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A new species of cephalaspidean sea slug of the genus *Melanochlamys* Cheeseman, 1881 (Heterobranchia: Aglajidae) from the Bay of Bengal, India

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ABSTRACT

A new species of head-shield sea slug, *Melanochlamys bengalensis*, is described from the northern part of the eastern coast of India using both external and internal morphological characters. Its novel status is supported by a molecular analysis. The maximum likelihood (ML) genetic tree (COI gene sequence) indicates that the new species represents a distinct clade compared to the other species of the genus *Melanochlamys*. The K2P distance of the new species is 16.2–23.7%, which is considerably more than the other congeners. This species was collected from the intertidal zone of the sandy beaches of Bakkhali, Tajpur, New Digha, Udaipur, Talsari, Chandipur and Kanika Island. Additionally, the list of valid species and distribution of all members of the genus *Melanochlamys* is presented herein.

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Mollusca; Cephalaspidea; head-shield sea slugs; systematics; morphology; molecules; intertidal; Odisha and West Bengal states

Introduction

The family Aglajidae Pilsbry, 1895 contains generally brightly coloured, shallow-water marine slugs that inhabit coral, rocky and sandy substrates in tropical and temperate waters (Zamora-Silva and Malaquias 2018). These sea slugs are active marauders and rapid hunters, feeding almost exclusively upon mobile prey such as other shelled and non-shelled sea slugs, nematodes, kinorhynchs, polychaetes, and small fish (Zamora-Silva and Malaquias 2015). They ingest the prey whole using the suctorial action of the muscular buccal bulb (Burn 2010). Traditional taxonomy based on morphological characteristics has proven sufficient to identify most of the genera. However, in the cases of polymorphism and speciation without variation in morphological characteristics, modern molecular methods have offered a useful tool to delineate cryptic species (Krug et al. 2008) and they serve as one of the more useful tools to provide evidence of speciation. The Aglajidae is the second most diverse family of the order Cephalaspidea (popularly known as head-shield sea slugs) and consists of 85 valid species worldwide divided amongst 15 genera (Zamora-Silva and Malaquias 2018). Zamora-Silva and Malaquias (2018) presented the monophyly and validated these 15 genera, thus proposing a classification based on Bayesian inferenceand maximum likelihood analyses of a large number of DNA sequences.

Melanochlamys Cheeseman, 1881 is the most speciose genus of the family with 16 presently recognised species (followed by *Philinopsis* Pease, 1860 with 15 species) (MolluscaBase 2022). The genus was initially described by Cheeseman (1881) when describing a new species from New Zealand, *M. cylindrica*. Much later, Rudman (1972) established its validity and provided details of its morphology, anatomy, and reproductive and nervous system. Cooke et al. (2014) reviewed the genus using morpho-anatomical and molecular analysis of gene sequences. Species of *Melanochlamys* inhabit the low intertidal zones of the Atlantic, Indo-West Pacific, and eastern Pacific Oceans (Zamora-Silva and Malaquias 2018; Zhang et al. 2020). The only truly tropical species in the genus, *Melanochlamys papillata* Gosliner, 1990, was described from the Gulf of Thailand (Gosliner 1990).

Melanochlamys is characterised morphologically by: a short, blunt and cylindrical body; smooth dorsal surface; two separate shields dorsally (i.e., a cephalic shield anteriorly and a posterior shield, with the latter being nearly equal in length to the cephalic shield); the caudal lobe present as two small projections at the rear of the foot; reduced parapodia; a pair of relatively small sensory mounds (bristles) at the front of the head; a spoon-shaped white internal shell; an inwardly coiled, massive and non-reversible buccal bulb; a conical penial papilla that is larger than the single prostate gland; a bilobed mucous gland – the primary lobe being coiled and the secondary lobe being blunt. The buccal bulb lacks jaws and

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radular teeth and, as mentioned above, it acts as a pump, sucking in prey whole (Rudman 1972).

Melanochlamys has only been mentioned a few times in Indian literature (Subba Rao et al. 1992, 1995; Mitra et al. 2010; Tudu et al. 2018a, 2018b), all from the northwestern Bay of Bengal. Mitra et al. (2010) presented some morphological characters of *Melanochlamys*. During the regular surveys of the Bay of Bengal conducted by the Zoological Survey of India, we collected specimens of a species of *Melanochlamys* that appeared undescribed from Bakkhali, Tajpur, New Digha, Udaipur, Talsari, Chandipur and Kanika Islands (Figure 1). This species was examined thoroughly by integrating morphological characters and conducting a molecular analysis, and its status as a new species was confirmed. Consequently, the present paper describes it and demonstrates that it is the second truly tropical species of *Melanochlamys*.

