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Reference collection amidst COVID-19 pandemic: fish, crustacea, and mollusc of rumphius expeditions deposited in Ambon, Indonesia

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Abstract. Due to COVID-19, many scientists have to work remotely and have limited access to physical reference collections. This situation has highlighted that providing online digital content is considered one of the most effective solutions. To make materials of reference collection more accessible to scientists or researchers, we here report the Rumphius expeditions (1973 – 1980) materials to Indonesia that still remain at the Ambon Research Station or now become reference collection of Centre for Deep-Sea Research, LIPI- Ambon, Indonesia. The morphological analyses of fish, crustacea, and mollusc collected during the Rumphius expeditions revealed: 34 species from 23 different genera of fish; 21 species from 19 different genera of crustacea; and 60 species from 42 different genera of mollusc. This study demonstrates the value of reference collections as a resource in marine biology science and the important role of archivists in this current pandemic situation.

Keywords: Biodiversity, checklist, digitization, Moluccas, scientific cruises

1. Introduction

Specimens in reference collection are important resources for investigating past and present species inventory [1]. It also serves as a crucial archive of biodiversity [2]. However, the COVID-19 pandemic compelled worldwide museums and public galleries to close their doors in March 2020 [3]. This situation makes many researchers have limited access to physical reference collections. Hence, providing digital data of biodiversity collections is considered one of the most effective ways for scientists to be able to continue their research in this pandemic era [4]. Additionally, digitizing catalogues and databases of sample collections allows small or regional collections to give a significant contribution to global studies [5].

In the 1970s, Indonesian Institute of Sciences (LIPI) conducted a series of scientific cruises named Rumphius Expedition to inventory biological resources of Moluccas waters at the Aru and Kei Island groups [6, 7]. The first expedition (Rumphius Expedition I) was carried out on 6 January – 1 February 1973 which involved six foreign participants and managed to collect stony corals, stomatopods, hermit, portunid crabs, molluscs, echinoderms, and fish. The second expedition (Rumphius Expedition II) was conducted on 5 January – 8 February 1975 with five foreign scientists and succeeded in collecting hermit, portunid crabs, molluscs, echinoderms, anemones, comatulid, and fish. The third



one (Rumphius Expedition III) was held on 3 October – 15 November 1977 collected stony corals, fish, echinoderms, polychaetes, and anemones, which involved four foreign scientists. The fourth Rumphius expedition (Rumphius Expedition IV) was conducted in October and November 1980 with five foreign scientists from Netherlands, United Kingdom, France, and Australia [8, 7, 9].

The material collected during Rumphius expeditions were deposited at the Museum National D'Histoire Naturelle, Paris (MNHN); the National Museum of Natural History (USNM), Washington, D.C.; the Bernice P. Bishop Museum (BPBM), Honolulu, Hawaii; the Natural History Museum of Los Angeles County (LACM), Los Angeles, California; the Australian Museum (AM), Sydney; Western Australian Museum; Museum Zoologicum Bogoriense, Bogor; LIPI Jakarta; and Ambon Research Station collection [10, 11, 12, 13, 14, 15, 16, 17].

We here report the material of fish, crustacea, and mollusc collected during Rumphius expeditions that still remain at the Ambon Research Station or now become reference collection of Centre for Deep-Sea Research, LIPI- Ambon, Indonesia. However, a lot of material collections of Rumphius expeditions were destroyed because of the conflict of Ambon in 1999. Additionally, many documents such as logbooks, journal reports, and catalogues were lost. Therefore, now the only available information is from the jar labels of the specimen. To make the Rumphius expeditions collection more accessible to researchers worldwide, especially in this pandemic situation, we made this checklist as a part of Moluccas's marine biota inventory.

2. Materials and methods

The whole material collection of Rumphius expeditions were separated, checked, catalogued in a database, and photographed. All images were taken using a digital camera (DSLR Nikon D200). Most of the fish specimens were described by Randall and Burhanudin, crustacean specimens were specified mostly by Kasijan and Serene, while molluscs were determined mostly by Slack-Smith and Budiman. Furthermore, each species here was listed under its current valid binomen based on a database from the World Register of Marine Species [18].

