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The lobsters of Christmas Island and Cocos (Keeling) Islands, with new records of *Palinurellus wieneckii* (De Man, 1881) and *Enoplometopus voigtmanni* Türkay, 1989 (Crustacea: Decapoda: Palinuridae, Scyllaridae, Enoplometopidae)

Peter K. L. Ng[1*] & Tohru Naruse[2]

Abstract. The reef lobster fauna of Christmas Island and Cocos (Keeling) Islands in the eastern Indian Ocean is documented. Five species of palinurids, one species of scyllarid and one species of enoplometopid are recorded from these islands. Two species, *Palinurellus wieneckii* (De Man, 1881) (Palinuridae) and *Enoplometopus voigtmanni* Türkay, 1989 (Enoplometopidae) are new records for Christmas Island and Australia. The taxonomy of *Parribaccus antarcticus* (Lund, 1793) is also discussed.

Key words. Palinuridae, Scyllaridae, Enoplometopidae, new records

INTRODUCTION

Between 2010 and 2012, staff from the Raffles Museum of Biodiversity Research (currently known as the Lee Kong Chian Natural History Museum) and Queensland Museum made a series of surveys of Christmas Island and Cocos (Keeling) Islands in the Indian Ocean, primarily to survey its decapod fauna. This included numerous day and night dives around the island, including the use of traps.

Five species of palinurid, one species of scyllarid and one species of enoplometopid lobsters are recorded from Christmas Island in the Indian Ocean. Of these, two species, *Palinurellus wieneckii* (De Man, 1881) (Palinuridae) and *Enoplometopus voigtmanni* Türkay, 1989 (Enoplometopidae) are new records for Christmas Island and Australia.

Specimens examined are deposited in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum, National University of Singapore (ZRC); Ryukyu University Museum, Okinawa, Japan (RUMF); National Taiwan Ocean University, Keelung (NTOU); and Queensland Museum, Brisbane (QM). Measurements provided in millimetres; the abbreviations cl and tl are used for the carapace length and total length, respectively.

[1]Lee Kong Chian Natural History Museum, Faculty of Science, National University of Singapore, 14 Science Drive 4, 117543 Singapore, Republic of Singapore;Email: dbsngkl@nus.edu.sg (*corresponding author)

[2]Transdisciplinary Research Organization for Subtropical and Island Studies, University of the Ryukyus, 1 Senbaru, Nishihara, Okinawa 903-0213, Japan; Email: naruse@lab.u-ryukyu.ac.jp

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TAXONOMY

FAMILY PALINURIDAE LATREILLE, 1802

Remarks. Three species of palinurid lobsters were listed by Morgan (2000) as being present on Christmas Island: *P. longipes* A. Milne-Edwards, 1868, *P. penicillatus* (Olivier, 1791) and *P. versicolor* (Latreille, 1804) (see also George, 1968). We did not obtain the latter species in Christmas Island but collected it from Cocos (Keeling) Islands, and believe *P. longipes* may be a misidentification of *P. femoristriga* (Von Martens, 1872), a species we found to be common on Christmas Island (see discussion below). Local weekend fishermen at Cocos (Keeling) Islands also told us that they occasionally catch a large species of lobster in the outer reefs of the atoll, and from their description, it is almost certainly *P. ornatus* (Fabricius, 1798), a widespread Indo-West Pacific species. They comment, however, that the two most common species in Cocos (Keeling) Islands are *P. versicolor* and *P. penicillatus*, as our surveys also confirm.

Panulirus femoristriga (Von Martens, 1872)
(Fig. 1)

Material examined. 1 female (cl 58.0 mm) (QM), station D17, Flying Fish Cove, reef slope, 10°25.815'S, 105°40.180'E, Christmas Island, coll. night dive, 10 February 2010. — 1 female (cl 68.0 mm) (ZRC 2012.0082), station D06, Thunderdome Cave, submarine cave, 3–16.6 m depth, 10°27.906'S, 105°36.465'E, Christmas Island, coll. night dive, 26 March 2011. — 1 male (cl 78.0 mm) (ZRC 2012.0083), station D19, Flying Fish Cove, shore dive, reef slope, 10°25.815'S, 105°40.180'E, Christmas Island, coll. evening dive, 30 March 2011.

