OPISTHOBRANCH (MOLLUSCA: GASTROPODA) FAUNA OF ROCKY REEF ECOSYSTEMS OF KERALA COAST, INDIA

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ABSTRACT

Baiju, P.T., Prabhakaran, M.P., Ajas Miraj, C.H., Kiran, J. & Benno Pereira, F.G. (2023). Opisthobranch (Mollusca: Gastropoda) fauna of rocky reef ecosystems of Kerala Coast, India. Braz. J. Aquat. Sci. Technol. 27(1). ISSN 1983-9057. DOI: 10.14210/bjast.v27n1.17676. Opisthobranchs are one of the least studied marine taxonomic groups in Kerala. The present study was carried out to explore the opisthobranch diversity of rocky reefs of Kerala. The study was able to record 13 species of sea slugs belonging to 3 Orders, 8 Families, and 9 Genera. Out of 13 species recorded in the study, 5 species were identified as new to the Kerala coast. Among the 3 Orders recorded in the study, Nudibranchia was noted with the highest species contribution of 10 species and among the 8 families, the Dentrodoridae with a maximum of 3 species.

Key Words: Opisthobranchs. Rocky Reefs. Subtidal Reefs. Kerala Coast.

INTRODUCTION

Opisthobranchs are shell-less molluscan gastropods found in both marine and freshwater ecosystems, and approximately 6000 species were reported throughout the world (Wagele et al. 2008). The distribution range of these fascinating animals stretches from the Indo-Pacific tropical region and the east coast of Africa to the Hawaiian Islands. Nudibranchs belong to Phylum Mollusca, Class Gastropoda, and Subclass Opisthobranchia. Gastropod group receives more importance due to the scarcity of studies in India. Opisthobranchs are one of the least studied groups of mollusks with highly diverse body forms, cryptic coloration, diets and habitats. The works done on Opisthobranchs in India and Kerala are little and patchy, and the earlier works, dating back to the 1880s by Alder & Hancock (1864), Kelaart (1858, 1859, 1883), and Gardiner (1903). From the beginning, opisthobranch diversity studies in India were restricted to the East and Southeast Coasts. The early records of these gastropods from the West Coast of India are limited to the works of Eliot (1905 and 1909), Gideon et al. (1957), Menon et al. (1961) and Narayanan (1968).

Recently, the opisthobranchs received good attention from various parts of the country by the promising studies done by renowned researchers. The opisthobranch diversity of Indian waters has a long history, from the very pioneer study of Alder and Hancock (1864) to the very recent and comprehensive updates from the various eminent researchers in the field of marine biodiversity, including Apte (2009), Bhave & Apte, 2013; Venkataraman et al. (2015), Raghunathan et al. (2016); Apte & Desai (2017); Vadher et al. (2020).

Even though the rocky reefs are important ecosystems of the Kerala coast, biodiversity studies are rare in this regard. The early studies on opisthobranch diversity of the Kerala coast were restricted to a few attempts (Narayanan, 1968b, Valdes et al. 1999). After that, the opisthobranch diversity studies received more attention through remarkable studies done by various researchers Biju Kumar (2012), Ravinesh & Biju Kumar (2013), Chinnadurai et al. (2014), Ravinesh et al. (2014), Sheeja & Padmakumar (2014 a,b), Venkataraman et al. (2015), Apte & Desai, (2017), Baiju et al. (2016), Anu et al. (2017) and Sneha Chandran et al. (2017). The present manuscript may get more attention due to the scarcity of opisthobranch diversity studies from the coast of Kerala.

The present study was carried out in various rocky reef structures of Kerala, the southwest coast of India. The study was able to record 13 species of opisthobranchs belonging to three orders, eight families and nine genera. Out of 13 species recorded
in the study, five species were identified as new to the Kerala coast.

MATERIALS AND METHODS

Study Area

Patchy rocky reefs are present along with the intertidal areas and occasionally at sub-tidal depths of the coast of Kerala. These rocky structures offer substratum for various biotic assemblages of the marine environment. The study mainly focused on coastal and sub-tidal rocky reefs of the coast. The rocky reefs are recognized as one of the most biodiversity-rich ecosystems among the others. These ecosystems are home to various life forms ranging from algae to various groups of invertebrates and fishes. Due to the shallow nature of the coast, extensive macroalgal communities are prominent include Bryopsis plumose, Caulerpa peltata, Caulerpa racemosa, Caulerpa taxifolia, Chaetomorpha antennina, Valoniopsis pachynema, Ulva prolifera, Ulva lactuca, Dictyota bartayresiana, Lobophora variegata, Sargassum wightii, Corallina officinalis and Kappaphycus alvarezi. The algal diversity of the rocky reefs will attract and supports various groups of invertebrates and fishes.

