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A new family, genus and species of cavernicolous crab (Crustacea: Decapoda: Brachura: Pseudozioidea) from Christmas Island, Australia

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Abstract. A new genus and species of cavernicolous pseudozioid crab, *Christmaplax mirabilis*, is described from Christmas Island, Australia. The new crab was found in a subterranean pool located near the underwater entrance of a marine cave on the northwestern coast of the island. *Christmaplax mirabilis* has cavernicolous adaptations (e.g., reduced eyes, elongated ambulatory legs and pale colour) and superficially resembles anchialine crabs of the genus *Orcovita* (Varunidae). The characters of the female gonopores, male gonopods 1 and 2, and male abdomens show that it is a member of the Pseudozioidea. However, *Christmaplax mirabilis* cannot be placed in any of the three recognised pseudozioid families (Pseudoziidae, Planopilumnidae and Pilumnoididae), requiring the establishment of a new family, Christmaplacidae. The genus *Flindersoplax* Davie, 1989, previously placed in Pseudoziidae, is also transferred to the Planopilumnidae.

Key words. Taxonomy, Pseudozioidea, new family, new genus, new species, Christmas Island, Australia

INTRODUCTION

Christmas Island is an isolated limestone-capped volcanic island (Grimes, 2001) in the eastern Indian Ocean. It has relatively easily accessible submarine caves at shallow depths as well as many anchialine cave systems accessible from land (Humphreys & Eberhard, 2001). In recent years, many interesting crustaceans have been found in these cave systems (see Ng, 2002; Namiotko et al., 2004; Bruce & Davie, 2006; Humphreys & Danielopol, 2006; Humphreys et al., 2009; Anker, 2010; Davie & Ng, 2012). Our SCUBA surveys over three consecutive years (2010–2012) in the submarine caves at Christmas Island have collected several interesting marine animals (Ng & Naruse, 2014; Tan et al., 2014). The present paper documents the most peculiar crab species collected from one of the submarine caves. This species is superficially similar to cavernicolous species of *Orcovita* Ng & Tomascik, 1994 (Varunidae), which also occur in anchialine pools at Christmas Island (Davie & Ng, 2012), in their pale colour and relatively small size (ca. 11 mm carapace width) and slender ambulatory legs, although differing significantly from *Orcovita* in its highly reduced eyes. A detailed examination showed that this cave crab is a member of the superfamily Pseudozioidea Alcock, 1898, but must be referred to a new family, genus and species, here named *Christmaplax mirabilis* in the Christmaplacidae.

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MATERIAL AND METHODS

Measurements refer to the carapace length × carapace width (in millimetres). The material examined is deposited in the Queensland Museum (QM), Brisbane, Australia; Ryukyu University Museum, Fujukan (RUMF), University of the Ryukyus, Japan; Florida Museum of Natural History, University of Florida (UF), Gainesville, U.S.A.; and Zoological Reference Collection (ZRC) of the Lee Kong Chian Natural History Museum (formerly Raffles Museum of Biodiversity Research), National University of Singapore. The abbreviations G1 and G2 are used for the male first and second gonopods, respectively; P2–P5 refer to pereopods 2–5, corresponding to ambulatory legs 1–4, respectively.

For comparative pseudozioid material, the following specimens were studied in addition to those already listed in Ng & Wang (1994), Ng & Liao (2002), Ng (2003, 2010), Ng & Kazmi (2010) and Ng & Ahyong (2013): *Haemocinus elatus* (A. Milne-Edwards, 1873): RUMF-ZC-3648, 1 male (exuvium), 8.7 × 11.4 mm, Midara, Iriomote Island, Ryukyu Islands, Japan. *Planopilumnus spongiosus* (Nobili, 1906): UF14594, 1 male, 13.0 × 16.6 mm, 1 female, 12.7 × 15.7 mm, Trois Freres islet, near Nosy Be, Madagascar, coll. G. Paulay et al., 20 May 2008. *Pseudozius caystrus* (Adams & White, 1849): RUMF-ZC-3016, 2 males, 7.0 × 12.3 mm, 13.5 × 23.0 mm, 1 female, 8.8 × 15.7 mm (with epicaridian parasite), Uguisu Bech, Ani Island, Bonin Islands, Japan, coll. T. Naruse et al., 2 March 2013; RUMF-ZC-3017, 2 males, 7.2 × 12.7 mm, 8.7 × 15.9 mm (with epicaridian parasite), 1 female, 8.0 × 14.0 mm, Mansaku Beach, Ani Island, Bonin Islands, Japan, coll. T. Naruse et al., 28 February 2013.

