

Land crabs (Crustacea: Brachyura: Gecarcinidae) of Singapore

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Abstract. Three species of gecarcinid land crabs are known from Singapore: *Cardisoma carnifex*, *Cardisoma armatum* and *Tuerkayana hirtipes*. *Cardisoma armatum* is a non-indigenous species and naturally occurs in West Africa. The records of the species in the wild are almost certainly escaped or released pets as it is frequently sold in aquariums. The taxonomy of these species and their conservation challenges are discussed.

Key words. *Cardisoma carnifex*, *Cardisoma armatum*, *Tuerkayana hirtipes*, land crabs, Singapore, taxonomy, ecology

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INTRODUCTION

Land crabs of the family Gecarcinidae MacLeay, 1838, have been well studied throughout its range, and seven genera and 26 species are now known from almost all tropical areas of the world (Türkay, 1970, 1973, 1974; Ng & Guinot, 2001; Ng et al., 2008; Perger et al., 2011; Ng & Davie, 2012; Ng & Shih, 2014, 2015; Perger & Wall, 2014; Lai et al., 2017; Guinot et al., 2018; Naruse et al., 2018; Perger, 2019).

Despite Singapore's long colonial history, there have been no formal records of gecarcinid land crabs on the island until relatively recently. Chia & Ng (1994) reviewed the land crab records for Peninsular Malaysia but not for Singapore. The first land crab record from Singapore was in 1979, when in listing the crabs in the zoological collections of the National University of Singapore, Yang (1979) recorded Paya Lebar as one of the locations for *Tuerkayana hirtipes* (Dana, 1851) (as a species of *Cardisoma*).

The present paper summarises what is known about land crab records for Singapore. It also formally records specimens of the non-indigenous African land crab, *Cardisoma armatum*, from northern Singapore. Aspects of their conservation are also discussed.

MATERIAL & METHODS

Specimens examined are deposited in the Zoological Reference Collection (ZRC) of the Lee Kong Chian Natural History Museum, National University of Singapore. The synonymy provided is restricted to the original description and citations for Singapore. The terminology used follows Ng et al. (2008) and Davie et al. (2015). Measurements provided, in millimetres, are of the maximum carapace width and length, respectively.

TAXONOMY

Family Gecarcinidae MacLeay, 1838

Cardisoma carnifex (Herbst, 1796)

(Figs. 1, 5A–D, 6A, B)

Cancer carnifex Herbst, 1796: 163, pl. 41 fig. 1.

Cardisoma carnifex – Tan & Tan, 2016: 129.

Material examined. 1 male (90.5 × 74.5 mm) (ZRC 2016.0305), at night, eastern part of Pulau Ubin, Singapore, coll. T.N. Tan, 9 September 2016.