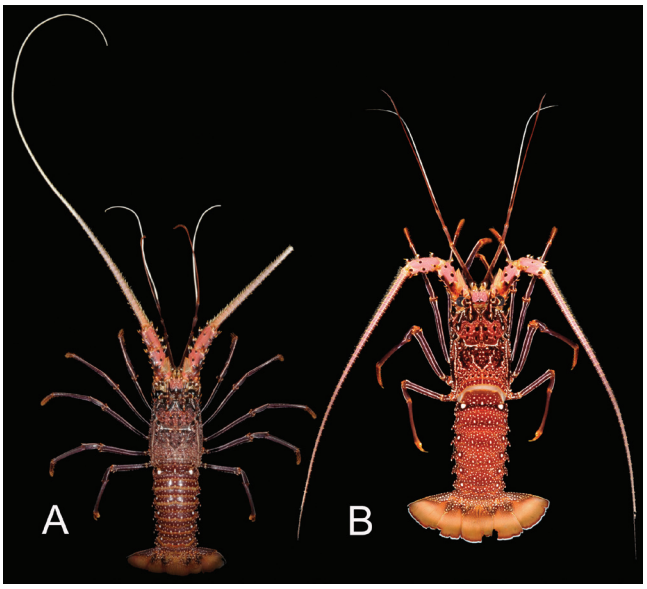

Fig. 1. *Panulirus femoristriga* (Von Martens, 1872). A, female (cl 58.0 mm) (QM), Flying Fish Cove; B, female (cl 68.0 mm) (ZRC 2012.0082), Thunderdome Cave. Both localities in Christmas Island. Photographs: HH Tan.

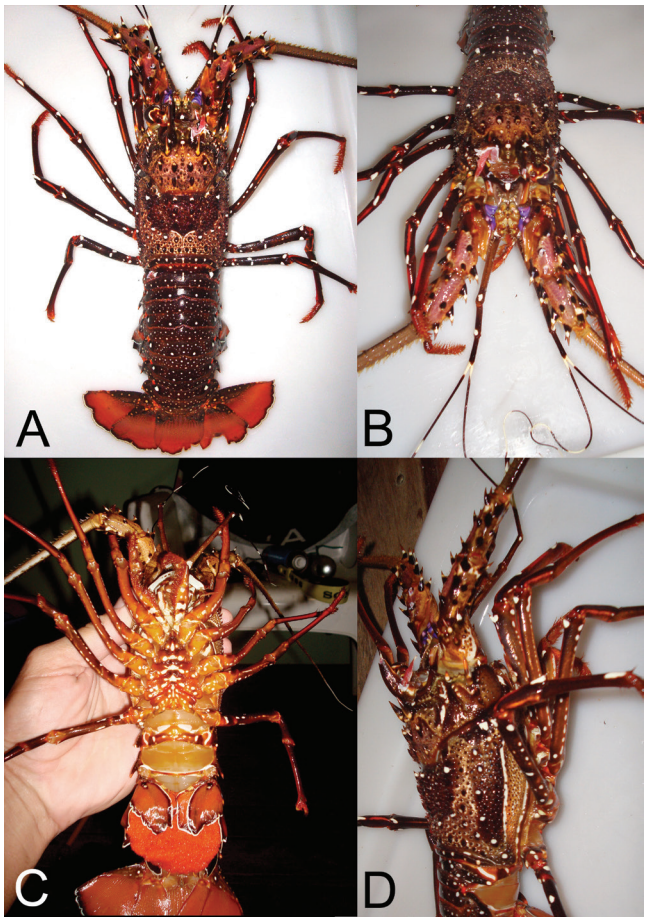

Fig. 2. *Panulirus longipes longipes* A. Milne-Edwards, 1868, ovigerous female, not preserved, Christmas Island. Photographs courtesy of J-P Hobbs.

Remarks. This widespread Indo-West Pacific species is most easily characterised by having one of its antennular flagella completely white while the other is brown (Fig. 1). Originally described as a new species, *P. albiflagellum*, by Chan & Chu (1996), it was later shown that the correct name should be *P. femoristriga* (Von Martens, 1872) s. str. (Chan & Ng, 2001). This was the most common species of palinurid observed on Christmas Island during the expeditions, although it was not seen on Cocos (Keeling) Islands.

George (1968) had earlier reported *P. longipes* A. Milne-Edwards, 1868, from Christmas Island (see also Morgan, 2000; Davie, 2002), but his concept of this species is almost certainly what is now known as *P. femoristriga*. We did not observe any specimen in Christmas Island that can be identified with *P. longipes longipes* as presently defined, or the similar subspecies *P. longipes bispinosus* Borradaile, 1899 (see Chan, 1998, 2010; Chan & Ng, 2001; Ng et al., 2011). However, one specimen referrable to Panulirus longipes longipes s. str. was obtained by another researcher (see next species).