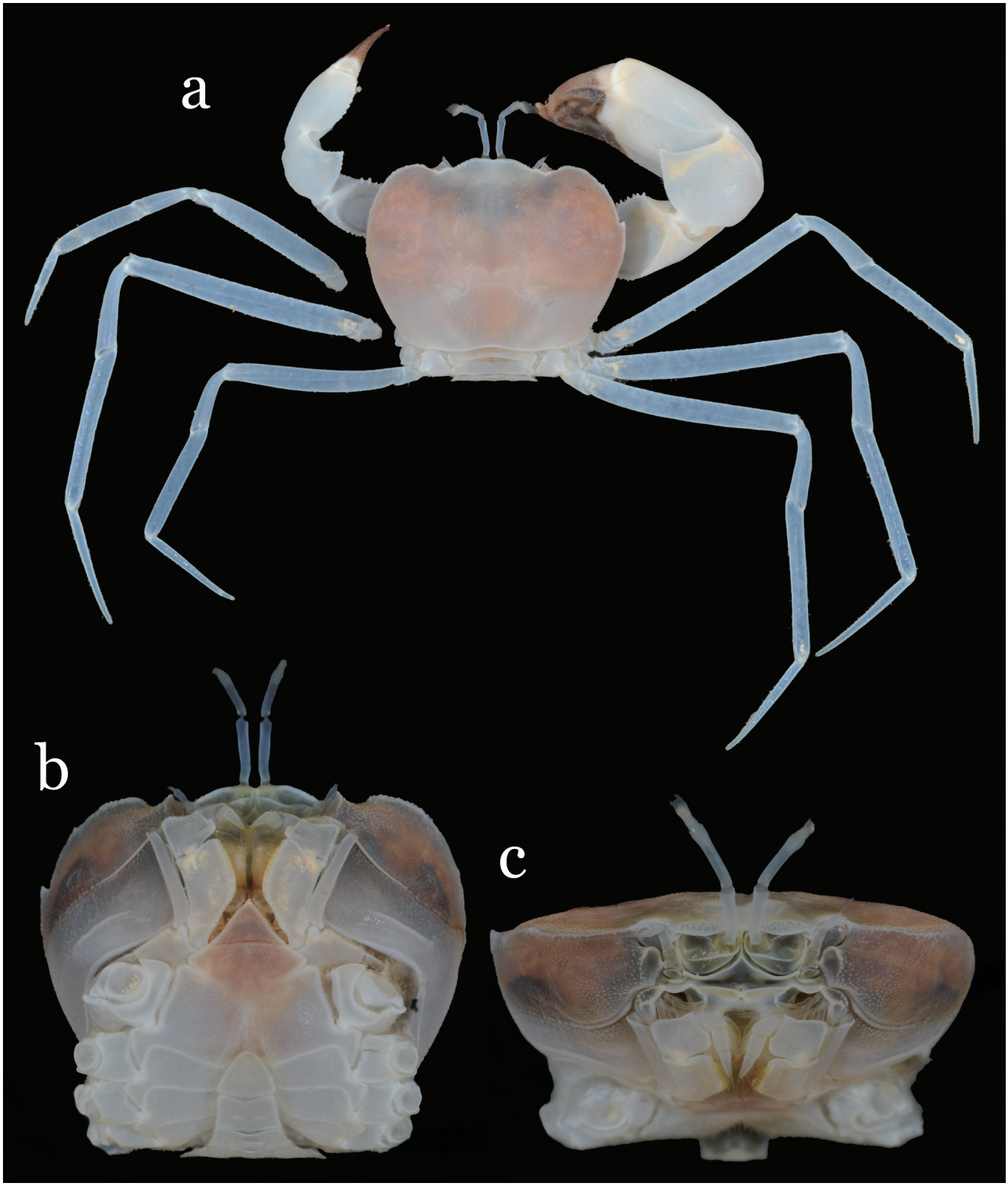

Fig. 1. *Christmaplax mirabilis*, new species; holotype male, 7.9 × 11.0 mm, QM W29223. a, habitus; b, cephalothorax, ventral view; c, cephalothorax, frontal view.

TAXONOMY

Superfamily Pseudozioidea Alcock, 1898
Christmaplacidae, new family

Type genus. *Christmaplax*, new genus, by present designation.

Diagnosis. Carapace subovate, regions poorly defined (Figs. 1a, 3a); endostomial ridge strongly developed (Figs. 1c, 2a); antennules well developed; second and third articles very long, not retractable into antennular fossa (Fig. 2a, b); antennal basal article quadrate, barely mobile, subsequent 2 articles elongate (Figs. 2a, 6a). Male thoracic sternites 1 and 2 fused, forming right-angled triangle; thoracic sternite 3 demarcated from sternite 2 by strong transverse ridge (Figs. 1b, 6c); thoracic sternites 3 and 4 demarcated by lateral sutures, medially interrupted except for shallow groove; sternite 4 long, width of male sternite 4 between P1 3.5 times distance between tip of closed telson to center of border between sternites 3/4 (Figs. 1b, 6c); male abdominal locking mechanism (press-button) present as rounded tubercle on median part of thoracic sternite 5 (Fig. 6c); penis protruding from gonopore anterior to proximal portion of P5 condyle (Fig. 6d). Cheliped merus lobiform-cristate, spiniform (Figs. 1a, 2d, 3); carpus with strong, sharp, lamellar tooth on inner margin (Figs. 1a, 2d, 3a). Male abdomen relatively broad; all somites and telson free (Fig. 5a). G1 slender, sinuous, surfaces without spines or sharp granules (Fig. 5b); G2 about one-third of G1 length, petaloid distally without long distal segment (Fig. 5c).

Remarks. The proportions of the lengths of the G1 and G2 (G2 about one-third length of G1), position of the penis (protruding on a gonopore that is anterior to the proximal portion of the condyle) and vulval stucture (relatively large vulva without operculum; vulvae positioned relatively close to each other) of *Christmaplax*, new genus, indicate that it is a member of Pseudozioidea Alcock, 1898 (see Ng, 2010: 35). The Pseudozioidea currently contains three families: Pseudoziidae Alcock, 1898, Planopilumnidae Serène, 1984, and Pilumnoididae Guinot & Macpherson, 1987 (Ng et al., 2008; Ng, 2010). These families have been recognised relatively recently (see Ng et al., 2008; Ng, 2010; Ng & Ahyong, 2013) and detailed diagnoses for the three are still lacking. In the context of the new family recognised here, all three are discussed at length and diagnostic characters of four families are summarised in Table 1.

