SHORT COMMUNICATION

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THE WINDOWPANE OYSTER FAMILY PLACUNIDAE RAFINESQUE, 1815 WITH ADDITIONAL DESCRIPTION OF PLACUNA QUADRANGULA (PHILIPSSON, 1788) FROM INDIA

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Abstract: The Bivalvia family Placunidae Rafinesque, 1815 in India is reviewed in this paper based on previous literature and records. Additionally, the species Placuna quadrangula is described from the Indian sub-continent. Being an economically important family in this geographic region, this paper can be regarded as a baseline for further ecological, management and policy-related studies pertaining to Placunidae and other exploited species.

Keywords: India, Placuna quadrangula, Placunidae, Taxonomy.

Abbreviations: ANI—Andaman & Nicobar Islands | GOM—Gulf of Mannar | GOK—Gulf of Kutch | MBRC—Marine Biological Research Centre | NZC—National Zoological Collections | PB—Palk Bay | GBR—Great Barrier Reef | QGIS—Quantum Geographic Information System | ZSI—Zoological Survey of India | RUMF—Ryukyu University Museum, Fujukan.

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The family Placunidae Rafinesque, 1815 is comprised of the genera Placunanomia and Placuna, the latter with seven accepted living species (Huber 2010). Distributed mostly within the Indo-West Pacific region.

Tamil Abstract: மண்டலவெளி குழுவுக் குடும்பம் Placunidae Rafinesque, 1815 இந்தியாவில் இருந்து இந்துக் குழுவுக் குடும்பத்தை விளக்கத்தில் விளக்கியது எனும் படிப்பு. இது ஒரு சுருக்கப்பட்ட விளக்கமானது. எனவே இது இந்துக் குழுவுக் குடும்பத்தை மேற்கொள்ளவுடன் இந்தியாவில் குழுவுக் குடும்பமேற்கொள்ளவுடன் செய்யப்பட்டது. Placuna quadrangula என்பது இந்தியாவின் பெண் பெணின்றால் குழுவின் செயல்பாட்டு மேற்கொள்ளப்பட்டது. Placunidae குழுவுக் குடும்பத்தின் செயல்பாட்டு மேற்கொள்ளப்பட்டது. Placuna quadrangula என்பது இந்துக் குழுவுக் குடும்பத்தின் செயல்பாட்டு மேற்கொள்ளப்பட்டது. Placuna quadrangula என்பது இந்துக் குழுவுக் குடும்பத்தின் செயல்பாட்டு மேற்கொள்ளப்பட்டது.
The genus *Placuna* Lightfoot, 1786 has a long documentary history, as it is commercially exploited for pearl production, food, lampshades and shell-craft items (Gallardo et al. 1995). From Indian waters, *Placuna placenta* (Linnaeus, 1758) (Image 1) is the only species that has been thoroughly studied due to its economic value (Laxmilatha 2015a). *Placuna sella* (Gmelin, 1791) now *P. ephippium* (Philipsson, 1788) was first reported from the Andaman & Nicobar Islands, India by Prashad (1932), followed by Gulf of Mannar, southeastern coast of India (Rao & Dey 2000; Venkataraman et al. 2004) and was later revised by Stella (2010) (Image 2) from the Mandapam coast (Adjacent to GOM). *Placuna ephippium* is also exploited, especially in the Bay of Banate, Philippines and its surrounding areas, and mainly known for its food value (Gallardo 1994). Currently, as per published reports, two species of *Placuna, P. ephippium* and *P. placenta* are reported from the Indian coast (Rao 2017) (Image 3). In this study we confirm the presence of a third species from India, *P. quadrangula* (Philipsson, 1788). This paper further attempts to distinguish all three species from the Indian coast based on morphology.