Abbreviations (including institutional acronyms)

BOLD = Barcode of Life Data System; COI = cytochrome I oxidase; EBRC = Estuarine Biology Regional Centre, Gopalpur-on-Sea, India; L = extended crawling length of the specimen when live; MARC = Marine Aquarium and Regional Centre, Digha, India; ML = maximum likelihood; NCBI = National Centre for Biotechnology Information (National Library for Medicine, Bethesda, MD, USA); NZSI = National Zoological Collections of the Zoological Survey of India, Kolkata, India; W = width of the specimen when live; WoRMS = World Register of Marine Species; ZSI = Zoological Survey of India.

Materials and methods

Specimen collection

Specimens were collected from the low intertidal zones of the northeastern coast of India, comprising several localities in Odisha and West Bengal states (Figure 1). The specimens were narcotised with menthol crystals and fixed in 99.9% ethanol. The living specimens were photographed in situ with a Sony DSC HX400v digital camera (Sony Corporation, Wuxi, Jiangsu, China). The type specimens are deposited in NZSI, MARC and EBRC.

Morphological analyses

The preserved specimens were dissected and examined under an Olympus SZ61 stereoscopic light microscope (Olympus Corporation, Tokyo, Japan (Made in Philippines)), and the photographs of the specimens and their shells were taken with either a Nikon SMZ25 stereomicroscope (Nikon Instruments Inc., New York, USA) or a Leica M205A stereomicroscope (Leica Microsystems, Wetzlar, Germany). Body length (L) and width (W) were

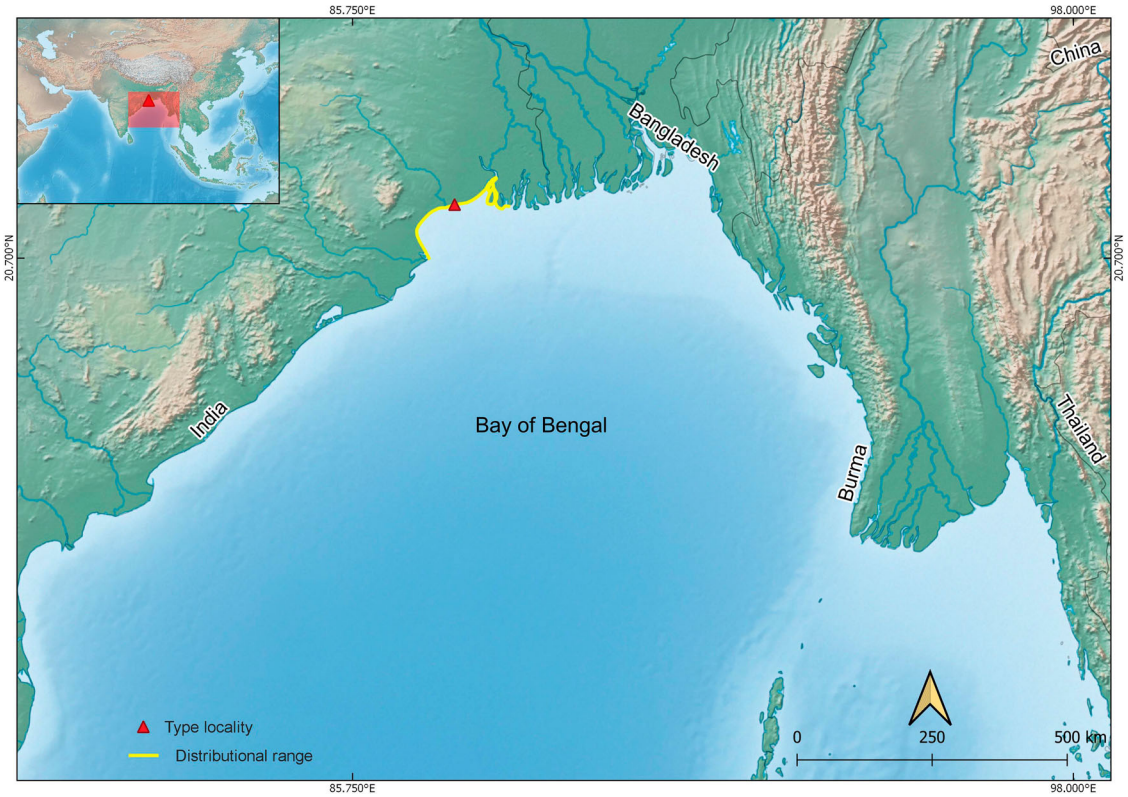

Figure 1. Map showing the type locality, New Digha coast (red triangle), and distribution range (yellow line) for *Melanochlamys bengalensis* n. sp.

Table 1. Kimura 2-parameter distance (K2P) as a percentage (%) between *Melanochlamys bengalensis* n. sp. and its congeners with the addition of *Onchidella binneyi* Stearns, 1894 as an outgroup. The "Comparison Sequence" column lists GenBank accession, species name and provenance.

