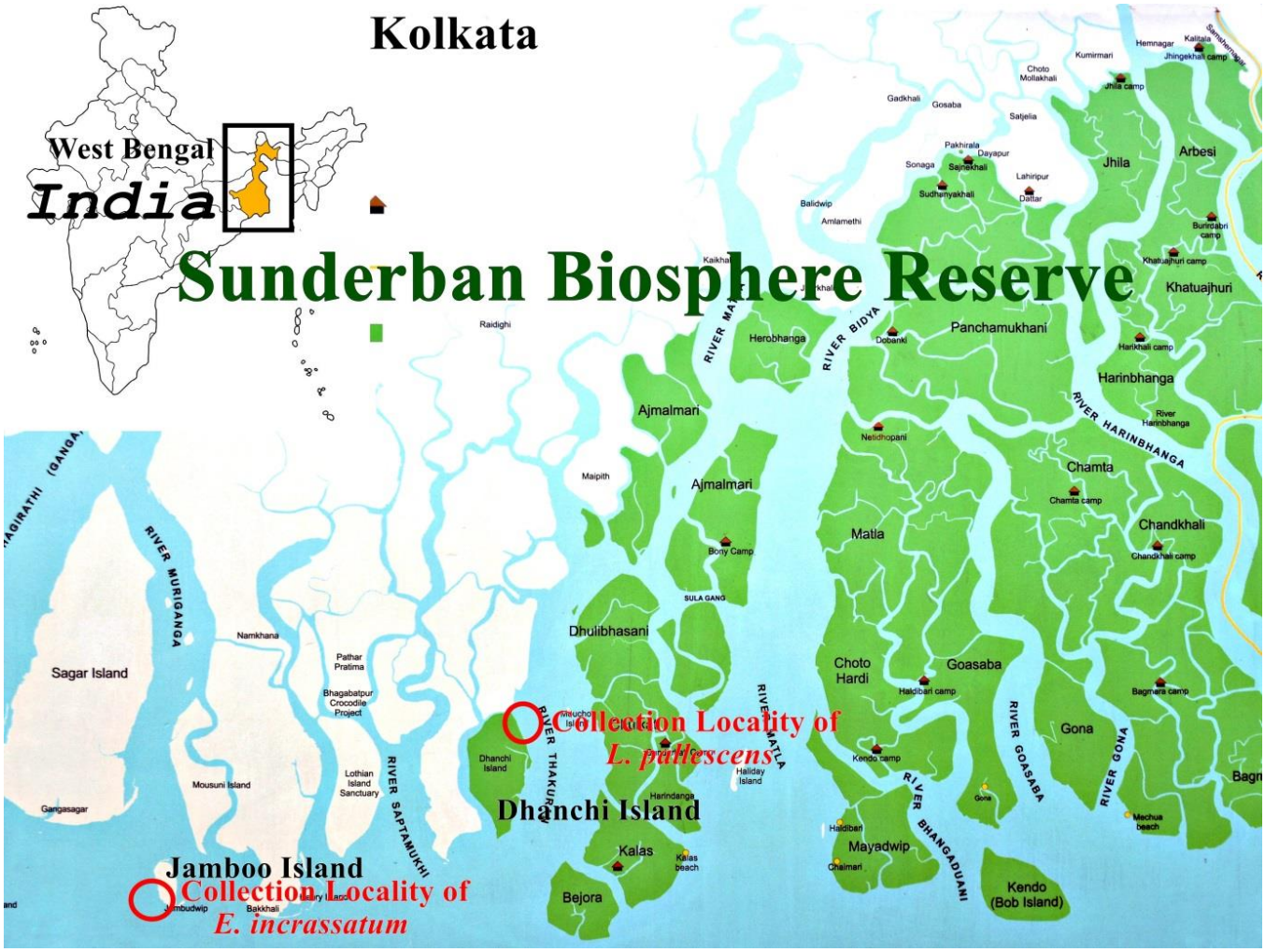

Figure 1. Map of the Sunderban Biosphere Reserve showing collection sites

Figure 2. Photographs of *Littoraria pallescens*. (a & b) Pink morph, (c & d) Yellow morph.

