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THE BLUE CRAB OF CHRISTMAS ISLAND, *DISCOPLAX CELESTE*, NEW SPECIES (CRUSTACEA: DECAPODA: BRACHYURA: GECARCINIDAE)

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ABSTRACT. — The indigenous Blue Crab of Christmas Island, previously misidentified as "*Discoplax hirtipes* (Dana, 1851)", is here recognised as a distinct new species, *D. celeste*. In addition to its unique blue-coloured carapace when adult, the new species can be distinguished from true *D. hirtipes* by carapace, male abdominal, and male first gonopod characters. To stabilise the taxonomy of *Cardisoma hirtipes* Dana, 1851, a neotype from the original type locality in Fiji, is selected. A separate eastern Indian Ocean taxon, *Discoplax* aff. *hirtipes*, present in the Andaman Islands, Nicobar Islands and western Sumatra is also found in small numbers on Christmas Island.

KEY WORDS. — Crustacea, Brachyura, *Discoplax*, new species, Christmas Island

INTRODUCTION

Christmas Island in the Indian Ocean is renowned for its land crabs (Gecarcinidae MacLeay, 1838), particularly the endemic Red Land Crab, *Gecarcoidea natalis* (Pocock, 1889). This species is present in huge numbers and its annual spawning migration has been described as one of the 10 living wonders of the planet. Also well known amongst those interested in carcinology is the endemic "Blue Crab" which, until now, has been considered a unique colour form of the widely distributed land crab, *Discoplax hirtipes* (Dana, 1851). The species was first recorded by Andrews (1900: 164) (incorrectly as *Cardisoma carnifex*), who wrote, "this species is now recorded from the island for the first time, the reason why it was not seen by previous collectors being that it occurs only in the neighbourhood of small fresh-water streams which up to the time of my visit had not been explored. In this island, at any rate, this species must be regarded as a fresh-water form, and, in fact, when a specimen was seen it might be taken as an indication that fresh water was not far off. It lives in deep holes in the mud at the sides and bottom of the brooks, and is especially common near the stream about two miles north of Steep Point. Its colour when living is a uniform light slate-grey. This form seems to differ slightly both in colour and in the proportions of its carapace from specimens in the Museum Collection from Tahiti, which have been referred to the same species."

The Blue Crab is less abundant than the Red Land Crab and has more aquatic habits, so it is restricted to parts of the island where there is surface fresh water (Gray, 1981, 1995; Hicks et al., 1984). It has also suffered more directly from human activities, and in particular was extensively harvested by the local people for food during the 1950s. As a result, it has been fully protected since 1980 (Hicks et al., 1984: 74–75) (see also Gray, 1981, 1995).

Studies of museum and fresh specimens of *Discoplax hirtipes* across most of its range in the Indo-West Pacific and eastern Indian Oceans, as well as an extensive series of specimens from Christmas Island, now shows that the Blue Crab is actually a distinct species. It is here described as new. In fact, Tweedie (1947) in his detailed account of the Christmas Island crabs had suggested as much. His comments are telling: "Alcock (l.c.) says of this species (referring to specimens from the Andamans and Nicobars) that the carapace in life is dark violet and the chelae bright cinnabar red. I have seen the species living on Christmas Island and recently received a series of freshly killed specimens from there from Dr. Gibson-Hill; the colour of the carapace of these crabs is light bluish grey and of the claws pale horn colour. I sent the specimens to Dr. B. N. Chopra of the Indian Museum for comparison with the material reported on by Alcock. He replied that the difference in colouration noticed by me could be seen in specimens that had long been preserved in spirit, but that he

could detect no significant morphological differences. In the absence of such I am not prepared to separate the Christmas Island form by name, but the matter is of considerable interest and observations on the living colours of this crab in others of the numerous localities where it occurs might furnish material for study of a form of geographical differentiation unusual in Crustacea." (Tweedie, 1947: 35). The present study confirms Tweedie's suspicions that the Christmas Island crabs belong to a separate taxon.

The first author and H.-T. Shih are currently revising *Discoplax* using a combination of morphological and genetic characters. This study is unlikely to be finished in the near future as numerous species are involved, and genetic samples from a wide range of localities are necessary. However, H.-T. Shih has kindly provided sequence data from the Christmas Island Blue Crab that show clear differences from the widely distributed *D. hirtipes* that helps confirm our present morphological results indicating it is a distinct new species endemic to the island. This reinforces the continuing need for its specific protection. Turner et al. (2011) voiced a particularly ominous warning: "During the survey, few juveniles were found, which could suggest an ageing population. Despite being protected by law on Christmas Island, this is potentially worrying for a species that due to its restricted distribution continues to be especially vulnerable to outside threats, including that of aggressive invasive species and long term habitat destruction." As such, we felt it was important to quickly formalise its novel status rather than wait for the planned full generic revision. The description of this new *Discoplax* species, as well as other new endemic crab species for the island (e.g., two new species of cave-dwelling *Orcovita* by Davie & Ng, 2012), has broader implications for the conservation management of all the island's endemic species (e.g., see Beeton et al., 2010).

The present paper is the third in a series that will treat the decapod crustaceans of Christmas Island and Cocos & Keeling Islands. These are based not just on the historical collections in the original Raffles Museum but also on two expeditions to the island in 2010 and 2011 by staff of the present Raffles Museum of Biodiversity Research of the National University of Singapore, supported by the staff of the Australian National Parks Board and the Queensland Museum (Xmas Island Expeditions 2010 and 2011). All the material collected in 2010 and 2011 were obtained during these expeditions, or had been collected by staff of the national parks in the last two years. One paper has already been published (Ng & Davie, 2011), while another is a companion paper in the present volume (Davie & Ng, 2012).

The material examined is deposited in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore; Muséum national d'Histoire naturelle (MNHN), Paris; and Queensland Museum (QM), Brisbane. The measurements provided (in millimetres) are of the carapace width and length, respectively. The abbreviations G1 and G2 are used for the male first and second gonopods, respectively.

TAXONOMY

Discoplax A. Milne-Edwards, 1867

Discoplax A. Milne-Edwards, 1867: 284; Balss, 1957: 1671; Guinot, 1979: 152; Türkay, 1987: 145; Guinot, 1994: 168; Ng & Guinot, 2001: 312; Davie, 2002: 185; Ng et al., 2008: 214.

Type species. — *Discoplax longipes* A. Milne-Edwards, 1867, by monotypy. Gender feminine.

Remarks. — Ng & Guinot (2001) separated *Discoplax* A. Milne-Edwards, 1867, from *Cardisoma* Latreille, 1828, and extensive remarks on the status of each genus are provided in that paper. *Discoplax*, as currently defined, contains five species, all from the Indo-West Pacific: *D. rotunda* (Quoy & Gaimard, 1824), *D. hirtipes* (Dana, 1851), *D. longipes* A. Milne-Edwards, 1867, *D. gracilipes* Ng & Guinot, 2001, and *D. celeste*, new species (described here).

Discoplax celeste, new species
(Figs. 1–4, 6C, 6D, 7F–J)

Cardisoma hirtipes: Balss, 1934: 226; Gibson-Hill, 1947: 48; Tweedie, 1947: 35; Türkay, 1974: 229 (part); George, 1978: 6; Hicks et al., 1984: 54; Morgan, 2000: 123 (not *Cardisoma hirtipes* Dana, 1851).

