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Distribution of Commercially Important Edible Mollusc (Bivalvia and Gastropoda) from Six Districts of Terengganu, Malaysia

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ABSTRACT

Terengganu has a large coastal and wetland area where it provides habitat for edible mollusc. The edible molluscs are one of the most important sources of animal protein for the local communities. The distribution of edible molluscs was studied in six districts of the Terengganu coastal waters between August 2020 and March 2022. In each district, samples were purchased from the wet market, fishing villages and roadside outlets every four months interval. A total of 1,043 individuals was observed and 23 species of edible molluscs were recorded from six districts of Terengganu representing 11 families. Bivalves were found to be dominated by 14 species from seven families. The family Cyrenidae (bivalve) was widespread in five districts where *Geloina expansa*, was recorded in almost all districts. Meanwhile, for gastropods, nine species from four families were found where Ellobiidae (gastropod) was dominant and the most common gastropod species was *Faunus ater*, which was found in four locations in Terengganu. These species have great commercial value in Terengganu districts as they are sought extensively as food by the locals and also represent one of their sources of financial survival, especially for those living near to coastal areas. This baseline study could serve as a future indicator for the sustainable management of fisheries resources and for further ecological studies.

Keywords**:** Brackish water, ecological, mangrove, morphological, Terengganu

INTRODUCTION

Beside fish, mollusc consist of bivalve and gastropod provide a significant source of protein for humans and it can be found in many parts of the world such as marine, brackish, fresh water and terrestrial areas (Han *et al.*, 2003). Molluscs are among the most well-known species on the earth and have invaded almost all terrestrial and aquatic ecosystems (Wanninger & Wollesen, 2019). Molluscs are the second largest and widest distribution and abundance after phylum Arthropoda which is, suffered by extinctions. Most recent numbers recorded by Cowie *et al.* (2017) are 638 species extinct, 380 possibly extinct and 14 extinct in the wild, a total of 1,032 species in these combined categories and more than twice as many as listed by IUCN (2020) in these categories (462) (Cowie *et al*., 2022). Approximately 15,000 species of bivalves distributed from tropical to temperate regions including clams, mussels, scallops and oyster (Pechenik, 2015). In Southeast Asia, about 1,211 species of bivalves was reported, and it was the highest diversity for bivalves compared to 29 regions around the world (Crame, 2000).

Marine gastropods and bivalves consist various species that are used for many purposes beside their nutritional source and certain country exploits gastropod and bivalve for food and decoration (Hamli *et al*., 2012a). Marine bivalves are one of the main food sources and have high commercial value in Asia-Pacific countries such as Indonesia, Malaysia, Japan, Vietnam and Thailand (Printrakoon *et al*., 2008; Hamli *et al*., 2012b; Kartika & Mu, 2014; Rahim *et al*., 2022). According to Rahim *et al*. (2022), in Malaysia, a total of 83 species of edible mollusc comprised of 40 species of bivalve from 19 families and 43 species of gastropod from 23 families were recorded. Hamli *et al*. (2012b) and Hamli *et al*. (2013) reported, eight division of Sarawak recorded a total of 19 species of edible bivalves from 10 families and 21 species of edible gastropod representing 21 families, which

inhabit marine, brackish, wetland and fresh water areas was sought by locals.

In general, gastropods also have economic value when multiple species are harvested for their meat (Octavina *et al*., 2015). According to Hamli *et al*. (2013), the edible gastropods recorded in the coastal waters of Sarawak are very important for source of protein for locals. According to Chowdhury and Yahya (2012), Malaysia is the largest consumer of seafood in Southeast Asia as the country relies on it as the main source of animal protein. The uncontrolled exploitation of shellfish for economic purposes is one of the reasons of their declining abundance. According to Hamdan *et al*. (2015), climate change also can affect aquaculture production performance in Malaysia. They are traded economically on a large scale to meet the high demand of the global market, especially as exports to wealthy economies, for example as nutritious food sources, jewellery, ornaments and medicines (Venkatesan, 2010). The value of exports of Malaysian seafood commodity (fish, crustaceans, molluscs and other aquatic invertebrate) with total value of RM3.2 billion in 2021 (TrendEconomy, 2023). According to Department of Fisheries (DOF) (2022), based on the data on marine mollusc landings in Malaysia, shellfish are among the most valuable groups for promoting population growth, wealth growth, and urbanisation (Figure 1). Kartika and Mu (2014) reported that mollusc fisheries offer good economic prospects for local fishermen in Indonesia living near the coastal waters. Mollusc production growth rates have declined from 1950 to 2011, with the average growth rate of 47.78% over the period from 1950 to 1969 22.02% (1970 – 1989) and 11.35% (1990 – 2011) (Kartika & Mu, 2014).

However, information on the diversity of edible molluscs in Terengganu is still unknown. Most invertebrate taxa are still minor, unknown, and poorly recorded (Reid, 2000; Baharuddin & Zakaria, 2018). Therefore, the data collected will be crucial for biodiversity conservation and sustainable management purposes. Therefore, the aim of this study was to determine the diversity and morphological characteristics of bivalves and gastropods in the coastal waters of Terengganu.

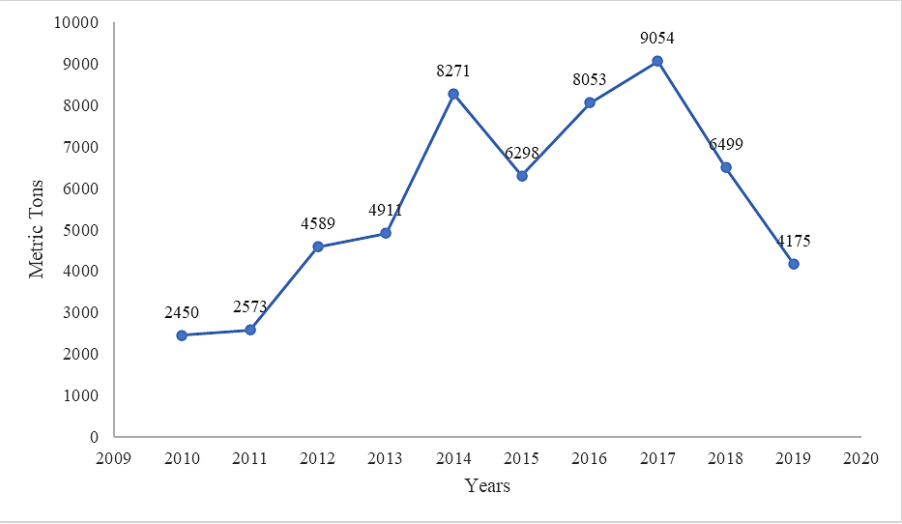

Figure 1. The annual count of marine species landing in Malaysia. (Department of Fisheries, 2023)

MATERIALS AND METHODS

Study Area

The sampling was carried out between August 2020 and March 2022 in six districts (Figure 2) of Terengganu, namely Besut (St1), Setiu (St2), Kuala Terengganu (St3), Marang (St4), Dungun (St5) and Kemaman (St6) together with the habitat profile (Table 1). The habitat area was recorded according to the information survey from the local fishermen. Most of these habitat areas were covered by mangrove in the lagoons with brackish water during high tide. Part of the area is covered with fresh water.

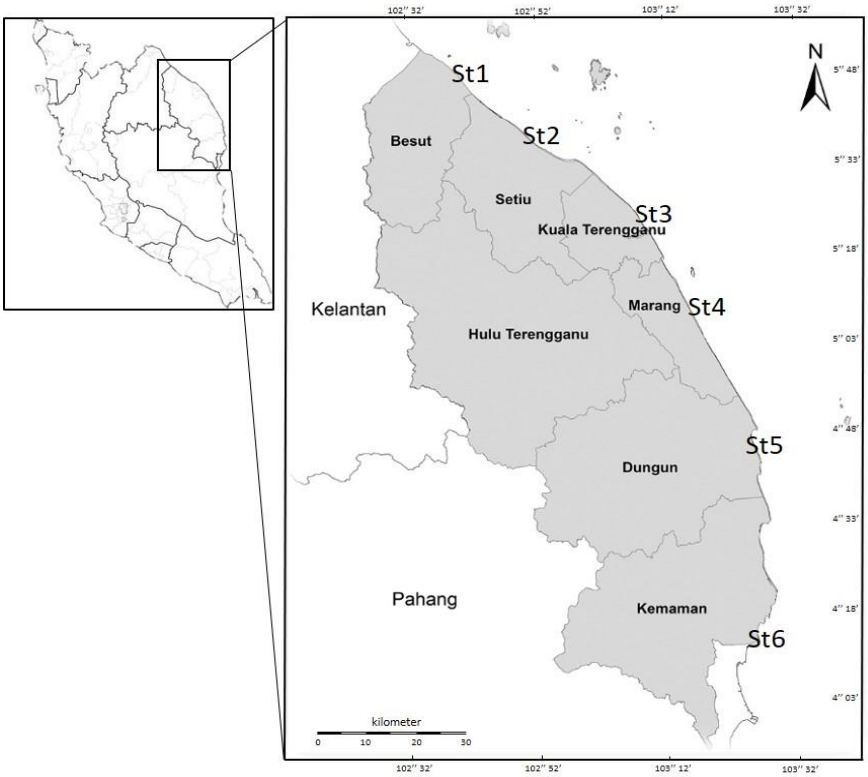

Figure 2. Location of the sampling areas in the selected divisions of Terengganu, Malaysia

Table 1. Sampling sites and habitat characteristics of six districts of Terengganu waters

Stations/Districts	Coordination	Habitats characteristics
Station 1 / Besut	Nº 5.826900, Eº 102.569176	Marine
Station 2 / Setiu	Nº 5.675962, Eº 102.711238	Marine, Brackish, Fresh water
Station 3 / Kuala Terengganu	Nº 5.335925, Eº 103.135600	Marine, Brackish, Fresh water
Station 4 / Marang	Nº 5.036317, Eº 103.296160	Brackish
Station 5 / Dungun	Nº 4.785639, Eº 103.421335	Brackish,
Station 6 / Kemaman	Nº 4.242884, Eº 103.441698	Marine, Brackish, Fresh water

Samples Collection

Approximately a total of 1,043 individuals of edible bivalves and gastropods of each station were purchased from the wet market, fishing village and road site selling outlets in each district of Terengganu every four-month interval (Sturm *et al.*, 2006). All samples were labelled and kept in zip lock beg and stored in an ice-covered box to preserve sample freshness before transferred to the Fisheries Science laboratory, Universiti Malaysia Terengganu for further analysis. The specimens were washed under running tap water and all sediment and other particle attached on the shell were removed. Only the shell of bivalves and gastropods were used in this study.