Comparison sequence	MW838968 *Melanochlamys bengalensis* n. sp. India
MK012183.1 *Melanochlamys* sp. Arctic Ocean	21.6
MK012182.1 *Melanochlamys* sp. Arctic Ocean	22.4
KU737568.1 *Melanochlamys* sp. Russia	22.9
KU737567.1 *Melanochlamys* sp. Russia	21.6
MT348780.1 *Melanochlamys aquilina* China	16.7
MT348779.1 *Melanochlamys aquilina* China	16.7
MT348778.1 *Melanochlamys aquilina* China	16.7
MT348777.1 *Melanochlamys aquilina* China	16.7
EU604714.1 *Melanochlamys diomedea* West coast of North America	23.6
EU604713.1 *Melanochlamys diomedea* West coast of North America	23.6
EU604712.1 *Melanochlamys diomedea* West coast of North America	22.8
EU604711.1 *Melanochlamys diomedea* West coast of North America	23.6
EU604710.1 *Melanochlamys lorrainae* New Zealand	19.6
EU604709.1 *Melanochlamys lorrainae* New Zealand	20.3
EU604708.1 *Melanochlamys lorrainae* New Zealand	20.3
EU604707.1 *Melanochlamys lorrainae* New Zealand	20.8
EU604706.1 *Melanochlamys cylindrica* New Zealand	19.4
EU604705.1 *Melanochlamys cylindrica* New Zealand	19.4
EU604698.1 *Melanochlamys* sp. 1 Australia	20.9
EU604697.1 *Melanochlamys* sp. 1 Australia	20.4
KJ704936.1 *Melanochlamys* sp. South Korea	22.1
KJ704935.1 *Melanochlamys kohi* Japan	23.7
KJ704934.1 *Melanochlamys kohi* Japan	23.1
KJ704933.1 *Melanochlamys kohi* Japan	23.4
KJ704932.1 *Melanochlamys kohi* South Korea	23.7
KJ704930.1 *Melanochlamys fukudai* Japan	17.9
KJ704931.1 *Melanochlamys kohi* South Korea	23.7
KJ704929.1 *Melanochlamys fukudai* Japan	17.9
KJ704922.1 *Melanochlamys fukudai* Japan	18.8
KJ704920.1 *Melanochlamys fukudai* Japan	18.8
KJ704902.1 *Melanochlamys ezoensis* Japan	16.2
KJ704899.1 *Melanochlamys ezoensis* Japan	17.4
KJ704897.1 *Melanochlamys diomedea* West coast of North America	22.8
AM421867.1 *Melanochlamys* sp. West coast of North America	21.3
AM421866.1 *Melanochlamys diomedea* West coast of North America	23.7
MZ073295.1 *Onchidella binneyi* Mexico (outgroup)	31.5

measured by a WorkZone digital caliper (Bromley, UK) with up to 0.5 mm accuracy.

DNA extraction and sequencing

A 12 mg tissue sample was taken from the foot and cephalic shield with sterilised scissors and then washed with distilled water. Isolation of DNA from the tissue sample was carried out using the salting-out method (Sambrook and Russell 2001). The concentration of DNA was measured using a Quibt 4 Fluorometer (Pub. No. MAN001217210). Once isolated, the DNA sample was stored at –20°C until further use.

The COI gene amplification was done in a Thermo Fisher PCR machine (Applied Biosystem by Thermo Fisher ScientificVeriti™, Singapore) by carrying a total volume of 50 µl [20 µl of nuclease-free water, 25 µl of 2X Hi G9 Taq PCR Master Mix, 1.5 µl forward of universal primer LCO1490 (5′GGTCAACAAATCATAAAGATATTGG3′), 1.5 µl of backward universal primer HCO2198 (5′TAAACTTCAGGGTGACCAAAAAATCA3′) (Parikh et al. 2015) and 2 µl of extracted DNA Template] with thermo-cyclic conditions for the PCR comprising an initial denaturation at 95°C for 1 min, 35 cycles at 95°C for 1 min, annealing at 40°C for 1 min and extension at 72°C at 1.05 min with final extension at 72°C for 7 min followed by an indefinite hold at 4°C.

Sequencing of the obtained amplified DNA product was achieved using the Sanger Sequencing method. The sequence assembly was performed using BioEdit version 7.2 (https://www.informer.com/). The COI gene sequence was submitted to NCBI with accession number MW838968 (length 660 bp). The multiple alignment of the similar COI gene sequences obtained from NCBI, BOLD database and pair-wise evolutionary distance (K2P) and maximum likelihood (ML) tree analysis using the Kimura 2-parameter model (Kimura 1980) were carried out using the software MEGA 10 (Kumar et al. 2018). The bootstrap analysis was carried out using 1000 replications for the verification of robustness of the internal nodes of the ML tree.

