

A checklist of the marine Anthuroidea (Crustacea: Isopoda: Cymothoida) from the reefs of Peninsular Malaysia, with some new distributional data

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Abstract

Background

An up-to-date checklist of the Peninsular Malaysian marine Anthuroidea is presented, based on previous taxonomic or ecological literature and recent collections. The present study, a part of the subproject on the Biodiversity of Sultan Iskandar Marine Park, recognised 24 species in 12 genera and 5 families from Peninsular Malaysia. An extensive list of bibliographical references, detailed information on habitat and distributional records, museum locations of type material are provided for each species. Amongst the listed species, 11 are recently discovered Malaysian species belonging to the genera *Amakusanthura* Nunomura, 1977, *Apanthura* Stebbing, 1900, *Expanathura* Wägele, 1981, *Leptanthura* G. O. Sars, 1897, *Kupellonura* Barnard, 1925, *Pendanthura* Menzies & Glynn, 1968 and *Tinggianthura* Chew, Rahim & bin Haji Ross, 2014. Our records were limited to shallow subtidal reefs of peninsular Malaysian coast, suggesting that the number of species in the list may rise with an extensive survey.

New information

The up-to-date checklist of marine Anthuroidea of the Peninsular Malaysia comprises 24 species in 12 genera and 5 families, including some new distributional data.

Introduction

Tropical reefs are known to support enormous biodiversity and portray a high priority for conservation action amongst marine ecosystems (Roberts 2002). A faunal inventory of our planet remains an urgent task. A basic taxonomic knowledge is necessary for bio-evolutionary studies, as well as for understanding biogeography. The Isopoda is one of the most successful and rapidly evolving malacostracan orders, displaying a tremendous diversity in marine, terrestrial and continental waters. Although isopods have colonised almost every niche and are the most important group in terms of specific diversity, they have been largely ignored in studies dealing with conservation strategies. According to Wilson (2007), the isopods contain over 10,300 species that are primarily marine, but they can also be found in brackish water and freshwater environments. In addition, more than 3,600 terrestrial species of isopods are known (Schmalfuss 2003). Isopods play an important role in marine food chains due to their scavenging nature in benthic communities Keable (2006). Placed strategically within the Sundaland region of biodiversity hotspot and the coral Indo-Malaysian triangle (Hoeksema 2007, Myers et al. 2000), Malaysia is expected to hold a high diversity of isopods, particularly the anthuroids. The aim of this work is to update the knowledge the anthuroids inhabiting the shallow water reef of the Malaysian Peninsular (MP).

Materials and methods

The material collected was obtained from both west and east coasts of the Peninsular Malaysia. The following collection localities were from the west coast of MP: Pulau Langkawi (6°21'56.05"N, 99°40'31.13"E), Pulau Payar (6°03'23.0"N, 100°01'55.0"E), Pulau Pangkor (4°11'22.32"N, 100°32'50.22"E) and Port Dickson (2°24'57.0"N, 101°51'10.3"E). The following collection localities were from the east coast of MP: Pulau Perhentian (5°52'59.48"N, 102°44'31.66"E), Pulau Tioman (2°54'15.44"N, 104°6'1.08"E), Pulau Seri Buat (2°41'13.59"N, 103°55'25.99"E), Pulau Aur (2°28'17.24"N, 104°30'53.14"E), Pulau Dayang (2°28'40.90"N, 104°30'19.12"E) and Pulau Tinggi (2°17'37.96"N, 104°6'1.97"E) (Fig. 1). See Chew et al. (2016) for an explanation of the biological material collection and Chew et al. (2018) for the identification and morphological study procedures. The identification was done using the specialised literature and identification keys from Kensley (1980), Kensley and Poore (1982), Negoescu 1997, Poore (2001) and Poore and Lew Ton (2002). Only primary synonyms are included for each species under the "Nomenclature" field. The checklist of the marine anthuroids from MP included an updated list of materials, habitat and distribution records. Materials are located in the following museums: Muzium Zoologi, Universiti Kebangsaan Malaysia (UKMMZ); Lee Kong Chian Natural History Museum, National University of Singapore (ZRC); Museum d'Histoire Naturelle, Genève (MHNG); Zoologisches Museum Berlin (ZMB); and Muséum National d'Histoire Naturelle, Paris (MNHN).

Data resources

All Anthuroidea records were cross-checked for their taxonomy in the World Register of Marine Species (WoRMS Editorial Board 2020).

Checklist of marine Anthuroidea known to occur in Peninsular Malaysia

Amakusanthura koonyumae Bamber, 1997

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255360>

Nomenclature:

Amakusanthura koonyumae Bamber 1997: 81–85, figs. 3-5; Bamber 2008: 860–861.

Material

- a. island: Labas, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°53'13.71", E104°3'54.65"; eventDate: 18 April 2014; habitat: In fine sand to medium sand from around '*Cerianthus*' at 2 to 3 m depth (Bamber, 1997); amongst coral rubble. Littoral 0.5 to 15 m depth (present study); eventRemarks: C. Melvin; collectionCode: (1 female) UKMMZ-1571; occurrenceID: 34D5A029-9768-5D74-B371-485D6C7F4A76

Distribution: HONG KONG—Tolo Channel (type locality), Conic Island Cave. MALAYSIA—Pahang State: Pulau Tioman (new record).