Ng et al. (2008: 179) discussed the status of the monotypic *Flindersoplax* Davie, 1989 (type species *Heteropanope vincentiana* Rathbun, 1929). Števčić (2005) had established the family Flindersoplacidae for the genus but Ng et al. (2008) argued it was not necessary and retained it in the Pseudoziidae, noting that it is close to *Pseudozius*. Ng (2010) revised the Planopilumnidae but did not consider *Flindersoplax*. The present reappraisal of the families as required in this study of *Christmaplax* has compelled us to reappraise its status. Although its carapace is ovate (Davie, 1989: fig. 12), its relatively wide proportions, and more

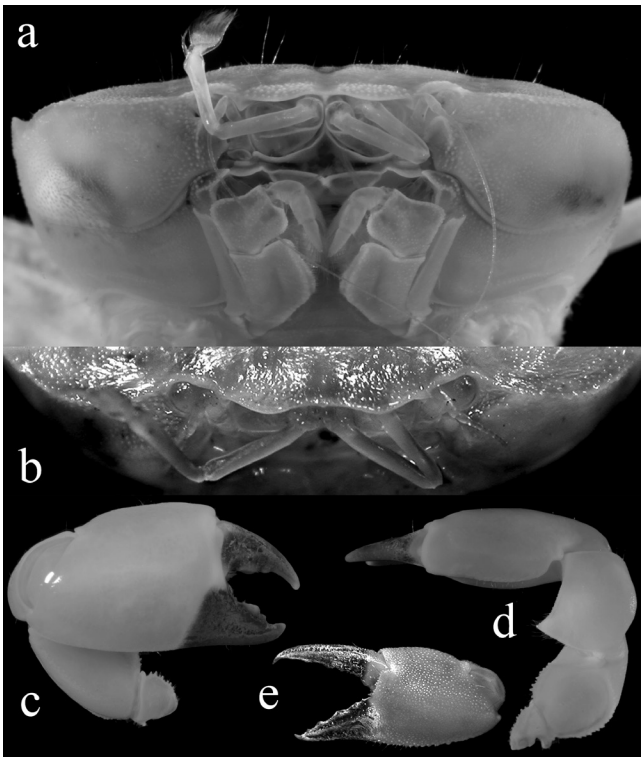

Fig. 2. *Christmaplax mirabilis*, new species, holotype male, 7.9 × 11.0 mm, QM W29223. a, cephalothorax, ventroanterior view; b, anterior part of cephalothorax, dorsal view; c, right chela, outer view; d, right cheliped, upper view; e, left chela, outer view.

significantly, the form of its anterior male thoracic sternum (sternites 3 and 4 are together much wider than long; Davie, 1989: fig. 11F), male abdomen with relatively wide somites 2 and 3 (Davie, 1989: fig. 11E) and a stout G1 with numerous spinules (Davie, 1989: fig. 11H, I) are diagnostic of Planopilumnidae; and for all intents and purposes, should be accommodated in this family. Planopilumnids otherwise have a more quadrate rather than ovate carapace as in pseudoziids, but this character is now regarded as less useful in many Brachyura (see Lai et al., 2011). In any case, the carapace of the planopilumnid *Haemocinus* Ng, 2003, is subquadrate (Ng, 2003: figs. 1A, 2, 3, 4A, B). As such, *Flindersoplax* is transferred to the Planopilumnidae.

Three groups can be recognised based on the relative width of the male anterior thoracic sternum (sternites 1–4). In the Planopilumnidae, sternite 4 is distinctly wider than sternite 3 and the width of sternite 4 is greater than the combined length of sternites 3 and 4, forming a transversely rectangular structure (cf. Davie, 1989: fig. 11F; Ng, 2003: figs. 1B, 6D; Ng, 2010: figs. 3B, 5B, 6H, 11C). In the Pseudoziidae, sternite 4 is also wider than sternite 3; and the width of sternite 4 is subequal to the combined length of sternites 3 and 4, resulting in a squarish structure (cf. Ng & Wang, 1994: figs. 2e, 6d; Ng & Liao, 2002: figs. 1c, 3c). In the Pilumnoididae, sternite 3 is much wider than sternite 4; and the width of sternite 3 is distinctly less than the combined length of sternites 3 and 4, resulting in a longitudinally rectangular structure (cf. Guinot & Macpherson, 1987: fig. 1; Ng & Ahyong, 2013: figs. 1C, 3C). In the form of the anterior thoracic sternites, *Christmaplax* most closely resembles the Pseudoziidae;

