REVIEW ON ESTUARINE AND MARINE MOLLUSCS OF MYANMAR: PART I*

Naung Naung Oo[1]

Abstract

A total of 40 orders, 164 families, 375 genera, and 1720 species of estuarine and marine molluscs were collected from intertidal, subtidal and deep-water areas from Nantha Island in northern Rakhine Coastal Region to Dawei Point in Tanintharyi Coastal Region from 2004 to 2024 in Myanmar coastal water. The collected specimens were recognized as 1 species of Aplacophora, 20 species of Polyplacophora, 2 species of Monoplacophora, 1106 species of Gastropoda, 529 species of Pelecypoda (= Bivalvia), 10 species of Scaphopoda, and 52 species of Cephalopoda. In the present study, 954 species of estuarine and marine molluscs were recorded from the Rakhine Coastal Region, followed by 598 species from the Tanintharyi Coastal Region, 134 species from the Ayeyawady Delta and Gulf of Martaban Coastal Region, and 34 species from unspecified localities, respectively.

Keywords: Estuarine, marine, molluscs, Myanmar water.

Introduction

Myanmar has diverse finfish and shellfish resources, productive inshore and offshore waters, with a 2,831 km coastline facing the Bay of Bengal and the Andaman Sea in the Indian Ocean. Estuarine and marine molluscs were classified into seven classes, such as Aplacophora von Jhering, 1876; Polyplacophora de Blainville, 1816; Monoplacophora Wenz, 1940; Gastropoda Cuvier, 1795; Pelecypoda (= Bivalvia) Linnaeus, 1758; Scaphopoda Bronn, 1862; and Cephalopoda Cuvier, 1795 by Seed (1983).

The Sclerite-bearing deep-sea shells of aplacophorans; Chiton shells of polyplacophorans; Bearing one plate or cup-like shells of monoplacophorans; Angaria shells, Keyhole limpets or slit limpets, Abalones, Lottiid limpets, Nacellid true limpets, Nerites, Patellid limpets, Top shells, Turban shells, Sundial shells, Frog shells, Hat or cup shells, Helmet and bonnet shells, Ceriths, Cerithiopsis, Triton's trumpet, Cowries, Staircase or ladder shells, Violet snails, Parasitic sea snails, Fig shells, Hoof shells, Iravadiid sea snails, Periwinkles, Moon snails, Egg cowries, Distorsios, Planaxids and cluster-winks, Swamp-ceriths or horn shells, Triton shells, Rissoinid sea snails, Conchs, Tun shells, Triphorid sea snails, Bean cowries, Turret shells, Worm shells, Carrier shells, Babyloniid whelks, Whelks, Clathurellid sea snails, Dwarf tritons, Dove shells, Cone shells, Costate miters, Horse conchs or spindle shells, Harp shells, Coral snails, Mangeliid sea snails, Marginellids, Melongenas, Miter shells, Purpuras, murex and rock shells, Nassa mud snails, Olive shells, Pisaniid sea snails, Raphitomid sea snails, Auger shells, Vase shells, Turrids, Volutes, Fragile bubble shells, Sea hares, Bubble shells, Haminoeid bubble shells, Lozenge-shaped slugs, Barrel-bubble snails, Canoe-bubble shells, Floating sea snails, Chromodorid nudibranchs, Dendrodorid nudibranchs, Discodorid nudibranchs, Sea lemon, Hexabranchid nudibranchs, Phyllidiid nudibranchs, Polycerid nudibranchs, Aitengid slugs, Side-gilled slugs, Sea butterflies, Pyramid shells, Bubble sea slugs, Sacoglossan sea slugs, Mangrove slugs, Cassidula and pythia snails, and False limpets of gastropods; Knife and razor clams, Ark shells, Cucullaeid ark shells, Bittersweet clams, Limopsis ark shells, Noetiid ark shells, Cockles, Donax clams, Sunset clams or sanguins, Semeles, Short razor clams, Tellins, Giant clams, Carditas, Lantern clams, Penicillid clams, Tiny galeommatid clams, Kelly clams, Flask cockles, File shells, Lucinas, Little basket clams or box clams, Zebra mussel, Angel wings or piddocks,

*First Prize(2024)