3. Results and discussion

In total, 164 specimens of fish, crustacea, and mollusc from Rumphius expeditions were studied (figure 1). We found a total of 45 fish specimens, 30 specimens of crustacea, and 89 mollusc specimens in the reference collection of Centre for Deep-Sea Research, LIPI- Ambon, Indonesia (figure 2). All fish and mollusc specimens were in a good condition with complete labels in the specimen jars, thus we can examine and take a picture of each specimen. Whilst for crustacean specimens, 17 specimens from 30 total specimens were in damaged condition, therefore we had a difficulty to examine and take pictures of those specimens.

All the material collection of Rumphius expeditions deposited and remained until now in Ambon were from the first, second, and third of Rumphius expeditions (1973, 1975, and 1977) and there was no single specimen from the fourth Rumphius expedition (1980). Fish specimens mostly are from Rumphius Expedition II (41 specimens), while from Rumphius Expedition I are four specimens and only one specimen from Rumphius Expedition III. Morphological analyses of all those fish specimens revealed 34 species and 23 genera (figure 2 and 3, table 1). However, this number of fish specimens is much less than the number of fish specimens from previous literature. For example, Randall *et al.* [15] wrote that a total of 477 species of fish were collected during Rumphius Expeditions I and II. According to Randall *et al.* [15], a lot of those fish specimens have been taken to the Bishop Museum in Honolulu for further identification.



Figure 1. Some material of fish, crustacea, and mollusc collected during Rumphius expeditions that still remain at the reference collection of Centre for Deep-Sea Research, LIPI- Ambon, Indonesia.

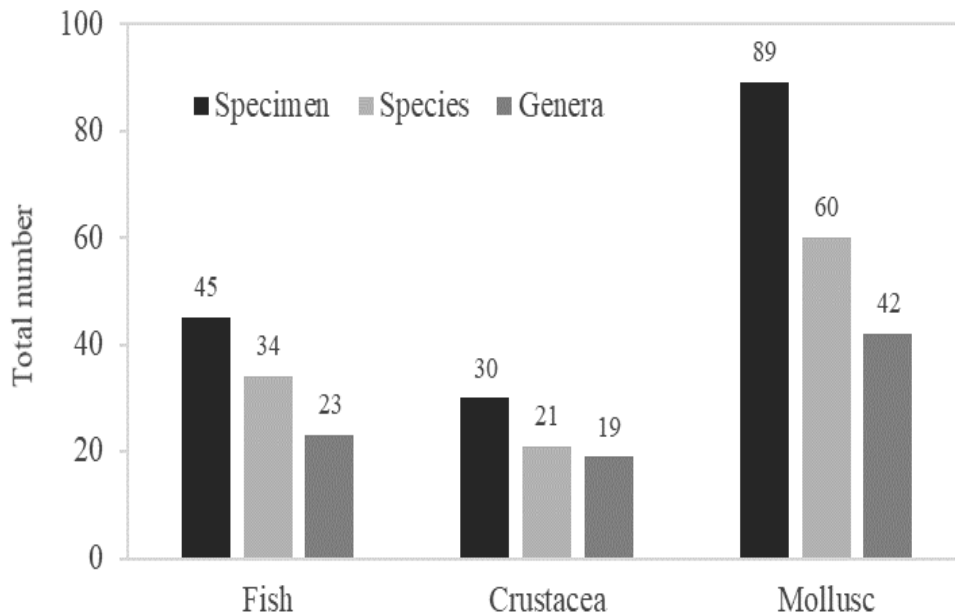


Figure 2.Total number of specimens, species, and genera of fish, crustacea, and mollusca collected during Rumphius expeditions that still remain at the reference collection of Centre for Deep-Sea Research, LIPI- Ambon, Indonesia.