Panulirus longipes longipes A. Milne-Edwards, 1868
(Fig. 2)

Material examined. None.

Remarks. The authors were given photographs of a large female specimen clearly referrable to Panulirus longipes longipes collected from Christmas Island on 29 August 2008. The specimen, obtained by Jean-Paul Hobbs, was not preserved. The photographs (Fig. 2), however, leave no doubt of its identity.

Panulirus penicillatus (Olivier, 1791)
(Fig. 3)

Material examined. 1 male (cl 90.0 mm) (ZRC 2012.0084), station D12, Thundercliff Cave, submarine cave with large air pocket, limestone bedrock, sand and gravel bottom, 6 m depth, 10–15 m wide air pocket, 10°27.964'S, 105°36.404'E, Christmas Island, in trap, morning dive, 30 January 2010. — 1 female (cl 92.0 mm) (QM), station D14, Thunderdome Cave, submarine cave, limestone bedrock, sand and gravel bottom, 10°27.906'S, 105°36.465'E, Christmas Island, coll. morning dive, 30 January 2010. — 1 juvenile male (cl 12.3 mm) (ZRC 2012.0096), station D10, Coconut Point, reef slope, submarine cave, 10°24.741'S, 105°41.868'E, coll. morning dive, 27 January 2010. — 1 female (cl 111.0 mm) (ZRC 2012.0085), station CK7/8, in *Acropora* clump, low tide, Trannies Beach, West Island, 12°08.507'S, 96°49.095'E, Cocos (Keeling) Islands, coll. PKL Ng et al., 20 March 2011.

Remarks. This widespread Indo-West Pacific species was first recorded from Christmas Island by Gordon (1935) and later by George (1968) (see also Morgan, 2000; Davie, 2002). One large ovigerous female specimen was photographed on reefs in the western coast of North Keeling Island on 9 February 2012 but was not collected. The presence of this

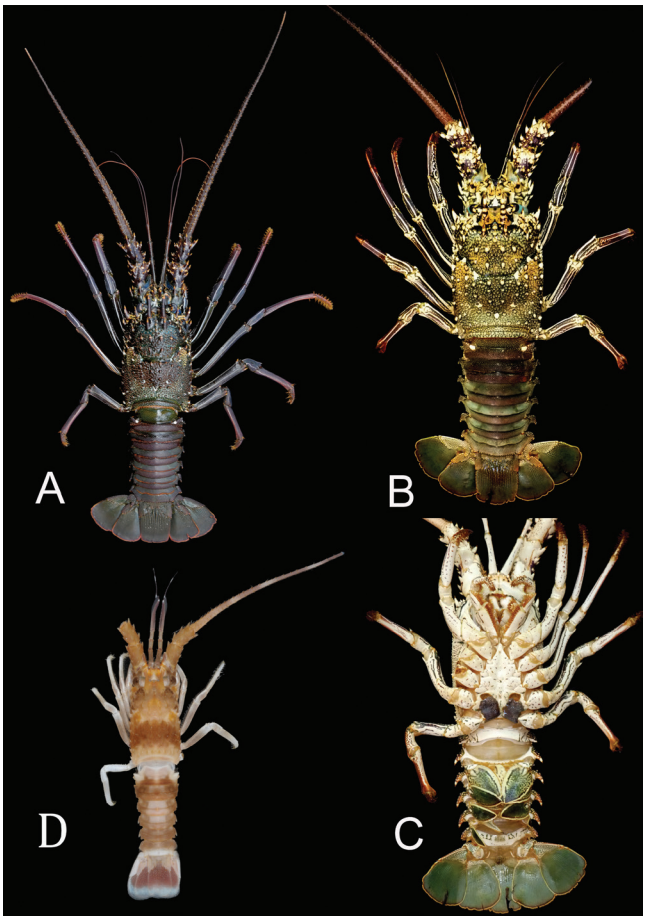

Fig. 3. A–C, *Panulirus penicillatus* (Olivier, 1791). A, male (cl 90.0 mm) (ZRC 2012.0084), Thundercliff Cave, Christmas Island; B, C, female (cl 111.0 mm) (ZRC 2012.0085), Trannies Beach, Cocos (Keeling) Islands; D, juvenile (cl 12.3 mm) (ZRC 2012.0096), Coconut Point, Christmas Island. Photographs: HH Tan.

species in Christmas, Cocos (Keeling) and North Keeling Islands is not surprising.

As has been described in Holthuis (1991) and Chan (1998), the colour is very variable (Fig. 3A, B). Juveniles are dull coloured, been brown, orange and white (Fig. 3D), although even at this size, they possess all the diagnostic characters of the adults (cf. Holthuis, 1991).