Notes: Fig. 2a

Apanthura bruscai Müller, 1992

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255383>

Nomenclature:

Apanthura bruscai Müller 1992b: 156–161, figs. 1–19.

Material

Holotype:

- a. island: Pulau Babi Besar; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°50.483', E104°9.566'; habitat: Fringing-reef and reef-flat under coral rocks mainly covered with coralline algae, intertidal (Müller 1992a); modified: male, 3.4 mm; datasetID: ZMB 26953; occurrenceID: 40FB4751-EA3A-5E33-8452-78D805440309

Distribution: Only known from type locality (Pulau Babi Besar, east coast Peninsular Malaysia).

Notes: This species record is based on literature only. No specimen was collected during the present study.

Apanthura pariensis Negoescu, 1997

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255402>
- GenBank [MF680510](https://www.ncbi.nlm.nih.gov/GenBank/MI000000000)

Nomenclature:

Apanthura pariensis Negoescu 1997: 186–194, figs. 6–10; Chew et al. 2018: 74–75, fig. 1.

Materials

- island: Pulau Pangkor; country: Malaysia; stateProvince: Perak; verbatimCoordinates: N4°11'22.32", E100°32'50.22"; eventDate: 15 Apr 2014; habitat: Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); collectionCode: (1 female) UKMMZ-1583; (1 male) UKMMZ-1584; (43 females, 2 males) UKMMZ-1585; occurrenceID: 2E6DEC59-3239-5028-B450-29B12B65758C
- island: Pulau Langkawi; country: Malaysia; stateProvince: Kedah; verbatimCoordinates: N 6°21'56.05" E 99°40'31.13"; eventDate: 4 Nov 2013; habitat: Intertidal, amongst coral rubble; collectionCode: (9 females) UKMMZ-1586; occurrenceID: 092CC1DC-6A7A-5030-9384-CBF13CF10501
- island: Pulau Langkawi; country: Malaysia; stateProvince: Kedah; verbatimCoordinates: N 6°21'56.05" E 99°40'31.13"; eventDate: 8 Mac 2015; habitat: Intertidal, amongst coral rubble; collectionCode: (8 females, 2 males) UKMMZ-1587; occurrenceID: E4B5575F-74A6-5827-8A23-86E4388FC967

Distribution: INDONESIA—Pari Island, Java Sea (type locality). MALAYSIA—Perak State: Pulau Pangkor (new record).—Kedah State: Pulau Langkawi (new record).

Notes: Fig. 2b

Apanthura stocki (Müller, 1991)

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255410>
- GenBank [MF680509](https://www.ncbi.nlm.nih.gov/GenBank/MI000000000)

Nomenclature:

Amakusanthura stocki Müller 1991: 595–600, figs. 30–56.

Apanthura stocki Müller 1992b: 166; Chew et al. 2018: 75–76, fig. 2.

Materials

- island: Mentinggi, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°16'21.67", E104°7'18.61"; eventDate: 19 April 2013; habitat:

- Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (1 female, 1 male) UKMMZ-1576; occurrenceID: 7548D348-E2B7-59BB-B072-0A5BBCF57F55
- b. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104°6'1.97"; eventDate: 18 Dec 2012; habitat: Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (3 females, 1 male) UKMMZ-1577; occurrenceID: B59F7CE9-D7D4-54D9-AF7C-50C4556FD8BE
- c. island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104°05.616'; eventDate: 18 Apr 2013; habitat: Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (14 females) UKMMZ-1578; occurrenceID: 9ED6C5B0-256C-5E88-BE45-10F063B430FC
- d. island: Pulau Seri Buat; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°41'13.59", E103°55'25.99"; eventDate: 19 Apr 2014; habitat: Littoral 0.5 to 7 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (1 male) UKMMZ-1579; occurrenceID: FCE010D5-D27D-5270-83C4-0F41E74F306F
- e. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104°6'1.97"; eventDate: 15 Jun 2015; habitat: Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (4 females) UKMMZ-1580; occurrenceID: 1B7EF786-4967-571D-B87F-569B2C4589EE
- f. island: Pulau Dayang; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°28'40.90", E104°30'19.12"; eventDate: 26 Jul 2016; habitat: Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (27 females) UKMMZ-1581; occurrenceID: 9A6352F3-2E58-5E5A-9D1F-2F9EE5FA1EBB
- g. island: Pulau Aur; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°28'17.24", E104°30'53.14"; eventDate: 26 Jul 2016; habitat: Littoral 0.5 to 3 m depth, amongst coral rubble (Chew et al. 2018); recordedBy: C. Melvin; collectionCode: (6 females) UKMMZ-1582; occurrenceID: 859B71BD-CF4F-5758-BA7D-8A0739848581

Distribution: SRI LANKA—Indian Ocean (type locality); MALAYSIA—Johor State: Pulau Besar; Pulau Tinggi; Pulau Seri Buat (new record).