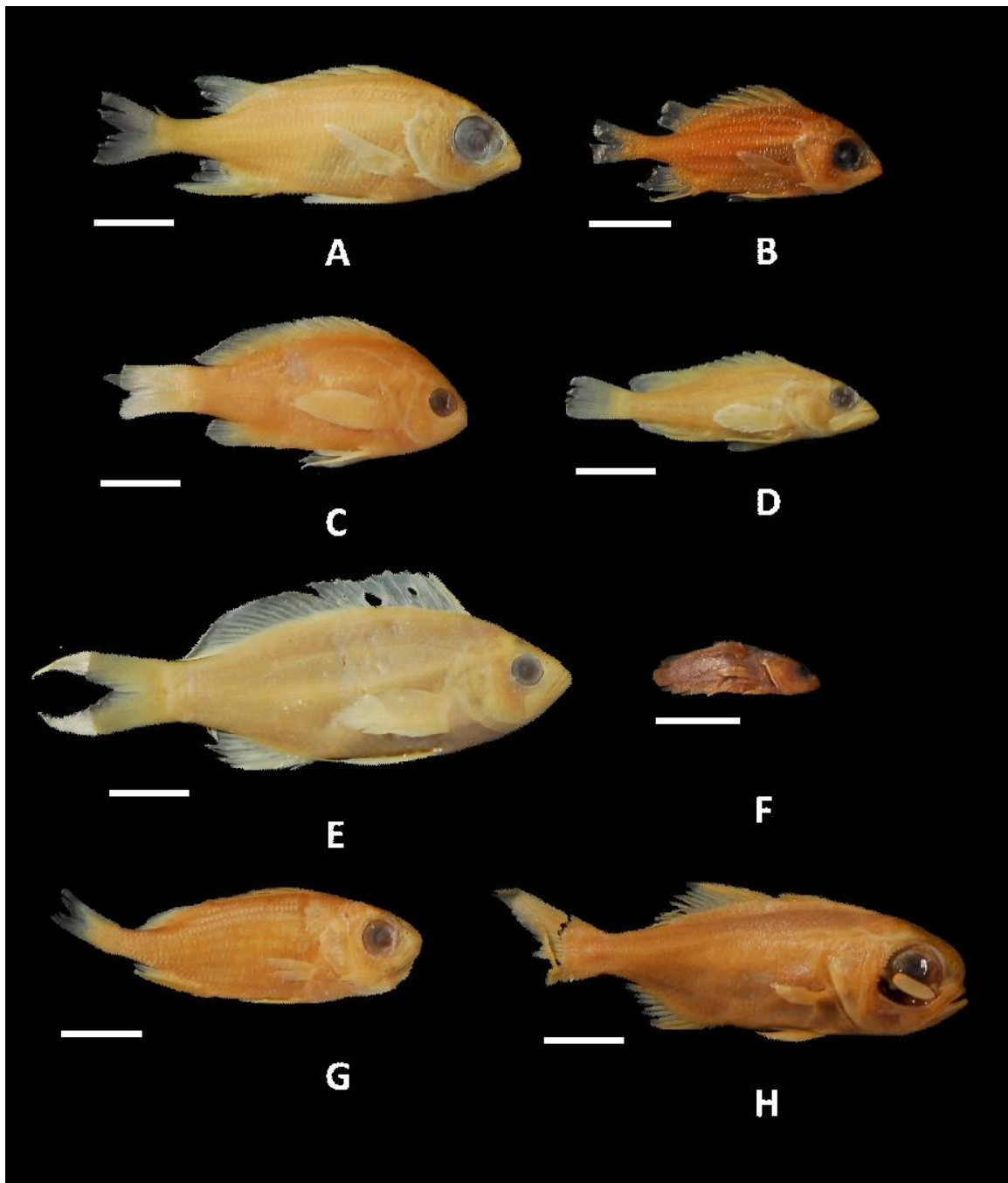


Figure 3. Some fish specimens collected during Rumphius expeditions **A.** *Sargocentron punctatissimum* (Cuvier, 1829); **B.** *Sargocentron rubrum* (Forsskål, 1775); **C.** *Pseudanthias squamipinnis* (Peters, 1855); **D.** *Epinephelus merra* Bloch, 1793; **E.** *Pseudanthias dispar* (Herre, 1955); **F.** *Pseudogramma polyacantha* (Bleeker, 1856); **G.** *Neoniphon sammara* (Forsskål, 1775); **H.** *Anomalops katoptron* (Bleeker, 1856). Scale bar: 1 cm.