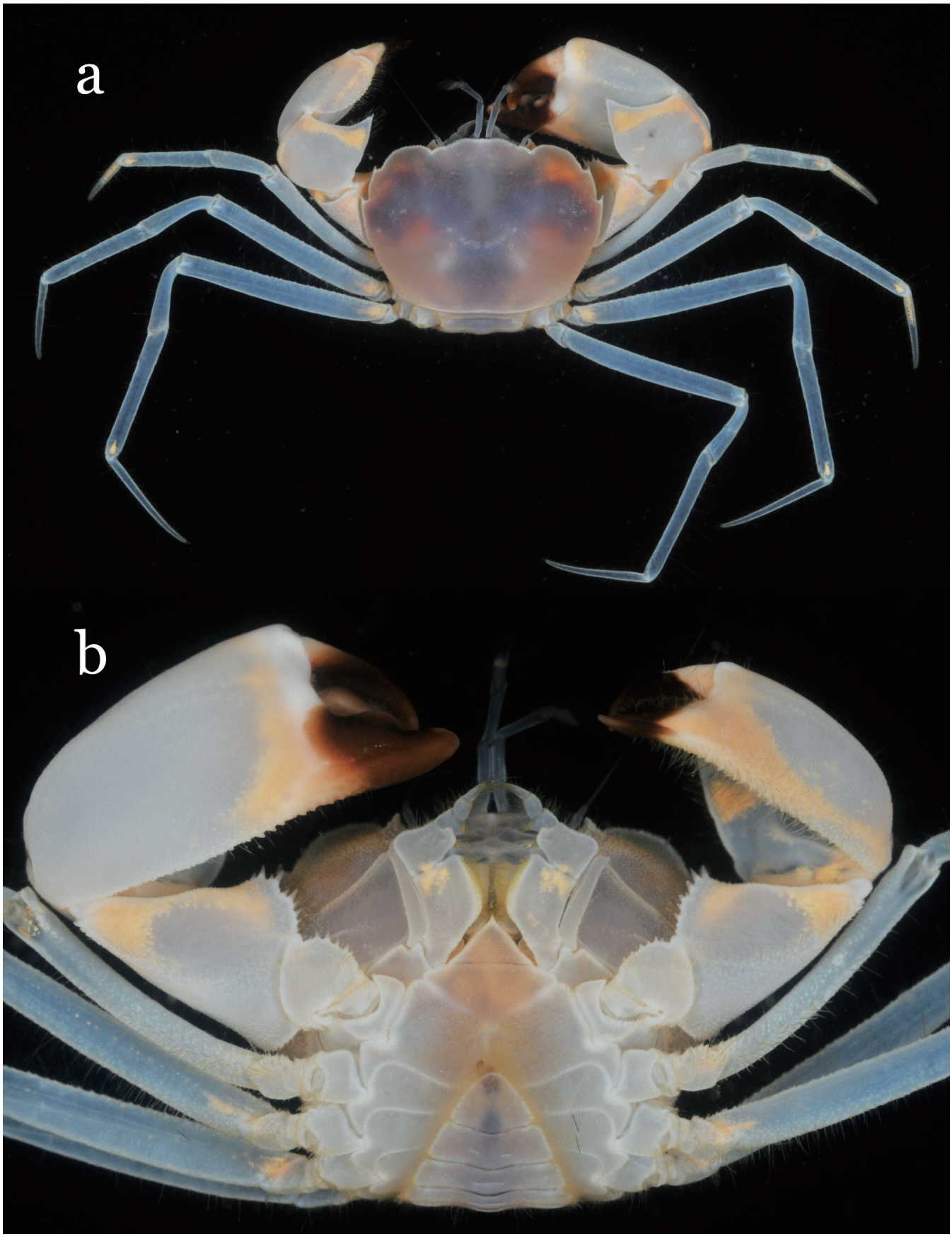

Fig. 3. *Christmaplax mirabilis*, new species; paratype female, 8.3 × 11.3 mm, ZRC 2014.0814. a, habitus; b, cephalothorax and chelipeds, ventral view.

Fig. 4. *Christmaplax mirabilis*, new species; paratype female, 8.3 × 11.3 mm, ZRC 2014.0814, in situ. Photographed by Yoshihisa Fujita.

but unlike pseudoziids, sternites 1 and 2 in *Christmaplax* form a right-angled triangle (Fig. 6c) rather than a broader triangle with concave lateral margins and pointed tip in most pseudoziids (cf. Ng & Wang, 1994: figs. 2e, 6d; Ng & Liao, 2002: figs. 1c, 3a). The structure of the thoracic sternum is also closely associated with the form of the sternoabdominal cavity. Among the species for which the male anterior sternum has been figured, the ratio of the distance between the tip of the male telson (when it is completely closed) to the suture of thoracic sternites 3 and 4, to the width of thoracic sternite 4 is different between genera of Planopilumnidae and the other two families; the ratios of planopilumnid genera are 3.80 to 11.52, whereas those of other two families are 2.60 to 2.65 in genera of Pseudoziidae and 2.38 in Pilumnoididae. In Christmaplacidae, the ratio is 3.53.

The position of the press-button male abdominal locking mechanism is significant. In all planopilumnids, the press-button is always positioned on or near the posterior margin of thoracic sternite 5 (cf. Ng, 2003: fig. 6D; Ng, 2010: fig. 11C). In pseudoziids, it is on the posterior margin of thoracic sternite 5 (unpublished data). In pilumnoidids, the press-button is either on the posterior margin of thoracic sternite 5 (Ng & Ahyong, 2013) or in a medial position (Guinot & Macpherson, 1987: fig. 1). In *Christmaplax*, it is clearly medial in position (Fig. 6c) so is most similar to Pilumnoididae in this respect.

The relatively broad male abdomen of *Christmaplax* (Fig. 5a) most closely resembles that of planopilumnids (cf. Davie, 1989: fig. 11E; Ng, 2003: fig. 6F; Ng, 2010: figs. 7A, 12F) in its general shape and proportions of the somites. In pseudoziids, the male abdomen is relatively more slender, especially for somites 2–4 (cf. Ng & Wang, 1994: figs. 3i, 4a, 7g; Ng & Liao, 2002: fig. 3c); and in pilumnoidids, it is very slender and long (cf. Guinot & Macpherson, 1987: fig. 1; Ng & Ahyong, 2013: fig. 3D).

The structure of the antennules is unique in *Christmaplax*. In all other pseudozioids, the articles of the antennule can fold into the fossa completely (cf. Guinot & Macpherson, 1987: pl. 2F; Davie, 1989: fig. 11A; Ng & Wang, 1994: figs. 2c, 3a, 6b; Ng & Liao, 2002: fig. 2a; Ng, 2003: figs. 1C, 4C, 6B; Ng, 2010: figs. 1B, 3A, 4B, 5C, 6B, 11B, C, 12B; Ng & Kazmi, 2010: figs. 1C; 4C, 5B, 6C; Ng & Ahyong, 2013: figs. 1B, 3A). In *Christmaplax*, the articles are too long to retract into the fossa (Fig. 2a). The inability to retract the antennules is a character shared by chasmocarcinids (cf. Serène, 1964a, 1964b). However, the simple coxal condition of the penis of *Christmaplax* (Fig. 6d) excludes

Table 1. Summary of diagnostic chracters of pseudozioid families.