[1] Department of Marine Science, Pathein University

Shipworms, Sea mussels, Swan neck shells, Yoldias, Nut clams, Honeycomb oysters, Tree oysters, Hammer oysters, Pearl oysters, Edible oysters, Pen shells, Winged oysters, Jingle shells or saddle oysters, Scallops, Windowpane shells, Kitten's paws, Thorny oysters, Awning clams, Jewel box shells, Marsh clams, Glauconomyas, Trough shells, Trapezid clams, and Venus clams of pelecypods; Tusk shells of scaphopods; Octopus, Squid, Cuttlefish, and Nautilus of cephalopods were predominantly found in Myanmar water.

The aims of this study are 1) to record the real existence of estuarine and marine molluscs in Myanmar water, and 2) to investigate the seashell resources and their utilization in the daily life of the local population.

Materials and Methods

Shells were collected from Nantha Island, northern Rakhine Coastal Region, down to Dawei Point, northern Tanintharyi Coastal Region, from 2004 to 2024 (Fig. 1) in the estuarine habitats of mangrove swamps, mudflats, salt marshes, sandflats, rocky fringes, and marine habitats of offshore Islands and deep-water zones along Myanmar coastal regions. **Rakhine Coastal Region:** Sittway Point (20˚ 06′ N, 92˚ 53′ E), Kyauk Phyu (19˚ 25′ N, 93˚ 31′ E), Kyauk Layaine Gyaing (19˚ 50′ N, 93˚ 25′ E), Sing aung (18˚ 32′ N, 94˚ 14′ E), Mazin (18˚ 27′ N, 94˚ 17′ E), Ngapali (18˚ 26′ N, 94˚ 18′ E), Shwewar Gyaing (18˚ 24′ N, 94˚ 19′ E), Lonetha Gyaing (18˚ 21′ N, 94˚ 20′ E), Kyauk Phone Gyi Maw (18˚ 18′ N, 94˚ 20′ E), Maung Shwe Lay Gyaing (18˚ 18′ N, 94˚ 19′ E), Kywe Thauk Gyaing (18˚ 17′ N, 94˚ 22′ E), Kwinwaing Gyaing (18˚ 17′ N, 94˚ 20′ E), Hmaw Chay Gyaing (18˚ 13′ N, 94˚ 25′ E), Gyaing Kauk Gyaing (17˚ 47′ N, 94˚ 28′ E), Hlyaw Gaung Taung Gyaing (17˚ 45′ N, 94˚ 30′ E), Yay Myet Taung Gyaing (17˚ 42′ N, 94˚ 31′ E), Maw Shwe Gyaing (17˚ 41′ N, 94˚ 32′ E), Chan Pyin Gyaing (17˚ 38′ N, 94˚ 33′ E), Yahaing kutoe (Gwa Aw) (17˚ 38′ N, 94˚ 34′ E), Makyeengu Gyaing (Gwa Aw) (17˚ 35′ N, 94˚ 33′ E), Shweya Gyaing (17˚ 35′ N, 94˚ 33′ E), Baw Di Gyaing (17˚ 29′ N, 94˚ 33′ E), Jade Lett Gyaing (17˚ 17′ N, 94˚ 30′ E), Tapin Maw (17˚ 16′ N, 94˚ 29′ E), Phoe Htaung Gyaing (17˚ 10′ N, 94˚ 29′ E), Wet Thay Gyaing (17˚ 08′ N, 94˚ 27′ E), Kyauk Nagar (17˚ 04′ N, 94˚ 27′ E), Shwe Thaung Yan (Ma Gyi) (17˚ 04′ N, 94˚ 27′ E), Boung Kyun I. (17˚ 04′ N, 94˚ 26′ E), Inn Din Gyi (17˚ 03′ N, 94˚ 26′ E), Thae Phyu Kyun (17˚ 01′ N, 94˚ 18′ E), Chaung Tha (16˚ 57′ N, 94˚ 25′ E), Ngwe Saung (16˚ 52′ N, 94˚ 22′ E), Thathanar Dauk (16˚ 36′ N, 94˚ 19′ E), Ngayoke Kaung Aw (16˚ 32′ N, 94˚ 17′ E), Ohn Kyun I. (16˚ 23′ N, 94˚ 13′ E), Cape Negrais (16˚ 02′ N, 94˚ 11′ E), Ngwe Taung Pagoda (16˚ 01′ N, 94˚ 12′ E), Zea Gyaing (16˚ 01′ N, 94˚ 12′ E), Mawtin Point (15˚ 57′ N, 94˚ 14′ E); **Ayeyawady Delta and Gulf of Martaban Coastal Region:** Letkokkon (16˚ 19′ N, 96˚ 08′ E), Kyauk Chaung (15˚ 59′ N, 94˚ 16′ E), Kha Mauk Hmaw (15˚ 59′ N, 94˚ 16′ E), Kyar Kan (15˚ 59′ N, 94˚ 13′ E), Haing Gyi I. (15˚ 58′ N, 94˚18′ E); **Tanintharyi Coastal Region:** Ahlyat (16˚ 37′ N, 97˚ 27′ E), Kyaikkhami (16˚ 05′ N, 97˚ 34′ E), Setse (15˚ 57′ N, 97˚ 36′ E), Kalegauk I. (15˚ 32′ N, 97˚ 39′ E), Sitaw (15° 11′ N, 97˚ 48′ E), Ka Byar Wa (15˚ 04′ N, 97˚ 48′ E), Maungmagan (14˚ 07′ N, 98˚ 05′ E), Thabawseik (Mwe Taung) (14˚ 06′ N, 98˚ 05′ E), Kanpani (14˚ 03′ N, 98˚ 04′ E), San Hlann (13˚ 54′ N, 98˚ 04′ E), South Moscos I. (13˚ 51′ N, 97˚ 55′ E), Nyaw Pyin Aw (13˚ 38′ N, 98˚ 08′ E), Wa Maw (13˚ 37′ N, 98˚ 08′ E), Myin Kwar Aw (13˚ 33′ N, 98˚ 08′ E).