**SYSTEMATICS**

Order Pectinida Gray, 1854  
Superfamily Anomioidea Rafinesque, 1815  
Family Placunidae Rafinesque, 1815  
Genus *Placuna* Lightfoot, 1786  

*Placuna* is monomyarian, with low umbones, V-shaped crurae and pallial line, often obscured. Valves circular to sub-circular and laterally compressed. All the characters are common in the species observed from the Indian subcontinent, and a detailed species wise description is given below.

*Placuna placenta* (Linnaeus, 1758)  
(Image 1)

**Description:** Shell thin, very flat, roughly circular or subcircular in shape, inequivalve, periostracum absent. Inner surface smooth, outer surface lamellate, growth lines present. Transparent when juvenile, turning opaque with age. Lacking radial lines on the external surface. Crurae below the umbones, unequal in size, adductor muscle scar slightly anterior of midline. Pallial line obscure and non-sinuated. Specimen examined has a damaged or broken outline.

**Distribution:** Extends from Gulf of Aden in the west to Taiwan in the east (Matsukuma 1987; Huber 2010).

*Placuna ephippium* (Philipsson, 1788)

**Description:** Shell saddle-shaped with curved dorsal margin without periostracum. Growth lines visible. External colour purple brown/brownish with black shades to large red-purplish-blackish spots on the interior surface. Lacking radial lines on the external surface. Crurae prominent, equal in size and widerset. Single adductor muscle scar in the center of midline; purplish in colour.

**Distribution:** India to Australia (Matsukuma 1987; Huber 2010).

**Remarks:** See Discussion.

**Table 1. Materials examined.**

| Locality                  | Coordinates (decimal) | No. of valves | Dimensions LxWxH (mm) | Date of collection | Collected by | Deposition no.         |
|--------------------------|-----------------------|---------------|-----------------------|-------------------|--------------|-----------------------|
| Kottivakkam (Chennai)    | 12.966/N, 80.265/E    | 2             | 80.38 x 78.77 x 8.23; 57.83 x 49.48 x 4.88 | 28.ii.2015       | GS           | ZSI/MBRC/M.2004; ZSI/MBRC/M.2005 |
| Serenity Beach, Kottakuppam (Puducherry) | 11.976/N, 79.845/E | 1             | 92.09 x 91.30 x 9.59  | 19.x.2015        | RRD          | ZSI/MBRC/M.2006        |
| Kasimedu, Royapuram (Chennai) | 13.123/N, 80.297/E | 2             | 71.94 x 61.37 x 7.32; 56.55 x 47.71 x 4.91 | 13.iii.2016      | RRD; GS      | ZSI/MBRC/M.2007; ZSI/MBRC/M.2008 |
Description of *Placuna quadrangula* from India

*Placuna quadrangula* (Philipsson, 1788)  
(Image 3. A–J)

**Description:** Shell thin, brittle, papery, laterally compressed but slightly concave (Image 3. A-J). Outline quadrangular, periostracum inconspicuous. Surface smooth, lamellate, growth lines fine with closely arranged radial threads. Externally pinkish to whitish with non-uniform white radial rays originating from umbones; internally pinkish to whitish. Prominent crurae of equal size. Adductor muscle scar centrally situated, rounded. Pallial line obscure and non-sinuated. Internal margins smooth. Internal and external surface of the specimens with attached fouling organisms.

**Distribution:** Present study – Tamil Nadu, Puducherry (eastern coast of India), Mergui Archipelago, Thailand, Indonesia, Philippines and Australia (Matsukuma 1987; Sanpanich 2011).

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Image 1. Dorsal and ventral side of *Placuna placenta* collected from Mandapam (southern India) (Coll. by R. Rajkumar, ZSI/MBRC/M.1718/5854) (© Deepak Samuel).

Image 2. Dorsal side of *Placuna ephippium*? collected from Mandapam (southeastern coast, India) (Scale = 2cm) (© C. Stella).

Image 3. (A–J) Specimens of *Placuna quadrangula* examined (Scale = 1cm). The white radial lines can be clearly seen in the dorsal side of the specimen A and G. (© Rocktim Ramen Das).
Description of Placuna quadrangula from India

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Remarks: The five examples collected from three different localities possess the typical radially rayed pattern.