Morphological Identification

At the laboratory, each specimen was washed under running water with a brush to remove the small barnacles, mold and excess slime from the shell of the samples and stored below freeze point before identification works. All specimens were identified to the lowest possible taxonomic level, based on taxonomic description and identification keys proposed by previous researcher (Morton, 1984; Rao, 1989; Poutiers, 1998; Perez *et al*., 2004; Tan & Clements, 2008; Mujiano, 2009; Hamli *et al*., 2012a; Baharuddin & Marshall, 2014; Akhmadi & Trijoko, 2016; Baharuddin *et al*., 2018, Htwe & Naung, 2019; Rahim *et al*., 2022). Both samples of bivalve and gastropod were measured using digital vernier calliper (± 0.01 mm) and weight using digital balance (± 0.01 g). Shell characters of bivalve have been measured based on their shell length (SL), shell height (SH), shell width (SW), ligament length (LL), posterior length (PL), anterior length (AL) and cardinal tooth length (LCT). Characters that were measured for gastropod such as from the curved larger end of the body whorl to the tip of the spiral apex (sL),

shell width (sW), aperture length (aL) and aperture width (aW) based on Hamli *et al*. (2012a), Hamli *et al*. (2012b), Hamli *et al*. (2013) and Akhmadi and Trijoko (2016). The validity of each species was later checked against the World Register of Marine Species (WoRMS) (WoRMS Editorial Board, 2023). Photographs were captured using Canon PowerShot G15 camera followed shell illustration orientation by Sturm *et al.* (2006) and photographs were kept as record. Representatives of specimens were deposited at the Fisheries Science laboratory, University Malaysia Terengganu.

RESULTS

Species Distribution

A total of 23 species of edible bivalve and gastropod from six district of Terengganu consisting of 7 families of bivalves with 14 species, and 4 families of gastropods with 9 species were recorded and identified (Table 2). The percentage of edible mollusc species in Terengganu waters composed mainly of bivalve species (60%) compared to gastropod species (40%). Arcidae, Cyrenidae, Pectinidae, Pinnidae, Unionidae, Veneridae and Ostreidae belong to the bivalve family, while Potamididae, Ellobiidae, Pachychilidae and Neritidae belong to the gastropod family. The family Cyrenidae (bivalve) and Ellobiidae (gastropod) families were widely distributed in five and three districts, respectively. The most diverse collection of bivalves and gastropods was found in the Kemaman district, where a total of nine species (eight gastropods and one bivalve) were recorded. However, the highest percentage of gastropod species was recorded in Kemaman (53%), while the higher percentage of bivalve species was recorded in Setiu (33%) (Figure 3).

The mangrove clam *Geloina expansa*, was recorded in almost all areas and was the most abundant species, followed by *Tegillarca granosa*, *Meretrix meretrix* and *Magallana bilineata* while the most abundant gastropod species are *Faunus ater* which covered three sites in the Terengganu coastal waters. In the bivalve group of seven species inhabit brackish water, four species inhabit marine water and three species inhabit freshwater. While nine species of gastropod were found to inhabit brackish water.

Table 2. List of edible molluscs (bivalves and gastropods) recorded from six districts of Terengganu with their habitat preference

Family	Species	Besut	Setiu	Kuala Terengganu	Marang	Dungun	Kemaman	Habitat
				Bivalves				
Arcidae	*Tegillarca granosa*	-	-	+	+	-	-	Brackish water
	Anadara cornea	-	+	-	+	-	-	Brackish water
Cyrenidae	*Corbicula fluminea*	-	-	+	-	-	-	Fresh water
	Geloina expansa	-	+	+	+	+	+	Brackish water
Veneridae	*Gafrarium pectinatum*	-	+			-	-	Brackish water
	Meretrix meretrix	-	+	+	+	-	-	Brackish water
	Paratapes undulatus	-	-	+	-	-	-	Marine Water
	Marcia japonica	-	+	-	-	-	-	Marine Water
Pinnidae	*Pinna deltodes*	+	-	-	-	-	-	Marine Water
	Atrina vexillum	+	-	-	-	-	-	Marine Water
Pectinidae	*Amusium pleuronectes*	+	-	-	-	-	-	Brackish water
Ostreidae	*Magallana bilineata*	-	+	-	+	-	-	Brackish water
Unionidae	*Sinanodonta elliptica*	-	+	-	-	-	-	Fresh water
	Sinanodonta lauta	-	-	+	-	-	-	Fresh water
				Gastropods				
Ellobiidae	*Cassidula nucleus*	-	-	-	-	-	+	Brackish water
	Cassidula aurisfelis	-	-	-	-	-	+	Brackish water
	Ellobium aurisjudae	-	-	-	-	-	+	Brackish water
	Ellobium aurismidae	-	+	-	+	-	+	Brackish water
Neritidae	*Nerita balteata*	-	-	+	+	-	+	Brackish water
Pachychilidae	*Faunus ater*	-	+	+	+	-	+	Brackish water
Potamididae	*Cerithidea obtusa*	-	-	+	-	-	+	Brackish water
	Cerithidea quoyii	-	-	-	-	-	+	Brackish water
	Telescopium telescopium	-	+	-	+	-	+	Brackish water

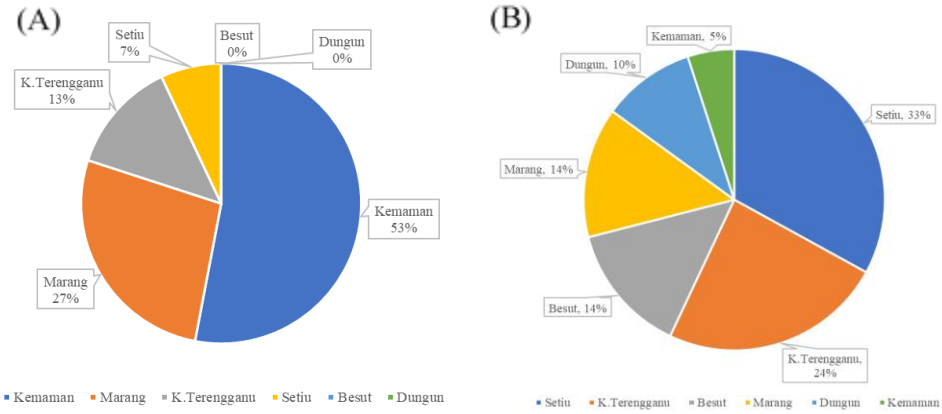

Figure 3. The percentage of gastropods (A) and bivalves (B) species in the six districts of Terengganu coastal waters

Morphological description

The morphological description of edible bivalves and gastropods, and the photos are presented in Figure 4 and 5 as listed below.

Tegillarca granosa (Linnaeus, 1758)

Synonyms: *Anadara (Tegillarca) granosa* (Linnaeus, 1758), *Anadara bisenensis* Schenck & Reinhart, 1938, *Anadara granosa* (Linnaeus, 1758), *Anadara thackwayi* Iredale, 1927, *Anomalocardia pulchella* Dunker, 1868, *Arca (Anadara) granosa* Linnaeus, 1758, *Arca aculeate* Bruguiere, 1789, *Arca corbicula* Gmelin, 1791, *Arca corbula* Dillwyn, 1817, *Arca granosa* Linnaeus, 1758, *Arca granosa kamakuraensis* H. Noda, 1966, *Arca nodulosa* Lightfoot, 1786, *Arca obessa* Kotaka, 1953, *Tegillarca granosa bessalis* Iredale, 1939.

Description: Shell length was 19.24 – 20.19 mm. Shell height was 20.37 – 20.87 mm (Figure 4A). Weight of *Tegillarca granosa* was 2.69 – 4.12 g. Shell was thick (16.37 – 16.77 mm) equivalve and inequilateral shape with slightly rounded at the ventral. Shell was slightly longer than high. Anterior shell length was between 11.35 – 11.48 mm and posterior length was range 14.23 – 14.61 mm. Ligament area wide and almost flat with length 10.47 – 10.96 mm. Hinge consists of transverse teeth which increase in size to the end and posterior point. Outer shell sculptured with strong axial ribs (24 to 31) and crenulations at the radial ribs. Shell colour white with little brownish periostracum. Inner shell was whitish. Ligament colour was black.

Habitat: *Tegillarca granosa* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu), Station 3 (Kuala Terengganu) and Station 4 (Marang).

Anadara cornea (Reeve, 1844)

Synonyms: *Arca cornea* Reeve, 1844, *Arca cecillii* R.A. Philippi, 1849, *Arca loricata* Reeve, 1844, *Cunearca cornea* (Reeve, 1844), *Scapharca cornea* (Reeve, 1844).