Discoplax hirtipes: Ng & Guinot, 2001: 334, 335 (part); Davie, 2002: 185 (not *Cardisoma hirtipes* Dana, 1851).

Material examined. — Holotype: male (106.0 × 83.6 mm) (QM-W29123), Waterfall Bay, near Christmas I. Resort, Christmas Island, coll. 30 Jan.2010. Paratypes: 1 male (41.9 × 36.5 mm) (QM-W8258), Christmas I., coll. J. Covacevich, Feb.1980; 1 male, 3 females (ZRC 1965.12.1.21–24), Ross Hill, coll. C. A. Gibson-Hill, Aug.–Sep.1932; 1 male (ZRC 2012.0026), Ross Hill Spring, coll. M. Orchard, 30 May 2005; 7 males, 1 female (ZRC 1965.12.1.13–20), coll. M. W. F. Tweedie, 1932; 1 male (68.3 × 50.2 mm), 3 females (largest 75.5 × 60.0 mm) (ZRC 1965.12.1.21–24), coll. M. W. F. Tweedie, Aug.–Sep.1932; 3 females (ZRC 2012.0020), station CI 11, Hosnie's Springs, freshwater spring, uplifted *Bruguiera* patch, sandy and limestone bedrock, 10°28.650'S, 105°41.491'E, coll. 24 Jan.2010; 6 males (ZRC 2012.0027), station CI 11, Hosnie's Springs, freshwater spring, uplifted *Bruguiera* patch, sandy and limestone bedrock, 10°28.650'S, 105°41.491'E, coll. 24 Jan.2010; 1 male (44.4 × 38.7 mm), 4 females (15.9 × 14.1 mm, 22.3 × 19.0 mm, 27.5 × 23.5 mm, 39.0 × 34.0 mm), 1 juvenile (7.9 × 7.1 mm) (ZRC 2012.0028), station CI 32, Hugh's Dale, freshwater springs, gravel muddy substrate and limestone blocks, 10°28.716'S, 105°33.556'E, coll. 3 Feb.2010; 3 young males, 4 young females, 1 juvenile (ZRC 2012.0019), 2 males (ZRC 2012.0017), station CI 32, Hugh's Dale, freshwater springs, gravel muddy substrate and limestone blocks, 10°28.716'S, 105°33.556'E, coll. 3 Feb.2010; 2 males (larger 103.9 × 77.8 mm) (ZRC 2012.0025), The Dales, coll. 3 Feb.2010; 2 males (ZRC 2012.0016), station CI 14, Whip Cave, along road to Waterfall Bay, in anchialine cave, loamy substrate, limestone bedrock, 10°25.377'S, 105° 42.081'E, coll. 27 Jan.2010; 2 females (42.4 × 35.8 mm, 47.1 × 39.2 mm) (ZRC 2012.0018), 2 males (99.3 × 80.8 mm, 60.9 × 51.1 mm), 2 females (75.4 × 61.4 mm, 80.6 × 66.1 mm) (QM-W29121), station CI 23, Waterfall Bay, near Christmas I. Resort, freshwater stream, sandy beach, limestone base rock, 10°27.54'S, 105°42.30'E, coll. 30 Jan.2010; 1 male (84.3 × 65.7 mm) (ZRC 2011.0166), stream near Waterfall Bay, before entrance of Christmas I. Resort, coll. P. K. L. Ng, Jan.2010; 1

female (82.7 × 66.3 mm) (ZRC 2011.0167), stream near Waterfall Bay, before entrance of Christmas I. Resort, coll. Jan.2010; 6 males, 2 females (ZRC 2011.0169), station CI 07, stream near Waterfall Bay, before entrance of Christmas I. Resort, coll. 23 Jan.2010; 4 males (largest 103.5 × 80.5 mm), 1 female (98.0 × 85.0 mm) (ZRC 2012.0022), Waterfall Bay, coll. Feb.2010; 1 male (104.9 × 82.7 mm) (ZRC 2012.0023), stream near Waterfall Bay, before entrance of Christmas I. Resort, coll. Mar.2011; 1 female (82.6 × 65.7 mm) (ZRC 2012.0024), Waterfall Bay, coll. Jan.–Feb.2010; 3 males (largest 112.7 × 88.5 mm), 1 female (ZRC 2012.0014), stream near Waterfall Bay, before entrance of Christmas I. Resort, coll. March 2011; 3 males (99.3 × 80.8 mm, 103.8 × 80.4 mm, 111.2 × 85.6 mm), 1 female (79.5 × 64.5 mm) (QM-W29122), 4 males (largest 106.2 × 83.4 mm) (ZRC 2012.0021), station CI 08, on path to Dolly Beach, 10°31.272'S, 105°40.512'E, coll. 23 Jan.2010. All localities in Christmas Island.