DISCUSSION

Comparative analysis among the Placuna species from India with some notes on other Indo-Pacific species

The radial colour patterns originating from the umbones (Image 3) a typical character for P. quadrangula is emphasized in Huber 2010. Although confused with P. ephippium which is larger, the specimen described from Mandapam has no mention of purple muscle scar nor the color predominance in the shell as seen in Huber 2010. Rather it is described as “almost transparent” along with light brownish nature with black patches (Image 3) (see Stella 2010). The transparent nature fits well with P. placenta juvenile as observed in the collections of the Ryukyu Museum (RUMF-ZM-03693) and in Kouri Shell Museum, Okinawa (Rocktim Ramen Das, pers. obs.) but is known to turn white and shiny after maturity. The presence of brown radial rays in the latter from southeastern Asian specimens (see Matsukuma 1987) might be misleading and needs reassessment. P. ephippium lacks such brown radial rays and possesses large red, purplish-black spots on the interior region (Henk Dekker pers. comm.).

Life history of genus Placuna

A review of literature revealed that there is a limited amount of research based on the life history of genus Placuna with exclusive information available only for P. placenta. Adam Young (1980), who did an extensive study on the larval growth and development of P. placenta, revealed that the shells remain inequivalve and transparent from a very early stage. The author also revealed that from fertilized egg to the formation of spat, it takes about 10–11 days and the final sedentary phase is reached when around 600µm in size is reached during which several key morphological changes take place, viz., active foot appearance during larval metamorphosis. Narasimham (1984), who later studied the biology of P. placenta from the eastern coast of India (Kakinada Bay) (Figure 1) mentioned about the biannual spawning strategy of the species and based on the gonadal appearance and morphology divided the maturity into four stages, viz.: active, ripe, partially spawned and spent/resting. Interestingly, a recent observation from the coast of Sonmiani (Balochistan) indicated that P. placenta spawns all-round the year (Parveen et al. 2018) which contradicts the findings of Hornell (1909) and Moses (1939) whose studies were from a not so distant area of Okha, Gujarat, India (~400 km). This probably indicates the local environmental parameters like temperature, salinity and monsoonal characteristics can play an important role at regional scales (Ladja 2002).

Status of genus Placuna in India

Along the coast of India, the windowpane oyster (P. placenta) was initially reported by Hornell (1909a,b). In the 1970s, Narasimham documented its utilization due to its high economic value while Laxmilatha (2015) reviewed the economic value. Though the species is reported from various places of the Indian sub-continent (Table 3), it is commercially exploited only from specific areas along the coastline (Table 3). Exploitation of the species in areas of Gulf of Kutch was mainly for pharmaceutical purposes (Alagawasami & Narasimham 1973; Narasimham et al. 1993). Presently the exploitation levels are low in the Gulf of Kutch. In Kakinada Bay, P. placenta is regarded as one of the most important bivalve resources, but the stock is under threat due to overexploitation (Rao & Somayajulu 1996; Laxmilatha 2015b). Nauxim Bay in Goa had a minor fishery where the meat was locally consumed (Narasimham et al. 1993). Apart from the above-mentioned locations, the collection of windowpane oyster from the coastal waters of Tamil Nadu mainly for the pearl and shell craft industries. Vellapatti fishing hamlet near Tuticorin is the hub for the utilization of P. placenta in the cosmetic and paint industry. Rameswaram is famous for the windowpane oyster lampshades and mirrors. It is important to highlight that due to such activities, previous densely populated areas of P. placenta are lost (Tripathy & Mukhopadhayay 2015). The saddle-shaped oyster P. ephippium collected in Mandapam, Gulf of Mannar is also used in the production of a variety of curios/souvenirs, viz., trays, lampshades (Stella et al. 2010). The third species P. quadrangula, reported here is either invasive or has been overlooked over the past decade. It is important to highlight that Iredale in the scientific reports published related to the GBR expedition refers to a publication from the Bolten Museum dating back to 1798 which mentions Ephippium anomia (synonym P. quadrangula) from Tranquebar (now Tharangambadi, ~230km from Chennai). Further in-depth analysis revealed the information is related to its morphological characters, leaving the information regarding its geography being rather vague (see Iredale 1939; Röding 1906).
Figure 1. Distribution of genus *Placuna* along the Indian subcontinent. GOK=Gulf of Kutch; GOM=Gulf of Mannar; PB=Palk Bay; ANI=Andaman & Nicobar Islands; * Exploited Regions.