	Pseudoziidae	**Planopilumnidae**	**Pilumnoididae**	**Christmaplacidae**
Carapace contours	Oval; posterolateral margins strongly converged posteriorly (e.g., Ng & Wang, 1994: figs. 1a, b, 2a, h, 5a, b, 7h).	Subtrapezoidal to subrectangular, sometimes ovate; posterolateral margins moderately converged posteriorly (e.g., Davie, 1989: fig. 12; Ng, 2010: figs. 1A, 2, 4A, 5A, 6A, 8, 11A).	Subcircular; posterolateral margins strongly converged posteriorly (e.g., Guinot & Macpherson, 1987: pls. 1, 2).	Subovate; posterolateral margins moderately converged posteriorly (e.g., Figs. 1a, 3a).
Antennules	Second and third articles short, completely retracting into fossae (e.g., Ng & Wang, 1994: figs. 2c, 3a, 6b).	Second and third articles short, completely retracting into fossae (e.g., Ng, 2010: figs. 1B, 3A, 4B, 5C, 6B, 11B, C, 12B).	Second and third articles short, completely retracting into fossae (e.g., Guinot & Macpherson, 1987: pl. 2F).	Second and third articles very long, unable to retract into fossae (Figs. 1c, 2a, b).
Cheliped merus and carpus	Merus subcylindrical without lobiform process; carpus with low, sharp tooth, lobiform (e.g., Ng & Liao, 2002: fig. 1a).	Merus subcylindrical without lobiform process; carpus with low, sharp tooth, not prominently lobiform (e.g., Ng, 2010: figs. 2, 5A, 6E).	Merus subcylindrical without lobiform process; carpus with low tooth (e.g., Guinot & Macpherson, 1987: pls. 1, 2).	Merus lobiform-cristate, spiniform; carpus with strong, sharp, lamellar tooth on inner margin (Figs. 1a, 2d, 3a).
Male thoracic sternites 1 and 2	Form a broad triangle with concave lateral margins and pointed tip (e.g., Ng & Liao, 2002: figs. 1c, 3a).	Form a right-angled triangle (e.g., Ng, 2010: figs. 3B, 5B, 6H, 11C).	Form a broad triangle with concave lateral margins and pointed tip or almost a right-angled triangle (e.g., Guinot & Macpherson, 1987: fig. 1; Ng & Ahyong, 2013: fig. 3c).	Form a right-angled triangle (Fig. 6c).
Relative proportions of male thoracic sternite 4	Sternite 4 is wider than sternite 3; width of sternites 4 subequal to combined length of sternites 3 and 4, forming squarish structure (e.g., Ng & Wang, 1994: figs. 2e, 6d).	Sternite 4 distinctly wider than sternite 3, width of sternite 4 is greater than combined length of sternites 3 and 4, forming transversely rectangular structure (e.g., Ng, 2010: figs. 3B, 5B, 6H, 11C).	Sternite 3 much wider than sternite 4; width of sternite 3 distinctly less than combined length of sternites 3 and 4, forming longitudinally rectangular structure (cf. Guinot & Macpherson, 1987: fig. 1).	Sternite 4 is wider than sternite 3; width of sternite 4 subequal to the combined length of sternites 3 and 4, forming squarish structure (Fig. 6c).
Telson-thoracic suture 3/4) / width of thoracic sternite 4	2.60 (*Euryozius camachoi*, Ng & Liao, 2002: fig. 3a); 2.65 (*Pseudozius caystrus*, present study).	3.80 (*Planopilumnus spongiosus*); 8.40 (Ng, 2003: fig. 6D); 11.52 (*Platychelonion planissimum*, present study).	2.38 (*Pilumnoides perlatus*, Guinot & Macpherson, 1987: fig. 1).	3.53 (present study).
Position of male abdominal locking mechanism (press-button)	On posterior margin of thoracic sternite 5 (unpublished data).	On or near posterior margin of thoracic sternite 5 (e.g., Ng, 2003: fig. 6D).	On posterior margin of thoracic sternite 5 or in medial position (cf. Ng & Ahyong, 2013; Guinot & Macpherson, 1987: fig. 1).	Distinctly medial in position (Fig. 6c).
Male abdomen shape	Relatively more slender, especially for somites 2–4 (e.g., Ng & Liao, 2002: fig. 3c).	Relatively broad (e.g., Ng, 2003: fig. 6F).	Very slender, long (cf. Guinot & Macpherson, 1987: fig. 1).	Relatively broad (Fig. 5a).

	Pseudoziidae	**Planopilumnidae**	**Pilumnoididae**	**Christmaplacidae**
G1	Relatively slender, long, gently curved, tapering; or stout, only slightly sinuous, tip bluntly pointed, simple or flared; lateral margins lined with distinct spinules (e.g., Ng & Wang, 1994: figs. 4b, c, 8a, b, 9a, c).	Stout, gently curved, tapering or prominently dilated, appearing flared; or more slender, long, gently curved outwards, distal part tapering to sharp tip; lined with distinct spinules (e.g., Ng, 2010: figs. 4C, D, 7B–D, 12G–I).	Slender, to stout, straight to weakly curved; lined with distinct spinules (e.g., Guinot & Macpherson, 1987: figs. 5A, C, E, G, 6A, C, E, H).	Slender, sinuous, without spinules on lateral margins (Fig. 5b).
G2	About half or shorter than half length of G1 (e.g., Ng & Wang, 1994: figs. 4f, 8e, 9e; Ng & Liao, 2002: fig. 3f).	About half length of G1 (e.g., Ng, 2010: figs. 4E, F, 7E, 12J).	About a third length of G1 (e.g., Guinot & Macpherson, 1987: figs. 5B, D, F, H, 6B, D, G, I).	About half length of G1 (Fig. 5c).