Comparative material examined: ***Discoplax hirtipes*** (Dana, 1851): Neotype male (64.2 × 53.0 mm) (ZRC 2010.0415), Suva Municipal Market, obtained by D. Huang, Fiji, 11 Dec.2010. Others: **New Caledonia** – 1 male (61.4 × 78.0 mm) (MNHN–B 24813), Loyalty Islands, Lifou Island, We Cave, coll. B. Richer de Forges, 14 Jul.1993; 1 male (61.0 × 79.0 mm) (MNHN–B 24811), Loyalty Islands. **Palau** – 1 male (79.5 × 63.1 mm), 1 female (ZRC 2000.1087), Anggaur Island, coll. S. H. Tan, Sep.1998; 1 male (87.4 × 68.3 mm) (ZRC 2000.1086), Anggaur Island, coll. S. H. Tan, Sep.1998; 1 male (86.4 × 68.5 mm) (ZRC 2000.1088), Anggaur Island, coll. S. H. Tan, Sep.1998. **Solomon Islands** – 1 male (54.2 × 45.3 mm) (QM-W15247), Tulagi Island, coll. J. Covacevich, 15 Dec.1976; 1 male (46.5 × 39.2 mm), 1 female (57.0 × 49.0 mm) (QM-W15248), on road leaving Honiara, Guadalcanal, coll. J. Covacevich, 15 Dec.1976. **Guam** – 1 male (93.5 × 73.4 mm) (ZRC 2001.2230), Pago Bay, coll. Louie, 31 Jul.2001; 1 male (66.6 × 54.0 mm) (ZRC 2001.0704), Merizo Bay, coll. P. K. L. Ng, 1 Aug.2001; 1 female with zoeae (ZRC 2001.705), Merizo Bay, coll. P. K. L. Ng, 1 Aug.2001. **Philippines** – 1 male (QM-W26690), in forest just outside of Virata Cave, Libaong, Panglao, Bohol, coll. P. K. L. Ng et al., 18 Dec.2000; 1 male (ZRC 2001.310), Panglao, Bohol, coll. P. K. L. Ng, 17 Dec.2000; 1 male (ZRC 2001.2308), Panglao, back beaches, coll. H.-C. Liu, 29 Nov.2001; 1 male (ZRC 2004.0462), Hinagdanan Cave vicinity, near Panglao I. Nature Resort, Panglao, Bohol, coll. P. K. L. Ng, 3 Mar.2004. **Taiwan** – 1 male (68.5 × 55.5 mm) (ZRC 1999.1039), 1 female (ZRC 1998.411), Hengchun Peninsula, Pingtung County, coll. H.-C. Liu & S. H. Tan, 22 May 1998; 2 males, 2 females (ZRC 1998.398, 439, 452, 472), Hengchun Peninsula, Pingtung, coll. H.-C. Liu et al., 19 May 1998; 2 males (larger 76.7 × 59.5 mm) (ZRC 1998.424), Hengchun Peninsula, Pingtung, coll. H.-C. Liu et al., 19 May 1998; 1 female (ZRC), Hengchun Peninsula, Pingtung County, coll. May 1998; 1 male (ZRC 1999.203), Hengchun Peninsula, Pingtung County, coll. P. K. L. Ng, 30 May 1997; 1 male (ZRC 1998.531), Hengchun Peninsula, Pingtung County, coll. P. K. L. Ng, 13 May 1998. **Japan** – 1 male (ZRC 1999.239), Yaeyama, Ryukyus, coll. 19 August 1969; 1 male (57.4 × 46.8 mm), 2 females (larger 64.2 × 53.7 mm), Kumejima Island, Rukyus, coll. P. K. L. Ng, Nov.2009; 1 female (ZRC 2009.0154), Funaura jetty and beach, Iriomote Island, Ryukyus, N. K. Ng & Y. Cai, 15 Jun.2000. **Indonesia** – 1 male, 1 female (ZRC 1965.12.1.11–12), Pulau Panjang, South Natuna Island, coll. August 1931; 1 male (54.5 × 44.1 mm) (ZRC 2003.0582), Geropok, Lombok, coll. local fisherman, 12 Feb.2002. **Vanuatu** – 3 males, 3 females (ZRC), Loganville Market, from around Santo Island, coll. P. K. L. Ng, 14 Sep.2006; 1 male (ZRC), near rocky areas at Maritime Centre, Santo, Vanuatu, coll. P. K. L. Ng, 10 Sep.2006. **Vietnam** – 1 male (ZRC 1973.10.31.275), Vietnam, coll. Nhathrang Oceanographic Institute, 9 Apr.1971. **Malaysia** – 2 males (ZRC 2000.2583), Pulau Pemanggil, Johor, coll. D. Chia, 11 Sep.1991. **Singapore** – 1 female (ZRC 1965.12.1.10), Paya Lebar, coll. Jul.1938. ***Discoplax* aff. *hirtipes***: **Indonesia** – 2 males (ZRC 1965.12.1.26–27), West Sumatra, coll. G. E. Rostados, 1897; 1 male (51.1 × 42.5 mm) (ZRC 2008.0575), Pantai Cerocok, Painan, West Sumatra, coll. J. C. Y. Lai & N. K. Ng, 6 Jul.2003; 1 male, 1 female (ZRC 1965.12.1.28–29), Sumatra, old museum exhibit; 1 male (69.7 × 55.5 mm) (ZRC 1965.12.1.25), South Pagi, Mentawei Island, coll. Dec.1902. **Nicobar Islands** – 12 males (largest 86.9 × 72.3 mm), 2 females (larger 66.4 × 55.1 mm) (ZRC 1965.12.1.30–39), Nicobar Islands, coll. C. A. Gibson–Hill, Oct.1950. **Christmas Island** – 1 female (47.1 × 39.7 mm) (ZRC 2012.0003), station CI 16, in beach forest, along road towards Dolly Beach, coll. P. K. L. Ng, 23 Jan.2010; 1 male (83.1 × 68.1 mm) (ZRC 2012.0004), stream near Waterfall Bay, before entrance of Christmas I. Resort, coll. P. K. L. Ng, 31 Mar.2011.

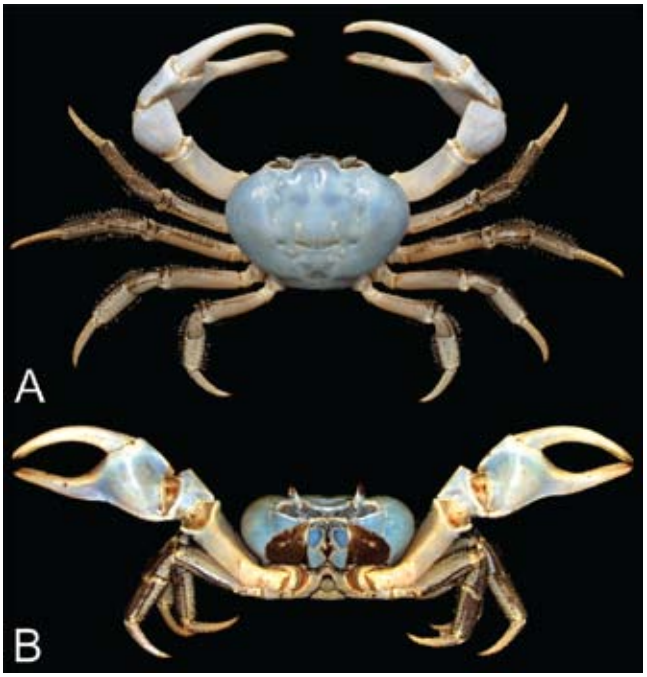

Fig. 1. *Discoplax celeste*, new species. Colour in life. Holotype male (106.0 × 83.6 mm) (QMW-29123), Waterfall Bay, Christmas Island. A, dorsal view; B, frontal view.

Diagnosis. — Adult (carapace width 45 mm or more) blue to bluish-white with completely white cheliped (Fig. 1). Carapace subovate, broader than long; dorsal surface evenly convex tranversely and longitudinally, regions poorly demarcated; epigastric regions swollen but margins poorly defined, separated from frontal margin by transversely narrow concavity, barely separated from postorbital cristae, without distinct furrow or groove (Figs. 1, 3A, 3B, 4); postorbital region gently swollen without trace of cristae, cervical groove very shallow (Figs. 1, 3A, 3B, 4); frontal margin almost straight from dorsal and frontal views; margin deflexed inwards to form relatively broad triangular plate touching proepistome (Figs. 1, 3A, 3B, 4). Male abdomen relatively broad; somite 6 with lateral margin strongly convex broader than long; distal margin gently concave; telson triangular, longer than broad, lateral margins gently concave to almost straight, tip rounded (Fig. 6C, D). G1 almost straight, relatively slender; tip bent outwards at an angle of about 90° from vertical; outer surface of distal part deeply concave, forming depression; distal part of inner margin prominently

convex, forming hump-like structure; subdistal part of dorsal (sternal) surface with well developed elongate, subovate flap appressed to main structure, distal-most part pectinated, beak-like, upper part sharply tapering to acute tip, lower part subtruncate (Fig. 7F–J).