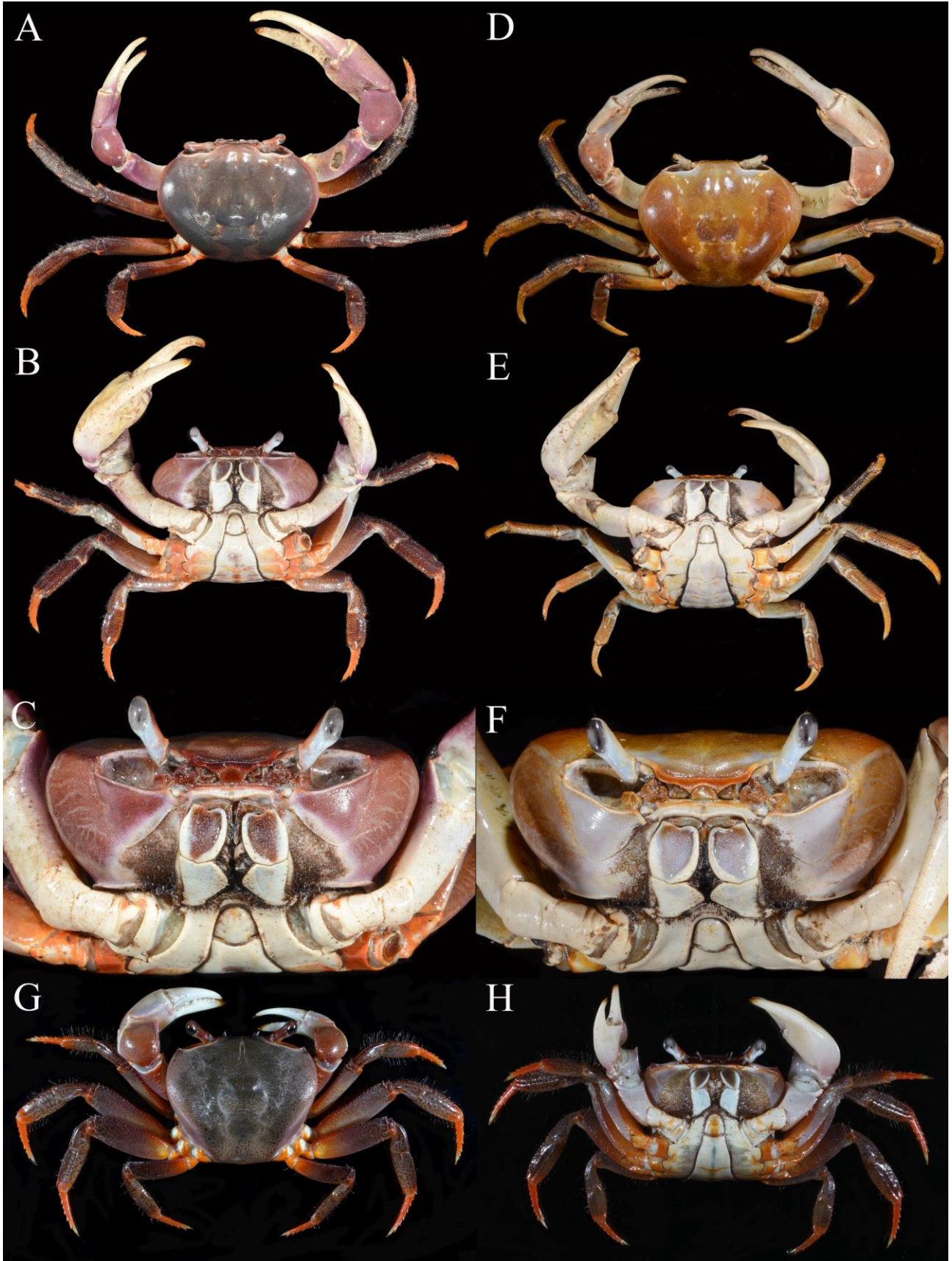


Fig. 1. *Cardisoma carnifex*, colour in life. A–C, male (86.6 × 72.0 mm) (ZRC 2020.0356), Palau; D–F, male (91.9 × 75.9 mm) (ZRC 2020.0355), Palau; G, H, male (carapace width ca. 45 mm, not preserved), Cocos-Keeling Island. A, D, G, dorsal view; B, E, H, ventral view; C, F, frontal view. (Photographs by: A–F, Lee Bee Yan; G, H, Tohru Naruse).

Comparative material: 1 male (91.9 × 75.9 mm) (ZRC 2020.0355), station PAL19-14, mangrove on small island along highway on Babeldaob, Palau, 7°31'53.8"N, 134°39'14.6"E, coll. B.Y. Lee, 10 January 2019; 1 male (86.6 × 72.0 mm) (ZRC 2020.0356), station PAL19-20, mangrove on small island along highway on Babeldaob, 7°31'53.8"N, 134°39'14.6"E, coll. B.Y. Lee, 12 January 2019; 1 female (51.5 × 42.0 mm) (ZRC 1999.1449), Phuket, Thailand, coll. P.K.L. Ng, April 1999.

Remarks. This is the most wide-ranging of all gecarcinid species, occurring from Madagascar to French Polynesia (Türkay, 1973, 1974; Ng, 2017). It is surprising that it was reported from Singapore only recently (Tan & Tan, 2016), considering its preferred habitat of muddy areas near mangroves and estuarine systems is relatively common on the island and the species is found in many similar areas in Peninsular Malaysia (Chia & Ng, 1994). Smaller specimens are relatively colourful with the joints and parts of the legs bright orange (Fig. 1G, H). Large adults are variable in colouration, with the carapace grey to greyish-blue to brown, with the chelipeds purple to white (Fig. 1A–F).

The species should be able to do well in the many coastal habitats and mangroves along the northern part of the island. It is hoped that the species can expand its distribution in years ahead as more coastal areas are protected.

***Cardisoma armatum* (Herklots, 1851)**

(Figs. 2, 3, 4A–D, 5E–H, 6C–E)

Ocypode (*Cardisoma*) *armatum* Herklots, 1851: 7, pl. 1 figs. 4, 5.

Cardisoma carnifex – Lee et al., 2016: 82 (not *Cancer carnifex* Herbst, 1796).