Taxonomic classification

Subclass : Heterobranchia Burmeister, 1837
Order : Ellobiida L. Pfeiffer, 1854 (1822)
Superfamily : Ellobioidea L. Pfeiffer, 1854 (1822)
Family : Ellobiidae L. Pfeiffer, 1854 (1822)
Subfamily : Ellobiinae L. Pfeiffer, 1854 (1822)
Genus : *Ellobium* Roding, 1798

***Ellobium incrassatum* (H Adams & A Adams, 1854)**

Conservation Status--Not Evaluated (IUCN 3.1) (IUCN, 2022)

Material examined: ZSI/SbRC/KN3363, 2 examples (dead, shell), SL 21.1, 28.4 mm, Jamboo Dwip, extreme southwestern side of Sundarban Biosphere Reserve (21°39'44.48"N, 88°12'8.24"E), 28.xii.2019, Coll: Somesh Banerjee.; (Deposited in the National Zoological Collections of ZSI-Sunderban Regional Centre) (Figure 2a, b). of Sundarban Biosphere Reserve (SBR) (21°39'44.48"N, 88°12'8.24"E) on 28.12.2019. Three specimens of *Littoraria* were collected from Dumbar Chor, a mudflat in the north-eastern side of Dhanchi Island, SBR (21°42'59.26"N, 88°29'27.11"E) on 04.03.2020. Collected live specimens were fixed in a 10% formalin (in saline water) solution and later preserved in 70% ethanol for long-term preservation. All the identified specimens used in the study were deposited in the National Zoological Collections of the Sunderban Regional Centre, Canning of Zoological Survey of India. We follow the classification based on Bouchet et al. (2017). All length measurements were taken to the nearest 0.1 mm using electronic calipers.

Description: Body Whorl - 22.9 mm, 14.6 mm; Spire Length - 5.5 mm, 6.5 mm. Shell is attenuated and conical, imperforate, thick, pinkish orange, and light yellow in color. Periostracum is whitish and blunt. Body whorls five. Body whorl large with a short spire. The aperture is longitudinally elongated with a thick outer lip. The shell surface is semi-smooth. Every spiral striae exhibits rhomboidal black or brown markings. Those markings are only seen along the spiral, not along the whole body. Both the tentacles are pale whitish in color, and there are black stripes from top to bottom. Opercular color of both specimens is pale white (Figure 3a, b). Table 1 provides the length measurements.

Figure 3. Photographs of *Ellobium incrassatum.*

***Distribution*: India:** West Bengal **-** Jamboo Dwip, Sunderban (current report). **Elsewhere**: Ryukyu Island (Molluscabase, 2022b).

***Remarks*:** Species under the family Ellobiidae are known as air-breathing snails, as they are found above the high tide mark of the mangrove tree. *E. gangeticum* and *E. aurisjudie,* these two species are mainly found to occupy crevices and deserted burrows of the woo-borers. We found *E. incrassatum* lying beside a small creak in Jamboo Dwip.

Discussions

Littoraria pallescens being a polymorphic species, can be differentiated from other reported species by some shell morphological characters as well as the colour appearance. *Littoraria pallescens* and *L. scabra* have an overall similar outlook, but collumellar type can differentiate between *L. scabra* and *L. pallescens,* where *L. pallescens* has excavated collumella with a convex pillar and pinched at the base compared to excavated collumella with a straight pillar and rounded at the base. *Littoraria intermedia* (Philippi, 1846) sometimes be confused with *L. pallescens* but the grooves of the shell are much wider and the shell is much broader in *L. intermedia*. The rounded inner appertural lip, absence of secondary sculpture, pattern of distinctive dashes in the ribs, and ribs on the last whorl range from 21 to 26; these are the characteristics that differentiate the species from other reported ones from India (Reid, 1984).

Ellobidae are primitive and pulmonate group gastropods, mostly occurring in the halophytic region (Martins 1996). Data on the Indian Ellobiidae is not up to the mark as no such focused work has been carried out for this family and only 11 species from this family; three species from the genus *Ellobium* have been reported from India (Dey & Tripathi, 2019). *Ellobium translucens* is only reported from India, and there is no worldwide record of the species. The species is also only reported and described from Basanti, Sundarban. This is the one and only record of the species and so far, there is no evidence of the species from anywhere (Annandale & Prashad, 1919). The other two species, *E. gangeticum* and *E. aurisjudae*, reported from India, are quite common in the mangrove regions of West Bengal, Andhra Pradesh, Orissa, Andaman, and the Nicober Islands (Dey & Tripathi, 2019). *Ellobium incrassatum* can be differentiated from the other reported species of this genus by several shell characters, such as: the shell shape is elongate ovate in *E. incrassatum* but fusiformly ovate and subovate in *E. gangeticum* and *E. aurisjudae*; periostracum is whitish in *E. incrassatum,* whereas *E. translucens* does not have a periostracum and *E. gangeticum* has a greenish periostracum, *E. aurisjudae* has