Meanwhile, publications on the crustacea collected during the Rumphius expeditions are those of Serene *et al.* [11] who focused on hippidea, brachyura, and stomatopoda. They reported 207 species of brachyura, one species of hippidea, and 15 species of stomatopoda that were only from the Rumphius expedition II. Whilst in this study, we found only 22 crustacean specimens of the Rumphius

expedition I, seven specimens from the Rumphius Expedition II, and one specimen from the Rumphius Expedition III. Analyses of all those 30 crustacean specimens yielded 21 species and 19 genera (figure 2 and 4, table 1).

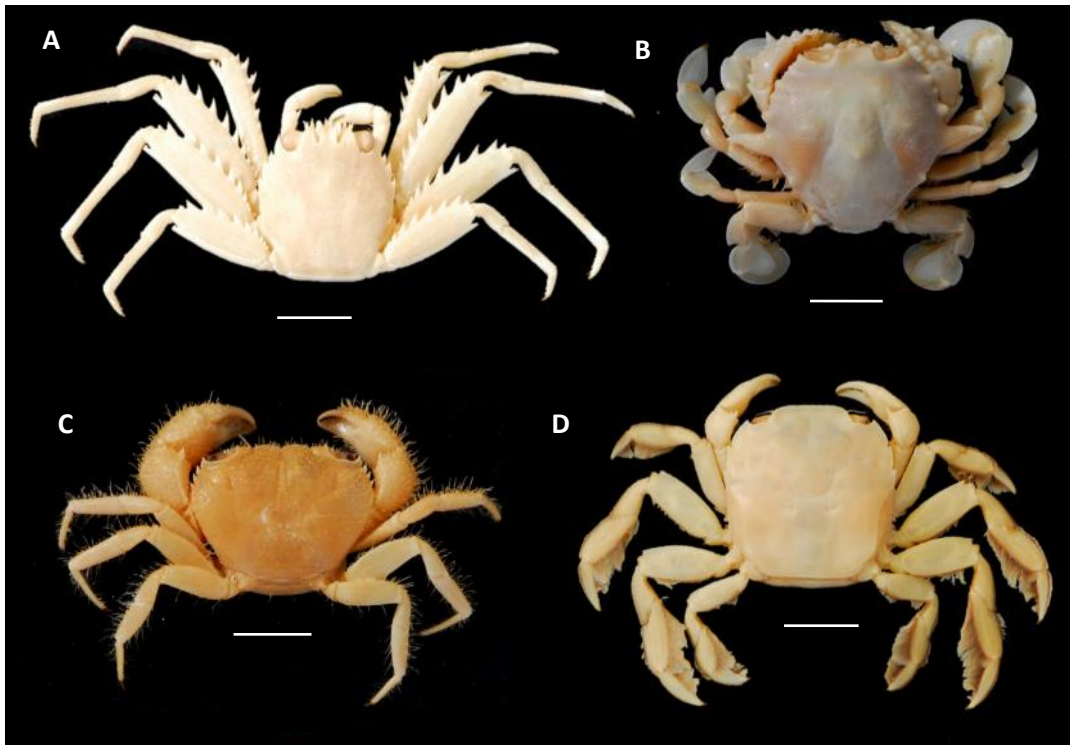


Figure 4. Some crustacean specimens collected during Rumphius expeditions **A.** *Percnon guinotae* Crosnier, 1965; **B.** *Ashtoret lunaris* (Forskål, 1775); **C.** *Eriphia aff. scabricula* Dana, 1852; **D.** *Varuna litterata* (Fabricius, 1798). Scale bar: 1 cm.