Vizhinjam is located at 08°22′36″ N and 76°59′32″ E. The reef substratum is typically granite boulder rocks that are covered with mussel beds (Perna perna). The mussel beds provide secondary hard substratum for many marine animals.

Thirumullavaram is situated along the Kollam coast (08°3′49.2″ N and 76°33′05.1″ E in the Kollam district of Kerala state. The shore substratum is partially formed by the combination of laterite rocks and sand and subjected to heavy wave action.

Velliyamkallu (Thikkodi, Kozhikode) is considered a subtidal rocky reef, a massive rock that has witnessed many battles in pre-independent India and was once a vantage point for the Marakkar to attack the invading Portuguese. The rocky island is situated between 11°6′6.32″ N and 75°54′16.81″ E, 10 to 14 km away from the Thikkodi coast. Scientifically it can be defined as “Marine Nearshore Supra tidal Rocky Reef. This zone includes areas above Mean Higher High Water (MHHW) that are affected by wave splash and overwash but does not include areas affected only by wind-driven spray. This zone is subjected to periodic high wave energy, exposure to air and often to variable salinity. The name ‘Velliyamkallu’ means the white rock because it looks white due to the bird’s droppings.

Methodology

Sampling was done from the rocky reef areas of the coast. Live specimens were collected by snorkeling and with the aid of SCUBA, handpicked specimens from the intertidal areas, inshore rocky reef, reef platforms, mussel beds, and subtidal reef areas of Vizhinjam, Thirumullavaram, and Velliyamkallu (Thikkodi, Kozhikode) of the Kerala coast between the depth range of 2 to 10 m. Sample collection was carried out from November 2018 to March 2019. These rocky reefs are partially formed by rocks and sand substratum and subjected to heavy wave action.

Species description, geographic location, and photographs of the live specimen are given. Collected specimens were photo-documented live whenever possible and preserved in 90% ethyl alcohol for further taxonomical studies. The opisthobranchs were identified with key references such as Alder & Hancock (1864), Apte (2009, 2012), Debelius & Kuiter (2007), Yonow (2008, 2012), Gosliner et al. (2008, 2015), Venkataraman et al. (2015), and Apte & Desai (2017). The material was identified following descriptions provided by Kay & Young (1969), Gosliner et al. (2008) and Yonow (2008).

RESULTS AND DISCUSSION

Present study was able to record 13 species belonging to the 9 Genera, 8 Families, and 3 Orders. Among these, five of them are noticed as a new record from the Kerala coast (Table 1). Of the 3 Orders reported in the study, Nudibranchia with maximum species representation of 10 (77%), followed by Pleurobranchida with 2 (15%) species, and Sacoglossa was the least in this context of 1 (8%) species (Figure 1). While considering the family-wise species distribution (Figures 2 and 3, and Table 3), Dendrodorididae was noticed with the highest species, the contribution of 3 (23%), followed by Facelinidae, Chromodorididae, and Discodorididae with 2 (15%) species in each and Pleurobranchidae, Bornellidae, Phyllidiidae and Plakobranchidae with 1 (8%) species on each.

Figure 1 - Order-wise species diversity of Opisthobranchs.
Figure 2 - Family-wise species diversity of opisthobranchs.

While categorizing the species according to the number of specimens observed in each observation, these thirteen species were grouped into 3 categories as common, rare and uncommon. Out of 13 species observed, uncommon 38% (5 species), rare 38% (5 species), and regular 24% (3 species) (Figure 4).

Comprehensive studies on the biodiversity of marine slugs were restricted to a few eminent researchers in the country. Among these, a few of them need to be discussed. Opisthobranchs are found in both marine and freshwater ecosystems and its approximately 6000 species were reported throughout the world (Wagele et al. 2008). From the beginning, Opisthobranch diversity studies in India were restricted to the East and Southeast coast. Records on these gastropods from the West Coast of India are limited to the works of Eliot (1905 and 1909), Menon et al. (1961), and Narayanan (1968). Venkataraman et al. (2015) provided the identification of Opisthobranch species, based on the collective experience of the authors who have been working for several years on marine biodiversity. Apte & Desai (2017) detailed study on about 361 species of sea slug species of Indian waters with their detailed descriptions. Vadher et al. (2020) validated the total sea slug fauna of the Gujarat coast with a report of 95 species belonging to 62 genera and 29 families.