Table 2. Summary of important morphological features among the Indian *Placuna* species.

|                          | Placuna placenta | Placuna ephippium | Placuna quadrangula |
|--------------------------|------------------|-------------------|---------------------|
| Morphology (Figure 2)    | Roughly circular | Saddle shape with curved dorsal margin | Quadrangular, thin, papery |
| Colour                   | Semi-transparent (juvenile); opaque and white (adult) | Purplish, large spots in the interior region (Red, Purple or Black) | Pinkish to whitish, with prominent white radial lines. |
| Crurae (Figure 2)        | V-shaped, narrow and unequal | V-shaped, wide apart and equal | V-shaped, wide apart and equal |
| Radial lines             | Absent           | Absent            | Irregular radial lines originating from umbones |
| Pallial Line             | Obscure          | Obscure           | Obscure |
| Posterior adductor muscle| Monomyarian      | Monomyarian       | Monomyarian |
| Adductor muscle scar     | Slightly anterior of midline | Center of midline, purplish | Center of midline, rounded |
| Umbones                  | Low              | Low               | Low |

Figure 2. Sketch of the V-shapes crurae and hinge shape: A—*P. quadrangula* | B—*P. placenta* | C—*P. ephippium*.
Table 3. Reports of genus *Placuna* from various parts of the Indian subcontinent*

| Source | Locality/Region | Species |
|--------|-----------------|---------|
| Hornell 1909b | Balapur Harbour, Beyt Island and Okha (Gujarat); Enmore (Tamil Nadu); Buckingham canal (Tamil Nadu); Pulicat lake (Andhra Pradesh) | *Placuna placenta* |
| Prashad 1932 | Andaman Islands | *Placuna sella* |
| Rai 1933 | Bombay coast (Maharashtra) | *Placuna placenta* |
| Alagawasami & Narasimham 1973 | Gulf of Kutch (Gujarat); Malabar coast, Vembanad lake (Kerala); Tuticorin**, Nagappattinam**, Kakinada bay** (Andhra Pradesh) | *Placenta placenta*** |
| Narasimham et al. 1993 | Naukim Bay** (Goa) | *Placenta placenta*** |
| Hameed & Somasundaram 1998 | Gulf of Mannar (Tamil Nadu) | *Placenta placenta*** |
| Rao & Dey 2000 | West Bengal | *Placuna placenta* |
| Venkataraman et al. 2004 | Andaman & Nicobar Islands | *Placuna placenta* |
| Samuel et al. 2005 | Dhanuskodi (Tamil Nadu) | *Placenta placenta*** |
| Stella et al. 2010 | Mandapam** (Tamil Nadu) | *Placuna ephippium* |
| Boominathan et al. 2012, 2014 | Kali River; Uttara Kannada district (Karnataka) | *Placuna placenta, Placenta placenta*** |
| Murugesan et al. 2013 | Parangipettai (Tamil Nadu) | *Placenta placenta*** |
| Prabhu et al. 2013 | Mallipattinam (Tamil Nadu) | *Placenta placenta*** |
| Thilagavathi et al. 2013 | Muthupettai (Tamil Nadu) | *Placenta placenta*** |
| Bijukumar et al. 2015 | Kavaratti Island (Lakshadweep) | *Placuna placenta* |
| Tripathy & Mukhopadhyay 2015 | Murud-Jinjira** (Maharashtra); Pouchitra**, Raida**, Goomara** (GOK, Gujarat), Chennai** | *Placuna placenta* |
| Mahapatro et al. 2016 | Chilika Lake (Odisha) | *Placuna placenta* |
| Rao 2017 | Pindara Bay (Gujarat); Baikkal cove and Pavin halla (Karnataka); Pambam, Kundupaul point (Tamil Nadu); Eitimukkala and Kalingapatnam (Andhra Pradesh); Irakali and Jambu Island (West Bengal) | *Placuna placenta* |
| Ravinesh et al. 2018 | Navi Mumbai (Maharashtra) | *Placuna placenta* |
| Present study | Chennai (Tamil Nadu); Kottakuppam (Puducherry) | *Placuna quadrangula* |