Results

Systematics

Order Cephalaspidea Fischer, 1883

Superfamily Philinoidea Gray, 1850 (1815) [this unusual citation with two different dates follows MolluscaBase 2022]

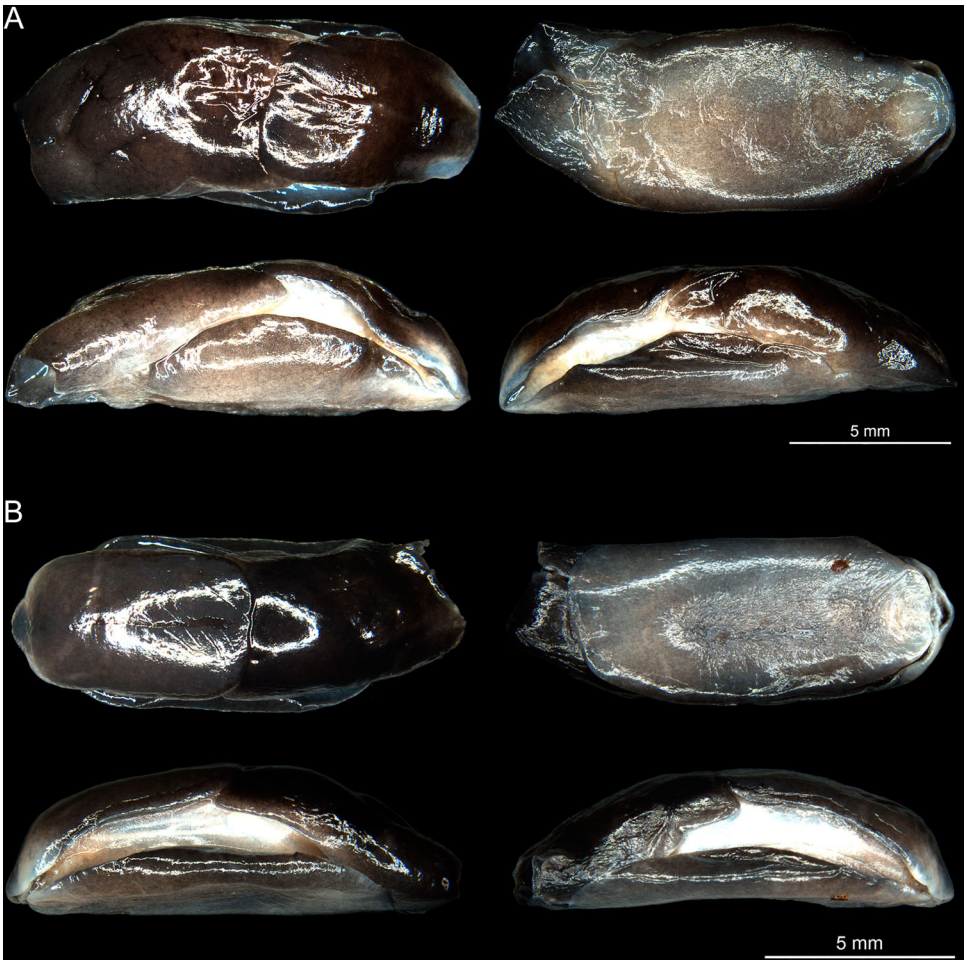

Figure 2. *Melanochlamys bengalensis* n. sp. **A,** holotype (NZSI M 34984/10); **B,** paratype (NZSI M 34985/10) (photographs by S. Sajan).

Figure 3. A live individual *Melanochlamys bengalensis* n. sp. photographed at 'Udaipur' showing its dorsal surface and its trail left on the sand at low tide (specimen not collected, photograph by P.C. Tudu).

Family Aglajidae Pilsbry, 1895
Genus *Melanochlamys* Cheeseman, 1881

Type species, by original designation, *Melanochlamys cylindrica* Cheeseman, 1881. Recent, New Zealand, Gender feminine.

Distribution: The genus is generally distributed in temperate regions of the Indo-Pacific Oceanic realm (Table 1), except for the only truly tropical species, *Melanochlamys papillata* Gosliner, 1989, which comes from the Gulf of Thailand (Cooke et al. 2014).

***Melanochlamys bengalensis* Tudu, Sajan, Mukhapadhyay n. sp.**
(Figures 2, 3)

Proposed common name: Bay of Bengal head-shield sea slug.

Zoobank registration number: https://www.zoobank.org/urn:lsid:zoobank.org:act:B8E1C3CC-7D01-4890-A438-151498ADB32C

Type material

Holotype. Intertidal zone of New Digha coast, West Bengal, India, 21°37.11′ N, 87°30.05′ E, collected by P.C. Tudu, 27 December 2017 (NZSI M 34984/10, 14 mm preserved length).
Paratypes. Same data as holotype (NZSI M 34985/10, 2 specimens, 12.5 and 13 mm preserved length, dry