Description: Shell length was 30.21 – 60.47 mm. Shell height was 24.43 – 49.39 mm (Figure 4B). Weight of *Andara cornea* was 9.12 g to 73.33 g. Shell was thick (15.59 – 48.28 mm) and solid, inequilateral shape with transversally elongate at the ventral. The left valve slightly overlapping with right valve along postero-ventral margin. Umbo moderately prominent and situated well anterior to midline valves. Anterior shell length was between 13.28 mm to 30.45 mm and posterior length was range from 17.78 mm to 39.72 mm. Ligament external often with V-shaped grooves with length 7.97 m to 43.36 mm. Cardinal area rather narrow and elongated which about 27 radial ribs (26 to 30) at each valve, mainly granulated on left valves. Outside of the shell white and covered with hairy stubble. Frequently tinged deep bluish-green posteriorly and periostracum was dark greyish-brown.

Habitat: *Anadara cornea* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu) and Station 4 (Marang).

Corbicula fluminea (O. F. Müller, 1774)

Synonyms: *Coricula (Corbicula) fluminea* (O.F. Muller, 1774), *Corbicula adunca* Heude, 1880, *Corbicula andersoniana* G. Nevill, 1877, *Corbicula aquiline* Heude, 1880, *Corbicula astronomica* Heude, 1880, *Corbicula aurea* Heude, 1880, *Corbicula bezuariana* Heude, 1880, *Corbicula bicolor* Heude, 1880, *Corbicula inflata* Clessin, 1878, *Cyclas chinensis* Lamarck, 1806, *Cyrena crebricostis* Westerlund, 1883, *Cyrena manilensis* R.A. Philippi, 1844, *Cyrena orientalis* Lamarck, 1818, *Tellina fluminea* O.F. Muller, 1774, *Tellina fluviatilis*, O.F. Muller, 1774.

Description: *Corbicula fluminea* is a small clam with an inflated shell, slightly round to triangular in shape (Figure 4C). Shell length was 22.98 – 23.16 mm. Shell width was 9.76 – 9.94 mm and shell height was 15.59 – 16.01 mm. The surface of shell has well marked concentric and regular sulcations (ridges). The hinge is very elongate with anterior and posterior serrate lateral teeth. There are three hinge teeth on each valve and two lateral teeth. Anterior shell length was between 10.93 – 10.94 mm and posterior length was range from 13.21 – 13.28 mm. The ligament is thick and strong, and is entirely external and posterior to the beaks with length 2.04 mm to 2.86 mm. The shell interior is glossy white to pale grey and sometimes with purple markings. Periostracum is present and thick.

Habitat: *Corbicula fluminea* was collected by fisherman from the freshwater areas of Terengganu river.

Distribution: Station 3 (Kuala Terengganu).

Geloina expansa (Mousson, 1849)

Synonyms: *Cyrena (Corneocyclas) galateae* Morch, 1850, *Cyrena compta* Deshaves, 1855, *Cyrena expansa* Mousson, 1849, *Cyrena fallax* Deshaves, 1854, *Cyrena moluccensis* E. von Martens, 1897, *Polymesoda (Geloina) galatheae* (Morch, 1850), *Polymesoda erosa* auct Lightfoot, 1786, *Polymesoda expensa* (Mousson, 1849).

Description: *Geloina expansa* weighed between 13.37 – 122.6 g (Figure 4D). Shell shape was hard, trigonal ovate of the outline and equivalve. Shell more expanded to posterior part (26.7 – 46.65 mm) and causes the shell inequilateral. Anterior length of the shell was 24.82 – 41.05 mm. Shell length was 45.16 – 74.70 mm. Shell width was 25.72 – 45.32 mm and shell height was 42.97 – 73.03 mm. Umbo was inflated and located in front of the midline of the shell. Ligament located at the umbo back with posterior area with length 15.66 – 33.02 mm. Periostracum on shell was thick, fibrous along the radial line and shell had three cardinal teeth. Periostracum normally in yellowish to dark green colour.

Habitat: *Geloina expansa* was collected by a fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 3 (Kuala Terengganu), Station 2 (Setiu), Station 4 (Marang), Station 5 (Dungun) and Station 5 (Kemaman).

Gafrarium pectinatum (Linnaeus, 1758)

Synonyms: *Circe pectinata* (Linnaeus, 1758), *Circe pythinoides* Tenison Woods, 1878,*'Crista pectinata* (Linnaeus, 1758), *Cytherea pectinata* Lamarck, 1818, *Cytherea pectinata var immaculata* G.B. Sowerby I, 1835, *Gafrarium cardiodeum* Roding, 1798, *Gafrarium depressum* Roding, 1798, *Gafrarium pectinata pectinatum* (Linnaeus, 1758) *Venus pectinata* Linnaeus, 1758

Description: The weight of *Gafrarium pectinatum* was range from 8.56 g to 33.12 g. Shell was thick (15.98 – 31.92 mm) and solid, equivalves with slightly laterally compressed. Shell length was 29.95 – 42.96 mm. Shell height was 28.05 – 39.77 mm (Figure 4E). It has an elongate shape, elliptical ovate in outline. Umbo thick, low and rounded direct towards the anterior part. Range of ligament area with length 6.67 – 12.66 mm. Anterior shell length was between 21.06 – 32.38 mm and posterior length was range 15.05 – 23.48 mm. Hinge plate is strong with 3 cardinal teeth at each valve and well-developed anterior lateral teeth (1 in left valve and 2 in right valve) separated by a deep socket. Outer colouration of shell variable from off-white to buff coloured with fawn or brown blotches or spots throughout.

Habitat: *Gafrarium pectinatum* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 3 (Setiu)

Meretrix meretrix (Linnaeus, 1758)

Synonyms: *Cytherea castanea* Lamarck, 1818, *Cytherea corpulenta* Gray, 1838, *Cytherea ponderosa* Schumacher, 1817, *Meretrix labiosa* Lamarck, 1801, *Meretrix meritrix var. alba* Fischer-Piette & P.H. Fischer, 1941, *Meretrix meritrix var. chenui* Fischer-Piette & P.H. Fischer, 1941, *Meretrix meritrix var. fulva* Fischer-Piette & P.H. Fischer, 1941, *Meretrix meritrix var. hidalgoi* Fischer-Piette & P.H. Fischer, 1941, *Venus meretrix* Linnaeus, 1758.

Description: Shell length was 31.33 – 58.13 mm. Shell width was 19.14 – 31.96 mm. Shell height was 27.85 – 64.76 mm (Figure 4F). The total weight of *Meretrix meretrix* was 8.54 – 27.98 g. Shell shape was trigonal ovate in outline and thick. Umbo was situated at the in front of midline shell or more to anterior region. Posterior length was 20.77 – 41.00 mm and anterior length was 16.11 – 32.29 mm. Outer shell was smooth and glossy but the radial line can be noticed even dim. The three-cardinal tooth (11.49 – 28.87 mm) clearly noticed the hinge plate. Hinge connected by ligament which length 8.47 – 18.32 mm. internal shell was white and outside of the shell normally in brown colour to fawn in the middle of the shell. Some of it had purple colour at the posterior dorsal slope which easy to be noticed.

Habitat: *Meretrix meretrix* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu), Station 4 (Marang) and Station 5 (Dungun)

Paratapes undulatus (Born, 1778)

Synonyms: *Paphia undulata* (Born, 1778), *Paratapes scordalus Iredale*, 1936, *Venus rimosa* R.A. Philippi, 1847, *Venus undulata* Born, 1778.

Description: Shell moderately inflated and shell length was 46.06 – 55.18 mm. Shell height was 27.73 – 32.82 mm and shell width was 15.67 – 18.42 mm (Figure 4G). The weight of *Paratapes undulatus* was between from 8.32 – 12.13 g. Shell outline was elliptical ovate which more elongate anterior (18.55 – 22.22 mm) and posteriorly (33.51 – 39.92 mm). Umbo located anterior and in front of shell midline. Length of the ligament was 14.90 – 18.63 mm. Ventral margin broadly rounded. Shell had three moderate strong cardinal teeth with length 3.33 – 4.52 mm. Outer surface smooth and glossy with undulating groves crossing the shallow concentric growth marks. Colour outside of the shell usually cream to light mauve. Zigzag pattern at the periostracum with brown colour. Interior white, generally with a mauve hue in the umbonal cavity.

Habitat: *Paratapes undulatus* was collected by the fisherman from the sea (marine area).

Distribution: Station 2 (Setiu), Station 3 (Kuala Terengganu).

Marcia japonica (Gmelin, 1791)

Synonyms: *Chione regularis* Deshayes, 1853, *Katelysia japonica* (Gmelin, 1791), *Tapes caledonica* Bernardi, 1856, *Venus aurisiaca* Gray, 1825, *Venus elegantina* Lamarck, 1818, *Venus japonicus*, Gmelin. 1791, *Venus labuana*, A. Adams & Reeve, 1850, *Venus porcata* Roding, 1798, *Venus striata* Gmelin, 1791, *Venus tristis* Lamarck, 1818, *Venus vulvina* Lamarck, 1818.

Description: Shell length was 23.97 – 43.21 mm. Shell width was 12.01 – 23.69 mm. Shell height was between from 20.60 – 35.88 mm (Figure 4H). The weight of *Marcia japonica* was between from 2.13 – 16.23 g. Shell solid, moderately inflated, inequilateral shape and roughly rounded-ovate in outline. Umboned markedly anterior to midline. Posterior length was from 16.87 – 31.24 mm and anterior length was 10.22 – 18.58 mm. Outer surface of valves covered with numerous, somewhat irregular concentric grooves and cords. Hinge with 3 diverging cardinal teeth (3.28 – 7.53 mm) at each valve but without lateral teeth. Hinge connected by ligament which length 7.89 – 15.03 mm. Outside of shell variable in colour and pattern, fawn-coloured or brown, frequently with zigzags pattern of fawn or purplish radial

bands. Interior shell in dirty white, often dark coloured on hinge area.