Description of adult male. — In life, carapace blue to bluish-white with completely white cheliped (Fig. 1). Carapace subovate, broader than long; dorsal surface evenly convex tranversely and longitudinally, regions not well demarcated; H-shaped (gastro-cardiac) median depression prominent (Figs. 1, 3A, 3B, 4). Epigastric regions swollen but margins poorly defined, separated from each other by deep, short, median longitudinal furrow, separated from frontal margin by transversely narrow concavity, barely separated from postorbital cristae, no furrow or groove discernible (Figs. 1, 3A, 3B, 4). Postorbital region gently swollen without trace of cristae, gently merging with other surfaces, in 2 parts,

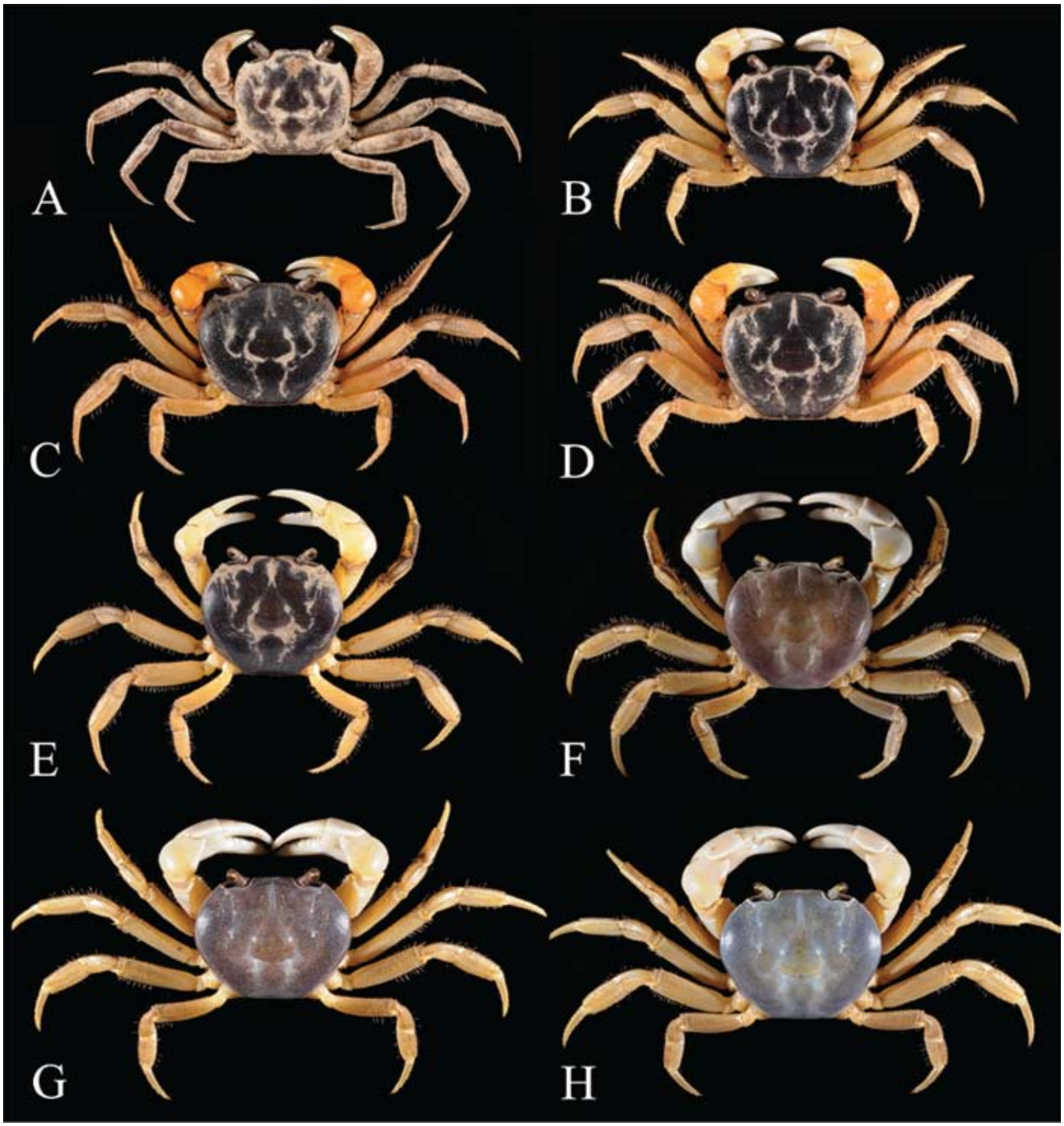

Fig. 2. *Discoplax celeste*, new species. Colour changes with size. A, juvenile (7.9 × 7.1 mm) (ZRC 2012.0028a); B, female (15.9 × 14.1 mm) (ZRC 2012.0028b); C, female (22.3 × 19.0 mm) (ZRC 2012.0028c); D, female (27.5 × 23.5 mm) (ZRC 2012.0028d); E, female (39.0 × 34.0 mm) (ZRC 2012.0028e); F, male (44.4 × 38.7 mm) (ZRC 2012.0028f); G, female (42.4 × 35.8 mm) (ZRC 2012.0018a); H, female (47.1 × 39.2 mm) (ZRC 2012.0018b). A–F from station CI 32, Hugh's Dale, Christmas Island; G, H, from station CI 23, Waterfall Bay, Christmas Island.

separated by short, very shallow longitudinal furrow, proximal part almost reaching very shallow cervical groove (Figs. 1, 3A, 3B, 4). Entire dorsal surface of carapace smooth (Figs. 1, 3A, 3B, 4). Pterygostomial region covered with dense short setae which completely obscure surface, setae partly reaching suborbital surface (Figs. 1B, 3B).

Frontal region gently upturned to form shallow shelf between it and epigastric regions; front deflexed downwards; frontal margin almost straight from dorsal and frontal views; margin deflexed inwards to form relatively broad triangular plate touching proepistome (Figs. 1, 3, 4). Supraorbital margin gently sinuous, smooth (Figs. 1, 3, 4). External orbital tooth broadly triangular, very low, tip not over-reaching orbit, outer margin almost straight, confluent with anterolateral margin (Figs. 1, 3, 4). Anterolateral margin strongly convex, rounded, smooth, without trace of cristae or ridges, gradually curving to meet posterolateral margin (Figs. 1, 3, 4). Posterolateral margin gently convex, smooth, rounded, converging sharply towards gently convex posterior carapace margin (Figs. 1, 3, 4). Suborbital margin weakly granulated, shelf-like, appearing gently sinuous in frontal view, gently arcuate in dorsal view; outer edge reaching point directly beyond end of external orbital tooth, not directly confluent with tooth but separated by gently convex surface (Figs. 1B, 3B). Eyes well developed, filling most of orbital cavity; eyestalks relatively short (Fig. 1B, 3B). Basal article of antenna subquadrate, separated from frontal margin by prominent gap; article 4 small, not closing hiatus between front and ocular peduncle. Antennules folding sub-obliquely (Figs. 1B, 3B). Epistome relatively narrow; posterior margin with median triangular lobe, lateral margins concave, lined with small rounded granules (Figs. 1, 3, 4). Buccal cavity relatively broad, third maxillipeds not closing anterior part which appears as a prominent transverse gap even with palp not fully folded (Figs. 1, 3, 4). Third maxillipeds relatively elongate, meri and ischia forming rhomboidal gape when maxillipeds closed; merus subquadrate, anterior and outer lateral margins concave, median surface depressed; ischium subquadrate with prominent submedian sulcus; exopod slender, tip reaching to about half length of merus, with well developed flagellum (Figs. 1, 3, 4).