shells); Same location as holotype (NZSI M 34986/10, dissected soft parts in ethanol); Bakkhali, West Bengal, 21°36.65′ N, 87°29.08′ E, collected by P.C. Tudu, 23 December 2012 (MARC/ZSI M 8099, 6 specimens with preserved length up to 7.5 mm); Chandipur, Odisha, 21°26.38′ N, 87°01.50′ E, collected by P.C. Tudu, 27 December 2012 (MARC/ZSI M 8100, 3 specimens with preserved length up to 10.5 mm); Talsari, Odisha, 21°36.08′ N, 87°27.91′ E, collected by P.C. Tudu, 1 September 2013 (MARC/ZSI M 8101, 4 specimens with preserved lengths ranging between 5 and 6.5 mm); Udaipur, Odisha, 21°36.69′ N, 87° 29.30′ E, collected by P.C. Tudu, 28 December 2017 (MARC/ZSI M 8102, 34 specimens, with preserved lengths ranging between 10.5 and 13 mm); Kanika Island, Odisha, 21°49.88′ N, 86°59.290′ E, collected by P.C. Tudu, 13 October 2019 (MARC/ZSI M 8103, one specimen, preserved length 9.5 mm); Udaipur, Odisha, 21°36.12′ N, 87°29.14′ E, collected by P.C. Tudu, 4 February 2021 (MARC/ZSI M 8104, 21 specimens with preserved lengths ranging between 8.5 and 11.5 mm; EBRC/ZSI M12611, one specimen, preserved length 4.5 mm, cut in half for DNA analysis; Udaipur, Odisha, 21°36.69′ N, 87°29.30′ E, collected by P.C. Tudu, 7 December 2020 (EBRC/ZSI M12692, two specimens, with preserved lengths ranging between 10.5 and 11 mm).

Additional material examined (not type material)

Udaipur, Odisha, 21°36.77′ N, 87°29.52′ E, collected by P.C. Tudu, 4 April 2013 (MARC/ZSI M 8105, 5 specimens, with preserved lengths up to 7.0 mm); Tajpur, West Bengal, 21°38.79′ N, 87°38.06′ E, collected by P.C. Tudu, 9 October 2017 (MARC/ZSI M 8106, 22 specimens, with preserved lengths up to 7.5 mm); Udaipur, Odisha, 21°36.68′ N, 87°29.54′ E, collected P.C. Tudu, 11 February 2020 (MARC/ZSI M 8107, 56 specimens, with preserved lengths ranging between 6 and 10 mm).

Type locality

Intertidal zone of New Digha coast, Bay of Bengal, West Bengal, India.

Etymology

The name is derived from of the type locality for this species, the Bay of Bengal.

Diagnosis

Colour (both in life and when preserved) velvety black. Body narrow and elongate, divided dorsally into cephalic and posterior shields. Cephalic shield elongate. Posterior shield longer than cephalic shield, with two long and wide caudal lobes of equal size at hind end. Parapodia relatively low, separated by large gap dorsally. Shell internal, beneath posterior shield. Eyes not visible externally. Female genital opening located near posterior end of parapodia on right side of body.

Description

External morphology

Living animals up to 12 mm when extended (corresponding with 14 mm long and 6 mm wide at the middle of the body in preserved specimens). Body cylindrical, elongate, narrow; divisible dorsally into an anterior cephalic shield and cylindrical posterior shield; anterior shield elongate, coverings about 55% of animal and overlapping posterior shield; anterior end of anterior shield narrowly blunt with marginal notch at centre; posterior shield elongate, longer than cephalic shield, covering about 58% of body and originating from dorsal notch which is covered by cephalic shield; hind end of posterior shield extended into two long and wide caudal lobes of similar size separated by a notch with the shape of a conical flask in preserved specimens. Ventral membrane of each caudal lobe slightly shorter than that of dorsal membrane. Posterior shield covering internal shell. Parapodia covering about 80% of total length of animal dorsally. Longitudinal lines visible on parapodia when animal is turned over in preserved state. External eyes not visible because of opacity of overlying skin. Mouth circular, located ventrally in the middle of shallow depression anteriorly, surrounded by some buccal cirri. Female genital opening located near posterior end of right parapodium. Male genital opening at right side of mouth anteriorly. Animal velvety black in colour (both living and when preserved), with greyish white colour between two dorsal shields and also between parapodia. Parapodia brown or blackish brown. Juvenile specimens whitish or greyish white to blackish on anterior end of cephalic shield and whitish brown to blackish hue inside parapodia. Parapodia held close to animal body when crawling, but separated from body in preserved specimens. Live animals continuously secrete clear mucus to form a sheath that prevents sand grains from entering parapodial space.

Shell morphology

Shell opaque white to brownish white in colour, thin, fragile but well calcified, greater than 1.3 whorls (Figure 4A). Body whorl wide. Spire small, with rounded apex; adapical section of outer lip higher than spire. External surface sculptured with strong axial and weak vertical growth lines. Inner surface smooth.