All live shells were preserved in 10% formalin in seawater. The collected specimens were taxonomically identified up to the lowest possible taxonomic units and housed in the Museum of Mawlamyine (MLM.MS), Sittway (MSS), and Pathein universities (PMS). Available shell books such as Indo-Pacific Mollusca, Monographs of Marine Mollusca, Molluscan Research and The Veliger were also examined. An extensive literature and internet search was conducted, including the World Register of Marine Species (WoRMS; WoRMS Editorial Board [2023]), to determine the current valid name and family placement.

Figure 1. Collection areas of molluscs in some coastal areas of Myanmar

Results and Discussion

There were 1833 species of estuarine and marine molluscs in some coastal areas of Myanmar in the present study, but 113 species were rejected or considered uncertain: 66 on geographic grounds because the species does not occur in the Southeast Asian marine biogeographic region; 34 on a taxonomic basis; 8 for being fossils; and 5 for being freshwater species.

Table 1. Estuarine and marine species in each class of mollusc recorded from Myanmar

Class	RCR	ACR	N.TCR	NSL	Total
Aplacophora von Jhering, 1876	0	1	0	0	1
Polyplacophora de Blainville, 1816	8	2	9	1	20
Monoplacophora Wenz, 1940	2	0	0	0	2
Gastropoda Cuvier, 1795	673	84	336	13	1106
Pelecypoda (= Bivalvia) Linnaeus, 1758	245	35	234	15	529
Scaphopoda Bronn, 1862	5	0	3	2	10
Cephalopoda Cuvier, 1795	21	12	16	3	52
Total	954	134	598	34	1720

Symbols: RCR = Rakhine Coastal Region; ACR = Ayeyawady Delta and Gulf of Martaban Coastal Region; N. TCR = Northern Tanintharyi Coastal Region; NSL = No Specific Locality.

The remaining 1720 species are classified under 7 classes, 40 orders, 164 families and 375 genera and are considered valid by the WoRMS Editorial Board (2023) and other sources. The species diversity was the highest in-class Gastropoda (1106 species), followed by Bivalvia (529 species) and Cephalopoda (52 species) (Table 1). Based on taxonomic criteria, seven classes of estuarine and marine molluscs were recorded from Myanmar coastal water as shown in Table 2.