Holthuis (1991) noted without comment that *Cancer theresae* Curtiss, 1938, from Tahiti was a junior synonym of *P. penicillatus*. Ng et al. (2011), however, discussed this matter at length, and argued that Curtiss's species is probably referable to *Panulirus longipes bispinosus* Borradaile, 1899, instead. They noted, however, that the matter should be decided at a later date as part of a revision with the then appropriate selection of a neotype for *Cancer theresae*.

Panulirus versicolor (Latreille, 1804)
(Fig. 4)

Material examined. 1 juvenile male (cl 22.4 mm), 1 young female (cl 36.2 mm) (ZRC 2012.0097), station CK2, beach and reef near airport, outside of lagoon, sandy beach to reef flat with sea grass beds and rocky bottom, Settlement, West

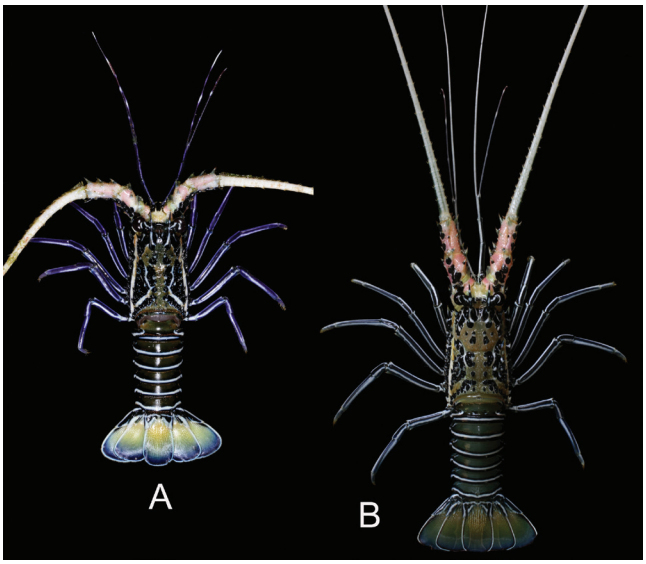

Fig. 4. *Panulirus versicolor* (Latreille, 1804). A, juvenile male (cl 22.4 mm) (ZRC 2012.0097); B, young female (cl 36.2 mm) (ZRC 2012.0097), West Island, Cocos (Keeling) Islands.

Island, 12°11''0.60"S, 96°49'42.83"E, Cocos (Keeling) Islands, coll. hand collecting at night, PKL Ng et al., 20 March 2011.

Remarks. Although Morgan (2000) recorded it from Christmas Island, we did not manage to obtain or observe this species there. The present specimen, a young male, was collected from intertidal waters in Cocos (Keeling) Islands. This species has a very wide Indo-West Pacific distribution (Holthuis, 1991; Chan, 1998).

Palinurellus wieneckii (De Man, 1881)
(Figs. 5, 6)

Material examined. 1 ovigerous female (cl 71.3 mm) (ZRC 2012.0086), station D12, Thundercliff Cave, submarine cave with large air pocket, limestone bedrock, sand and gravel bottom, about 50 m from the entrance, 1 m depth, 10°27.964'S, 105°36.404'E, Christmas Island, in trap baited with Pacific saury (*Cololabis saira*), morning dive, 30 January 2010. — 1 female (cl 58.0 mm) (QM), station D06, Thunderdome Cave, submarine cave, 3–16.6 m depth, 10°27.906'S, 105°36.465'E, Christmas Island, coll. Tan HH, 26 March 2011.

Remarks. While *Palinurellus wieneckii* has been reported from a wide span of the Indo-West Pacific (Davie, 1990; Ng, 1994; Fujita & Ohta, 2010; Lin et al., 2012), it has surprisingly never been reported from Australia before. While its type locality is Pulau Tikus in western Sumatra (De Man, 1881), it has been reported only sporadically before in the Indian Ocean, from Sri Lanka (Ng, 1994), Mauritius and perhaps South Africa (see Titgen & Fielding, 1986). Its presence in Christmas Island is nevertheless noteworthy.