Habitat: *Marcia japonica* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu).

Pinna deltodes Menke, 1843

Synonyms: *Exitopinna deltodes* (Menke, 1843), *Exitopinna deltodes ultra* Iredale, 1939, *Pinna (Exitopinna) deltodes* Menke, 1843, *Pinna scapula* Hedley, 1924.

Description: Shell can reach up to 227.71 – 275.20 mm in length and 124.32 – 194.54 mm in width. The shell extremely flared posteriorly and the width nearly equal to the length (Figure 4I). The total weight of *Pinna deltodes* was 149.64 – 253.89 g. Dorsal margin was larger than the ventral margin with length 116.28 – 240.56 mm. Ventral margin was posteriorly convex and concave anteriorly. Posterior adductor muscle to posterior shell margin was between 85.46 – 111.82 mm and anterior to posterior adductor muscle length was range from 106.81 – 132.87 mm. The colour of the shell was translucent, light horn to dark brownish purple.

Habitat: *Pinna deltodes* was collected by the fisherman from the sea (marine area).

Distribution: Station 1 (Besut).

Atrina vexillum (Born, 1778)

Synonyms: *Atrina (Atrina) vexillum* (Born, 1778), *Atrina gouldii banksiana* Iredale, 1939, *Pinna gubernaculum* Roding, 1798, *Pinna nigra* Dillwyn, 1817, *Pinna nigra* Chemnitz, 1785, *Pinna nigrina* Lamarck, 1819, *Pinna vexillum* Born, 1778.

Description: Shell reaching a very large size, thick and solid, inflated, variable in shape from triangular to hatched-shaped or sub-globular. The range of total length was 186.30 – 295.01 mm and measurement of width length was 137.51 – 183.11 mm (Figure 4J). The total weight of *Atrina vexillum* was 122.21 – 580.31 g. Dorsal margin usually nearly straight with length 122.03 – 156.21 mm. Posterior adductor muscle to posterior shell margin was between 68.82 – 70.15 mm and anterior to posterior adductor muscle length was range from 102.28 – 114.45 mm. Outside the valves with arise 10 to 17 main radial ribs, often with scale-like spines, and with smaller interstitial ribs. The colour outside the shell, dark reddish brown to almost black, generally dull. The interior of shell is dark brown to black, iridescent in the nacreous area.

Habitat: *Atrina vexillum* was collected by the fisherman from the sea (marine area).

Distribution: Station 1 (Besut)

Magallana bilineata (Röding, 1798)

Synonyms: *Crassostrea (Magallana) bilineata* (Roding, 1798), *Crassostrea bilineata* Roding, 1798, *Crassostrea iredalei* (Faustino, 1932), *Crassostrea lugubris* (G.B. Sowerby II, 1871), *Crassostrea madrasensis*)Preston, 1916), *Ostraea angulata* (Lamarck, 1819), *Ostraea lugubris* G.B. Sowerby II, 1871, *Ostraea bilineata* Roding, 1798, *Ostraea iredalei* Faustino, 1932, *Ostraea lischkei* Lobbecke, 1882, *Ostraea madrasensis* Preston, 1916, *Ostraea orientalis* Dillwyn, 1817, *Ostraea pennigera* Jousseaume 1925, *Ostraea radiata* Bory de Saint-Vincent, 1827.

Description: Shell length was 42.74 – 51.4 mm. Shell width was 14.15 – 26.91 mm. Shell height was 62.64 – 83.80 mm. Shell very hard, rough and thick (Figure 4K). The total weight of *Magallana bilineata* was between 31.62 – 75.23 g. Shell irregularly shaped inequivalve. Shell large, elongate, spatulate form, sculpture with numerous foliaceous growth lines, no chomata. Left valve very thick and long to ventral area compared to right valve which are flatter and shorter. Anterior shell length was between 26.41 – 32.14 mm and length of posterior shell was range from 39.90 – 40.55 mm. Left valve was higher than long and no hinge tooth. Adductor muscle scar was kidney in shaped and only had posterior adductor muscle scar. Shell colour was whitish to brown and adductor muscle scar colour was dark purple-brown.

Habitat: *Magallana bilineata* was collected by the fisherman from the brackish area such as lagoon and wetland areas.

Distribution: Station 2 (Setiu) and Station 4 (Marang).

Amusium pleuronectes (Linnaeus, 1758)

Synonyms: *Amusium magneticum* Roding, 1798, *Amusium pleuronectes australiae* Habe, 1964, *Amusium pleuronectes nanshaensis* Z-R. Wang & R. Chen, 1991, *Amusium pleuronectes pleuronectes* Linnaeus, 1758, *Ostrea pleuronectes* Linnaeus, 1758, *Pecten (Amusium) milneedwardsi* De Gregorio, 1884, *Pleuronectia laevigata* Swainson, 1840.

Description: Shell was thin (11.57 – 18.51 mm) and in medium sized (55.23 – 84.17 mm in length). Shell height was 56.54 – 84.76 mm (Figure 4L). The weight of *Amusium pleuronectes* was range from 11.57 – 41.04 g. Shell was almost circular for outline and laterally compressed. Both valves slightly convex, however the lower (right) valve more inflated and larger than the upper (left) valve. The umbo was small and hard to notice at the dorsal margin. Umbo length was 26.01 – 40.74 mm. Ligament located at the centre of the dorsal margin with triangle shape. Anterior length was 25.20 – 48.11 mm and posterior length was 25.50 – 30.2 mm. Shell do not have any cardinal tooth. Outside of the shell was polished and smooth with distinct radial ribs at the left valve. Interior of both shells was rough because protrusion of the radial ribs (24 to 26). Right valve colour was whitish for inner and outer. Left valve colour was pinky brownish with dark line of growth and radial rib line at the outer.

Habitat: *Amusium pleuronectes* was collected by the fisherman from the sea (marine area).

Distribution: Station 1 (Besut), Station 3 (Kuala Terengganu), Station 5 (Dungun) and Station 6 (Kemaman).

Sinanodonta elliptica (Heude, 1878)

Synonyms: *Anodon elliptica* (Heude, 1878)

Description: The range of shell length was 73.00 – 143.50 mm and 29.86 – 52.14 mm width. The shell height was 49.00 – 84.50 mm (Figure 4M). *Sinanodonta elliptica* weighed between 12.97 – 87.53 g. *Sinanodonta elliptica* has an elongated, rough and thin shell. This species is almost similar to *Sinanodonta woodiana* species which the ventral border is convex, rising posteriorly and the dorsal border is convex. The umbo more arises than *Sinanodonta woodiana*. Umbo length range 30.12 – 128.89 mm. Exterior part of shell was dark black. Interior was dirty white and smooth. Length of ligament was range 16.32 – 120.66 mm. Anterior length was between 14.52 – 73.84 mm and posterior length was from 30.15 to 124.17 mm. Outer shell was dark brownish to black colour. Inner shell was shiny with dim pallial line and pallial sinus. Growth mark was clear at the inner shell.

Habitat: *Sinanodonta elliptica* was collected by fisherman from freshwater area.

Distribution: Station 2 (Setiu)

Sinanodonta lauta (E. von Martens, 1877)

Synonyms: *Anodon agricolarum* Heude, 1879, *Anodon despecta* Heude, 1880, *Anodon filippiana* Heude, 1885, *Anodon irregularis* Heude, 1879, *Patularia rotundata* Swainson, 1841, *Sinanodonta gibba* (Benson, 1842), *Symphinota magnifica* Lea, 1834, *Symphinota woodiana* Lea, 1834, *Symphynota woodiana* I. Lea, 1834, *Sinanodonta woodiana* (I. Lea, 18340.

Description: Shell length was 44.12 – 173.84 mm. Shell width was 15.99 – 68.31 mm. Shell height was 31.26 – 104.31 mm (Figure 4N). The total weight of *Sinanodonta lauta* was 11.69 – 81.35 g. Shell oval-subtrapezoidal. Inequilateral, thick with concentric wrinkles from ventral area to umbo area. Umbo length range 32.41 – 130.67 mm. Ventral margin convex, rising posteriorly, dorsal margin convex, slightly sloping, anterior end rounded, and posterior end biangulate or truncate. Length of ligament was range 17.52 – 110.74 mm. Anterior length was between 15.44 – 76.73 mm and posterior length was from 32.60 – 128.08 mm. Outer shell was brownish to black colour. Inner shell was shiny with dim pallial line and pallial sinus. Growth mark was clear at the inner shell.

Habitat: *Sinanodonta lauta* was collected by fisherman from freshwater area.

Distribution: Station 3 (Kuala Terengganu).

Cassidula nucleus (Gmelin, 1791)

Synonyms: *Auricula (Cassidula) crassiuscula var. vitiensis* Mousson, 1870, *Auricula mustelina* Deshaves, 1830, *Auricula rhodostoma* Hombron & Jacquinot, 1848, *Cassidula (Cassidula) nucleus* (Gmelin, 1791), *Cassidula mustelina* (Deshaves, 1830), *Helix nucleus* Gmelin 1791, *Melampus nucleus* (Gmelin 1791), *Sidula mustelina* (Deshaves, 1830).