Notes: Fig. 2c

Apanthura tiomanae Müller, 1992

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255413>

Nomenclature:

Apanthura tiomanae Müller 1992b: 161–166, figs 20–39.

Material

- a. island: Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; recordedBy: C. Melvin; collectionCode: (1 female) UKMMZ-1572; occurrenceID: 2F191771-7CD1-5D39-BE16-4D846F8D2B1C

Distribution: MALAYSIA—Pahang State: Pulau Tioman (type locality).

Notes: Fig. 2d

***Cyathura bentotae* Müller, 1991**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255423>

Nomenclature:

Cyathura bentotae Müller 1991: 603–607, figs. 57–80; Müller 1992b: 166.

Material

Holotype:

- a. habitat: Fringing-reef and sabellid reef; dead coral substratum, 1 to 3 m depth; collectionCode: (male, 3.4 mm) ZMB 26953; 1 cr (ZMB 26956); occurrenceID: 41A57B7B-0D8A-53E4-9C4B-6589ACF7F032

Distribution: SRI LANKA—Indian Ocean (type locality); MALAYSIA—Pahang State: Pulau Tioman.

Notes: This species record is based on literature only. No specimen was collected during the present study.

***Mesanthura albolineata* Barnard, 1925**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=258320>

Nomenclature:

Mesanthura albolineata Barnard 1925: 144, fig. 9c; Wägele 1984: 394–398, figs. 5–7; Negoescu and Wägele 1984: 125; Kensley 1987: 118; Müller 1993: 20.

Material

Holotype:

- a. country: Singapore; habitat: Fringing reef, outer reef-flat, reef-margin and upper coral-slope; dead coral substratum, *Acropora* sp. and *Pocillopora damicornis* (Linnaeus, 1758).; collectionCode: (2 immature adults, 1 manca) ZMB 26938; occurrenceID: 11B8BF42-81AE-5CA0-B39D-B8B2090206BE

Distribution: SINGAPORE—(type locality); MALAYSIA—Johor State: Pulau Babi Besar.

Notes: This species record is based on literature only. No specimen was collected during the present study.

***Mesanthura asiatica* Müller, 1993**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=258321>

Nomenclature:

Mesanthura asiatica Müller 1993: 20–25, figs. 1–25.

Materials

Holotype:

- a. habitat: Fringing reef, outer reef-flat, reef-margin and upper coral-slope; dead coral substratum, *Acropora* sp. and *Pocillopora damicornis* (Linnaeus, 1758); collectionCode: (female, 4.0 mm) ZMB 26939a. ; occurrenceID: 35C303AF-7B19-55F4-9DC8-6A5BF8661B07

Paratype:

- a. collectionCode: (2 immature adults, 1 preparatory male; 1 manca) ZMB 26939b; occurrenceID: 7CF63688-74BF-55D8-964B-031BC84E29F8

Other materials:

- a. island: Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104°6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; collectionCode: (1 female) UKMMZ-1588; (1 male) UKMMZ-1589; (6 females, 1 male) UKMMZ-1590; occurrenceID: 781EB270-4D08-5C7C-A925-C4F36274B810
- b. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104°6'1.97"; eventDate: 16 Jun 2015; habitat: Amongst coral rubble, littoral 0.5 to 3 m depth; collectionCode: (1 female) UKMMZ-1591; occurrenceID: ED9C7AF9-A5F4-5BEE-987D-CD2BFD95442A

Distribution: MALAYSIA—Johor State: Pulau Babi Besar (type locality); Pulau Tinggi (new record);—Pahang State: Pulau Tioman (new record).

Notes: Fig. 2e

Mesanthura kiliani Müller, 1993

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=258340>

Nomenclature:

Mesanthura kiliani Müller 1993: 25–29, figs. 26–42.

Materials

Holotype:

- a. island: Pulau Tioman; country: Malaysia; habitat: Fringing reef, outer reef-flat, reef-margin and upper coral-slope; dead coral substratum, *Acropora* sp. and *Pocillopora damicornis* ; collectionCode: (female, 7.2 mm) ZMB 26940a; occurrenceID: 9D156D8D-31E9-5987-8813-0ABB9E33DBED

Paratype:

- a. island: Pulau Tioman; country: Malaysia; habitat: Fringing reef, outer reef-flat, reef-margin and upper coral-slope; dead coral substratum, *Acropora* sp. and *Pocillopora*

damicornis ; collectionCode: (2 postmancas, 2 mancas) ZMB 26940b.; occurrenceID: CBEC4987-6B79-5CCD-863E-B19BE7EEF3E3

Distribution: MALAYSIA—Pahang State: Pulau Tioman;—Johor State: Pulau Babi Besar.

Notes: This species record is based on literature only. No specimen was collected during the present study.

***Mesanthura protei* Kensley, 1980**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=211377>

Nomenclature:

Mesanthura protei Kensley 1980: 30–32, figs. 22–23; Kensley and Poore 1982: 631–632, fig. 6; Wägele 1984: 748–752, figs. 8–10; Müller 1993: 33–39, figs. 61–99.