Table 2. Taxonomic status of estuarine and marine molluscs recorded from Myanmar

Class	**Orders**	**Families**	**Genera**	**Species**
Aplacophora von Jhering, 1876	1	1	1	1
Polyplacophora de Blainville, 1816	2	5	13	20
Monoplacophora Wenz, 1940	1	1	1	2
Gastropoda Cuvier, 1795	13	88	204	1106
Pelecypoda (= Bivalvia) Linnaeus, 1758	16	50	126	529
Scaphopoda Bronn, 1862	2	3	4	10
Cephalopoda Cuvier, 1795	5	16	26	52
Total	40	164	375	1720

The aplacophoran shells are tiny, relatively barrel, worm-like structures, without outer shells and the length is 1 mm to 30 cm but usually less than 5 cm long (Fig 2A). The epidermal layer secretes calcareous spicules or scales embedded in the dorsal mantle. They live in the sediment of the deep-sea floor. The single species of *Falcidens crossotus* Salvini-Plawen, 1968 was recorded during Dr Fridtjof Nansen Marine Ecosystem and Oceanographic Survey (2013) in Myanmar waters.

The chitons are composed of eight overlapping rough shell plates, three layers in young individuals, small tubes that photoreceptors pierce plates and various sizes of marine molluscs groups that are found in the class of Polyplacophora which was formerly known as Amphineura. These shells were grazed on rocky intertidal zones and hard substratum (Fig 2B). In Rakhine and Tanintharyi coastal regions, chiton shells were collected by local people for their daily consumption and the sale of dry meat at local markets.

The monoplacophorans are worm-like molluscs, without shells, crystalline style, and feet; they live in vertical burrows on the deep-sea floor. Its shell resembles a cap. Shells are found in soft and hard substrates on the continental shelf and in the deep sea. Only two species of

Neopilina bruuni Menzies, 1968 and *N. galatheae* Lemche, 1957 were recorded in deep water depths of 100-500m in the Rakhine Coastal Region (Fig 2C).