Description: Shell was moderately solid and ovate. Shell Length was 21.74 – 23.72 mm. Width length was 12.85 – 14.35 mm (Figure 5A). Total weight of *Cassidula nucleus* was between 1.7 – 2.1 g. Outline inverted ovoid, short spire made up of rather flat whorls. Large body whorl that is entirely covered by fine spiral grooves. Aperture likely an ear in shape. Aperture fairly broad, with 2 folds below middle of inner lip, and smaller fold at top. Length of the aperture was 17.93 – 20.69 mm and width was range from 10.18 – 11.88 mm. Outer lip with strong denticle internally, extending as thickened ridge to bottom. Colour of the shell was brown or black with white spiral bands. The aperture usually cream or bright pink in coloured.

Habitat: *Cassidula nucleus* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 6 (Kemaman).

Cassidula aurisfelis (Bruguière, 1789)

Synonyms: *Auricula felis* Lamarck, 1822, *Auricula fusca* Hombron & Jacquinot, 1848, *Bulimus aurisfelis* Bruguiere, 1789, *Cassidula (Cassidula) aurisfelis* (Bruguiere, 1789), *Cassidulus chemnitzi* Beck, 1837, *Cassidulus chemnitz* Beck, 1838, *Ellobium inflammatum* Roding, 1798, *Sidula aurisfelis* (Bruguiere, 1789).

Description: Shell length was 20.92 – 27.90 mm. Width length was 12.54 – 16.69 mm (Figure 5B). Shell was medium in size and thick. Weight of *Cassidula aurisfelis* was 1.6 – 3.6 g. Oval in shape with a rather short conical spire and low sculpture, had a direction of rotation dextral shell (rotate to the right). Outline inverted ovoid, short spire made up of convex whorls. Large body whorl that is entirely covered by fine spiral grooves. Apex was blunt and the aperture was oval in shape. Aperture length was 18.27 – 21.56 mm and width range from 10.69 – 13.92 mm. Outer lip was thick, flat and had a raised margin. Inner lip had tree medium strong folds. Shell surface was brownish in colour. Outer lip of aperture cream coloured, occasionally pink.

Habitat: *Cassidula aurisfelis* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 6 (Kemaman).

Ellobium aurisjudae (Linnaeus, 1758)

Synonyms: *Auricula (Auricula) judae* (Linnaeus, 1758), *Auricula (Auricula) judae turrita* L. Pfeiffer, 1854, *Auricula aurisjudae* (Linnaeus, 1758), *Auricula australiana* Tapparone Canefri, 1874, *Auricula dactylus* L. Pfeiffer, 1854, *Auricula percha* Prashad, 1921, *Auricula polita* Metcalfe, 1852, *Auricula polita var. elata* Issel, 1874, *Auricula reticulata* Schumacher, 1817, *Auricular turrita* L. Pfeiffer, 1854, *Bulla aurisjudae* Linnaeus, 1758, *Ellobium (Ellobium) aurisjudae* (Linnaeus, 1758), *Ellobium dactylus* (L. Pfeiffer, 1854), *Ellobium labrosum* Roding, 1798, *Ellobium politum* (Metcalfe, 1852), *Ellobium subtile* Roding, 1798, *Voluta aurisjudae* (Linnaeus, 1758).

Description: Shell was medium with thick and solid shell. Shell length was 38.65 – 52.18 mm. Width length was 20.08 – 25.35 mm (Figure 5C). Total weight of *Ellobium aurisjudae* was 8.23 – 12.44 g. Outline especially at the body whorl elongate ovate. Shell does not had shoulder. Shell had 3 whorls. Spire was moderate, apex was blunt and eroded. Sculptured not clear which consists of intersection lines and axial grooves to form lattice pattern. Periostracum strongly covers the body whorl area. Aperture length was 20.56 – 29.86 mm and width was range between 5.95 – 16.94 mm. Columella areas had 3 folds near the anterior shell. Outer lip was thick and middle lip curve slightly at the into aperture area. Shell does not have any siphonal canal. Shell had spire whorl. Outside of shell whitish under the dark brown periostracum. Outer lip was whitish.

Habitat: *Ellobium aurisjudae* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 6 (Kemaman).

Ellobium aurismidae (Linnaeus, 1758)

Synonyms: *Auricula midae* Lamarck, 1801, *Bulla aurismidae* Linnaeus, 1758, *Ellobium (Ellobium) aurismidae* (Linnaeus, 1758), *Ellobium ceramense* Roding,1798, *Ellobium midae* Roding, 1798, *Ellobium tumidum* Roding, 1798, *Voluta aurismidae* (Linnaeus, 1758).

Description: Shell was very large, thick and solid shell. Shell length was 77.04 – 91.69 mm. Width length was 39.86 – 51.03 mm (Figure 5D). The weight *of Ellobium aurismidae* was 68.3 – 84.9 g. Outline ellipsoid to ovoid with a high spire. Shell had strong shoulder. Spire low to moderately high, Well-developed sculpture of spiral rows of irregular granules on the shoulder and weak granules and irregular axial lines on the rest of the shell. Periostracum strongly covers the body whorl area. Aperture about 80% length of the body whorl which is large with a thick lip that had swelling in the middle. Aperture length was 54.60 – 65.16 mm and width was range from 26.96 – 32.61 mm. Columella areas had three folds near the anterior shell. The shell was wrapping by thick periostracum with medium to dark brown coloration.

Habitat: *Ellobium aurismidae* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu), Station 4 (Marang) and Station 6 (Kemaman).

Nerita balteata Reeve, 1855

Synonyms: *Nerita (Amphinerita) articulate* Gould, 1847, *Nerita (Cymostyla) balteata* Reeve, 1855, *Nerita (Nerita) articulate* A. Gould, 1847, *Nerita (Pila) birmanica* Troschel, 1878, *Nerita articulate* A. Gould, 1847, *Nerita lineata* Gmelin, 1791.

Description: Shell shape was hemisphere with calcareous D shape of operculum. Shell length was range 22.16 – 30.40 mm. Shell width was 15.59 – 20.81 mm (Figure 5E). Total weight of *Nerita balteata* was 4.5 – 9.3 g. Shell was thick and solid with no spire and body whorl length are equal as shell length. Spiral cords were visible on the outside of the shell. Many large grooves around the outer surface of spiral cords (21 to 42). Aperture was semi-circular without siphonal canal with length between 21.53 – 27.64 mm. Aperture width was range between 16.56 – 21.87 mm. There were many teeth at the outer lip (12 to 21) and at the inner lip area (2 to 5). Shell colour was yellowish with black spiral cord. Sometimes colour of the body was green because of algae.

Habitat: *Nerita balteata* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 3 (Kuala Terengganu), Station 4 (Marang) and Station 6 (Kemaman).

Faunus ater (Linnaeus, 1758)

Synonyms: *Baccinum acicula* Gmelin, 1791, *Cerithium fluviatile* J. Ferussac, 1807, *Faunus melanopsis* Montfort, 1810, *Melanopsis princeps* I. Lea, 1834, *Pirena acus* Lesson, 1831, *Pirena atra* (Linnaeus, 1758), *Pirena cantori* Reeve, 1859, *Pirena nana* Reeve, 1860, *Pirena pagodus* Reeve, 1859, *Pirena picta*, Reeve, 1859, *Pirena terebralis*, Lamarck, 1822, *Strombus ater* Linnaeus, 1758, *Strombus dealbatus* Gmelin, 1791, *Turritella fuscata* Link, 1807.

Description: Shell was elongated and more slender in shape. The weight of *Faunus ater* was 4.2 – 10.5 g and large in size, reaching up to 44.74 – 63.30 mm in length (Figure 5F). Width length was 12.45 – 15.68 mm. Most of the shells comprises of around 20 straight-sided to slightly inflated whorls. The whorls of the shells here appear to be weakly convex in general, with some individuals showing increasing inflation as their size increases. The apical whorls may be eroded in older snails. Shell was wrapping with thick periostracum and the colour of the periostracum is dark brown or black. Aperture shape was ovate and white in colour. Length of aperture was 12.76 – 16.70 mm and width was 3.37 – 9.46 mm. It is distinguished from other cerithioidean species by its peculiar aperture

with two deep sinuses comprised of anterior and anal canals. The aperture also has a smooth outer lip with a strongly concaved columella. Operculum was oval in shape, corneous and dark brown in colour.

Habitat: *Faunus ater* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu), Station 3 (Kuala Terengganu), Station 4 (Marang) and Station 6 (Kemaman).

Cerithidea obtusa (Lamarck, 1822)

Synonyms: *Cerithium obtusum* Lamarck, 1822, *Cerihidea (Cerithidae) obtusa* (Lamarck, 1822), *Cerithium obtusum* Lamarck, 1822, *Potamides obtusus* (Lamarck, 1822).

Description: The weight of *Cerithidea obtusa* was 1.4 – 5.6 g. Shell was thick and medium in sized, with a moderately high conical spire. Shell length was 30.90 – 46.42 mm (Figure 5G). Shell width was 17.73 – 22.80 mm. Many convex spire whorls range from 6 to 7 and usually had broken apex. This convex spire whorl formed moderately deep suture. Shell had spire cords which for the body whorl had 12 to 15 from the shell bottom. Between of this spire cord had spiral groves. Shell had strong axial ribs in each whorl; they crossed the spiral cords which cause the groove look like net pattern and the crossing area form nodule shape of the shell. The body whorl of this shell was wide and had rounded periphery. It had subcircular shape of the aperture and had length between 11.3 7– 17.08 mm. Aperture width was range 9.393 – 12.41 mm. Outer lip was thickened and flaring, with the tongue shape protrudes at the siphonal canal area. The siphonal area located at the anterior of the aperture. Shell colour was brownish with bright colour at the below after the suture base. Outer lip colour was cream for the matured and sometimes brownish for young.