The condition of mollusc specimens were similar with fish specimens. This study found only 89 specimens consisting of 60 species and 42 genera of mollusc from Rumphius Expedition I, II, and III (figure 2 and 5, table 1). This number is much less than the previous species number recorded from old literature. Budiman [13] listed a total of 147 molluscs species only from Rumphius Expedition II. However, mollusc specimens that remained in Ambon are mostly from Rumphius Expedition I (55 specimens), while from Rumphius Expedition II are 12 specimens and 22 specimens from Rumphius Expedition III. Overall, members of the family Neritidae and Cypraeidae are the most diverse with eight and seven species recorded. Moreover, Strombidae, Muricidae, and Conidae are also well represented by each five species deposited in the reference collection.



Figure 5. Some mollusc specimens collected during Rumphius expeditions. **A.** *Haliotis varia* Linnaeus, 1758; **B.** *Euchelus atratus* (Gmelin, 1791); **C.** *Angaria delphinus* (Linnaeus, 1758); **D.** *Turbo chrysostomus* Linnaeus, 1758; **E.** *Nerita albicilla* Linnaeus, 1758; **F.** *Pseudovertagus aluco* (Linnaeus, 1758); **G.** *Erronea erronea* (Linnaeus, 1758); **H.** *Mauritia arabica* (Linnaeus, 1758); **I.** *Littoraria scabra* (Linnaeus, 1758); **J.** *Euprotomus aurisdianae* (Linnaeus, 1758); **K.** *Cymbiola vesperilio* (Linnaeus, 1758); **L.** *Conus capitaneus* Linnaeus, 1758; **M.** *Conus marmoreus* Linnaeus, 1758; **N.** *Fragum fragum* (Linnaeus, 1758); **O.** *Tridacna maxima* (Röding, 1798); **P.** *Vasticardium subrugosum* (G. B. Sowerby II, 1839). Scale bar: 1 cm.

A list of the species of fish, crustacea, and mollusc collected during the Rumphius expeditions (1973, 1975, 1977) and deposited in the reference collection of Centre for Deep-Sea Research, LIPI-Ambon, Indonesia can be seen in table 1.

Table 1. Fish, crustacea, and mollusc collected during the Rumphius expeditions (1973, 1975, 1977) and deposited in the reference collection of Centre for Deep-Sea Research, LIPI- Ambon, Indonesia.