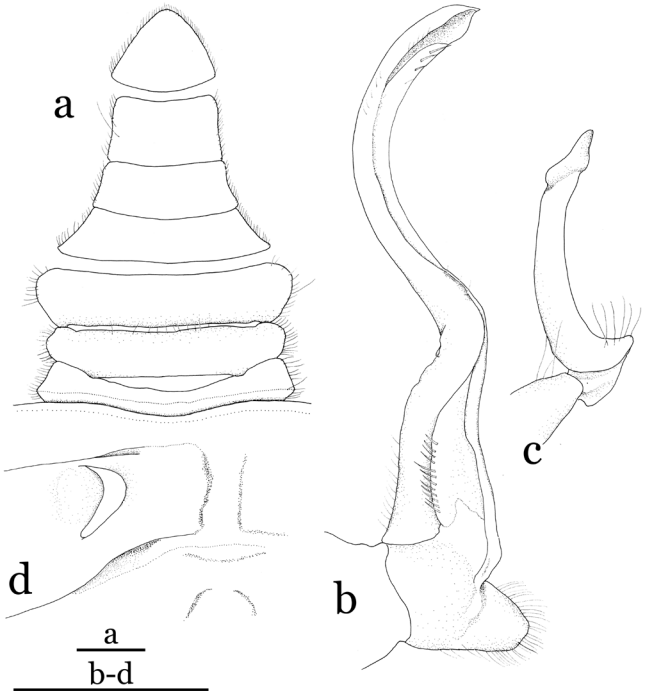

Fig. 5. *Christmaplax mirabilis*, new species; a–c, holotype male, 7.9 × 11.0 mm, QM W29223; d, paratype female, 8.3 × 11.3 mm, ZRC 2014.0814. a, abdomen, telson and posterior margin of carapace; b, left G1, ventral view; c, left G2, ventral view; d, right sexual opening and thoracic sternites 5 and 6. Scale bars = 1.0 mm.

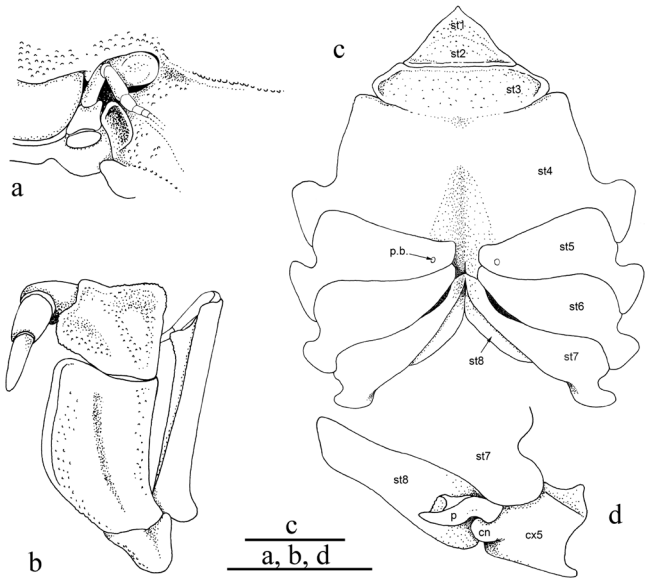

Fig. 6. *Christmaplax mirabilis*, new species; holotype male, 7.9 × 11.0 mm, QM W29223. a, frontal view of cephalothorax showing antennae and orbit (antennular articles not drawn); b, left third maxilliped (setae not drawn); c, male thoracic sternum and sternoabdominal cavity; d, left side of thoracic sternum showing penis. Abbreviations: cn = condyle of fourth ambulatory leg; cx5 = coxa of fourth ambulatory leg; p = penis; p.b. = press button; st1–8 = thoracic sternites 1–8. Scale bars = 1.0 mm.

its classification in the Chasmocarcinidae Serène, 1964a. True chasmocarcinids have a coxosternal condition for the penis, with the organ lodged in a channel on the sternum and covered by a supplementary plate (cf. Serène, 1964a, 1964b; Davie & Guinot, 1996).

The structure of the G1 of *Christmaplax* is unique in the Pseudozioidea. It is distinctly sinuous, without spinules on its lateral margins (Fig. 5b), and closely resembles those of most pilumnoids. In pseudozioids, the G1 is almost straight, gently curved or only slightly sinuous and the lateral margins are lined with distinct spinules (cf. Guinot & Macpherson, 1987: figs. 5A, C, E, G, 6A, C, E, H; Serène, 1984: fig. 242; Davie, 1989: fig. 11H, I; Ng & Wang, 1994: figs. 4b, c, 8a, b, 9a, c; Ng & Liao, 2002: fig. 3d, e; Ng, 2003: fig. 7F, G; Ng, 2010: figs. 4C, D, 7B–D, 12G–I; Ng & Ahyong, 2013: fig. 3E, F).

In the G2s of planopilumnids, pseudoziids and pilumnoidids, the basal segment of the G2 is long and slender; with the distal segment usually slightly elongated (cf. Guinot & Macpherson, 1987: figs. 5B, D, F, H, 6B, D, G, I; Serène, 1984: fig. 243; Davie, 1989: fig. 11J, K; Ng & Wang, 1994: figs. 4f, 8e, 9e; Ng, 2003: fig. 7H; Ng, 2010: figs. 4E, F, 7E,

12J; Ng & Ahyong, 2013: fig. 3G, H). Only in the pseudoziid *Euryozius* is the G2 relatively short and the distal segment also elongated (Ng & Liao, 2002: fig. 3f). In proportions, the G2 of *Christmaplax* most closely resembles that of *Euryozius* except that the distal segment is not elongated (Fig. 5c).