Habitat: *Cerithidea obtusa* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 3 (Kuala Terengganu) and Station 6 (Kemaman).

Cerithidea quoyii (Hombron & Jacquinot, 1848)

Synonyms: *Cerithium quoyii* Hombron & Jacquinot, 1848, *Cerithidea (Cerithidea) quadrata* G. B. Sowerby II, 1866, *Cerithidea obtusa quadrata* G. B. Sowerby II, 1866, *Cerithidea quadrata* G.B. Sowerby II, 1866, *Cerithium quoyii* Hombron & Jacquinot, 1848.

Description: Shell was small, thin but not transparent and elongate conical with spire angle 30 – 40°. Shell length was 32.69 – 50.04 mm. Shell width was 11.11-18.80 mm (Figure 5H). Weight of *Cerithidea quoyii* was range from 1.6 g to 6.1 g. Many convex spire whorls range from 6 to 9 whorls and usually the apex often eroded. This convex spire whorl formed moderately deep suture. Shell had spire cords which only located at the bottom of the shell. Both spiral and axial ribs present on spire, equal in strength. The body whorl of this shell was rounded and had angular periphery. It had quadrangular shape of the aperture with the length range from 9.08 – 16.51 mm. Aperture width was range from 6.19 – 13.38 mm. An outer lip was flared and slightly thickened. Shell colour was brownish on base and lighter to the apex.

Habitat: *Cerithidea quoyii* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 6 (Kemaman).

Telescopium telescopium (Linnaeus, 1758)

Synonyms: *Cerithium montisselae* K. Martin, 1879, *Cerithium telescopium* (Linnaeus, 1758), *Potamides telescopium* (Linnaeus, 1758), *Telescopium indicator* Montfort, 1810, *Telescopium mauritsi* Butot, 1954, *Trochus telescopium* Linnaeus, 1758.

Description: Shell large and thick with high conical spire. Shell length was 41.38 – 49.60 mm. Shell width was 92.19 – 105.40 mm (Figure 5I). The weight of *Telescopium telescopium* was between 55.8 – 100.5 g and it had broad and flat base. Suture of the shell weakly define. It had 3 spiral cords in each whorl which starting from the shell base. Spiral cord was also easy to erode by the age. One of the spiral cords at the base form strong spiral grove at the columella. Body

whorl was rounded at the periphery and showed clearly growth mark at the dorsal area. Aperture shape was small and oblique, not flare compare with other species of the same family. Aperture length was 30.39 – 33.66 mm. the aperture width was 16.62 – 1808 mm. Columella twisted with strong central spiral ridge. Shell colour was reddish brown to black.

Habitat: *Telescopium telescopium* was collected by the fisherman from the brackish area such as lagoon, wetland and estuaries areas.

Distribution: Station 2 (Setiu), Station 4 (Marang) and Station 6 (Kemaman).

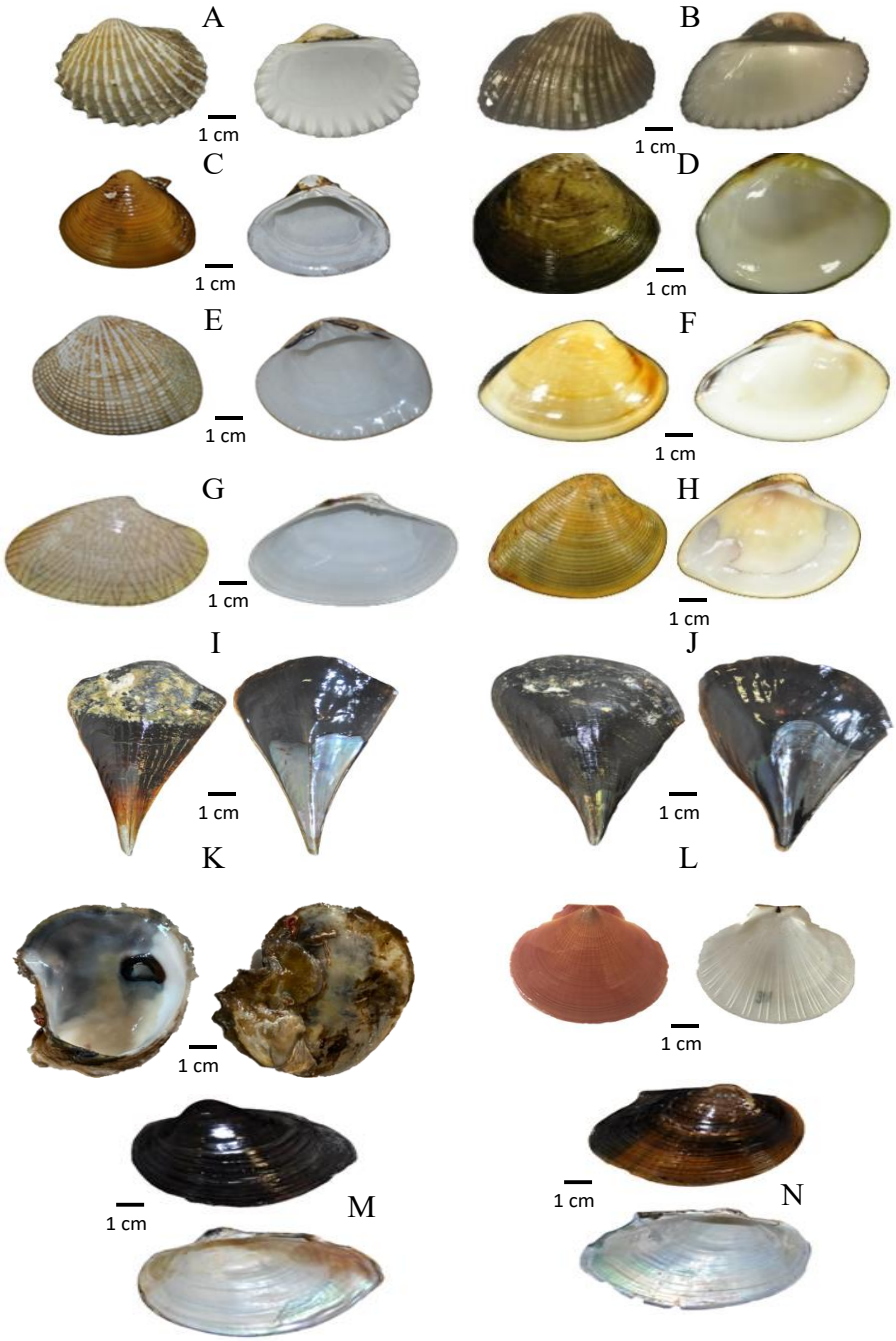

Figure 4. Edible bivalve species recorded from Terengganu waters; (A) *Tegillarca granosa*, (B) *Anadara cornea*, (C) *Corbicula fluminea*, (D) *Geloina expansa*, (E) *Gafrarium pectinatum*, (F) *Meretrix meretrix*, (G) *Paratapes undulatus*, (H) *Marcia japonica*, (I) *Pinna deltodes*, (J) *Atrina vexillum*, (K) *Magallana bilineata*, (L) *Amusium pleuronectes* (M) *Sinanodonta elliptica* and (N) *Sinanodonta lauta*