The two present specimens were collected from submarine caves. An ovigerous female specimen (ZRC 2012.0086) was collected from a trap set about 50 m from the entrance

Fig. 5. *Palinurellus wieneckii* (De Man, 1881). A, ovigerous female (cl 71.3 mm) (ZRC 2012.0086), Thundercliff Cave; B, female (cl 58.0 mm) (QM), Thunderdome Cave. Both localities in Christmas Island. Photographs: SH Tan.

of the cave, but the water depth was about 1 m. They live deep in narrow crevices. Little is known about their ecology and biology (see aquarium observations of the behaviour by Ng, 1992, 1993). One of the specimens was ovigerous, but the eggs are still some time from hatching, been bright orange, measuring 0.6–0.7 mm in diameter (Fig. 6A). This is only the second time an ovigerous specimen has been collected, the first was from the stomach of a grouper in southern Japan (Fujita & Ohta, 2010). The phyllosoma larvae are known (see Coutures & Booth, 2004) but only from plankton-caught material.

The two specimens agree well in morphological characters, except that the second pereiopod is relatively stouter in the larger female. The smaller specimen is a brighter orange (Figs. 5B, 6B) while the larger one is a deeper red (Figs. 5A, 6A).

Originally classified in the family Synaxidae Spence Bate, 1881, Davie (1990: 689) discussed the systematics of the genus at length, and argued that *Palinurellus* is a palinurid. This has since been confirmed with molecular data (Palero et al., 2009; Tsang et al., 2009), and followed in recent listings (e.g., Chan, 2010).

FAMILY SCYLLARIDAE LATREILLE, 1825

Remarks. Two species are known from the islands, *Thenus orientalis* (Lund, 1793) and *Parribacus antarcticus* (Lund, 1793). Gordon (1935) first recorded *Thenus orientalis* (Lund, 1793) from Christmas Island (see also Morgan, 2000), but this record needs to be rechecked with fresh material,

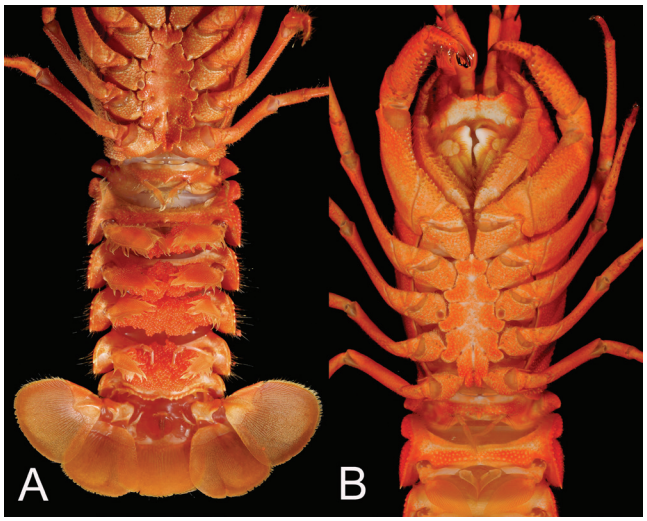

Fig. 6. *Palinurellus wieneckii* (De Man, 1881). A, ovigerous female (cl 71.3 mm) (ZRC 2012.0086), Thundercliff Cave; B, female (cl 58.0 mm) (QM), Thunderdome Cave. Both localities in Christmas Island. Photographs: SH Tan.

especially in view of the revision of Burton & Davie (2007) that indicates that *T. indicus* Leach, 1816, is also present in northeastern Indian Ocean, with *T. parindicus* Burton & Davie, 2007, also possibly occurring there as well. In view of this, Burton & Davie (2007) only tentatively retained Gordon's (1935) record under *T. orientalis*, which is followed here. The general habitat in and around Christmas Island is not really suitable for *Thenus* species, which generally prefers relatively shallow sandy-muddy sublittoral waters, and if indeed present there, is probably not common. Certainly it has not been reported since Gordon (1935).

Parribacus antarcticus (Lund, 1793)

(Figs. 7, 8)

Material examined. 1 male (cl 74.9 mm) (ZRC 2012.0087), station D9, Thundercliff Cave, 6 m depth, submarine cave with large 10–15 m wide air pocket, limestone bedrock, sand and gravel bottom, 10°27.964'S, 105°36.404'E, Christmas Island, coll. afternoon dive, 29 January 2010. — 1 male, 1 female (ZRC 2012.0095), 1 male, 1 female (QM), West White Cave, off West White Beach, submarine cave, limestone bedrock, sand and gravel bottom, 10°27.733'S, 105°35.054'E, Christmas Island, coll. night dive, 29 January 2010. — 1 male (cl 64.8 mm) (ZRC 2012.0088), 1 female (cl 61.3 mm) (ZRC 2012.0089), station D16, Flying Fish Cove, shore dive, reef slope, 10°25.815'S, 105°40.180'E, Christmas Island, coll. evening dive, 29 March 2011. — 1 male (cl 67.0 mm) (ZRC 2012.0090), station D17, Flying Fish Cove, reef slope, 10°25.815'S, 105°40.180'E, Christmas Island, coll. night dive, 1 February 2010. — 1 male (cl 51.3 mm) (ZRC 2012.0091), 1 female (cl 49.8 mm) (ZRC 2012.0092), station D19, Flying Fish Cove, shore dive, reef slope, 10°25.815'S, 105°40.180'E, Christmas Island, coll. evening dive, 30 March 2011. — 1 female (cl 73.0 mm) (ZRC 2012.0093), Trannies Beach, West Island, 12°08.507'S, 96°49.095'E, Cocos (Keeling) Islands, coll. PKL Ng et al., 20 March 2011.