With regards to the more rounded carapace shape, *Christmaplax* resembles those of pilumnoidids (cf. Guinot & Macpherson, 1987: pls. 1, 2; Ng & Ahyong, 2013: fig. 1A). In planopilumnids and pseudoziids, the carapace is much broader than long. The immobile eyes without pigmentation, elongated antennules that cannot retract into their fossae, large lobiform inner carpal spine of the cheliped, large lobiform and spiniform flexor margin of the merus of the cheliped, and the elongated ambulatory legs are unique characters in the Pseudozioidea. Consideration of all the available characters discussed above mean that *Christmaplax* cannot be classified in the Pseudoziidae, Planopilumnidae or Pilumnoididae as now understood. The only recourse is therefore to place *Christmaplax* in its own family, Christmaplacidae, in the Pseudozioidea.

It is also important to note that in a recent study, Lai et al. (2014: 60) observed that the molecular data did not appear to support the composition of the Pseudoziidae as recognised at present, with *Pseudozius* possibly allied to *Eriphia* Latreille, 1817 (Eriphiidae MacLeay, 1838) and *Euryozius* sister to *Carpilius* Desmarest, 1823 (Carpiliidae Ortmann, 1893), despite their generally dissimilar morphologies. However, the statistical support for the molecular trees was rather weak, and clearly more work needs to be done with superfamilies such as Eriphioidea, Carpilioidea and Pseudozioidea. Members of these superfamilies have many plesiomorphic characters, and their relationships remain unclear (see discussion in Lai et al., 2014). Certainly a detailed molecular study of the Pseudozioidea should help clarify relationships within the superfamily.

Christmaplax, new genus

Type species. *Christmaplax mirabilis*, new species, by present designation.

Diagnosis. As for family.

Etymology. The genus name "*Christmaplax*" is derived from an arbitrary combination of the type locality of the type species, Christmas Island, and a common suffix for brachyuran genera "*-plax*". Gender feminine.

Christmaplax mirabilis, new species
(Figs. 1–6)

Material examined. Holotype male, 7.9 × 11.0 mm, QM W29223, station CI-D04, Thundercliff cave, Christmas Island, Australia, about 150 m from the underwater entrance of the cave, with large air pocket and influence of freshwater, at water depth about 1–2 m, in a narrow crack of limestone, coll. T. Naruse & Y. Fujita, 15 February 2012. Paratype: 1 female, 8.3 × 11.3 mm, ZRC 2014.0814, station CI-D07, same locality as holotype, at water depth about 5 m, coll. Y. Fujita & T. Naruse, 16 February 2012.

Description. Carapace subovate, 1.36–1.39 times wider than long, dorsal surface relatively flat, only slightly convex, regions poorly defined; H-shaped gastric grooves barely discernible (Figs. 1a, 3a). Front weakly produced anteriorly, with slight medial concavity in dorsal view, appearing as gentle concavity in ventral projection from anterior view (Figs. 1a, 2a, 3a). Supraorbital margin granulated, with low granulated angle submedially, separated from front by small notch, ventral projection present below notch, notch separating antennule fossa and orbit in frontal view; neither infraorbital margin nor below external orbital angle rimmed (Figs. 1a, c, 2a, 3a, 6a); orbit small, laterally unarmed, inner orbital angle produced anterolaterally as subvertical lobiform tooth, mesial surface forming cavity for accommodating distal end of second antennular article when folded, tooth produced anteriorly beyond orbit when viewed dorsally (Figs. 1a, c, 2b, 3a, 6a). External orbital angle not clearly marked in dorsal view, margin between orbit and first epibranchial tooth forming widely rounded lobe (Figs. 1a, 3a). Anterolateral margin with 2 strong teeth in female paratype; male holotype with weak first tooth and strong second tooth on right side, no trace of teeth on left side (previously damaged, injury scars visible) (Figs. 1a, 3a). Posterolateral margins almost straight, convergent posteriorly; surfaces covered with tiny granules (Figs. 1a, 3a). Suborbital, subhepatic and pterygostomial regions covered with tiny granules; pterygostomial region with 1 granulated ridge anterior to relatively wide Milne Edwards' aperture (Figs. 1b, c, 2a, 6a). Epistome short, with medial transverse depression, posterior margin with a small median projection (Figs. 1c, 2a). Endostomial ridge strongly developed (Fig. 1c, 2a).

Antennules developed; basal antennular segment large, high, upper half forming cavity for second article; second and third articles very long, cannot retract into antennular fossae (Figs. 1c, 2a, b); mesial concavity of inner orbital angle accommodating joint of second and third antennular articles when folded (Fig. 2a). Antennal basal article quadrate, slotted into orbit, barely mobile, subsequent 2 articles elongate, cylindrical (Figs. 2a, 6a); flagellum very long, reaching beyond second anterolateral tooth when folded laterally along anterolateral margin (Figs. 1c, 2a).

Eye reduced, immovable; not visible from dorsal view of carapace, with small granules on dorsal surface; cornea not clearly discernible, remnant just visible as slightly raised, rounded, golden spot distally from subdorsal view (Figs. 1c, 2b, 6a).

Buccal cavern convergent posteriorly (Figs. 1b, c, 2a, 3b). Male thoracic sternites 1 and 2 fused, forming right-angled triangle, sternites barely discernible by shallow groove; thoracic sternite 3 demarcated from sternites 2 by strong transverse ridge (Figs. 1b, 6c); thoracic sternites 3 and 4 demarcated by lateral sutures, medially interrupted except for shallow groove; sternite 4 long, width of male sternite 4 between P1 3.53 times distance between tip of closed telson

to center of border between sternites 3/4 (Figs. 1b, 6c); press-button male abdominal locking mechanism present as rounded tubercle on median part of thoracic sternite 5 (Fig. 6c); thoracic suture 6/7 connected medially, with narrow hole along suture on slope of thoracic cavity, suture 7/8 meeting medially, distally connected to longitudinal suture; sternite 7 widely exposed when abdomen closed, wider than long (Figs. 1b, 6c).