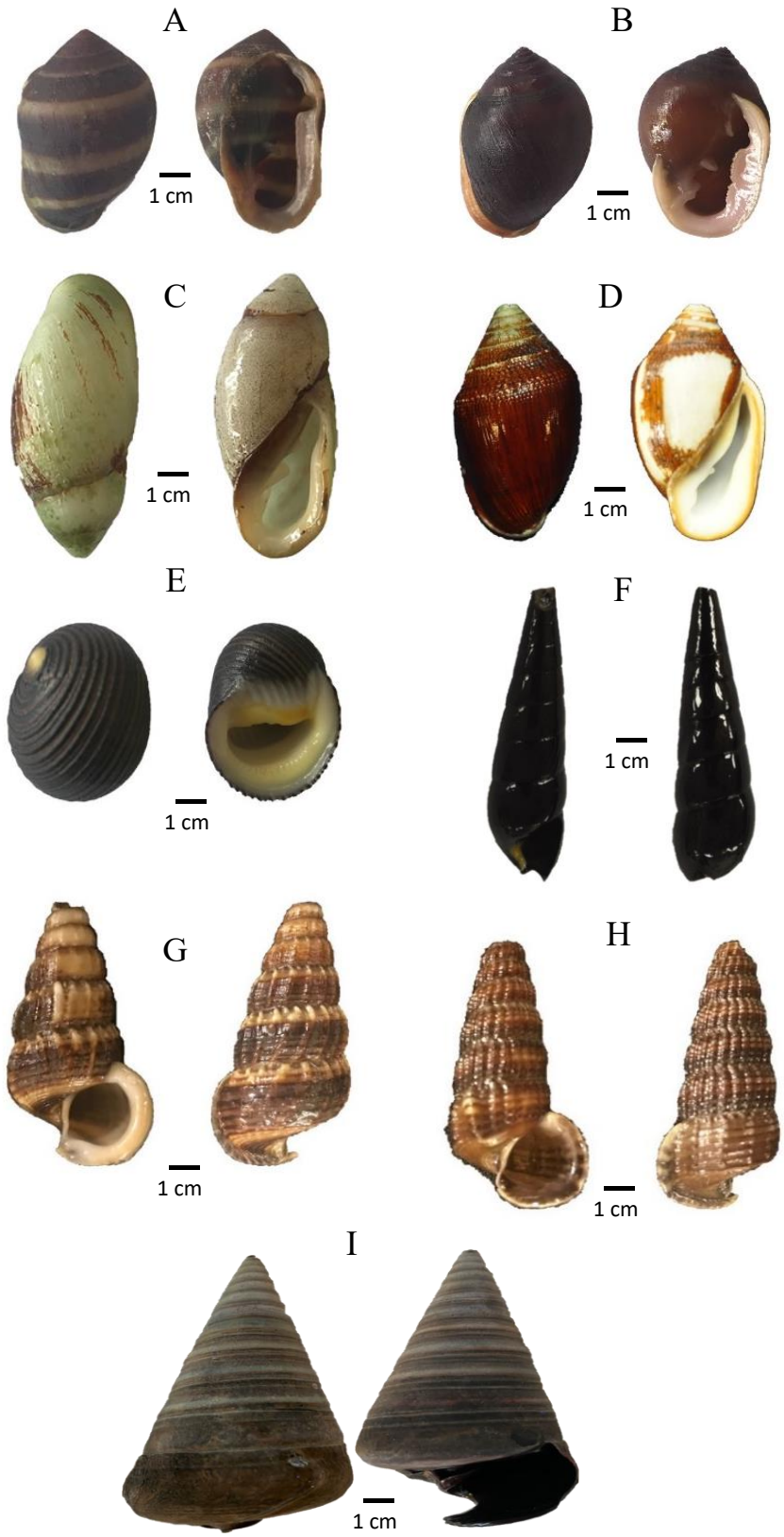

Figure 5. Edible gastropod species from Terengganu waters; (A) *Cassidula nucleus*, (B) *Cassidula aurisfelis*, (C) *Ellobium aurisjudae* (D) *Ellobium aurismisdae*, (E), *Nerita balteata*, (F) *Faunus ater*, (G) *Cerithidea obtusa*, (H) *Cerithidea quoyii* and (I) *Telescopium telescopium*

DISCUSSION

The samples from this present study were purchased from wet market and street vendors. The information provided by the seller regarding the habitat of the bivalves and gastropods were recorded, which 16 species inhabit brackish water, four species in salt water and three species inhabit freshwater and no bivalve or gastropod species are collected by fishermen in rocky coastal areas. Based on Hamli *et al.* (2012a; 2012b; 2013) and Idris *et al.* (2013), all of the samples used for the study were using samples purchased from the wet market-based suppliers and street vendors and based on information provided by the seller that all of these samples were collected at river areas, river estuaries, rocky beaches and mangrove areas in eight divisions of Sarawak. Most of the gastropods recorded in Sarawak waters inhabit rocky coastal areas while current studies identify which gastropods are found in shallow waters with sand and muddy bottom and mangrove tree roots. Based on Rahim *et al*. (2022), most of the recorded bivalves and gastropods are a group of marine species and brackish water that inhabit different areas and substrates such as the muddy bottom, intertidal reef, sandy bottom, coral areas, rocky area, seagrass area and mangrove swamp areas. This habitat characteristic was supported by this present study and from the previous studies by Brandt (1974), Frith *et al.* (1976) and Printrakoon *et al*. (2008) in Thailand, Idris *et al*. (2012), Hamli *et al*. (2012a) and Hamli *et al*. (2012b) and Hamli *et al.* (2013) in Sarawak, Malaysia has shown that edible bivalve and gastropods from brackish and saltwater areas are gaining more attention than locals living in freshwater environments. Yahya *et al.* (2018) reported that bivalve and gastropod species survive in a variety of water salinity and inhabit muddy, brackish, and almost freshwater mangrove sections.

Both bivalves and gastropods contribute significantly to the ecosystem and the sustainability of the coastal community's economy. In this study, 14 species of bivalves and nine species of gastropods were discovered to be widely distributed throughout six districts of Terengganu. The edible molluscs from six Terengganu districts show low species distribution especially in the gastropod group. The number of edible bivalve and gastropod species was low in six districts in Terengganu, probably because the species was not commercially exploited by locals, especially the gastropod group. In Terengganu, the local fishermen primarily focus on harvesting bivalve species as a source of protein as well as a source of livelihood especially for residents living near coastal areas and lagoons. The edible bivalves and gastropods have their demand in all areas of Malaysia and not just in the State of Terengganu. Rahim *et al*. (2022) recorded 40 species of edible bivalves from 19 families and 43 species of gastropods that were edible from 23 families from the Malaysian waters and the State of Sabah recorded 37 species of gastropod. While, in Sarawak, Idris *et al.* (2012) recorded 41 species of bivalves and gastropods that were edible from seven divisions of Sarawak and Hamli *et al.* (2012a; 2012b; 2013) reported a total of 15 species of edible bivalves recorded in eight divisions of Sarawak.

Although the geography of Terengganu and Sarawak are different, it is found from this study that there are five family and six species of bivalve group which belong to the family of Arcidae (*Tegillarca granosa*), Cyrenidae (*Geloina expansa*), Pectinidae (*Amusim pleuronectes*), Unionide (*Sinanodonta lauta*) and Veneridae (*Meretrix meretrix* and *Paratapes undulatus*), recorded the similarity of edible bivalve species as reported by Hamli *et al*. (2012a; 2012b; 2013), Idris *et al*. (2013) and Rahim *et al.* (2022) (Table 3). All similar bivalves species exist in Terengganu, Sabah and Sarawak were recorded in these different areas inhabiting brackish (*Tegillarca granosa, Geloina expansa* and *Meretrix meretrix*, marine (*Amusim pleuronectes* and *Paratapes undulatus*) and freshwater areas (*Sinanodonta lauta*).

In this present study, species of *Geloina expansa* of the family Cyrenidae and *Meretrix meretrix* of the family Veneridae dominate the bivalve group and were found in all districts of Terengganu. Hamli *et al*. (2012a) reported that the family Veneridae, *Circe scripta*, *Paratapes undulatus*, *Meritrix meritrix* and *Meritrix Iyrata* were bivalve groups with commercial values that attracted attention in eight divisions of Sarawak. The results of the present study revealed that, *Geloina expansa* of the family Cyrenidae was the most commonly found bivalve in six districts of Terengganu especially in mangrove areas. The same scenario reported by Hamli *et al.* (2012b) in Sarawak, where the mangrove area

Table 3. List of the edible bivalves and gastropods reported from the present study and by another researcher until year of 2022

Family	Species	Present Study	Hamli *et al*. (2012a)	Hamli *et al*. (2012b)	Idris *et al.* (2012)	Hamli *et al*. (2013)	Rahim *et al*. (2022)
			Bivalves				
Arcidae	*Tegillarca granosa*	+	+	+	+	-	+
	Anadara cornea	+	-	-	-	-	-
	Anadara antiquata	-	-	-	-	-	+
	Barbatia foliata	-	-	-	-	-	+
Cardiidae	*Hippopus hippopus*	-	-	-	-	-	+
	Tridacna crocea	-	-	-	-	-	+
	Tridacna squamosa	-	-	-	-	-	+
Cyrenidae	*Corbicula fluminea*	+	-	-	-	-	-
	Geloina expansa	+	+	+	+	-	+
	Geloina bengalensis	-	+	+	+	-	-
	Geloina erosa	-	+	+	+	-	-
Donacidea	*Donax faba*	-	-	-	-	-	+
Gluconomidae	*Gluconome virens*	-	+	+	+	-	+
Isognomonidae	*Isognomon ephippium*	-	+	-	+	-	+
	Isognomon isognomon	-	-	-	-	-	+
Mactridae	*Lutraria rhynchaena*	-	-	-	-	-	+
Margaritidae	*Pinctada chemnitzii*	-	-	-	-	-	+
	Pinctada margaritifera	-	-	-	-	-	+
	Pinctada maxima	-	-	-	-	-	+
Mytilidae	*Arcuatula arcuatula*	-	-	-	+	-	-
	Arcuatula senhousia	-	-	-	-	-	+
	Modiolus philippinarum	-	-	-	-	-	+
	Perna viridis	-	-	-	-	-	+
Pinnidae	*Pinna deltodes*	+	-	-	-	-	-
	Atrina vexillum	+	-	-	-	-	+
	Atrina pectinata	-	-	-	-	-	+
Pectinidae	*Amusium pleuronectes*	+	+	+	+	-	+
Pharidae	*Cultellus attenuatus*	-	-	-	-	-	+
	Sinonovacula constricta	-	-	-	-	-	+
Pholadidae	*Pholas orientalis*	-	+	+	+	-	+
Placunidae	*Placuna placenta*	-	+	-	+	-	-
Pteriidae	*Pteria penguin*	-	-	-	-	-	+
Solenidae	*Solen regularies*	-	+	+	+	-	-
	Solen lamarckii	-	+	+	+	-	-
	Solen ceylonensis	-	-	-	-	-	+
	Pharella acutidens	-	+	+	+	-	-
Spondylidae	*Spondylus versicolor*	-	-	-	-	-	+
Ostreidae	*Magallana bilineata*	+	-	-	-	-	-
	Crassostrea lugubris	-	+	-	+	-	-
	Dendostea folium	-	-	-	-	-	+
	Magallana belcheri	-	-	-	-	-	+
	Magallana bilineata	-	-	-	-	-	+
	Saccrostrea cucullata	-	-	-	-	-	+
Tellinidae	*Tellina* sp.	-	-	-	-	-	+
Unionidae	*Sinanodonta elliptica*	+	-	-	-	-	-
	Sinanodonta lauta	+	+	+	+	-	-
	Pilsbryoconcha exilis	-	+	-	+	-	-
Veneridae	*Gafrarium pectinatum*	+	-	-	-	-	-
	Meretrix meretrix	+	+	+	+	-	+
	Meretrix lyrata	-	+	+	+	-	-
	Meretrix sp.	-	-	-	-	-	+
	Paratapes undulatus	+	+	+	+	-	+
	Paratapes textilis	-	-	-	-	-	+
	Paphia crassisulca	-	-	-	-	-	+
	Marcia japonica	+	-	-	-	-	-
	Circe scripta	-	+	+	+	-	-
	Callista sp.	-	-	-	-	-	+
	Chamelea sp.	-	-	-	-	-	+
	Gafrarium tumidum	-	-	-	-	-	+