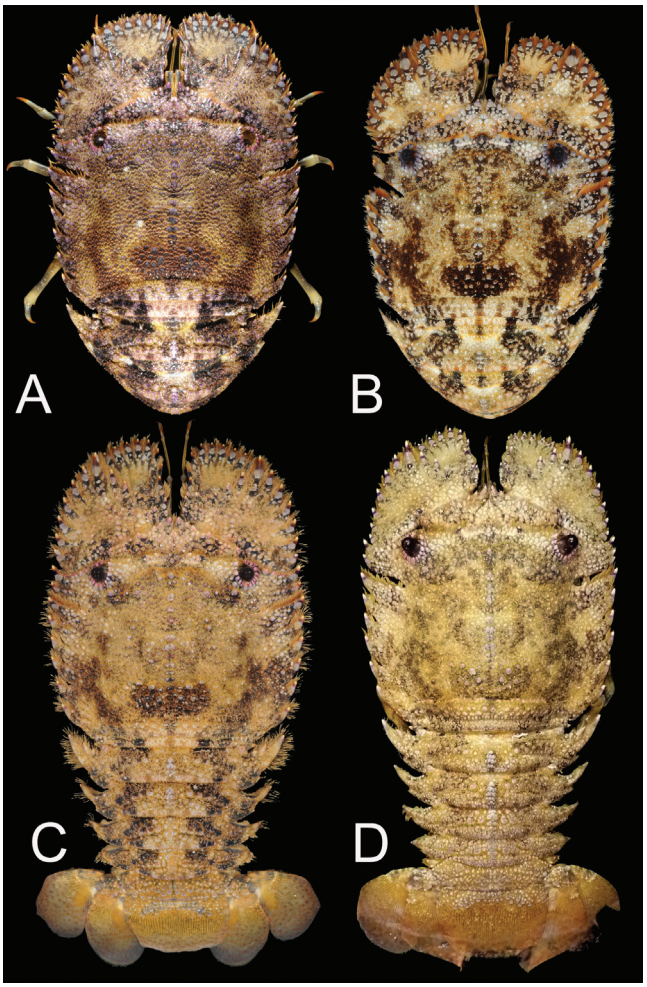

Fig. 7. *Parribacus antarcticus* (Lund, 1793). A, male (cl 74.9 mm) (ZRC 2012.0087), Thundercliff Cave Christmas Island; B, male (cl 64.8 mm) (ZRC 2012.0088), Flying Fish Cove, Christmas Island; C, female (cl 61.3 mm) (ZRC 2012.0089), Flying Fish Cove, Christmas Island; D, female (cl 73.0 mm) (ZRC 2012.0093), Trannies Beach, Cocos (Keeling) Islands. Photographs: SH Tan.

Comparative material. *Parribacus antarcticus* (Lund, 1793): 1 female (RUMF-ZC-456), Okinawa Island, Ryukyu Islands, Japan, coll. 1989; 1 female (RUMF-ZC-533), Nakagusuku Bay, Okinawa Island, Ryukyu Islands, Japan, coll. 1999; 1 female (cl 61.0 mm) (RUMF-ZC-1519), Gun Beach, N end of Tumon Bay, Guam, Marianas, coll. T Naruse et al., 12 June 2010.

Remarks. This is a very widespread species in the Atlantic and Indo-West Pacific (Holthuis, 1991; Chan, 1998), and the present specimens agree well with what is known about the species. Morgan (2000) was the first to record this species from Christmas Island. The record for Cocos (Keeling) Islands is new.