*The information may be non-exhaustive  +*Placuna sella is the synonym of *Placuna ephippium* **Placenta placenta is a group under which *Placuna placenta* was assigned by Gray 1849, thus can be regarded as a synonym in this context, **Exploited Area

### Conclusion

*Placuna placenta* is the only species under the genus that is listed (as *Placenta placenta*) under Schedule IV of the Indian Wildlife Protection Act, 1972. As mentioned in the act, “*No person shall hunt any wild animal specified in Schedules I, II, III, and IV except as provided under section 11 and section 12*”. Furthermore, Section 11 and 12 allows for hunting only in special cases and with proper documents and permissions from the concerned government authority; however, surreptitious fishing of this species continues even in protected areas, e.g., Kakinada Bay (Coringa Wildlife Sanctuary) (Laxmilatha 2015a,b) apart from other areas as mentioned above. Moreover, the recent news of *P. placenta* being smuggled to western Asian and South American countries in alternate forms (Ravinesh et al. 2018) further highlights the urgent need to assess the genus. As our study highlights the morphological aspects of this genera, a thorough comparative assessment of the internal organs and the application of molecular methods should provide essential insights. On the other hand, biogeographical assessment of *P. quadrangula*, its ecology and its implications on *P. placenta* distributions is urgent. As the Indian Ocean is home to large and unknown malacofauna (see Das et al. 2017), continuous surveys to discover these understudied resources remains imperative.

### References

Alagawasami, K. & K.A. Narasimham (1973). Clams, cockle and oyster resources of the Indian Ocean. Proceedings of the Symposium on Living Resources of the Seas Around India, Special Publication 648–658.

Bijukumar, A., R. Ravinesh, A.R. Arathi & K.K. Idreesabu (2015). On the molluscan fauna of Lakshadweep included in various schedules of Wildlife (Protection) Act of India. *Journal of Threatened Taxa* 7(6): 7253–7268. [https://doi.org/10.11609/JoTT.o4140.7253-68](https://doi.org/10.11609/JoTT.o4140.7253-68)

Boominathan, M., G. Ravikumar, M.D. Subash Chandran & T.V. Ramachandra (2012). Mangrove associated molluscs of India. *Lake 2012 - National Conference on Conservation and Management of Wetland Ecosystems*. Mahatma Gandhi University, Kottayam, Kerala, 1–11pp.

Boominathan, M., G. Ravikumar, M.D. Subash Chandran & T.V.
Ramachandra (2014). Impact of hydroelectric projects on commercial bivalves in a south Indian west coast estuary. Journal of Biodiversity 5(1(2)): 1–9.

Das, R.R., G. Kantharajan, S. Goutham, V.D. Samuel, P. Krishnan, R. Rajkumar & R. Purvaja (2017). First report of Antigona somwangi huber, 2010 (mollusca: bivalvia: veneridae) from India. Journal of Conchology 42(5): 379–380.