Table 3. Continued

Family	Species	Present Study	Hamli *et al*. (2012a)	Hamli *et al*. (2012b)	Idris *et al*. (2012)	Hamli *et al*. (2013)	Rahim *et al*. (2022)
			Gastropods				
Ampullariidae	*Pomacea bridgesii*	-	-	-	+	+	-
	Pomacea canaliculata	-	-	-	+	+	-
Babylonidae	*Babylonia areolata*	-	-	-	-	-	+
Bursidae	*Tutufa rubeta*	-	-	-	-	-	+
Cassidae	*Cassis cornuta*	-	-	-	-	-	+
Charoniidae	*Charonia tritonis*	-	-	-	-	-	+
Cypraeidae	*Cypraea tigris*	-	-	-	-	-	+
Ellobiidae	*Cassidula nucleus*	+	-	-	-	-	
	Cassidula aurisfelis	+	-	-	-	-	-
	Ellobium aurisjudae	+	-	+	+	+	-
	Ellobium aurismidae	+	-	-	-	-	-
Fasciolariidae	*Latirus polygonus*	-	-	-	-	-	+
	Pleuroploca trapezium	-	-	-	-	-	+
Ficidae	*Ficus gracilis*	-	-	-	-	-	+
Haliotidae	*Haliotis asinine*	-	-	-	-	-	+
Muricidae	*Thais aculeata*	-	-	+	+	+	-
	Chicoreus brunneus	-	-	-	-	-	+
	Chicoreus capucinus	-	-	-	-	-	+
	Chicoreus ramosus	-	-	-	-	-	+
	Murex pectin	-	-	-	-	-	+
	Murex trapa	-	-	-	-	-	+
	Murex ternispina	-	-	-	-	-	+
Nacellidae	*Cellana testudinaria*	-	-	-	-	-	+
Naticidae	*Paratectonatica tigrine*	-	-	-	-	-	+
Nautilidae	*Nautilus pompilius*	-	-	-	-	-	+
Neritidae	*Nerita balteata*	+	-	-	-	-	-
	Nerita chamaeleon	-	-	+	+	+	-
	Nerita articulata	-	-	+	+	+	-
	Nerita albicilla	-	-	+	+	+	-
	Clithon retropictus	-	-	+	+	+	-
Ovulidae	*Ovula ovum*	-	-	-	-	-	+
Pachychilidae	*Faunus ater*	+	-	-	-	-	-
	Brotia costula	-	-	-	+	+	-
	Tylomelania helmuti	-	-	-	+	+	-
Potamididae	*Cerithidea obtusa*	+	-	+	+	+	+
	Cerithidae rizophorarum	-	-	+	+	+	-
	Cerithidae quadrata	-	-	-	+	+	-
	Cerithidea quoyii	+	-	-	-	-	-
	Telescopium telescopium	+	-	+	+	+	+
	Terebralia palustris	-	-	-	-	-	+
	Terebralia sulcate	-	-	-	-	-	+
Planaxidae	*Planaxis sulcatus*	-	-	+	+	+	-
Rostellariidae	*Tibia fusus*	-	-	-	-	-	+
Strombidae	*Conomurex luhuanus*	-	-	-	-	-	+
	Euprotomus bulla	-	-	-	-	-	+
	Harpago chiragra	-	-	-	-	-	+
	Laevistrombus csnsrium	-	-	-	-	-	+
	Lambis crocata	-	-	-	-	-	+
	Lambis lambis	-	-	-	-	-	+
	Lentigo lentiginosus	-	-	-	-	-	+
Tegulidae	*Rochia nilotica*	-	-	-	-	-	+
	Tectus dentatus	-	-	-	-	-	+
Terebridae	*Oxymeris maculate*	-	-	-	-	-	+
Thiaridae	*Melanoides costellaris*	-	-	-	+	+	-
	Blanocochlis glandiformis	-	-	-	+	+	-
Tonnidae	*Tonna sulcosa*	-	-	-	-	-	+
Trochidae	*Trochus radiatus*	-	-	+	+	+	-
	Monodonta labio	-	-	+	+	+	-
	Monodonta canalifera	-	-	-	-	-	+
Turbinellidae	*Vasum turbinellus*	-	-	-	-	-	+
Turbinidae	*Turbo crassus*	-	-	+	+	+	-
	Lunella cinereal	-	-	-	-	-	+
	Turbo chrysostomus	-	-	-	-	-	+
	Turbo petholatus	-	-	-	-	-	+
Volutidae	*Melo melo*	-	-	+	+	+	+
	Cymbiola chrysostoma	-	-	-	-	-	+
	Cymbiola nobilis	-	-	-	-	-	+

Note: (+) = Present, (-) = Absent

also provides good habitat for *Geloina* spp. where *Geloina erosa* was found in the Sibu, Mukah, Bintulu, Miri, Limbang and Lawas areas. Elsewhere in Indo-pacific areas, this marsh clam can be described under the subgenus *Geloina* (Morton, 1984) which is distributed in the mangrove area where brackish water provided a similar habitat of China (Han *et al*., 2003), Australia (Wells, 1986) and Thailand (Printrakoon *et al*., 2008). In the marine habitat, *Pinna deltodes* and *Atrina vexillum* of the family Pinnidae were first time recorded on Rhu Island, Besut, Terengganu. These species live in muddy areas and are associated with some green algae. Idris *et al*. (2008) identified seven species of the family Pinnidae, consisting of five *Pinna* species and two *Atrina* species, namely *Pinna bicolor, Pinna muricata, Pinna deltodes, Pinna atropurpurea* and *Pinna incurve* and *Atrina pectinata* and *Atrina vexillum* in coastal waters of Peninsular Malaysia which particularly in the muddy areas which are associated with seagrass. Rahim *et al*. (2022) reported two species of *Atrina* genus from Bt. Lancang Market, Penang and Kg. Pulau Sayak for *Atrina vexillum* and *Atrina pectinata* from Sabah.

In this study, two family and three species of the edible gastropod were by Hamli *et al.* (2012a; 2012b; 2013) Idris *et al* (2013) and Rahim *et al*. (2023) in which the family Ellobiidae (*Ellobium aurisiudae*) and Potamididae (*Cerithidae obtuse* and *Telescopium telescopium*) were recorded in brackish and marine areas. The family Ellobiidae of the gastropod group has the highest number of species (4 species) compared to the others, consisting of *Cassidula nucleus, Cassidula aurisfelis, Ellbium aurisjudae* and *Ellbium aurismidae*. According to Hamli *et al*. (2013) a total of 21 gastropod species from 11 families were recorded in eight parts of Sarawak coastal waters. The family Potamididae and Neritidae were reported to be a higher species of gastropod with each of the four species compared to the six Terengganu districts where only one species was recorded, *Nerita balteata*. According to Madin *et al.* (2021) the harvesting of gastropod for food and other purpose may affect the diversity and abundance of intertidal gastropod especially Neritidae family. Most gastropod species are endemic species, that have different types of distribution living on muddy substrates as well as roots and stems of mangrove trees (Nurhayati *et al*., 2021).

Also known locally as black snails, *Faunus ater* has been spotted widely in the waters of the Terengganu lagoon as an edible gastropod by locals. From a study conducted by Hamli et al. (2012a; 2012b; 2013) and Idris *et al*. (2013) in Sarawak waters, no records have been reported in connection with the distribution of *Faunus ater*. Similarly, to Rahim *et al.* (2022) no information related to *Faunus ater* is recorded as an edible gastropod in Malaysia. *Faunus ater* usually inhabits brackish water and is associated with mangrove forests, is highly resistant to changes in water quality and acts as a bioindicator of organic pollution and heavy metal accumulator (Sahidin *et al*., 2021). According to Udayantha and Munasinghe (2009), higher amounts of *Faunus* sp. along the Lunuwila Ela, Galle can be found on substrates consisting of fine sand, silt and clay.

In the Terengganu, areas such as coastal areas, wetland, lagoons, estuary and rivers provide habitat to all edible bivalve and gastropod species in six districts in Terengganu State. Edible bivalves and gastropods composite a cheap protein source for the locals. Therefore, they are the vital edible molluscs food, in addition to others fresh and marine items. This study revealed that in addition to commercially valuable bivalves and gastropods, other species are mostly used for local use and not extensively disseminated in the big commercial markets.

CONCLUSION

In conclusion, a total of 23 species from 11 families of bivalves and gastropods were recorded in six districts of Terengganu. It was found that bivalve species with 14 species from seven families were dominant in the study areas, while gastropods with nine species from four families were represented. The distribution of bivalves and gastropods species recorded from this study was very low. However, some species such as *Gafrarium pectinatum, Meretrix meretrix* and *Paratapes undulatus* of the family Veneridae and *Geloina expansa* of the family Cyrenidae are species which can also be found in Sabah and Sarawak, were also found in Terengganu. In Sabah and Sarawak, the demand for seafood and edible molluscs is particularly high compared to Terengganu, which has low demand for edible molluscs, especially gastropod group. This study's findings can assist local authorities in enforcing existing policies,

laws, and enforcement measures to control the collection of these marine products and prevent the demise of the aquatic life conservation programme from extinction.

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