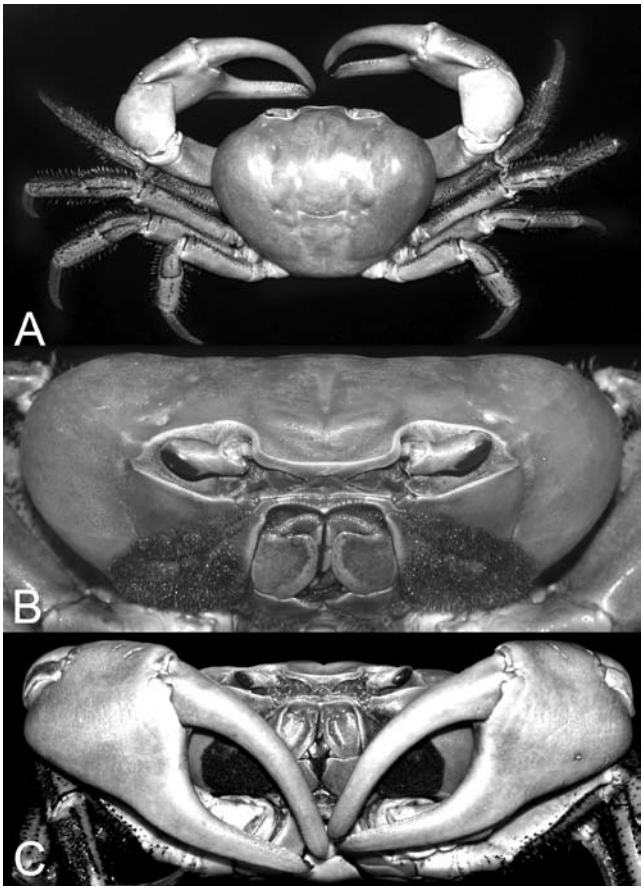

Fig. 3. *Discoplax celeste*, new species. Holotype male (106.0 × 83.6 mm) (QMW-29123), Waterfall Bay, Christmas Island. A, dorsal view; B, frontal view of carapace; C, outer view of chelae.

Chelipeds subequal; surfaces smooth (Figs. 1, 3C, 4). Merus with dorsal margin rugose or uneven but not prominently serrated or granular; ventral margin lined with low granules, otherwise unarmed. Carpus with large, well developed triangular inner subdistal tooth (Figs. 1, 3A, 4). Chela large, surfaces smooth; lower margin of palm sinuous; fingers slender, curved, longer than palm; cutting margins with low denticles along length, distal-most part pectinated, tip gently recurved; fingers forming large gape between them when closed (Figs. 1B, 3B).

Ambulatory legs with second pair longest, last pair shortest; surfaces smooth to slightly rugose (Figs. 1A, 2, 3A, 4). Merus laterally flattened, cross-section ovate, relatively stout; dorsal margin uneven but not granulated or serrate, subdistal tooth low; margins with dense, long, stiff setae that partially obscure margins. Carpus slender; outer surface with 2 low, subparallel carinae; margins and carinae lined with dense stiff setae. Propodus quadrate; lateral margins generally subparallel, lined with dense stiff setae, outer median surface with longitudinal row of short stiff setae; anterior distal margin with prominent rounded lobe into which base of dactylus fits. Dactylus elongate, styliform, gently curving, subquadrate in cross–section, margins lined with strong short spines; tip corneous (Figs. 1A, 2, 3A, 4).

Thoracic sternites 1 and 2 completely fused, forming small semi-circular plate, separated from sternite 3 by gently convex suture; sternites 3 and 4 completely fused without trace of suture (Fig. 6C, D). Sternite 4 with relatively broad sterno-abdominal cavity reaching almost to approximate position between sternites 3 and 4, level with imaginary line joining anterior edges of coxae of chelipeds (Fig. 6C, D).

Male abdomen relatively broad, all segments and telson freely articulating; lateral margins of somites lined with short setae. Somite 1 longitudinally very narrow. Somite 2 similar to somite 1 but relatively broader longitudinally. Somites 3–5 increasingly trapezoidal in shape, all lateral margins gently convex. Somite 6 with lateral margin strongly convex especially along distal part, transversely broad, broader than long; distal margin gently concave. Telson triangular, longer than broad, lateral margins gently concave to almost straight, tip rounded (Fig. 6C, D).

G1 almost straight, relatively slender; distal surfaces adjacent to pectinated tip densely lined with long, stiff setae which almost completely obscure structure and margins, rest of surface with scattered long and short soft setae; tip bent outwards at an angle of about 90° from vertical; outer surface of distal part deeply concave, forming depression; distal part of inner margin prominently convex, forming hump-like structure; subdistal part of dorsal (sternal) surface with well developed elongate, subovate flap which is appressed to main structure, distal margin convex, lined with dense stiff setae; distal-most part pectinated, beak-like, upper part sharply tapering to sharp tip, lower part subtruncate (Fig. 7F–J). G2 short, ca. 0.2 times length of G1; tip spatulate.

Morphological variation. — The carapace shape is more quadrate in smaller specimens (Fig. 2A–C), becoming increasingly rounded in medium-sized specimens (Figs. 2D–H, 4A). In large males and females, the carapace appears more transversely subovate (Figs. 1A, 3A, 4B). The carapace of specimens below about 60 mm carapace width have the anterolateral margins cristate, with striae and flattened granules, these being relatively weaker in larger specimens (Figs. 2, 4A). Once they reach carapace widths in excess of 60 mm, these cristae disappear, with the margins becoming rounded; and the carapace surface generally very smooth (Figs. 1, 2A, 4B).

The live colour of *D. celeste* varies with maturity but is generally consistent within size classes. In small individuals (carapace widths ca. 40 mm or less), the carapace is invariably brown or purplish-brown, with the chelae yellow or orange (Fig 2A–D). When they reach carapace widths of between 41–51 mm, the carapace remains purplish-brown but the chelipeds become white, with the carpus and chela losing almost all trace of yellow or orange (Fig. 2E–G). At carapace widths of 46–52 mm, the entire carapace and chelipeds are already bluish white to powder blue (Fig. 2H), with larger specimens always completely white or blue (Fig. 1) (see later for very rare exceptions).

Etymology. — The name is derived from the French céleste meaning sky or heaven and alludes to the sky or powder blue live colour of adults of this species. The name is used as a noun in apposition.

Remarks. — A preliminary genetic study of *Discoplax* species by H.-T. Shih shows that *Discoplax hirtipes* sensu lato is split into two major clades. One major clade contains all the material from West Pacific (including Sundaic Southeast Asia). *Discoplax hirtipes* was originally described from Fiji, and thus the true *D. hirtipes* belongs genetically to the West Pacific clade. The second major clade contains the Indian Ocean material. The Indian Ocean clade, however, has two well-defined subclades: one which contains the Blue Crab from Christmas Island (i.e. *Discoplax celeste*), while the second includes the purple carapace and orange-red cheliped specimens from western Sumatra, Nicobar Islands

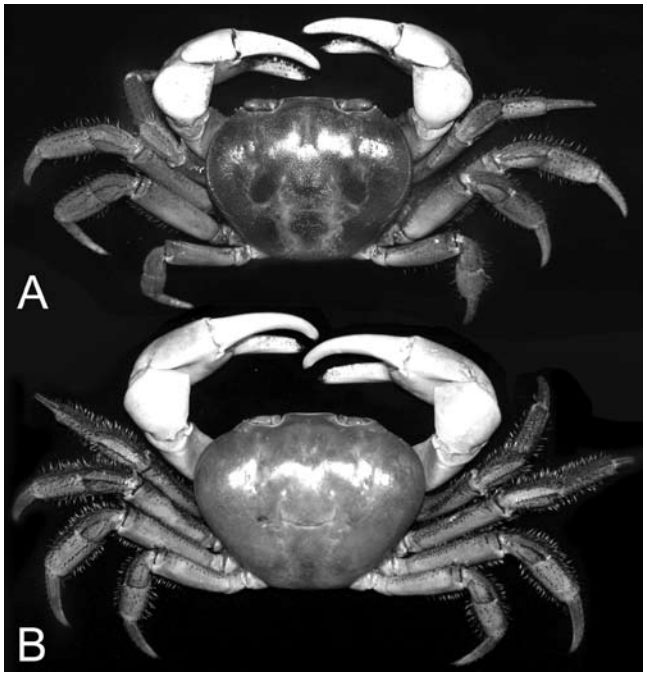

Fig. 4. *Discoplax celeste*, new species. A, paratype male (52.0 × 44.0 mm) (ZRC 2012.0027), station CI 11, Waterfall Bay, Christmas Island; B, paratype male (84.3 × 65.7 mm) (ZRC 2011.0166), Waterfall Bay, Christmas Island.