Species name	Locality	Rumphius Expedition
Fish		
<i>Anomalops katoptron</i> (Bleeker, 1856)	P. Krakat, Gunung Api, Banda	II
<i>Atherinomorus endrachtensis</i> (Quoy & Gaimard, 1825)	Gorong Island	II
<i>Brotula multibarbata</i> Temminck & Schlegel, 1846	Morela, Ambon Island	II
<i>Cephalopholis leopardus</i> (Lacepède, 1801)	Lautaka, Banda Island	II
<i>Cephalopholis sexmaculata</i> (Rüppell, 1830)	Banda Neira	II
<i>Diploprion bifasciatum</i> Cuvier, 1828	Point Sikuda, Ambon Bay	II
<i>Echidna nebulosa</i> (Ahl, 1789)	Banda Besar	II
<i>Encrasicholina heteroloba</i> (Rüppell, 1837)	Rumah tiga, Ambon Bay	I
<i>Epinephelus merra</i> Bloch, 1793	Banda Besar	II
<i>Gymnothorax rueppelliae</i> (McClelland, 1844)	Banda Besar	II
<i>Gymnothorax</i> sp. Bloch, 1795	Gorong Island, Banda Besar	II
<i>Hypoatherina valenciennesi</i> (Bleeker, 1854)	Gorong Island	II
<i>Moringua</i> Gray, 1831	Rotenone, Banda Besar	II
<i>Myripristis pralinia</i> Cuvier, 1829	Silale, Ambon Bay	II
<i>Myripristis vittata</i> Valenciennes, 1831	Silale, Ambon Bay	II
<i>Neoniphon sammara</i> (Forsskål, 1775)	Banda Besar	II
<i>Opisthognathus</i> sp. Cuvier, 1816	Banda Besar	II
<i>Plesiops coeruleolineatus</i> Rüppell, 1835	Gorong Island	II
<i>Plesiops</i> sp. Oken, 1817	Sawai, Ceram Island	II
<i>Pseudanthias dispar</i> (Herre, 1955)	Latuhalat, Ambon Island	II
<i>Pseudanthias huchtii</i> (Bleeker, 1857)	Poin Sikuda, Ambon Bay; Gorong Island	II
<i>Pseudanthias squamipinnis</i> (Peters, 1855)	Sa-1 & Sa-2 (Kp. Said)	I
<i>Pseudogramma polyacantha</i> (Bleeker, 1856)	Banda Besar	II
<i>Sargocentron caudimaculatum</i> (Rüppell, 1838)	Banda Besar	II
<i>Sargocentron punctatissimum</i> (Cuvier, 1829)	Banda Besar	II
<i>Sargocentron rubrum</i> (Forsskål, 1775)	Banda Besar	II
<i>Sargocentron tiereoides</i> (Bleeker, 1853)	Silale, Ambon Bay	II
<i>Saurida gracilis</i> (Quoy & Gaimard, 1824)	Latuhalat, Ambon Island; Banda Neira	II

Species name	Locality	Rumphius Expedition
<i>Stolephorus commersonnii</i> Lacepède, 1803	Seleman Bay, Ceram Island; Lilinta Bay, Misool Island	II
<i>Stolephorus indicus</i> (van Hasselt, 1823)	Lilinta Bay, Misool Island	II
<i>Stolephorus</i> sp. Lacepède, 1803	Tg Martha-Fons; Pulau Maas	I, III
<i>Synodus</i> sp. Scopoli, 1777	Eri, Ambon Bay	II
<i>Uropterygius</i> sp. Rüppell, 1838	Banda Besar; Gorong Island	II
<i>Zenarchopterus dunckeri</i> Mohr, 1926	Gorong Island	II
Crustacea		
<i>Ashtoret lunaris</i> (Forskål, 1775)	Ambon Bay	I
<i>Austruca lactea</i> (De Haan, 1835 [in De Haan, 1833-1850])	W-R 3	I
<i>Eriphia</i> aff <i>scabricula</i> Dana, 1852	Nalahuia, Nusalaut Island, Kp. Aboru, Tg. Neira	I
<i>Eriphia sebana</i> (Shaw & Nodder, 1803)	Sawah Telu, Morela	I
<i>Gelasimus tetragonon</i> (Herbst, 1790)	Kp. Liang, Seram Island	I
Goneplacidae MacLeay, 1838	Kp. Tantui	I
<i>Grapsus intermedius</i> de Man, 1888 [in de Man, 1887-1888]	Kp. Sawah, Morela, Ambon	I
<i>Iphiculus spongiosus</i> Adams & White, 1849	D-4	II
<i>Labuanium politum</i> (de Man, 1888 [in de Man, 1887-1888])	Wailela river, Ambon Bay	II
Majoidea Samouelle, 1819	Weti River	I
<i>Metopograpsus frontalis</i> Miers, 1880	Sel 1, Ihamahu, Pia Tuhaha Bay, Saparua Island	I, II
<i>Metopograpsus thukuhar</i> (Owen, 1839)	Sel 2, Said, Ambon Island	I, II
<i>Mictyris longicarpus</i> Latreille, 1806	Banda Neira	II, III
<i>Ocypode ceratophthalmus</i> (Pallas, 1772)	Suli, Tanjung Suli, Ambon	I
<i>Oxyrhynchaxius</i> Parisi, 1917	Said, Ambon Island	I
<i>Paraleptuca crassipes</i> (White, 1847)	Ihamahu, Pia, Tuhaha Bay, Saparua-Island	I
<i>Percnon guinotae</i> Crosnier, 1965	Banda Neira; Kulur, Saparua	I, II
<i>Pilumnopeus</i> sp.	Kp. Nalahuia, Nusalaut Island	I