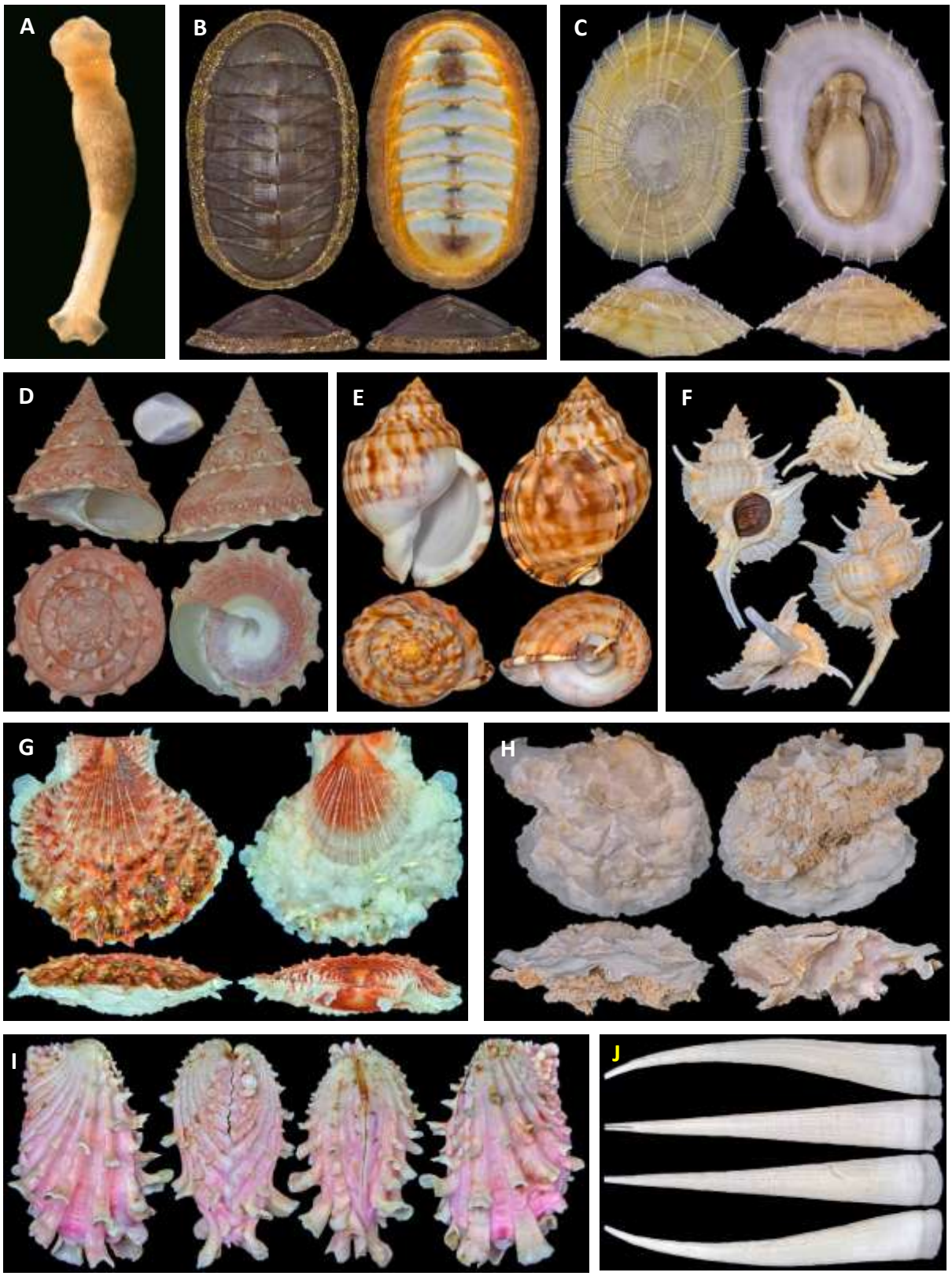

Figure 2. (A-J): Typical species of estuarine and marine molluscs in Myanmar. A) Aplacopod; B) Polyplacopod; C) Monoplacopod; D-F) Gastropods; G-I) Bivalves; J) Scaphopod.