There appear to be two forms of *Parribacus antarcticus* on Christmas Island and Cocos (Keeling) Islands. Most of the specimens we have obtained belong to the typical form (viz. Holthuis, 1985; 73, 1991: 209; Chan, 1998: 1037) which has a relatively long carapace, with the posterior margins of abdominal somites 4 and 5 crenulated, abdominal somite 6 relatively broad, the posterior thoracic sternites relatively

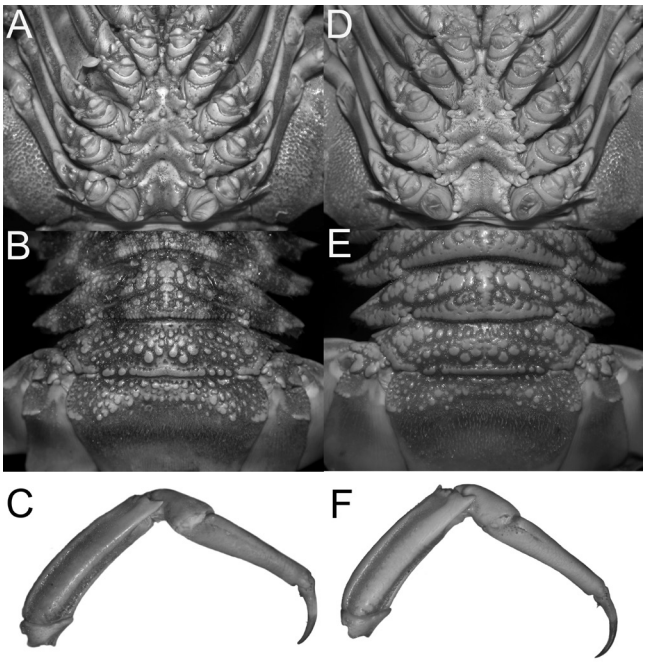

Fig. 8. *Parribacus antarcticus* (Lund, 1793). A–C, male (cl 74.9 mm) (ZRC 2012.0087), Thundercliff Cave, Christmas Island; D–F, male (cl 64.8 mm) (ZRC 2012.0088), Flying Fish Cove, Christmas Island. A, D, thoracic sternum; B, E, posterior somites of abdomen and tail fan; C, F, first ambulatory leg (pereiopod 1).

narrow longitudinally, and the ambulatory dactyli are gently hooked (Figs. 7A, C, D, 8A–C). However, there are two specimens (1 male, cl 64.8 mm [ZRC 2012.0088]; 1 female, cl 49.8 mm [ZRC 2012.0092]) of another form in which the carapace is relatively broader, with the posterior margins of abdominal somites 4 and 5 entire, abdominal somite 6 relatively less broad, the posterior thoracic sternites relatively are transversely broader, and most characteristically, the ambulatory dactyli are proportionately more slender, longer and more prominently hooked (Figs. 7B, 8D–F). They also appear to differ somewhat in colour. The typical form invariably has the granules around the orbit pink to light purplish (Fig. 7A, C, D) while the second form has the granules lining the orbit white with specks of blue (Fig. 7B).

Parribacus antarcticus (type locality Ambon), has six junior synonyms: *Cancer* (*Astacus*) *ursus major* Herbst, 1793 (type locality Ambon), *Scyllarus carinatus* Guilding, 1825 (type locality St. Vincent), *Ibacus ciliatus* Guilding, 1825 (type locality St. Vincent), *Ibacus parrae* H. Milne Edwards, 1837 (type locality Cuba), *Parribacus papyraceus* Rathbun, 1906 (type locality Hawai'i), and *Cancer barffi* Curtiss, 1938 (type locality Tahiti) (see discussion in Holthuis, 1985) (see also Ng et al., 2011). These taxa all appear to agree with *P. antarcticus* as presently defined and not the second form. More specimens are needed to ascertain the identity of this second form and determine if it is a new species. Interestingly, no synonym has previously been described from the Indian Ocean.

Chan Tin Yam (pers. comm.) kindly examined material from Taiwan and nearby areas at our request and commented that the differences observed above appear to be variable and are

also evident in his material. A female specimen from Guam (RUMF-ZC-1519) possesses features of both types (i.e., entire posterior margins of the abdominal somites 4 and 5 but with only gently hooked ambulatory dactyli). Chan T-Y is of the opinion that it may be due to variation but comments that more studies, including molecular methods, may help throw more light on the observed differences. The matter will need to be resolved by examining a larger number of specimens from across the distribution of the species.

FAMILY ENOPLOMETOPIDAE SAINT LAURENT, 1988

Enoplometopus voigtmanni Türkay, 1989
(Fig. 9)

Material examined. 1 female (cl 37.3 mm, tl 103.5 mm) (ZRC 2012.0094), station D17, Thunderdome Cave, submarine cave, 3.0–16.6 m depth, 10°27.906'S, 105°36.465'E, Christmas Island, coll. Tan HH, 30 March 2011.