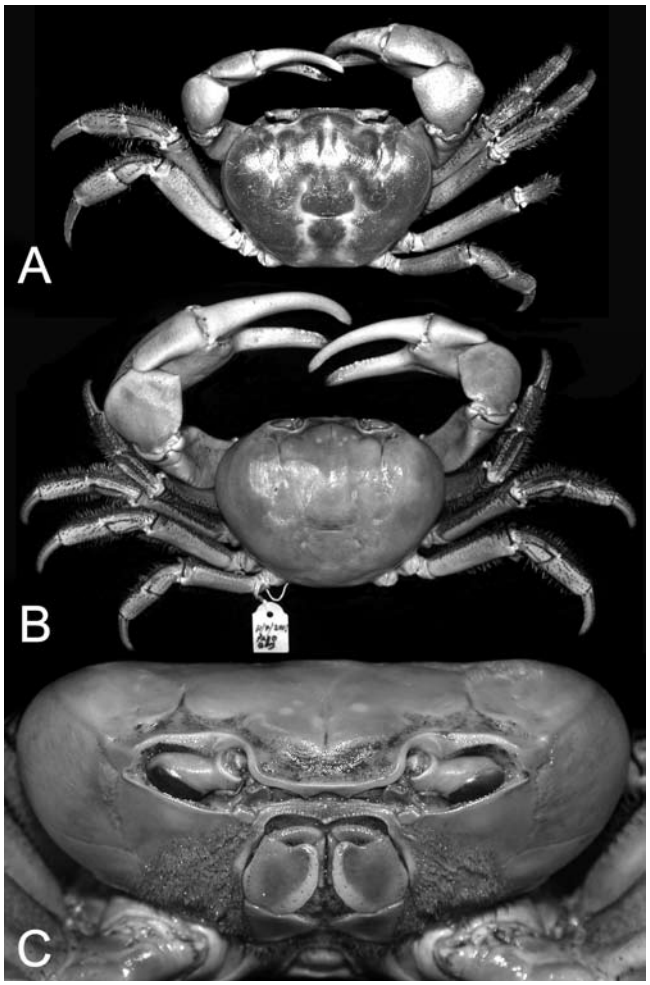

Fig. 5. *Discoplax hirtipes* (Dana, 1851) s. str. A, neotype male (64.2 × 53.0 mm) (ZRC 2010.0415), Suva, Fiji; B, C, male (93.5 × 73.4 mm) (ZRC 2001.2230), Pago Bay, Guam. A, B, dorsal overall views; C, frontal view of carapace.

and Christmas Island (here referred to as *Discoplax* aff. *hirtipes*).

As with most of Dana's material, the type specimens of *Discoplax hirtipes* are lost (see Evans, 1967; Deiss & Manning, 1981). In view of the present recognition of the Christmas Island population as a separate species, it is consequently important to designate a neotype for *Cardisoma hirtipes* Dana, 1851, to fix the identity of that species. The specimen we have on hand from Fiji agrees very well with the type description and figures by Dana (1851), and we are confident it is conspecific with *D. hirtipes* s. str. Thus we here designate a male (64.2 × 53.0 mm) (ZRC 2010.0415) collected from Fiji (Figs. 5A, 7A–E) as the neotype. It was collected alive, with colour photographs obtained; tissue was preserved in 95% alcohol for genetic studies.

Apart from colour, there are some morphological differences between *D. celeste* and the Western Pacific *D. hirtipes*, most obviously in the degree of development of the epigastric and postorbital regions. In *D. hirtipes* s. str., these regions are sharply defined, and separated from each other by relatively deep grooves or notches (Fig. 5). The cervical grooves are also relatively deeper (Fig. 5). As a result, when viewed from the front, the postorbital and branchial regions appear more swollen and more clearly demarcated from the lower gastric