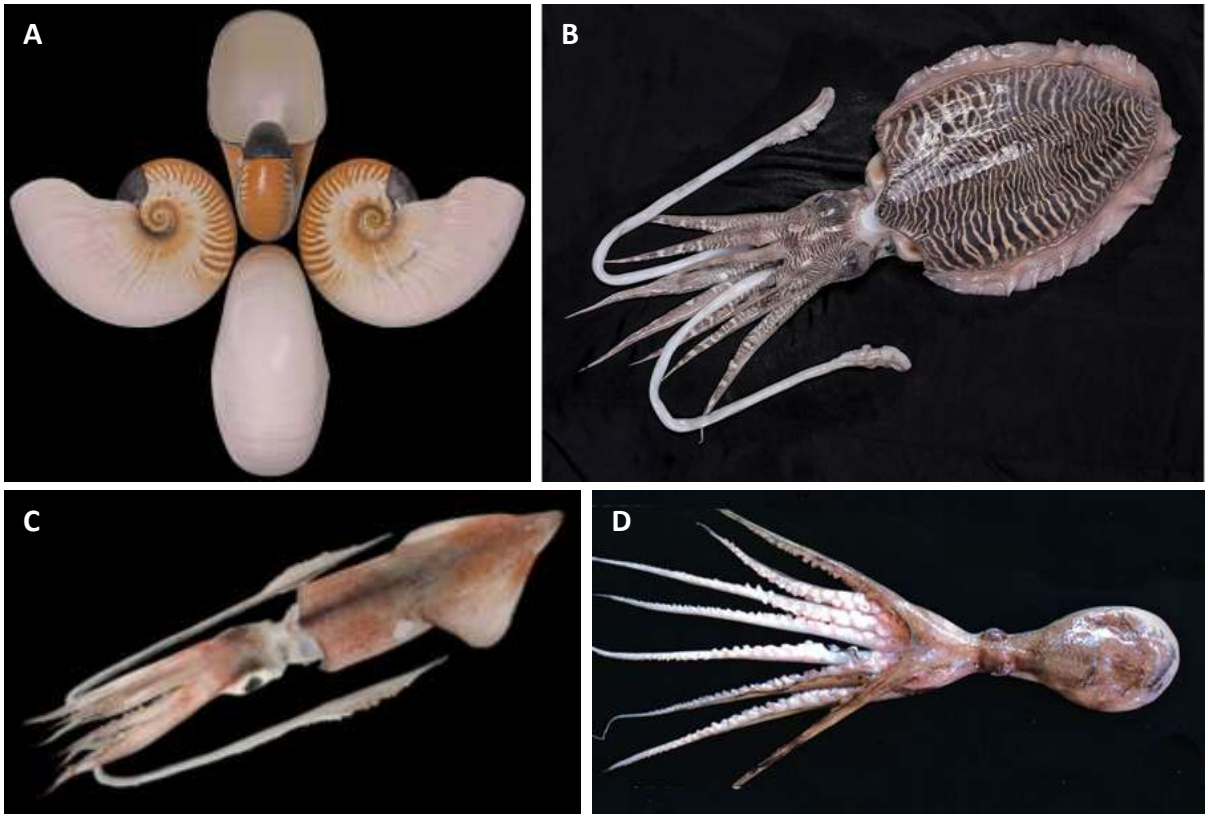

Figure 3. (A-D): Typical Cephalopod species in Myanmar. A) Nautilus species; B) Cuttlefish species; C) Squid species; D) Octopus species.

Gastropods are spirally coiled and asymmetrical shells. Their soft body is divided into 4 main regions: the head, the foot, the visceral mass, and the mantle (Fig 2D-F). Gastropods are usually divided into 4 main subclasses: Prosobranchia, Opisthobranchia, Pulmonata, and Gymnomorpha. Among the marine-shelled gastropods, the prosobranchs contained the most commercial interest to fisheries. In this study, 1106 known species were recorded along Myanmar water. The highest species was recorded at 673 species in the Rakhine Coastal Region followed by 336 species in the northern Tanintharyi Coastal Region, 84 species in the Ayeyawady Delta and Gulf of Martaban Coastal Region, and the last 13 species had no specific locality.

The pelecypods or bivalves are composed of 2 calcified valves which are equally convex (equivalve shell), but they may differ in size and shape (inequivalve shell) as a result of an alteration of bilateral symmetry. The valves are characterized by the hinge, the ligament, 1 or 2 (sometimes 3) adductor muscles, well-defined imprints, and adductor muscle scars. The soft and unsegmented body of bivalves is laterally compressed, fused and covered by the mantle, pallial lobes, pallial line, foot and elastic filaments (byssus) (Fig 2G-I). These shells were the second largest species outnumbered in the present study and most of the shells were consumed and traded by coastal populations.

Tusk shells or scaphopods are curved, tooth-like shells open at both ends, bilaterally symmetrical marine forms, lack eyes and burrow with shovel feet in marine mud and sediments (Fig 2J). Scaphopod shells are truly marine organisms that can be found at an incredible depth of up to 4570 meters. In this study, 10 species of scaphopods were recorded in deep water areas of Rakhine and northern Tanintharyi coastal regions.