Studies on opisthobranch diversity the Kerala coast were limited to a few studies. Narayanan (1968 b) reported the three opisthobranchs to belong to Pleurobranchidae (Pleurobranchus (Susania ceylonicus)), Doridae (Platydoris tabulate) and Hexabranchidae (Hexabranchus flammulatus) collected from Thankassery Coast (Kerala State) on the South-west Coast. Valdes et al. (1999), in that study reported one of the species, Chromodoris mandapamensis was collected from Muttom, Kerala. Ravinesh & Bijukumar (2013) mentioned six Opisthobranch species in the study of intertidal biodiversity associated with the natural rocky shore and sea wall of the Kerala coast. Chinnadurai et al. (2014) recorded the long-tailed sea slug Stylocheilus longicauda for the first time from the Southwest coast of India. This was the first record of the long-tailed pelagic sea slug Stylocheilus longicauda (Gastropoda: Opisthobranchia) from the Arabian Sea off Narakkal, Vypeen Island, Kochi, Southwest coast of India. Ravinesh et al. (2014) recorded as first time the sea slug species Polybranchia orientalis (Sacoglossa: Caliphyllidae) from the Southwest coast of India.

### Table 1 - Opisthobranch fauna of rocky reefs of Kerala.

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>Present Record</th>
<th>Previous Record from Kerala</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bornellida</td>
<td>Bornella</td>
<td>Bornella stelligera (Adams &amp; Reeve, 1848)</td>
<td>Vizhinjam</td>
<td>Apte &amp; Desai (2017)</td>
</tr>
<tr>
<td>Nudibranchia</td>
<td>Facelinidae</td>
<td>Morinilla</td>
<td>Morinilla brocki (Bergh, 1888)</td>
<td>Vizhinjam</td>
<td>Anu et al. (2017)</td>
</tr>
<tr>
<td></td>
<td>Phidiana</td>
<td>Phidiana</td>
<td>Phidiana militaris (Aider &amp; Hancock, 1864)</td>
<td>Vizhinjam</td>
<td>Ravinesh &amp; Kumar (2013), Apte &amp; Desai (2017)</td>
</tr>
<tr>
<td></td>
<td>Nudibranchia</td>
<td>Dendrodonis</td>
<td>Dendrodonis tuberculosa (Quoy &amp; Gaimard, 1832) Thirumullavaram New to Kerala coast</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phyllida</td>
<td>Sebadoris</td>
<td>Sebadoris fragilis (Alder &amp; Hancock, 1864)</td>
<td>Vellyyamkallu</td>
<td>New to Kerala coast</td>
</tr>
<tr>
<td></td>
<td>Sebadoris</td>
<td>Sebadoris</td>
<td>Sebadoris nubiosa (Pease, 1871)</td>
<td>Vellyyamkallu</td>
<td>New to Kerala coast</td>
</tr>
<tr>
<td></td>
<td>Phyllida</td>
<td>Sebadoris</td>
<td>Sebadoris nubiosa (Pesa, 1871)</td>
<td>Vellyyamkallu</td>
<td>New to Kerala coast</td>
</tr>
<tr>
<td></td>
<td>Elysia</td>
<td>Elysia</td>
<td>Elysia grandifolia (Kelaart, 1858)</td>
<td>Vellyyamkallu</td>
<td>New to Kerala coast</td>
</tr>
</tbody>
</table>

Figure 4 - Species abundance of opisthobranchs observed.

Figure 3 - Species recorded in rocky reefs of Kerala.
Table 2 - Taxonomic description of species recorded in rocky reefs of Kerala.

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>Observed Locality</th>
<th>Distribution in World</th>
<th>Distribution in India</th>
<th>Size (mm)</th>
<th>Taxonomic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella blanda</td>
<td>Ao &amp; Reave, 1962</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>15-17</td>
<td>Rare</td>
</tr>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella conchyliatus</td>
<td>Eliot, 1864</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>45</td>
<td>Rare</td>
</tr>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella cavae</td>
<td>Eliot, 1864</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>45</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella stellifera</td>
<td>Eliot, 1864</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>45</td>
<td>Rare</td>
</tr>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella conchyliatus</td>
<td>Eliot, 1864</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>45</td>
<td>Rare</td>
</tr>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella conchyliatus</td>
<td>Eliot, 1864</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>45</td>
<td>Rare</td>
</tr>
<tr>
<td>Goniobranchus</td>
<td>Phoebesidae</td>
<td>Benthidae</td>
<td>Bornella</td>
<td>Bornella</td>
<td>Bornella conchyliatus</td>
<td>Eliot, 1864</td>
<td>Tropical Indo-West Pacific</td>
<td>Gulf of Mannar, Richelles Archipelago, South Andaman and Nicobar Islands</td>
<td>45</td>
<td>Rare</td>
</tr>
</tbody>
</table>