Gallardo, W.G., S.W. Siar & V. Encena II (1995). Exploitation of the window-pane shell Placuna placenta in the Philippines. Biological Conservation 73(1): 33–38.

Gallardo, W.G. (1994). Bivalves. In: Lacanlao, F., R.M. Coloso, & G.F. Quintino (eds.). Proceedings of the Seminar-Workshop on Aquaculture Development in Southeast Asia and Prospects for Seafarming and Searanching. 19–23 August 1991, Ilollo City, Philippines. (pp. 40–45). Tigbauan, Iloilo, Philippines: SEAFDEC Aquaculture Department.

Gray, J.E. (1849). Description of the species of the genus Placenta of Retzius. Proceedings of the Zoological Society of London, for 1849: 114–115, Moll. Pl. 1.

Hameed, P.S. & S.S.N. Somasundaram (1998). A survey of bivalve molluscs in Gulf of Mannar, India. Indian Journal of Fisheries 45(2): 171–181.

Hornell, J. (1909a). Report to the government of Baroda, on the prospects of establishing a pearl fishery and other marine industries on the coast of Okhamandal. Williams and Norgate, London, 43–97pp.

Hornell, J. (1909b). Report to the Government of Baroda on the marine zoology of Okhamandal in Kattiarai. Williams and Norgate, London, 43–97pp.

Huber, M. (2010). Compendium of bivalves: A full-colour guide to 3,300 of the World’s Marine Bivalves. A status on Bivalvia after 250 years of research. Hackenheim, Conch Books, 901pp.

Huber, M. (2015). Placuna quadrangula. In: MolluscaBase (2015). World Register of Marine Species at http://www.marinespecies.org/aplha.php?taxaId=504275 on 2016-05-02

Iredale, T. (1939). Mollusca, Part 1. Sci. Rep. Great Barrier Reef Exp. 1928-29, 5(6): 209–425, pls. 1–7.

Laxmilatha, P. (2015a). Status and conservation issues of window-pane oyster Placuna placenta (Linnaeus 1758) in Kakinada Bay, Andhra Pradesh, India. Journal of the Marine Biological Association of India 57(1): 92–95. https://doi.org/10.6024/jmbai.2015.57.1.1843-15

Laxmilatha, P. (2015b). Gastropod and bivalve fishery of Kakinada Bay, Andhra Pradesh, India: Management and conservation issues. Aquaculture Asia. Volume XX(4): 214(1–4): 21–26.

Madrones-Ladja, J.A. (2002). Salinity effect on the embryonic development, larval growth and survival at metamorphosis of Placuna placenta Linnaeus (1758). Aquaculture 214(1-4): 411–418.

Matsukuma, A. (1987). Studies on the Kawamura Collection (Mollusca) Stored in the National Science Museum, Tokyo IV: The Family Placunidae (Bivalvia) with Special Reference to their Ligament. Venus (Japanese Journal of Malacology) 45(4): 231–244.

Mahapatro, D., R. Panigrahy, S. Panda & R.K. Mishra (2016). Malacofaunal diversity of Chilka lake, Odisha, India. Proceedings of the Zoological Society of India 9(17): 1–9.

Moses, S.T. (1939). The recent Placuna pearl fishery in Baroda and some notes on the window-pane oyster. Journal of Bombay Natural History Society 41: 119–122.

Muruganandan, P., A. Silambarasan, S. Purusothaman, S. Muthuvelu & T. Anantharaj (2013). Diversity of Invertebrate trawl bycatch off Cuddalore, Parangipettai and Pazhayar, south-east coast of India. Indian Journal of Fisheries 60(1): 41–49.

Narasimham, K.A. (1973). On the molluscan fisheries of the Kakinada Bay. Indian Journal of Fisheries 20(1): 209–214.

Narasimham, K.A. (1984). Biology of windowpane oyster Placenta placenta (Linnaeus) in Kakinada Bay. Indian Journal of Fisheries 31(2): 272–284.