Table 3. Reviews of estuarine and marine molluscs in Myanmar

Sr. No.	Author	Year	Field of study and area
1	Mason	1850 1852 1882	Taxonomy (Northern Rakhine Coastal Region and Tanintharyi Coastal Region)
2	Mann	1888	
3	Soe Thu	1970	Taxonomy (Ngapali, Rakhine Coastal Region)
		1971	Taxonomy (Maungmagan, Tanintharyi Coastal Region)
		1972	Taxonomy (Myanmar Coastal Water)
		1980	Taxonomy (Myanmar Coastal Water)
4	Kyaw Myint	1971	Taxonomy (Moscos Islands, Tanintharyi Coastal Region)
5	Khin May Gyi	1973	Morphology and Taxonomy
6	Maung Win	1975	Morphology and Taxonomy (Myanmar Coastal Water)
7	Kyi Bin	1979	Anatomy of *Octopus* sp.
8	Aye Thida Thein	1982	Morphology and Taxonomy (Myanmar Coastal Water)
9	Mar Lar Myo Sein	1982	Morphology and Taxonomy (Myanmar Coastal Water)
10	Wai Wai Kan Oo	1982	Anatomy of *Sepia* sp.
11	Tint Tun	1984	Anatomy and Histology of Pearl Oyster
12	Lwin Lwin	1985	Aquaculture (Ye River Mouth, Mon State)
13	Tin Nu	1985	Aquaculture (Ye River Mouth, Mon State)
14	Htay Aung	1987	Aquaculture (Setse Coastal Water, Mon State)
15	Phyu Phyu Khin Win	1990	Taxonomy (Bottom Trawled, Myanmar Coastal Water)
16	Su Su Khin	1992	Anatomy of *Sepia* sp.
17	Mya Mya Htwe	1995	Anatomy and Histology of Spider Conch
18	Myint Myint Khaing	1995	Aquaculture (Setse Coastal Water, Mon State)
19	Hla Hla Aye	1996	Anatomy and Histology of Top Shell
20	Htwe-Nyunt	1996	Aquaculture (Setse Coastal Water, Mon State)
21	Nan Nwe Nwe Aye	1998	Ecology (Chaung Tha Coastal Water, Ayeyawady Region)
22	Taat Tun Thu	1998	Taxonomy (Tanintharyi Coastal Region)
23	Aye Thant Zin	2007	Taxonomy (Sin Ma Coastal Water, Ayeyawady Region)
24	Kay Thwe Tun	2007	Aquaculture of Pearl Oyster
25	San San Aye	2007	Aquaculture of Pearl Oyster
26	Sandar Win	2009	Ecology (Chaung Tha Coastal Water, Ayeyawady Region)
27	Htay Aung	2011	Aquaculture of Oyster spp.
28	Jar San	2011	Taxonomy (Mon State, Tanintharyi Coastal Region)
29	Naung Naung Oo	2012	Taxonomy (Mon State, Tanintharyi Coastal Region)
30	Phoo Thet Su Win	2012	Taxonomy (Setse Coastal Water, Tanintharyi Coastal Region)
31	Phyu Phyu Than	2012	Ecology (Myeik Coastal Water, Tanintharyi Region)
32	Sint Sint Hlaing	2012	Taxonomy (Palaw Coastal Water, Tanintharyi Coastal Region)
33	Thaw Zin Naing Tun	2012	Taxonomy (Kampani Coastal Water, Tanintharyi Coastal Region)
34	Phoo Thet Su Win	2013	Taxonomy (Mon State, Tanintharyi Coastal Region)
35	Khin Myo Thin	2015	Taxonomy (Ye River Mouth, Mon State)
36	Su Pyae Tun	2016	Taxonomy (Myanmar Coastal Water)
37	Aung Ko Latt	2017	Taxonomy (Kawdut Coastal Water, Tanintharyi Coastal Region)
38	Khin Yu Nwe	2017	Fishery Biology (Myeik, Tanintharyi Coastal Region)
39	Aung Pyae Phyo	2019	Taxonomy (Mon State, Tanintharyi Coastal Region)
40	Nu Sein	2019	Ecology (Bo Ron Ga I., Northern Rakhine Coastal Region)
41	Win Win Nwe	2019	Aquaculture (Ye River Mouth, Mon State)
42	Hsu Thawdar Hnin	2021	Population Dynamics (Ye River Mouth, Mon State)

A total of 52 species of cephalopods, including nautiluses, cuttlefish, squids, and octopuses were included in the present study. They may not be as diverse as other mollusc groups or as the bony fishes in terms of the number of species (about 600 cephalopod species described worldwide), but these species are very common and some have large body sizes. Hence, they are of considerable ecological and commercial fisheries importance globally and in Myanmar (Fig 3A-D).

The works of literature concerned with Myanmar seashells have been very few in the past. The earliest study on Myanmar seashells is that of Mason (1850, 1852, 1882) and Mann (1888) collected from the northern Rakhine Coastal Region and Tanintharyi Coastal Region during the colonial period. In this way, there was an entire lack of modern literature on Myanmar molluscs, and information gained from this literature was very scarce and inadequate. The seashells study of Myanmar coastal water was revised and compiled by Naung Naung Oo (2022) (Table 3 and Fig 4).