Penis stout, protruding from gonopore anterior to proximal portion of P5 condyle (Fig. 6d). Female thoracic structure similar to that of male (Fig. 3b); vulvae relatively large, occupying nearly half length of sternite 6, short, wide sternal cover developed from lateral margin (Fig. 5d); medial part of thoracic sternites 6 and anterior part of sternite 7 semi-transparent, forming bridge-like structure on posterior margin, suture 7/8 complete, sternite 8 with longitudinal median suture.

Third maxillipeds with narrow triangular median hiatus when closed (Figs. 1b, c, 2a, 3b); ischium long, mid-length about twice of that of merus, with shallow median oblique sulcus; merus quadrate, anterior margin concave, proximal third of mesial margin produced mesially, margins granulated; carpus, propodus, dactylus similar in length; exopod slender, with subdistal triangular tooth on mesial margin, flagellum long (Fig. 6b).

Chelipeds asymmetrical, right chelipeds stronger in examined material, no obvious sexual difference (Figs. 1a, 3a). Basis and ischium fused, suture clearly visible. Basis-ischium to merus of both chelipeds lined with sharp teeth on anterior margin, upper margin of merus lobiform, cristate, spiniform, lower outer margin with subdistal tooth (Figs. 1a, 2d, 3a, b). Carpus smooth, with strong, sharp, lamellar tooth on inner margin (larger in major cheliped), almost glabrous except for slightly pubescent surfaces beneath inner angle (Figs. 1a, 2d, 3a). Major male chela nearly smooth, weakly granulated on upper and lower surfaces, upper surface with longitudinal carina near inner surface, inner side of carina lined with short setae, outer side only with sparse setae, lower margin granulated (Fig. 1a, 2c, d); major female chela similar to male but with lower margin strongly granulated (Fig. 3a, b). Major chela with fingers short, stout; immovable finger longer than movable finger, almost straight except for upcurved tip; base of fingers with molariform teeth, occlusal surface with proximal inner and subproximal outer blunt teeth on proximal half, crowns of both teeth abraded; holotype with additional smaller teeth on distal half (Fig. 2c). Movable finger gently curved downwards, with proximal flattened stout tooth of paratype occupying proximal half, while that of holotype occupying subproximal quarter of length, base with tuft of short setae (Fig. 2c). Minor chelae with similar form and number of teeth, setae and granules, except for its smaller size, granulation more distinct, appears serrated, on lower surface of palm, and smaller finger teeth (Figs. 1a, 2e, 3a).

Ambulatory legs very slender, long; P4 longest, combined length of merus to dactylus 2.30–2.44 times carapace width (Figs. 1a, 3a, 4). Margins of legs with scattered long, stiff setae; basis with granules and short spines; merus to dactylus with subparallel margins, anterior and posterior margins of P2, P3 meri distinctly granulated or with short spines; anterior margins of P4, P5 meri granulated, posterior margins weakly granulated to almost smooth; dactylus terminating in sharp claw (Figs. 1a, 3a).

Male abdomen with all somites and telson free (Fig. 5a); somites 1 and 2 short, first somite partially concealed under posterior margin of carapace, with transverse ridge; somite 3 widest, from distal third of somites 3, 4 abruptly narrowed; telson almost right triangular, rounded distally (Figs. 1b, 5a). Female abdomen with all somites and telson free; relatively narrow, somite 3 widest, telson wider than long (Fig. 3b); pleopods developed, with dense setation.

G1 slender, sinuous, proximal two-fifths relatively stout, surfaces without spines or sharp granules; distal two-fifths curved outwards, proximolateral lobe produced laterally, covering penis (Fig. 5b). G2 about one-third of G1 length, petaloid distally (Fig. 5c).

Colour. In life, the carapace is beige to white, with the anterior parts a pale purplish-pink. The chelipeds, ambulatory legs and ventral surfaces are mostly white; with the fingers of the chelae brown (Figs. 1, 3, 4).

Ecological notes. *Christmaplax mirabilis* was collected from inside Thundercliff cave. The cave has an entrance at the sea with a depth of about 10 m. There is a long air pocket, and water depth in the cave becomes shallower at about 30 m from the entrance. The submerged area occupies just one side of the cave floor, about 100 m to where *C. mirabilis* was collected. This cave is totally dark throughout the air pocket and no openings or light sources were observed. *Christmaplax mirabilis* was found in a pool with a water depth of about 1–2 m, in a narrow crack of the limestone (holotype), and a water depth of about 5 m at the floor of the pool (paratype, Fig. 4). This pool appears to have freshwater influence at the surface; and the water temperature at about 1 m was much colder than below this. The area that divers can access is only down to about 10 m, but the pool continues further inland.

The habitat of *C. mirabilis* has a relatively poor fauna; we could observe neritiliid gastropods, *Parhippolyte* sp. (Hippolytidae), *Pagurixus nomurai* Komai & Asakura, 1995 (Paguridae) and undescribed species of Paguridae and Diogenidae (M. Osawa, pers. comm.), as well as an unidentified acorn worm (Enteropneusta). Asymmetry of chelae of crabs is, in general, common in males, both male and female of *Christmaplax mirabilis* have a right chela stronger than the left (Figs. 1a, 2c, e, 3a, b). The abraded molariform teeth present on both fingers of the major chela of *C. mirabilis* are similar to those of molluscivorous crabs (see Bertness & Cunningham, 1981; West et al., 1991; Chia & Ng, 2006; Schubart & Ng, 2008). Cave gastropods may thus be an important food source for *Christmaplax mirabilis*.

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