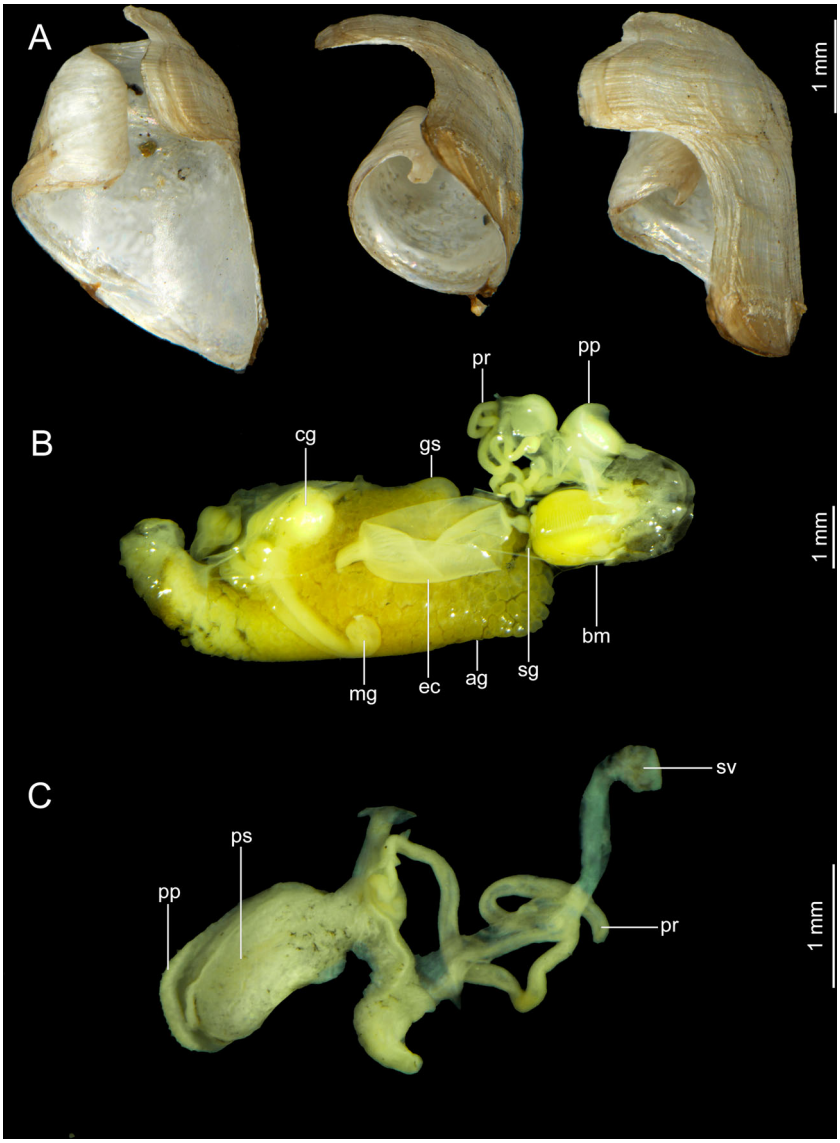

Figure 4. *Melanochlamys bengalensis* n. sp. **A,** Internal shell (NZSI M 34985/10); **B,** internal structure; **C,** penial structure (NZSI M 34986/10). Abbreviations: ag = albumen gland; bm = buccal mass; cg = capsule gland; ec = oesophageal crop; gs = gametolytic sac; mg = mucous gland; pp = penial papilla; pr = prostate; ps = penial sac; sg = salivary gland; sv = seminal vesicle (photographs by S. Sajan).

Penial structure

Penial sac located just below buccal mass on the right side, roughly ovate, convoluted, tightly packed (Figure 4B, C). Penial structure covered by thin, brownish, penial sheath. Penis relatively short and wide, oblanceolate in shape. Several more or less blunt and curved cuticular papilla present over surface of penis. Basal part of penial sac consisting of two tubular openings which are connected to blunt seminal vesicle and long, intricately coiled prostate.

Natural history

Reproduction apparently occurs between November and January as juveniles first appear in February each year. Individuals leave long trails behind them when they are crawling on soft and wet sandy areas. As they crawl just below the surface (Figure 3), they are not visible most of the time, except for their trails. Their location is given away by a bulge in the sand at the end of the trail. Individuals burrow into the sand when the surface becomes dry during daytime exposure.

Phylogenetic analyses

The ML tree (Figure 5) suggests *Melanochlamys bengalensis* occupies a different clade in comparison to all its congeners. *Melanochlamys bengalensis* is placed in the clade closest to *M. ezoensis* (Baba, 1957) and *M. aquilina* Zhang et al., 2020. The K2P distance (Table 1) between *M. bengalensis* and *M. ezoensis* is 16.2–17.4% (based on the two sequences available from Japan) and between *M. bengalensis* and