Species name	Locality	Rumphius Expedition
<i>Raninoides</i> sp.	Kp. Tantui	I
<i>Rhinolambrus</i> sp.	Batu Capeo	I
<i>Varuna litterata</i> (Fabricius, 1798)	Poka, Ambon	I
Mollusc		
<i>Angaria delphinus</i> (Linnaeus, 1758)	Said, Ambon Island; Piru Bay, Ceram; Babi Island	I, III
<i>Astraliium calcar</i> (Linnaeus, 1758)	Suli, Ambon Island; Said, Ambon Island	I
<i>Canarium labiatum</i> (Röding, 1798)	Piru Bay, Ceram; Said, Ambon Island; Babi Island	I, III
<i>Canarium microunceus</i> Kira, 1959	Piru Bay, Ceram Island	I, II
<i>Cerithium nodulosum</i> Bruguière, 1792	Suli, Ambon Island	I
<i>Chicoreus brunneus</i> (Link, 1807)	Said, Ambon Island	I
<i>Clypeomorus bifasciata</i> (G. B. Sowerby II, 1855)	Ubur Island, Tual	III
<i>Conomurex luhuanus</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Conus capitaneus</i> Linnaeus, 1758	Babi Island	I
<i>Conus ebraeus</i> Linnaeus, 1758	Suli, Ambon Island	I
<i>Conus magus</i> Linnaeus, 1758	Piru Bay, Ceram	I
<i>Conus marmoreus</i> Linnaeus, 1758	Suli, Ambon Island; Piru Bay, Ceram	I
<i>Conus miles</i> Linnaeus, 1758	Marsegu Island	II
<i>Cymbiola vespertilio</i> (Linnaeus, 1758)	Marsegu Island	II
<i>Drupa ricinus</i> (Linnaeus, 1758)	Banda Island	II
<i>Drupina grossularia</i> (Röding, 1798)	Sfat Island	III
<i>Erronea erroneus</i> (Linnaeus, 1758)	Suli, Ambon Island	I
<i>Erronea ovum</i> (Gmelin, 1791)	Piru Bay, Ceram	I
<i>Euchelus atratus</i> (Gmelin, 1791)	Babi Island	III
<i>Euprotomus aurisdianae</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Fragum fragum</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Fragum unedo</i> (Linnaeus, 1758)	Banda Island	III
<i>Gafrarium pectinatum</i> (Linnaeus, 1758)	Elat Island	III
<i>Gibberulus gibberulus gibbosus</i> (Röding, 1798)	Tayandu Island	III
<i>Haliotis varia</i> Linnaeus, 1758	Piru Bay, Ceram	I
<i>Littoraria scabra</i> (Linnaeus, 1758)	Ubur Island, Tual;	I, III