Material

- a. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; institutionCode: (1 female) UKMMZ-1592; (14 females) UKMMZ-1593; occurrenceID: DF27BDF0-D2B1-50A3-8DD1-0298C1B2617D

Distribution: MOZAMBIQUE—South of Inhambane (type locality); MADAGASCAR—Abrolhos Islands; THAILAND—Ko-Sichang; KENYA; MALAYSIA—Johor State: Pulau Babi Besar;—Pahang State: Pulau Tioman, (new record).

Notes: Fig. 2f

***Mesanthura quadrata* Kensley & Schotte, 2000**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=211379>

Nomenclature:

Mesanthura quadrata Kensley and Schotte 2000: 2080–2083, figs. 17–18.

Materials

- a. island: Pulau Seri Buat; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°41'13.59", E103°55'25.99"; eventDate: 19 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; collectionCode: (1 female) UKMMZ-1594, (3 immature females) UKMMZ-1595; occurrenceID: 7E5C5F1A-6443-50DF-A0BD-D2C4E5D7C767
- b. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104°6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; collectionCode: (1 immature female) UKMMZ-1596; occurrenceID: 0392D686-4855-5227-8177-728272344DD1

- c. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104°6'1.97"; eventDate: 15 June 2015; habitat: Amongst coral rubble, littoral 0.5 to 3 m depth; collectionCode: (1 female) UKMMZ-1597; occurrenceID: ADB0B097-0411-581A-AFA7-49CAC7B843E0
- d. island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104°05.616'; eventDate: 15 June 2015; habitat: Amongst coral rubble, littoral 0.5 to 3 m depth; collectionCode: (1 female) UKMMZ-1598; occurrenceID: 12460387-2FDF-565F-B95B-DA8D3A30FFCE
- e. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104°6'1.97"; eventDate: 13 Oct 2012; habitat: Assoc. artificial substrate unit at 3 m depth; collectionCode: (29 juveniles) UKMMZ-1599; occurrenceID: 4FCEA678-750D-5D8F-8C06-68F4A0F56823
- f. island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104°05.616'; eventDate: 18 April 2013; habitat: Amongst coral rubble, littoral 0.5 to 3 m depth; collectionCode: (1 female) UKMMZ-1560; occurrenceID: 4D238BCA-7612-52D9-B1CE-4067250B098B

Distribution: SEYCHELLES—Mahé beach, Mahé Island (type locality); MALAYSIA—Pahang State: Pulau Seri Buat, (new record); Pulau Tioman, (new record);—Johor State: Pulau Tinggi, (new record).

Notes: Fig. 2g

Pendanthura tinggiensis Chew, bin Abdul Rahim & Mohd Yusof, 2016

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=882015>
- GenBank [MF680512](https://www.ncbi.nlm.nih.gov/GenBank/MI680512)

Nomenclature:

Pendanthura tinggiensis Chew et al. 2016: 232–238, figs. 2–8.

Materials

- a. island: Mentinggi, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°16'21.67", E104° 7'18.61"; eventDate: 19 April 2013; habitat: Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (1 female) UKMMZ-1541; (1 male) UKMMZ-1542; (39 females) UKMMZ-1543; (2 males) UKMMZ-1544; (10 females) ZRC 2016.0013; (2 males) ZRC 2016.0014; occurrenceID: 7F15126A-6E72-5007-90C9-44947070A3E4
- b. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'35.08", E104° 6'7.13"; eventDate: 16 Aug 2012; habitat: Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (63 females, 3 males) UKMMZ-1544; occurrenceID: A031ECC8-AB96-5B25-93FB-499083BD68C2
- c. island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104° 05.616'; eventDate: 18 April 2013; habitat: Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (10 females) UKMMZ-1545; occurrenceID: BD90E14B-9506-5D6B-B9E7-EFFDFE469BB6
- d. island: Kg Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'35.08", E104° 6'7.13"; eventDate: 15 June 2015; habitat:

- Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (37 females) UKMMZ-1546; occurrenceID: 4EF07793-2E4B-55BC-80FA-29885FDF7E0E
- e. island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104° 05.616'; eventDate: 15 June 2015; habitat: Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (54 females) UKMMZ-1621; occurrenceID: 5909205D-93CB-58D8-85C7-3EEEC0FF55B3

Distribution: Only known from type locality (Pulau Tinggi, Johor, Malaysia)

***Pendanthura tiomanensis* Chew, bin Abdul Rahim & Mohd Yusof, 2016**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=882016>

Nomenclature:

Pendanthura tiomanensis Chew et al. 2016: 238–241, figs. 9–11.

Material

- a. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble. Littoral 0.5 to 7 m depth; collectionCode: (1 female) UKMMZ-1547; (3 females) UKMMZ-1549; (2 females) ZRC 2016.0015; occurrenceID: A63655F6-F705-5191-9DA5-C93D601AA890

Distribution: Only known from type locality (Pulau Tioman, Pahang, Malaysia)

***Tinggianthura alba* Chew, bin Abdul Rahim & bin Haji Ross, 2014**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=1054956>

Nomenclature:

Tinggianthura alba Chew et al. 2014: 1–11, figs 2–9.