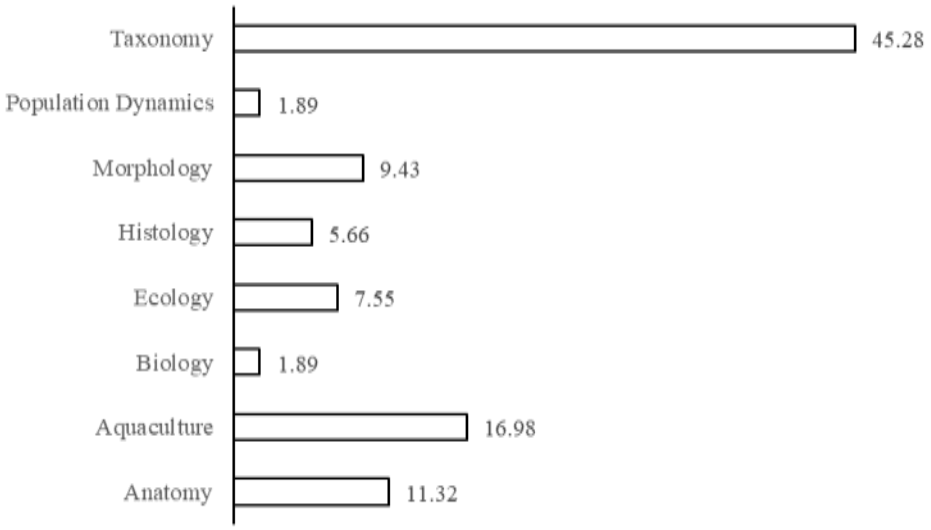

Figure 4. Percentage field of study of estuarine and marine molluscs in Myanmar

Conclusion

The three coastal regions of Myanmar are huge habitats with rich biodiversity. The shellfish biodiversity holds significant social, economic and cultural values for the local population. The intertidal zones of Myanmar are all aware of the role of coastal ecosystems, particularly mangrove swamps, coral reefs, seagrass meadows, dunes, mudflats, and rocky fringes in sustaining the recruitment of shellfish and in supporting fisheries too. The coastal water from Nantha Island to Dawei Point has 1833 species of estuarine and marine molluscs, 1 species of aplacophora, 20 species of polyplacophora, 2 species of monoplacophora, 1106 species of gastropoda, 529 species of pelecypoda, 10 species of scaphopoda, 52 species of cephalopoda, and 113 species are considered uncertain as of the studies done so far. However, much information on deep-sea and offshore species of molluscan fauna in Myanmar water remained unknown.

Acknowledgements

I would like to express my gratitude to Dr Than Tun, Rector of Pathein University; Dr Khine Le Win and Dr Moe Moe Aye, Pro-rectors of Pathein University for their permission to undertake this research work. I would like to express my sincere thanks to Dr Soe Pa Pa Kyaw, Professor and Head of the Department of Marine Science at Pathein University, for her advice and needful assistance. My final thank goes to local people from my study areas, for their assistance in the sample collections and Daw Lwin Lwin, who has put in back-breaking hours studying seashells but more importantly, has kept me focused.

References

Mann, J. G. D. (1888) "Fauna of Mergui Archipelago." *Marine Zoology, Taylor and Francis,* London, vol. 1, no. 1, pp. 56- 80.

Mason, R. F. (1850) *The natural productions of Burma or Notes on the fauna, flora and minerals of the Tenasserim provinces and the Burma Empire*. American Mission Press, Moulmein.

Mason, R. F. (1852) *Tenasserim or Notes on the fauna, flora, minerals and nations of British Burma and Pegu: with systematic catalogues of the known minerals, plants, mammals, fishes, molluscs, sea–nettles, corals, sea urchins, worms, insects, crabs, reptiles and birds: with vernacular names*. American Mission Press, Moulmein.

Mason, R. F. (1882) *Burma, its people and production. Notes on the fauna, flora and minerals of Tenasserim, Pegu and Burma. Volume 1: Geology, Mineralogy and Zoology*. Stephen Austin and Sons Company Ltd, Hertford.

Naung Naung Oo. (2022) *Estuarine and Marine Molluscs of Myanmar: Part I*. Lap Lambert Academic Publishing, Germany.

Seed, R. (1983) "Structural organization, adaptive radiation, and classification of molluscs. *In*: Hochachka, P. W. (Ed.). The Mollusca, 1: Metabolic biochemistry and molecular biomechanics." *Academic Press*, London, pp. 1-54.