a brown periostracum. Shell colouration is pinkish orange and light yellow in *E. incrassatum*, translucent in *E. translucens*, whitish in *E. gangeticum*, and light brown in *E. aurisjudae*. *E. incrassatum*, *E. gangeticum* and *E. aurisjudae*, all have five body whorls, and the shell is almost thick for each species, but *E. translucens* has six body whorls and the shell is very thin. The shell's outer appearance is semi-smooth with longitudinal striae on each whorl, separate from each other, with mostly granulated striae just over the starting of each whorl in *E. incrassatum,* but in the case of *E. gangeticum* it is minutely granulated. Shell appearance is quite different in *E. aurisjudae due to*the presence of spiral rows of fine granules in the shoulder and the weaker sculpture of these rows of granules with irregular axial lines elsewhere on the shell. *Ellobium translucens* is different from all these three by having longitudinally curved striae widely separated by numerous more fine transverse striae. The outer lip margin is thick and has little seretation in the case of *E. incrassatum*. Whereas there is no serration in the other three species and the margin is very thin in the case of *E. translucens. Ellobium incrassatum* and *E. gangeticum* have three collumellar folds, whereas the other two species have only two. The columellar margin of *E. incrassatum* is larger than the other three; appressed, protruding upwards into a thin callus, and the first fold is extended and slightly curved at the end. The columellar margin of *E. translucens* is not very prominent. *Ellobium gangeticum* has a flat columellar margin and the columellar margin of *E. aurisjudae* is angular, and the middle fold is the largest (Pfeiffer, 1857; Annandale & Prashad, 1919).

Species composition, diversity, biomass, and abundance of invertebrates change under disturbance, exploitation, or rehabilitation of mangrove associations (Skilleter, 1996; Skilleter & Warren, 2000; Sasekumar, 1974). Therefore, such parameters may reflect the status of the mangrove ecosystem and can be used as an indicator of changes in both natural and planted mangroves. Different root systems of mangroves, a heavy decomposition rate, high productivity, and complex water channel systems (creeks, mudflats, channels, mud holes, and burrows) are the source of a very complex food chain in a mangrove ecosystem, making it an outstanding habitat for different kinds of Mollusca in several ways (Blaber, 2007).

This study reports the occurrence of the two mollusca species from the Indian Sunderban as well as West Bengal and *E. incrassatum* from India, and there could be several reasons behind this. Salinity is a very important factor in the Sunderban region, and this can be one of the reasons behind this discovery because salinity variation on a long-term scale affects species distribution patterns (Lugendo et al., 2007). A previous study suggests that *Littoraria* occurs in flocks on the leaves or barks of mangrove trees, where two to three species can be present (Sanpanich et al., 2004). *L. pallescens* was collected from a submerged mud flat in Dumbar Chor, which is located on the north-east side of Dhanchi Island. Which is quite unusual as Littorinid snails are always found in dead or alive leaves of mangrove tree trunks. *Ellobium incrassatum* was collected from human foot trails inside the jungle of Jamboo Island, which is located far away from the water body present there. Both of these two species werefound on the very first surveys taken out in those two locations, which indicate that those areas are totally out of the thorough and extensive surveys that need to be carried out.

The distribution of *E. incrassatum* so far recorded from japan and Philippines only, and *L. pallescens* has a wide distribution, focused in eastern Indian and western Pacific Ocean. However, both species has never been recorded from Indian mangroves, due to polymorphic characters of Littorinidae snails and similarities between different species of *Ellobium*. This report conveys a detailed morphological description as well as collection locality for both species and extends the distribution range of *E. incrassatum* from India and *L. pallescens* from east Indian coastline. Habitat heterogeneity of India forces harboring on species diversity and creates a barrier for studying this. Malacofaunal diversity is a great component for understanding the benthic ecosystem and focused studies should be undertaken for studying the mollusks for a better conservational approach.

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Ethical Approval

No need to ethical approval for this study.

Conflicts of Interest

All the authors declare that they do not have any conflict of interest.

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