Materials

Paratype:

- a. island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'35.08", E104° 6'7.13"; eventDate: 16 August 2012; habitat: Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (12 females, 2 males, 1 juvenile) UKMMZ-1481; (12 females, 2 males, 1 juvenile) UKMMZ-1482; (12 females, 2 males, 1 juvenile) UKMMZ-1483; occurrenceID: 9AEFB88A-95B5-5EC8-80DB-A27081A8528A

Other materials:

- a. island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'35.08", E104° 6'7.13"; eventDate: 18 Dec 2012; habitat: Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (92 females, 8 males) UKMMZ-1622; occurrenceID: D0174F42-5450-564D-ACD3-67344F690654
- b. island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'35.08", E104° 6'7.13"; eventDate: 28 Feb 2013; habitat:

Amongst coral rubble. Littoral 0.5 to 3 m depth; collectionCode: (26 females) UKMMZ-1623; occurrenceID: 1A882242-8228-55B0-BEC9-0CD6D84BCA79

Distribution: Only known from type locality (Pulau Tinggi, Johor, Malaysia)

***Eisothistos besar* Müller 1992**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255500>

Nomenclature:

Eisothistos besar Müller 1992c: 370–371, figs. 1–26.

Material

Holotype:

- a. island: Pulau Babi Besar; country: Malaysia ; stateProvince: Johor; verbatimCoordinates: N2°50.483', E104°9.566'; habitat: Fringing reef, outer reef-flat, reef-margin and upper coral-slope; dead coral substratum, *Acropora* sp. and *Pocillopora damicornis* ; collectionCode: (immature adult, 1.7–2.1 mm) MHNG.; occurrenceID: 5C28ACF0-DE92-58F8-845F-83FB82402815

Distribution: Only known from type locality (Pulau Babi Besar, east coast Peninsular Malaysia)

Notes: This species record is based on literature only. No specimen was collected during the present study.

***Eisothistos tiomanensis* Chew, bin Abdul Rahim & binti Mohd Yusof, 2018**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=1056465>

Nomenclature:

Eisothistos tiomanensis Chew et al. 2018: 76–79, figs. 5–6.

Material

- a. island: Labas, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°53'13.71", E104° 3'54.65"; eventDate: 18 April 2014; habitat: Amongst coral rubble. Littoral 0.5 to 15 m depth; collectionCode: (1 male) UKMMZ-1559; occurrenceID: E8E89D7B-0287-56E5-9934-BE540BC72008

Distribution: Only known from type locality (Pulau Tioman, Malaysia).

***Expanathura collaris* (Kensley, 1979)**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=260392>
- GenBank [MF680511](https://www.ncbi.nlm.nih.gov/GenBank/MI000000000)

Nomenclature:

Panathura collaris Kensley 1979: 823–827, figs 7–9; Kensley and Poore 1982: 635.

Expanathura collaris Wägele 1981: 89, 121–122; Negoescu 1999: 214–220, figs 9–11; Negoescu and Wägele 1984: 118; Negoescu and Brandt 2001: 121–129, figs 14–18; Poore and Lew Ton 2002: 26–32, figs 16–19, 20a.

Materials

- a. island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104° 5.616'; eventDate: 16 May 2013; habitat: Amongst coral rubble, littoral 0.5 to 3 m; collectionCode: (1 female) UKMMZ-1565; (1 Male) UKMMZ-1566; (54 females, 3 males) UKMMZ-1567; occurrenceID: DE9E8EFF-FE82-5E0C-9D51-99B950364AFD
- b. island: Mentinggi, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°16'21.67", E104° 7'18.61"; eventDate: 19 April 2013; habitat: Amongst coral rubble, littoral 0.5 to 3 m; collectionCode: (12 females) UKMMZ-1568; occurrenceID: 51C79914-E7EF-562C-8A95-45ADD0380098
- c. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m; collectionCode: (56 females, 9 males) UKMMZ-1569; occurrenceID: 4AAF64E9-272A-5250-9278-C4B000C7505F
- d. island: Labas, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°53'13.71", E104°3'54.65"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 15 m; collectionCode: (35 females, 2 males) UKMMZ-1570; occurrenceID: 97614E38-DEC5-531E-95B0-5BB89E0B4EA3
- e. island: Pantai Kok, Pulau Langkawi; country: Malaysia; stateProvince: Kedah; verbatimCoordinates: N6°21'56.05", E99°40'31.13"; habitat: Intertidal coral rubble; collectionCode: (14 females, 4 males) UKMMZ-1625; occurrenceID: 54171FB4-4077-5339-A286-81CC7366A96C
- f. island: Batu Bonchek, Pulau Dayang; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°28'40.90", E104° 30'19.12"; eventDate: 26 July 2016; habitat: Amongst coral rubble, littoral 0.5 to 3 m; collectionCode: (7 females, 1 male) UKMMZ-1568; occurrenceID: F6D6FC68-7FE8-5381-8B9E-1F74D46FF775

Distribution: FIJI (Type locality); COOK ISLAND; MOOREA—Chesterfield and Melish Reefs, Coral Sea; LORD HOWE ISLAND—Tasman Sea; PAPUA NEW GUINEA; AUSTRALIA—Northern Territory, Queensland; MALAYSIA—Pulau Dayang, Pulau Tinggi, (New record); Pulau Tioman, Malaysia (New record); Pulau Langkawi (New record).