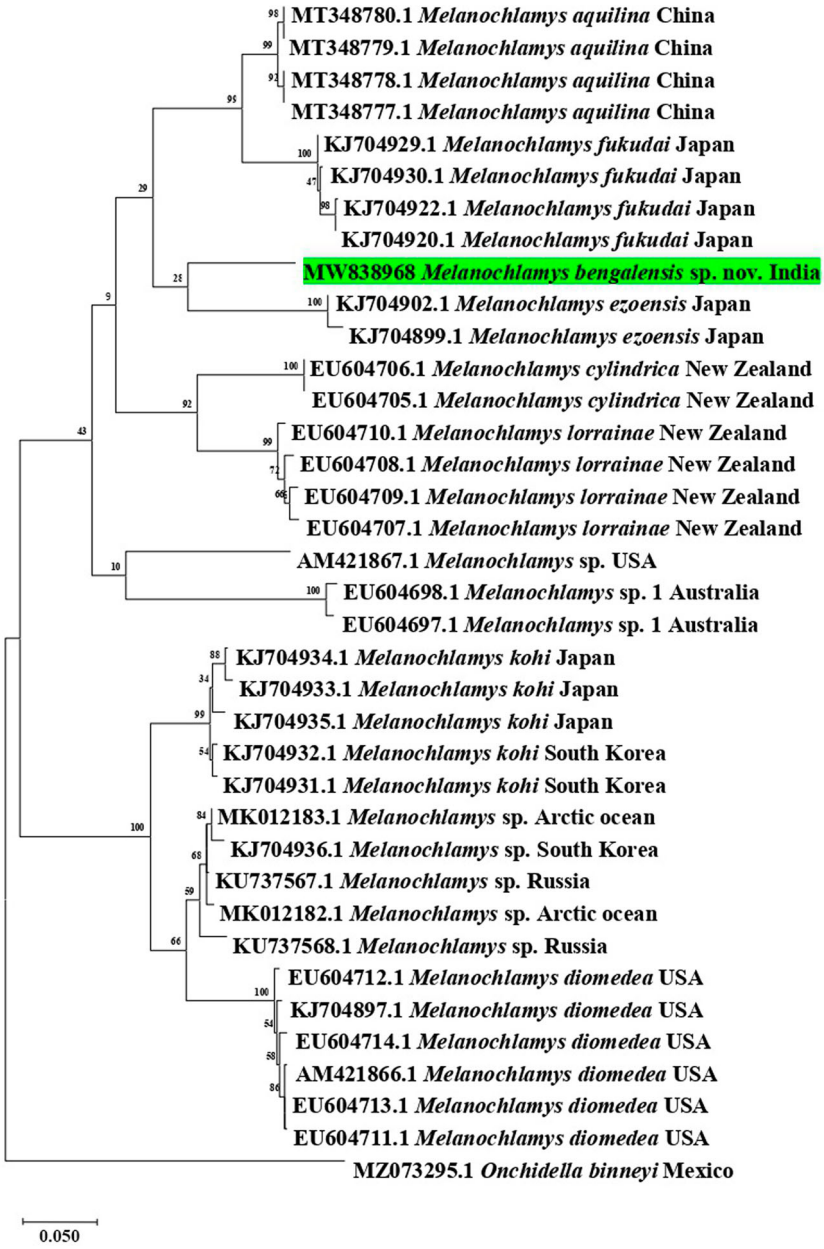

Figure 5. Maximum likelihood (ML) tree showing the relationship of *Melanochlamys bengalensis* n. sp. with other species inferred from the COI sequences. The numerical bootstrap value is shown at each node of the ML tree.

M. aquilina by 16.7% (based on all the four sequences from China). The K2P distance between *M. bengalensis* and *M. fukudai* Cooke et al., 2014 is 17.9–18.9% (based on the four sequences from Japan). The species with the most similarity in colouration is *M. cylindrica*, which exhibited a K2P distance of 19.5% (based on the two sequences from New Zealand). *Melanochlamys bengalensis* shows a much greater K2P distance (19.7–23.7%) from all the remaining species of the genus. Thus, *M. bengalensis* clearly belongs in a different clade and has a significant genetic distance from all its congeners.

Distribution

Melanochlamys bengalensis inhabits the sandy intertidal zone from Bakkhali of West Bengal to Kanika Island of Odisha state, along the northwestern region of Bay of Bengal, a total distance of approximately 295 km (Figure 1).

Discussion

Unlike many aglajid species, all the known species of *Melanochlamys* have been found to have relatively restricted geographic distribution (Table 2). This anomaly is because their larvae have a limited capacity for dispersal (Zhang et al. 2020). Apart from the geographic distribution, all the previously described species of *Melanochlamys* differ in various ways. *Melanochlamys bengalensis* is similar to the temperate *M. cylindrica* in colour, but the latter is larger (to 30 mm extended crawling length), with equal sized cephalic and posterior shields; it has two translucent grey

Table 2. Complete list of the species of the genus *Melanochlamys*, and an indication of their global distribution.