Narasimham, K.A., V. Kripa & K. Balan (1993). Molluscan shellfish resources of India - An overview. Indian Journal of Fisheries 40(1, 2): 112–124.

Parveen, S., G. Siddiqui & S. Hassan (2018). Temporal variation in reproductive pattern of windowpane oyster Placuna placenta (Mollusca: Placunidae) from Sonmiani, Balochistan, Pakistan. International Journal of Aquatic Science 9(2): 112–119.

Prashad, B. (1932). The Lamellibranchia of the Siboga Expedition, Systematic Part, II, Pelecypoda (exclusive of the Pectinidae), Siboga-Expeditie, Monograffe 53 c, Livr. 118, July, pp. 353, 9pls., 1 map

Prabhu, P., U. Balasubramaniam & S. Purushothaman (2013). Diversity of invertebrate trawl by catch off Mallippattum, Sathuvasatherum, Memesal, southeast coast of India. Advances in Applied Science Research 4(6): 249–255.

Rai, H.S. (1933). The shellfisheries of the Bombay Presidency. Journal of the Bombay Natural History Society 35: 826–845.

Rao, G.S. & K.R. Somayajulu (1996). Resource characteristics of exploited bivalves and gastropods of Kakinada Bay with a note on stock assessment. Marine Fisheries Information Service, Technical and Extension Series 144: 13–19.

Rao, N.V.S. & A. Dey (2000). Catalogue of marine molluscs of Andaman & Nicobar Islands. Records of the Zoological Survey of India, Occasional Paper 187: 1–323.

Rao, N.V.S. (2017). Indian seashells, Part 2: Bivalvia. Records of the Zoological Survey of India, Occasional Paper 375: 1–676.

Ravinesh, R., A. Bijukumar & V.D. Samuel (2018). Status of marine molluscs in illegal wildlife trade in India. G Wild Cry 34–39pp.

Röding, P.F. (1906). Museum Boltenianum sive catalogus cinelorum e tribus regnis naturae quo alim collegarit Joa. Fried. Bolten... Pars secunda: Contineins Conchylia sive Testacea univalvia, bivalvia & multivalvia. British Museum (Natural History).

Samuel, V.D., D. Chacko & J.K.P. Edward (2005). Preliminary study on the molluscan diversity of “the lost world” – Dhanushkodi, East coast of India. Proceedings of the National seminar on Reef ecosystem remediation. SMDRI research publication, Tuticorin, 9: 54–58pp.

Sanpanich, K. (2011). Marine bivalves occurring on the east coast of the Gulf of Thailand. Science Asia 37: 195–204. https://doi.org/10.2306/scienceasia1513-1874.2011.37.195

Stella, C., J.S. Serebiah & J. Siva (2010). New distributonal records of Placuna ephippium (Reizius, 1788) Family: Placunidae from Mandapam area - South east coast of India. World Journal of Fish and Marine Sciences 2(1): 40–41.

Thilagavathi, B., D. Varadharajan, A. Babu, J. Manoharan, S. Vijayalakshmi & T. Balasubramaniam (2013). Distribution and Diversity of Macrobenthos in Different Mangrove Ecosystems of Tamil Nadu Coast, India. Journal of Aquaculture Research and Development 4(6): 1–12.

Tripathy, B., A.K. Mukhopadhyay (2015). Marine Molluscan Diversity in India. In: Venkataraman, K. & C. Sivarupan. Marine Faunal Diversity in India, Taxonomy, Ecology and Conservation. Elsevier, 519pp.

Venkataraman, K., P.C. Raghuram & J.R.B. Alfred (2004). Bibliography and checklist of corals and coral reef associated organisms of India. Records of the Zoological Survey of India, Kolkata 468pp.

Young, A.L. (1980). Larval and post larval development of the windowpane shell, Placuna placenta Linnaeus, (Bivalvia: Placunidae) with a discussion on its natural settlement. Veliger 23(2): 141–148.
Peer Commentary

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