Notes: Fig. 2h

Kupellonura gidgee Poore & Lew Ton, 1988

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255527>

Nomenclature:

Kupellonura gidgee Poore and Lew Ton 1988: 181, 183, 184, fig 10.

Material

- a. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; collectionCode: (1 female) UKMMZ-1602; occurrenceID: 2085FB3A-D224-5DCC-B2AB-EC526BC44BB6

Distribution: AUSTRALIA—Lizard Island (type locality); MALAYSIA—Pulau Tioman (new record).

Notes: Fig. 2i

Accalathura barnardi (Nierstrasz, 1941)

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=258455>

Nomenclature:

Katanthura barnardi Nierstrasz 1941: 243–247, figs 1–13.

Accalathura barnardi Poore 1980: 59; Poore and Lew Ton 1990: 386, 388, fig 5.

Materials

- a. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; collectionCode: (1 female) UKMMZ-1603; (1 male) UKMMZ-1604; (6 females) UKMMZ-1605; occurrenceID: B76AE852-D267-5CBA-A268-EE974CDCBB5C
- b. island: Labas, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°53'13.71", E104° 3'54.65"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 15 m depth; collectionCode: (9 females, 2 males) UKMMZ-1606; occurrenceID: AD29BA84-7A95-5E37-B2BD-DF5208E2395
- c. island: Pulau Seri Buat; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°41'13.59", E103° 55'25.99"; eventDate: 19 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 7 m depth; collectionCode: (6 females) UKMMZ-1607; occurrenceID: 4016544A-0D64-5582-B7F3-15E567F722CF
- d. island: Batu Bonchek, Pulau Dayang; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°28'40.90", E104° 30'19.12"; eventDate: 26 July 2016; habitat: Amongst coral rubble, littoral 0.5 to 3 m depth; collectionCode: (13 females, 2 males) UKMMZ-1608; occurrenceID: 97B0258D-B031-54D0-90C4-BBBA531EA2F6
- e. island: Teluk Rha, Pulau Aur; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°28'17.24", E104° 30'53.14"; eventDate: 27 July 2016; habitat: Amongst coral rubble, littoral 0.5 to 3 m depth; collectionCode: (1 female, 1 males) UKMMZ-1609; occurrenceID: EB9BC93E-4560-546A-B8EC-1A61CEC9637F

Distribution: INDONESIA—Solo Strait, Java Sea (type locality); MALAYSIA—Pulau Tioman; Pulau Seri Buat (new record).

Notes: Fig. 2j

Accalathura borradailei (Stebbing, 1904)

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=258457>
- GenBank [MF680508](https://www.ncbi.nlm.nih.gov/genbank/MF680508)

Nomenclature:

Calathura borradailei Stebbing 1904: 700, pl. 49A; Chilton 1924: 881.

Accalathura borradailei Barnard 1925: 149; Pillai 1966: 157–158, fig 3.

Materials

- island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104° 6'1.97"; eventDate: 28 February 2013; habitat: coral rubble, intertidal; collectionCode: (1 female) UKMMZ-1610; (1 male) UKMMZ-1611; (35 females, 3 males) UKMMZ-1612; occurrenceID: 6D787F61-EAA3-582A-B353-A2913C508151
- island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104° 6'1.97"; eventDate: 18 December 2012; habitat: coral rubble, intertidal; collectionCode: (34 females) UKMMZ-1613; occurrenceID: E5EDAA02-AF85-5879-8230-8616F8EF19E0
- island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104°6'1.97"; eventDate: 15 June 2015; habitat: coral rubble, intertidal; collectionCode: (1 female) UKMMZ-1614; occurrenceID: D1A7E53A-BE18-5DA6-B740-6F1A54AA9FE4
- island: Sebirah Kechil, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°18.622', E104° 05.616'; eventDate: 15 June 2015; habitat: coral rubble, intertidal; collectionCode: (20 females) UKMMZ-1615; occurrenceID: 7BEC649E-6E3E-5CC8-9D46-69733233F457
- island: Batu Bonchel, Pulau Dayang; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°28'40.90", E104° 30'19.12"; eventDate: 26 July 2015; habitat: coral rubble, 0.5 to 3 m depth; collectionCode: (14 females, 1 male) UKMMZ-1616; occurrenceID: 8BBD542B-1C83-5156-93F2-19B9B8599952

Distribution: MALDIVES—Fadifolu (type locality); THAILAND; INDIA—Chilka Lake; Kollam; MALAYSIA—Pulau Dayang, Pulau Tinggi (new record).

Notes: Fig. 2k

Leptanthura coralliophila Müller, 1992

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255547>

Nomenclature:

Leptanthura coralliophila Müller 1992a: 181–186, figs 1–19.