Species	Holotype locality	Distribution	Source
M. algirae (A. Adams, 1850)	Algiers	Algeria (Mediterranean Sea)	A. Adams (1855, p: 598)
M. aquilina Zhang *et al.*, 2020	Laizhou Bay, Shandong Province	Bohai sea (China)	Zhang et al. (2020)
M. barryi Gosliner, 1990	False Bay, Cape Province	South Africa	Gosliner (1990, p: 214)
M. bengalensis Tudu, Sajan, Mukhapadhyay n. sp.	New Digha (West Bengal)	Along the northwestern region of the Bay of Bengal from Bakkhali in West Bengal to Kanika Island, Odisha state, India	Present study
M. chabanae Breslau, Valdés & Chichvarkhin, 2016	Vladimir Bay, Primorsky Krai	Russia (Sea of Japan)	Breslau et al. (2016)
M. cylindrica Cheeseman, 1881	Tamaki Heads, Auckland Harbour	New Zealand	Krug et al. (2008)
M. diomedea (Bergh, 1894)	Richmond Yacht Harbor, Contra Costa County, California (paratype, *M. nana.*)	Pacific coast of North America, from southern California to Alaska	Rudman (1972), Cooke et al. (2014)
M. ezoensis (Baba, 1957)	Akkeshi, Hokkaido	Japan, Sea of Japan coast of Russia (North Pacific Ocean)	Baba (1957), Cooke et al. (2014)
M. fukudai Cooke *et al.*, 2014	Banzu, Kisarazu, Boso Peninsula Chiba	Japan from Hokkaido to Sagami Bay	Cooke et al. (2014)
M. handrecki Burn, 2010	Waratah Bay, South Gippsland, Victoria	Victorian coast of Australia and Macquarie Harbour on the western coast of Tasmania	Burn (2010)
M. kohi Cooke *et al.*, 2014	Wando Island, South Jeolla Province	Yellow and East China Sea coast of South Korea (North Pacific Ocean)	Cooke et al. (2014)
M. lorrainae (Rudman, 1968)	Manukau Harbour	New Zealand	Krug et al. (2008)
M. maderensis (Watson, 1897)	Madeira (Portugal)	Canary Islands, Cape Verde Islands	Watson (1897, p: 238), Ortea and Moro (1998)
M. miqueli (Pelorce, Horst & Hoarau, 2013)	Calanque du Mugel, Marseille, France	Western Mediterranean and Adriatic Seas	Pelorce et al. (2013), Pontes et al. (2013)
M. papillata Gosliner, 1990	Hua Hin	Thailand	Gosliner (1990)
M. queritor (Burn, 1957)	Portarlington, Victoria	Southern New South Wales to southern Western Australia including Tasmania	Burn (1957, 2006, 2010), Rudman (1972)
M. wildpretii Ortea, Bacallado & Moro, 2003	Sardina del Norte, Gáldar, Gran Canaria	Gran Canaria, Canary Islands	Ortea et al. (2003)

areas on each side of the head-shield, and its parapodia touch the caudal notch (Krug et al. 2008; Willan and Davey 2020), whereas *M. bengalensis* has unequal shields, the head-shield is completely black, and the parapodia are relatively smaller (extending up to 80% of body length). In addition, the shape of the shell of these two species differs greatly. *Melanochlamys bengalensis* lies in the clade closest to the temperate *M. ezoensis* but the K2P distance between these two species is 16.2–17.4% (based on the two sequences from Japan) and morphologically *M. ezoensis* has parapodia that extend along the entire length of the animal, its colour is brownish grey with mottled dark pigment, its penis bears a large cuticularised and curved penial spine, and its shell has less prominent growth lines (Cooke et al. 2014). The tropical species *M. papillata* differs in body colouration (Gosliner 1990), being off-white with varying amounts of brownish pigment on the dorsal surface, a rounded head shield covering half of body, short blunt caudal lobes, thin parapodia extending most of the body length, a thick internal shell with 1.5 whorls, and a penis with two distinct papillae. *Melanochlamys aquilina* S.-Q. Zhang et al., 2020 differs from *M. bengalensis* by having equal-sized cephalic and posterior shields, parapodia equal in length to that of the body, a U-shaped caudal notch, and dark blue colouration (Zhang et al. 2020). The colour of the temperate *M. lorrainae* varies from white to mottled grey, its shell is visible through the posterior shield, and the shell has a width of 1.5 whorls (Krug et al. 2008).

The habitat of *M. bengalensis* is dynamic beaches containing large intertidal areas with fine sand and relatively low wave heights. The type locality (New Digha, a border town between West Bengal and Odisha states) itself has a shallow beach with an intertidal zone that is wider than 500 m at low tide. The widest intertidal zone of about 2 km is at Chandipur with a very shallow beach and the lowest wave height. The northwestern region of the Bay of Bengal is part of an unusual biogeographic area possessing an estuarine environment during the monsoon season from July to September and a marine environment throughout the rest of the year. Bakkhali is located at the mouth of the Hooghly River which is a tributary of the River Ganges, and very close to the Sundarban mangrove forest. Although the molluscan diversity of this region has been well documented, with 301 species now recorded from the West Bengal coast (Tudu et al. 2018a) and 496 species from the Odisha coast (Tudu et al. 2018b), the discovery of *M. bengalensis* n. sp. shows that the Indian region, particularly that of the Bay of Bengal, needs further investigation for its marine biodiversity.

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Disclosure statement

The authors declare that they have no conflict of interest.

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