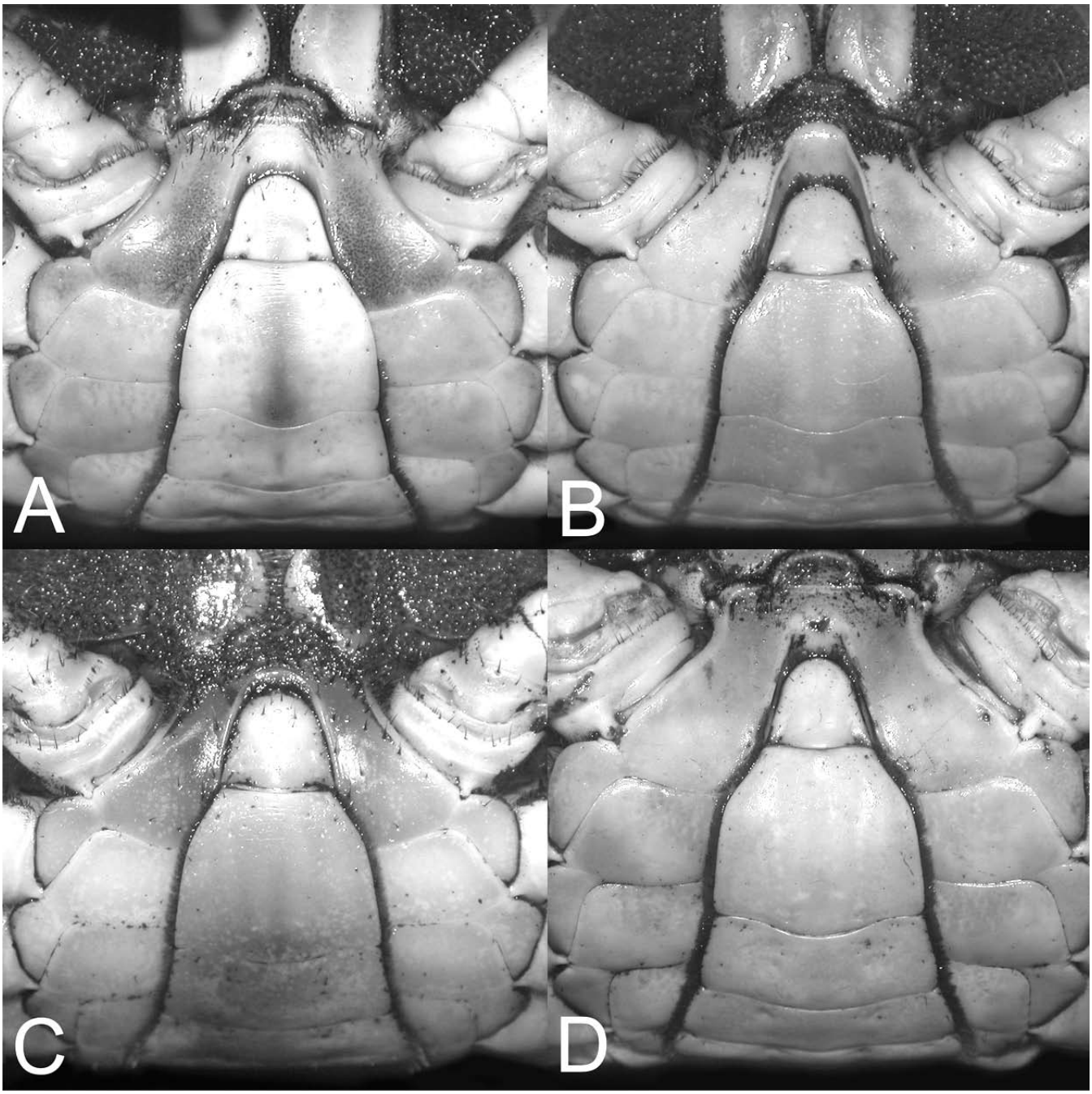

Fig. 6. Male abdomens and anterior thoracic sternums. A, *Discoplax hirtipes* (Dana, 1851), neotype male (64.2 × 53.0 mm) (ZRC 2010.0415), Suva, Fiji; B, *D. hirtipes* (Dana, 1851), male (73.5 × 58.4 mm) (ZRC 2001.0706), Merizo Bay, Guam; C, *D. celeste*, new species, paratype male (52.0 × 44.0 mm) (ZRC 2012.0027), station CI 11, Hosnie's Spring, Christmas Island; D, *D. celeste*, new species, holotype male (106.0 × 83.6 mm) (QMW-29123), Waterfall Bay, Christmas Island.

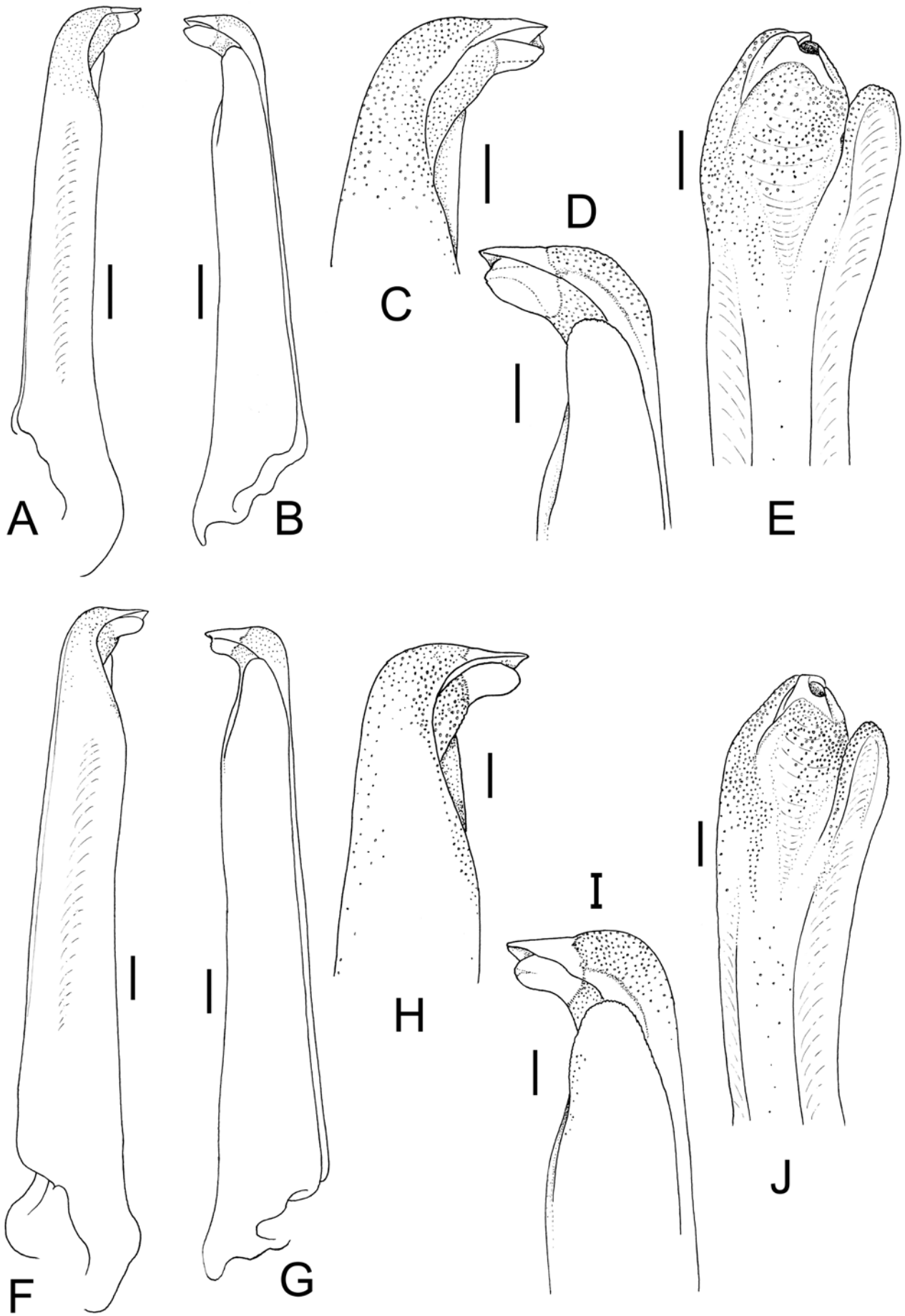

Fig. 7. G1s. A–E, *Discoplax hirtipes* (Dana, 1851), neotype male (64.2 × 53.0 mm) (ZRC 2010.0415), Suva, Fiji; F–J, *D. celeste*, new species, holotype male (106.0 × 83.6 mm) (QMW-29123 ex ZRC 2011.0168), Waterfall Bay, Christmas Island.

regions (Fig. 5C) when compared to that of *D. celeste* (Fig. 3B). In *D. celeste*, the postorbital and branchial regions are less markedly separated (Figs. 1–4).

The male abdomens of relatively smaller *D. celeste* are very similar to those of *D. hirtipes* (Fig. 6) but in adults of *D. celeste*, somite 6 (Fig. 6C, D) is relatively longer than that of *D. hirtipes* (Fig. 6A, B). Most markedly, the G1 structures of the two species are different. The G1 of *D. celeste* is relatively more slender and proportionately longer (Fig. 7F–J) compared to that of *D. hirtipes* (Fig. 7A–E), the difference been all the more apparent when similar sized specimens are compared. In addition, the outer margin of the subdistal part is relatively more produced in *D. hirtipes* (Fig. 7A–D) compared to that of *D. celeste* (Fig. 7F–I).