Material

- a. island: Pulau Seri Buat; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°41'13.59", E103°55'25.99"; eventDate: 19 April 2014; habitat: Amongst coral rubble, intertidal to 7 m depth; collectionCode: (1 female) UKMMZ-1617; (1 female) UKMMZ-1618; occurrenceID: 4D1998D6-0B55-5313-AB4B-6A69DACE7FE4

Distribution: MALAYSIA—Pulau Babi Besar (type locality); Pulau Seri Buat.

Notes: Fig. 2l

Paranthura astrolabium Kensley, 1979

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255571>

Nomenclature:

Paranthura astrolabium Kensley 1979: 830–833, figs. 12–13; Negoescu 1999: 237–242, figs 21–23.

Materials

- a. island: Batu Malang, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°54'15.44", E104° 6'1.08"; eventDate: 18 April 2014; habitat: Amongst coral rubble, intertidal to 7 m; collectionCode: (1 female) UKMMZ-1619; (18 females 1 male) UKMMZ-1621; occurrenceID: 61109B50-OCE3-5610-BE62-3136BFDE32FF
- b. island: Pulau Seri Buat; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°41'13.59", E103°55'25.99"; eventDate: 19 April 2014; habitat: Amongst coral rubble, intertidal to 7 m; collectionCode: (3 females) UKMMZ-1622; occurrenceID: 678D7D8D-A9A8-5E1C-8190-6AD7FAAB922B

Distribution: FIJI—Great Astrolabe Barrier Reef (type locality); Suva Reef; MALAYSIA—Pulau Tioman, Malaysia; Pulau Seri Buat (new record).

Notes: Fig. 2m

Paranthura setigera Negoescu, 1997

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=255615>

Nomenclature:

Paranthura setigera Negoescu 1997: 232–241, figs. 33–38.

Materials

- a. island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E 104° 6'1.97"; eventDate: 18 December 2012; habitat: coral rubble, intertidal; collectionCode: (1 female) UKMMZ-1623; (1 male) UKMMZ-1624; (91 females, 7 males) UKMMZ-1625; occurrenceID: 55057385-C0FF-5992-855D-448DB779EAA0

- b. island: Kampung Pasir Panjang, Pulau Tinggi; country: Malaysia; stateProvince: Johor; verbatimCoordinates: N2°17'37.96", E104° 6'1.97"; eventDate: 28 Feb 2013; habitat: coral rubble, intertidal; collectionCode: (26 females) UKMMZ-1626; occurrenceID: 52570B52-4EDF-5212-B056-EAB2BBC0E6A3

Distribution: INDONESIA—Southeast Bali Island, Sanur beach, Bali Island (type locality); MALAYSIA—Pulau Tinggi (new record).

Notes: Fig. 2n

***Paranthura seychellensis* Kensley & Schotte, 2000**

- WoRMS <http://www.marinespecies.org/aphia.php?p=taxdetails&id=211339>

Nomenclature:

Paranthura seychellensis Kensley and Schotte 2000: 2114–2116, fig 39.

Materials

Holotype:

- a. island: Labas, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°53'13.71", E104° 3'54.65"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 15 m depth; collectionCode: (1 female) UKMMZ-1627; (1 male) UKMMZ-1628; (1 premature female) UKMMZ-1629; occurrenceID: ED6631B4-669D-5633-B2EA-068C2645C060
- b. island: Labas, Pulau Tioman; country: Malaysia; stateProvince: Pahang; verbatimCoordinates: N2°53'13.71", E104° 3'54.65"; eventDate: 18 April 2014; habitat: Amongst coral rubble, littoral 0.5 to 15 m depth; collectionCode: (1 female, 4 males) UKMMZ-1630; occurrenceID: 7DA54D0D-C34F-5135-9C2E-C62155D5AFCB

Distribution: SEYCHELLES—Mahé Beach Mahé Island (type locality); MALAYSIA—Pulau Tioman (new record).

Notes: Fig. 2o

Discussion

Currently five families of the marine Anthuroidea are known from the Malaysian Peninsular, comprising 12 genera and 24 species. Of these, 10 species (*Apanthura bruscai*, *A. tiomanae*, *Mesanthura asiatica*, *M. kiliani*, *Pendantthura tinggiensis*, *P. tiomanensis*, *Tinggianthura alba*, *Eisothistos besar*, *E. tiomanensis* and *Leptanthura coralliophila*) are recently discovered Malaysian species and they contribute about 1.5% of all known Anthuroidea of the world. Clearly, this number is only a fraction of their true diversity, given that habitats like shallow reefs, seagrasses and mangroves have not received much taxonomic attention. More species are yet to be discovered, especially after exploring inaccessible habitats, revealing of cryptic species using molecular methods and exploring east Malaysian (Sabah and Sarawak) waters. The latter is a region of high known marine biodiversity.