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coast of India. Sheeja & Padmakumar (2014 a,b) recorded the Plakobranchus ocellatus VanHasselt, 1824 and Berthellina citrina (Rüppell & Leuckart, 1828) (Mollusca: Gastropoda) from the Kerala coast, India. In this, Berthellina citrina (Rüppell & Leuckart, 1828) was reported for the first time from the Southwest coast of India. An extensive study was done by Yogesh et al. (2019) to explore the opisthobranchs diversity and associated faunal community in and around the Gulf of Mannar Marine Biosphere Reserve (GoMBR), South-east coast of India, resulting in eight species of Opisthobranch which includes few new records in the South-east coast of India. Vadher et al. (2020) validated the total sea slug fauna of the Gujarat coast with a report of 95 species belonging to 62 genera and 29 families.

By perusing the available literature on previous records about Opisthobranch diversity from Kerala's coastal water. The studies on opisthobranch diversity on the Kerala coast were limited to a few studies during the two different periods. The most pioneer study on Opisthobranch diversity from the Kerala coast done by Narayanan (1968 b), reported the three opisthobranchs belong to Pleurobranchidae (Susania ceylonicus), Doridae (Platydoris tabulate) and Hexabranchidae (Hexabranchus flammulatus) collected from Thankassery Coast (Kerala State) on the Southwest Coast. After a long period, Valdes et al. (1999), reported three species of opisthobranchs along with the redescription of Chromodoris trimarginata (Winckworth, 1946) in that study, one of the species, Chromodoris mandapamensis was collected from Muttom, Kerala. Ravinesh & Bijukumar (2013), mentioned six opisthobranch species in the study of intertidal biodiversity associated with the natural rocky shore and sea wall of the Kerala coast. Ravinesh et al. (2014), recorded the sea slug Polybranchia orientalis (Sacoglossa: Caliphyllidae) from the coasts of Vizhinjam, Kovalam, and Thirumullavaram for the first time. Sheeja and Padmakumar (2014 a, b) recorded two species belonging to Pleurobranchomorpha (Berthellina citrina (Rüppell & Leuckart, 1828) (Mollusca, Gastropoda)) and Planocobranchia (Plakobranchus ocellatus Hasselt, 1824 (Sacoglossa, Opisthobranchia)). Chinnadurai et al. (2014) recorded the long-tailed sea slug Stylocheilus longicauda for the first time from the Southwest coast of India. This was the first record of long-tailed pelagic sea slug Stylocheilus longicauda (Gastropoda: Opisthobranchia) from the Arabian Sea off Narakkal, Vyypeen Island, Kochi, Southwest coast of India. Bajju et al. (2016) reported six species of opisthobranchs from the coast of Vizhinjam while studying the biodiversity associated with mussel fishery. Anu et al. (2017) recorded four opisthobranch species as an associated fauna of mussel beds (Perna perna) of Vizhinjam, South coast of Kerala, India, including two new records to Kerala coast. Sheeja Chandran et al. (2017) reported 15 species of opisthobranchs to belong to 4 families through the countries' first citizen science initiative, which includes two new records to India and five new records to the West coast of India. Present study recorded thirteen species of opisthobranchs and taxonomically identified under 3 Orders, 8 Families, and 9 Genera. The study specifically recognized the presence of eight new records on the Kerala coast.

The present study results prove that rocky reef ecosystems are under-exploited in the sense of Opisthobranch diversity. In-depth studies are required to assess the diversity of one of the least studied animals from the coast. Even in the short span of the study period, we were able to record thirteen species of sea slugs belonging to 8 Families and 9 Genera.

CONCLUSION

Compared with other areas of marine biodiversity documentation, the knowledge about the opisthobranchiate faunal diversity of the Indian subcontinent is too little to interpret. The research gap will become more prominent in the Kerala scenario. A little research was carried out on this group of animals. The recent and sudden changes in the coastal ecology are due to the pressure from both natural and anthropogenic sources. The biodiversity of coastal ecosystems rocky reefs is subjected to silent loss of biodiversity. The concern is that we may lose many species without being aware of their existence in our coastal rocky reef ecosystems. The present attempt was able to record 13 species of opisthobranchs belonging to 3 orders, 8 families and 9 genera. This manuscript deals with the strictly rocky reef ecosystem-based biodiversity study. Present study results prove that rocky reef ecosystems are under-exploited in the sense of opisthobranch diversity.

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