Comparative material. 1 male (cl 40.1 mm) (NTOU M00992), Kume Island, station Dive 40, Hidenchigama, Okinawa, Ryukyus, Japan, scuba diving, 40 m, coll. KUMEJIMA 2009 Expedition, 20 November 2009. — 1 male (cl 39.1 mm) (RUMF-ZC-01325), Ichunjya-shita, Ryukyus, Japan, scuba diving, 16 m, coll. 25 August 2010.

Remarks. Chan & Ng (2008) discussed the taxonomy of *Enoplometopus* at length and also provided an updated key to the 12 known species (Chan, 2010). The genus was previously represented by only three species from Australia, *E. occidentalis* (Randall, 1840), *E. daumi* Holthuis, 1983, and *E. crosnieri* Chan & Yu, 1998 (see Debelius, 2001; Davie, 2002). *Enoplometopus voigtmanni* Türkay, 1989, described on the basis of two females from the Maldives and a record from Sri Lanka (Türkay, 1989; Chan, 2010), has also been reported in a number of underwater guide books (Allen & Steene, 1994; Debelius & Baensch, 1994; Jeng, 1998; Debelius, 1999; Minemizu, 2000; Kawamoto & Okuno, 2003) from Papua New Guinea, Taiwan, Okinawa, and possibly from Tuamotu, French Polynesia. Recently, Chan & Fujita (2012) examined male specimens, from the Ryukyu Islands, Japan, for the first time. The present specimen agrees very well with description and figures by Türkay (1989) and Chan & Fujita (2012), and we have no doubt they are conspecific. Their live colours and patterns (Fig. 9) are almost identical (cf. Türkay, 1989: pl. 2)

The species lives among the rocky crevices in submarine caves. Several specimens were observed in the caves at night but their cryptic habits made capture difficult.

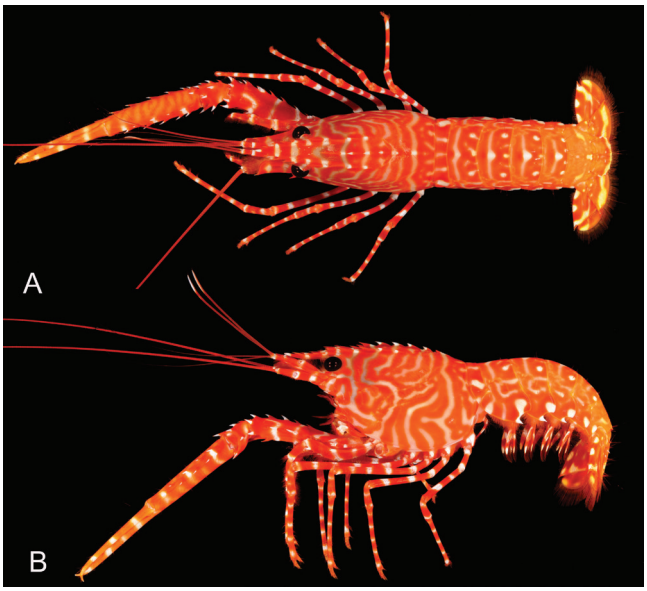

Fig. 9. *Enoplometopus voigtmanni* Türkay, 1989, female (cl 37.3 mm) (ZRC 2012.0094), Thunderdome Cave, Christmas Island. A, dorsal view; B, lateral view. Photographs: HH Tan.

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The Christmas Island expeditions started on the encouragement of ex-chief ranger Max Orchard of the Christmas Island National Park—and his help throughout has been fantastic. The present material was mostly collected by the intrepid dive team led by Tan Heok Hui, together with Tohru Naruse, Yoshihisa Fujita and Joelle Lai. Photographs were taken by Tan Heok Hui, Tan Swee Hee and Tohru Naruse; and we also thank the logistical support by Jose C. Mendoza, Tan Siong Kiat and Tan Kai-xin. The Australian National Parks Service kindly facilitated with the various research and export permits between 2010 and 2012 as well as giving us access to their facilities. We are extremely grateful for their support. We are also grateful to Chan Tin-Yam (National Taiwan Ocean University) for his kind comments on the taxonomy of *Parribacus*. He and Shane Ahyong read the manuscript, with the latter also confirming the presence of *Enoplometopus daumi* from the Great Barrier Reef in Australia. The present study has been supported by travel grants to the Raffles Museum from the Faculty of Science, National University of Singapore to PNKL.

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