The anthuroids of Peninsular Malaysia are similarly taxonomically represented as the adjacent thoroughly studied Indian Ocean region by Kensley and Schotte (2000). In terms of faunistic composition, both the regions show a high proportion of Anthuridae species with 58.3% in the Malaysian region and 45.8% in the Indian Ocean region. It is followed by a small number of Leptanthuridae (12.5% in Malaysia and 20.8% in the Indian Ocean), Paranthuridae (12.5% in Malaysia and 12.5% in the Indian Ocean), Expanthuridae (12.5% in Malaysia and 8.3% in the Indian Ocean) and Hyssuridae (4.2% in Malaysia and 8.3% in the Indian Ocean). Having highlighted the similarity, a minor but crucial difference was also noticed, particularly on the occurrence of Antheluridae species in the Indian Ocean. According to Poore (2001), most of the Antheluridae species are restricted to deep-water, cool-temperate or polar regions. Although several species are found to inhabit the warmer and shallower seas, particularly the eight species of *Anthomuda* Schultz, 1979, they are mostly captured from the Indian Ocean (Poore and Lew Ton 1988). The high species diversity, particularly in the family Anthuridae (17 species), can be attributed to the fact that the family is the largest and most widespread (Chew et al. 2014, Song and Min 2015). Some of its species-rich genera, *Apanthura* and *Mesanthura*, are recorded with the highest species diversity amongst the Malaysian anthuroid fauna. On the other hand, there is no record of any Antheluridae species occurring in the Malaysian region, most probably due to the fact that they are rare in the warmer seas (Poore 2001, Poore and Lew Ton 1988).

Currently, all known Malaysian anthuroids are found to be associated with coral rubble. Other habitats, such as sandy and muddy sediments and algal beds, have not been sampled. Due to the fact that they are very well represented in the high spatial complexity coral rubble (Bruce 2011, Kensley 1998), coral rubble samplings were prioritised in the past works, as well as in the present study. From all coral rubble collections around the world, one generally true characteristic is that the *Eisothistos* species are rare and, if reported, they have usually been collected from breaking open serpulid tubes (Wägele 1981). Moreover, *Amakusanthura koonyumae*, a species previously known to inhabit sandy substratum (Bamber 1997, Bamber 2008), is now found to be associated with coral rubble of the Malaysian coral reefs.

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Author contributions

MC: Sample collection, wrote the manuscript draft and prepared line drawings. ABAR: Conducted sampling trips, provided generic identification, technical expertise, edited the draft, improved the taxonomic concept of the find, wrote the discussion and prepared the manuscript for the publication.

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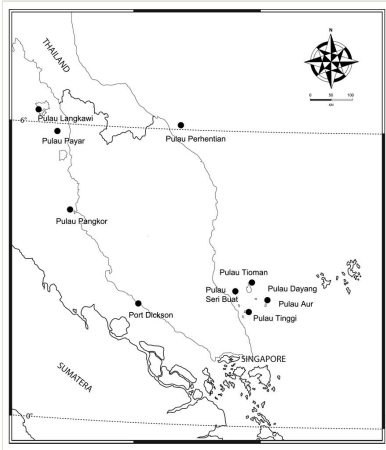


Figure 1.
Map of collection localities in the Malaysian Peninsular.

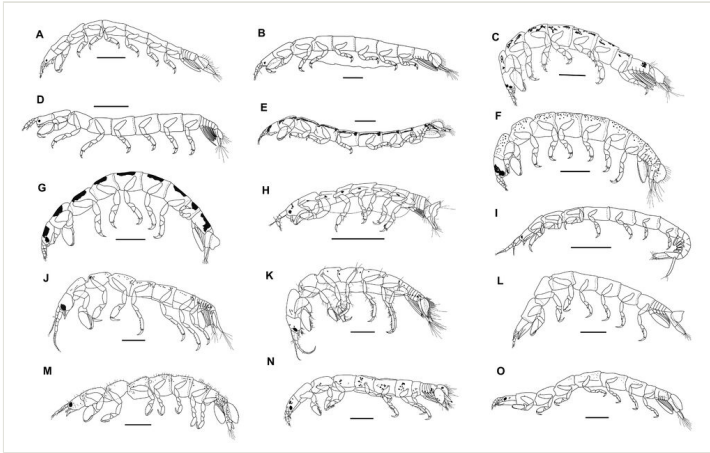


Figure 2.

Habitus of Anthuroidea (females) of the reefs of Peninsular Malaysia: **A.** *Amakusanthura koonyumae* Bamber, 1997; **B.** *Apanthura pariensis* Negoescu, 1997; **C.** *Apanthura stocki* (Müller, 1991); **D.** *Apanthura tiomanae* Müller, 1992; **E.** *Mesanthura asiatica* Müller, 1993; **F.** *Mesanthura protei* Kensley, 1980; **G.** *Mesanthura quadrata* Kensley & Schotte, 2000; **H.** *Expanthura collaris* (Kensley, 1979); **I.** *Kupellonura gidgee* Poore & Lew Ton, 1988; **J.** *Accalathura barnardi* (Nierstrasz, 1941); **K.** *Accalathura borradalei* (Stebbing, 1904); **L.** *Leptanthura coralliophila* Müller, 1992; **M.** *Paranthura astrolabium* Kensley, 1979; **N.** *Paranthura setigera* Negoescu, 1997; **O.** *Paranthura seychellensis* Kensley & Schotte, 2000. All species are illustrated here for the first time.