Species name	Locality	Rumphius Expedition
	Said, Ambon Island	
<i>Lyncina lynx</i> (Linnaeus, 1758)	Suli, Ambon Island	I
<i>Lyncina vitellus</i> (Linnaeus, 1758)	Suli, Ambon Island; Said, Ambon Island	I
<i>Mauritia arabica</i> (Linnaeus, 1758)	Piru Bay, Ceram; Nusalaut Island	I
<i>Monetaria moneta</i> (Linnaeus, 1758)	Suli, Ambon Island	I
<i>Monodonta labio</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Monoplex pilearis</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Naria erosa</i> (Linnaeus, 1758)	Piru Bay, Ceram; Said, Ambon Island	I
<i>Nassarius albescens</i> (Dunker, 1846)	Suli, Ambon Island	I
<i>Nerita albicilla</i> Linnaeus, 1758	Piru Bay, Ceram; Banda Island; Piru Bay, Ceram	I, III
<i>Nerita chamaeleon</i> Linnaeus, 1758	Gorong; Lilinta Island	II
<i>Nerita costata</i> Gmelin, 1791	Lilinta Island	II
<i>Nerita planospira</i> Anton, 1838	Yokam Island, Dobo	III
<i>Nerita polita</i> Linnaeus, 1758	Maskecil Island	III
<i>Nerita signata</i> Lamarck, 1822	Suli, Ambon Island; Piru Bay, Ceram	I
<i>Nerita</i> sp.	Maskecil Island	III
<i>Nerita undata</i> Linnaeus, 1758	Benjina Island	III
<i>Polinices mammilla</i> (Linnaeus, 1758)	Suli, Ambon Island	I
<i>Pseudovertagus aluco</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Reishia bitubercularis</i> (Lamarck, 1822)	Nalahia, Nusalaut	I
<i>Rhinoclavis vertagus</i> (Linnaeus, 1767)	Babi Island	III
<i>Tectarius tectumpersicum</i> (Linnaeus, 1758)	Maos Island, Tual	III
<i>Tectus fenestratus</i> (Gmelin, 1791)	Marsegu Island; Piru Bay, Ceram	I, II
<i>Tellinella cruciata</i> (Spengler, 1798)	Piru Bay, Ceram	I
<i>Terebellum terebellum</i> (Linnaeus, 1758)	Piru Bay, Ceram	I
<i>Tridacna maxima</i> (Röding, 1798)	Marsegu Island	II
<i>Trochus maculatus</i> Linnaeus, 1758	Said, Ambon Island; Nalahia, Nusalaut; Said, Ambon Island;	I, III

Species name	Locality	Rumphius Expedition
<i>Trochus stellatus</i> Gmelin, 1791	Babi Island Gorong	III
<i>Turbo argyrostomus</i> Linnaeus, 1758	Lilinta Island; Said, Ambon Island; Ambon Island	I, II
<i>Turbo bruneus</i> (Röding, 1798)	Marsegu Island; Benjina Island	II, III
<i>Turbo chrysostomus</i> Linnaeus, 1758	Tayandu Island	III
<i>Tylothais aculeata</i> (Deshayes, 1844)	Lilinta Island	II
<i>Vasticardium subrugosum</i> (G. B. Sowerby II, 1839)	Key Island	III
<i>Vasum turbinellus</i> (Linnaeus, 1758)	Sfat Island; Ambon Bay; Suli, Ambon Island	I, III
<i>Vexillum rugosum</i> (Gmelin, 1791)	Piru Bay, Ceram	I

Since the first circum navigation voyages, the Ambon Island as a part of the Moluccas Islands has long been an important destination for a lot of scientific expeditions [19]. However, only a few specimens from a lot of those scientific expeditions were deposited and remained in Ambon. Yet, the specimens deposited in Ambon are overall not documented and not well taken care of. Consequently, a lot of fragile specimens were broken i.e., it happened to some crustacean specimens of Rumphius expeditions in this study. In addition, high temperature and humidity in Ambon make specimens in the reference collection need special maintenance. For example, it should be stored in an air-conditioned room and for wet collections, it has to be checked frequently because the alcohol evaporates faster. Apart from the weather factor, large parts of the collections were also destroyed during the conflict of Ambon in 1999.

Considering all Ambon's conditions above, underline again the necessity of providing digital data of collections that still remain in the Ambon Island. However, we also realize that a more comprehensive study by gathering more information or comparing the Rumphius expedition specimens deposited in other reference collections would be ideal. But, we hope our initiative in this study could increase a better understanding of marine biodiversity in the Moluccas Islands and promote the digitization and scientific use of the reference collection, especially in this pandemic era.

Author contribution

Pipit Pitriana is the main author of this paper and predominantly planned, wrote, and accomplished the paper.

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