The colour of the adult crabs is very important. The authors have collected or observed numerous specimens of *D. hirtipes* s. lato from throughout the western Pacific and have never seen crabs with the sky-blue carapace and uniformly pale white claws anywhere other than Christmas Island. Adults of *D. hirtipes* invariably have brown to purplish-brown carapaces, and while very large males have most of the chelae white, fringes and patches of purple or orange always remain on the dorsal parts, and the carpus retains most of the purple or orange colour (see Chia & Ng, 1994). This is also true of all photographs of *D. hirtipes* we have seen. While as described earlier, smaller specimens of *D. celeste* closely resemble *D. hirtipes*, but once they reach larger sizes (carapace widths ca. 50 mm), their colour differences are unmistakable.

Fig. 8. Top, *Discoplax celeste*, new species; bottom, *Discoplax* aff. *hirtipes*. Waterfall Bay, Christmas Island (specimens not collected), all ca. 80 mm carapace width (Photograph by: H. H. Tan, 2007).

There remains the question of the population of *D.* aff. *hirtipes* from the Andaman and Nicobar Islands which has dark violet carapaces and cinnabar red chelae, as reported by Alcock (1900: 448). The specimens in the ZRC from the Nicobars collected by the late Carl Gibson-Hill still retain some of the original colours. We have also specimens of *D.* aff. *hirtipes* from the western shores of Sumatra and Mentawei Islands, and their morphologies agree with those from the Nicobars in most aspects. One of these Sumatran specimens (ZRC 2008.0575) was collected relatively recently, and the colour of its carapace was purplish-brown with bright reddish-orange chelae when alive (J. Lai, pers. comm.). Morphologically, the Sumatran and Nicobar specimens most closely resemble *D. celeste* in that the epigastric and postorbital regions are relatively less inflated and more rounded, with the G1 relatively slender and elongate. However, the G1 of *D.* aff. *hirtipes* from the Indian Ocean is proportionately even more slender than that of *D. celeste*. In addition, the male abdomen of these specimens is relatively more slender with somite 6 proportionately longer. We believe they should be also referred to a separate species, but this will be undertaken later as part of the larger revision of the genus.

Interestingly, we observed three medium sized individuals on Christmas Island (carapace lengths ca. 50–80 mm) that had the purplish-brown carapace and orange chelipeds (Figs. 8, 9), of the more northern Indian Ocean *Discoplax* aff. *hirtipes* from the Nicobars and Sumatra. As discussed earlier, at

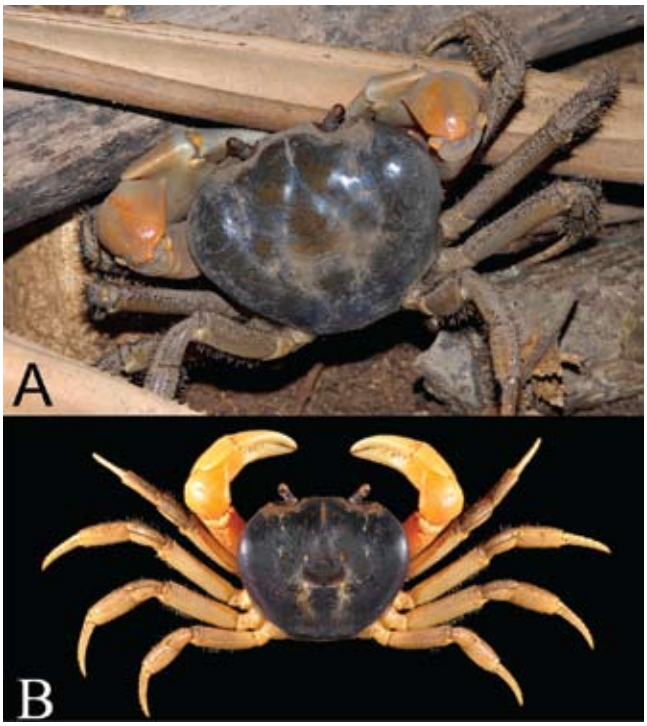

Fig. 9. *Discoplax* aff. *hirtipes* from Christmas Island. A, probably male, ca. 80 mm carapace width (not collected), Waterfall Bay (Photograph by: H. H. Tan, 2007); B, female (47.1 × 39.7 mm) (ZRC 2012.0003), station CI 16.

these sizes the carapace of *D. celeste* may still be purplish but the chelipeds should already be almost completely white (Fig. 2H). A male and a female specimen were collected. The male specimen (ZRC 2012.0004) was morphologically typical in all respects with the Nicobar and Sumatran crabs, including the form of the G1. Its DNA also clusters with the Sumatran specimens rather than with Christmas Island *D. celeste* (H.-T. Shih, unpublished data). A photograph of the female specimen (ZRC 2012.0003) is presented in Fig. 9B. These two specimens are tentatively referred to *Discoplax* aff. *hirtipes*. The presence of both species on Christmas Island is not surprising. Although the dominant species of *Gecarcoidea* on Christmas Island is the Red Land Crab, *G. natalis*, specimens of the closely related *G. lalandii* H. Milne Edwards, 1837, have also been found there, albeit very rarely (see Hicks et al., 1984). With Indonesia relatively near and the pattern of currents known, it can be expected that some larvae of *Gecarcoidea lalandii* and *Discoplax* aff. *hirtipes* would occasionally reach Christmas Island, but apparently few survive and even fewer reach maturity as the ecological niches are dominated by the indigenous species.

Biology. — Hicks et al. (1984) give an excellent account of the ecology and habits of *Discoplax celeste*, new species (as *Cardisoma hirtipes*) (see also Gibson-Hill, 1947; Tweedie, 1947). It has occasionally been found entering the mouth of cave systems (Humphreys & Eberhard, 2001). The preferred habitat of *Discoplax celeste* is quite different from that of *D. hirtipes* s. str. and *Discoplax* aff. *hirtipes*. As discussed earlier, *D. celeste* is almost always found next to streams or swampy areas, digging burrows in the soft soil adjacent to the stream, or inbetween the roots of the trees growing next to the water. It is also frequently found in the water itself (see also Gibson-Hill, 1947; Tweedie, 1947; Gray, 1981, 1995; Hicks et al., 1984). *Discoplax hirtipes* s. str. and *Discoplax* aff. *hirtipes* on the other hand are found in much drier karstic habitats, often far from surface water or freshwater swamps, and their burrows are often dug next to rocks (unpublished data).

The general biology of this species (as *Cardisoma hirtipes* or *Discoplax hirtipes*) has also been relatively well studied, with many papers on its respiratory and digestive physiology (e.g., Adamczewska & Morris, 1996, 2000; Dela-Cruz & Morris, 1997a, 1997b; Farrelly & Greenaway, 1994; Greenaway, 1989, 1993, 1998; Linton & Greenaway, 2004; Linton et al., 2006; Morris, 2005; Morris & Dela-Cruz, 1998), gill ultrastructure (Farrelly & Greenaway, 1992) and population structure (Turner et al., 2011).

The population of the Red Land Crab (*Gecarcoidea natalis*) has been substantially impacted by the invasive yellow crazy ant (*Anoplolepis gracilipes*) (see Abbott, 2005; O'Dowd et al., 2003; Green et al., 2004). However, the Blue Crab seems to have been less markedly affected because of its more aquatic habits and typically water-filled burrows (see Greenaway, 1989; Turner et al., 2011; M. Orchard, pers. comm.) that are unsuitable for the fully terrestrial ants.

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