Material examined. 1 male (83.4 × 67.4 mm) (ZRC 2020.0071), from bushes next to Sungei Tengah Lodge, near Tengah River, old Choa Chu Kang Road, ca. 1°22'32.5"N, 103°43'05.9"E, Singapore, coll. D. Faezal, 6 July 2020; 1 male, 1 female (ZRC), from aquarium trade, from West Africa, coll. K. Lim, 23 April 1996; 1 male (51.9 × 41.3 mm) (ZRC 1999.0026), from aquarium shop, from West Africa, coll. P.K.L. Ng, 1997; 1 young male (ZRC 1999.0006), from aquarium shop, from West Africa, coll. P.K.L. Ng, January 1998; 3 males (ZRC 2000.2258), from aquarium shop, from West Africa, coll. K. Lim, 2000; 1 female (47.8 × 37.9 mm) (ZRC 2001.0762), West Africa, aquarium trade in Singapore,

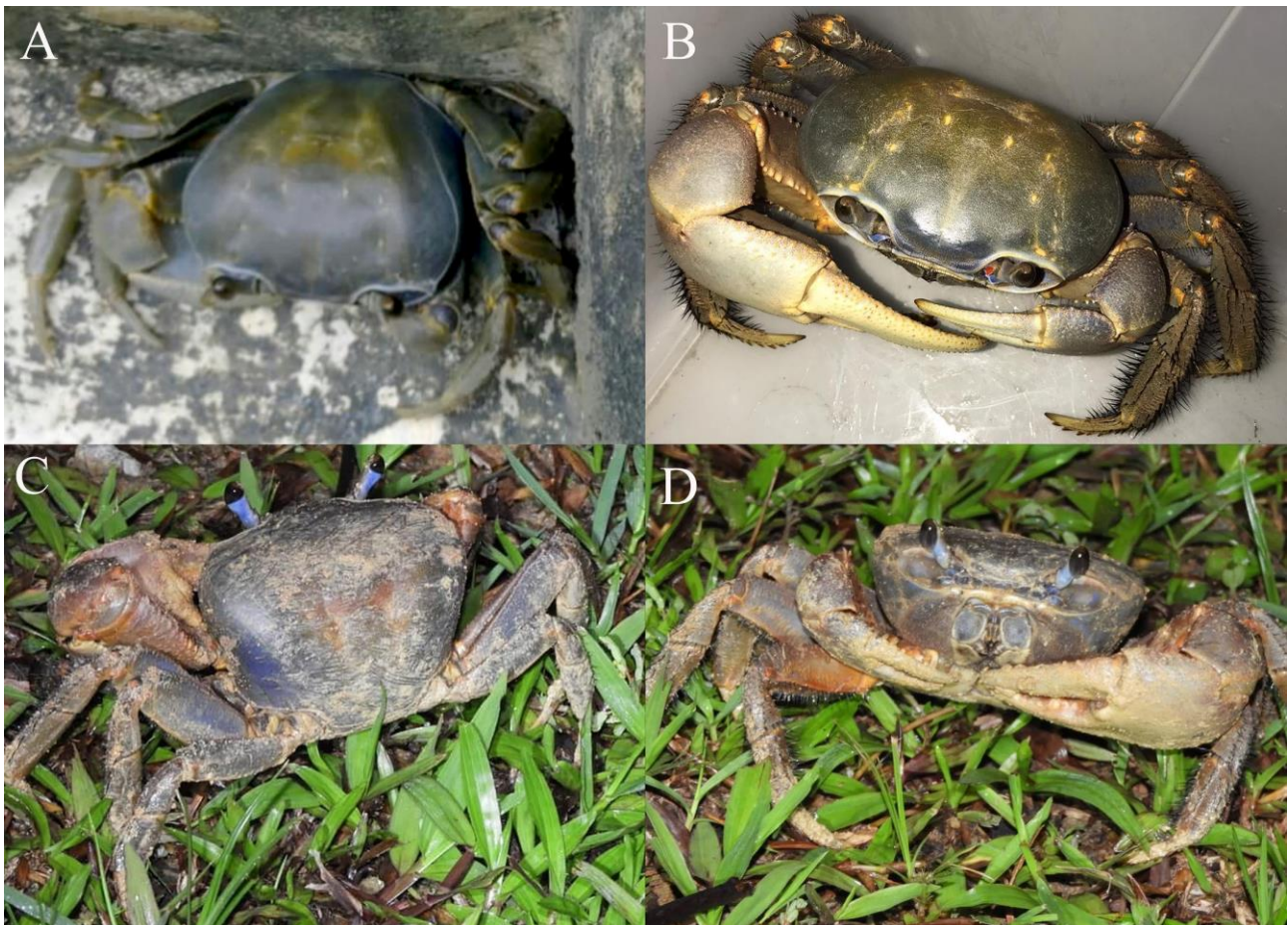


Fig. 2. *Cardisoma armatum*, in situ. A, B, male (83.4 × 67.4 mm) (ZRC 2020.0071), Choa Chu Kang, Singapore; C, D, male, Serangoon, Singapore (not collected). (Photographs by: A, Joanne Lee; B, Duraimi Faezal; C, D, Naomi Kim).

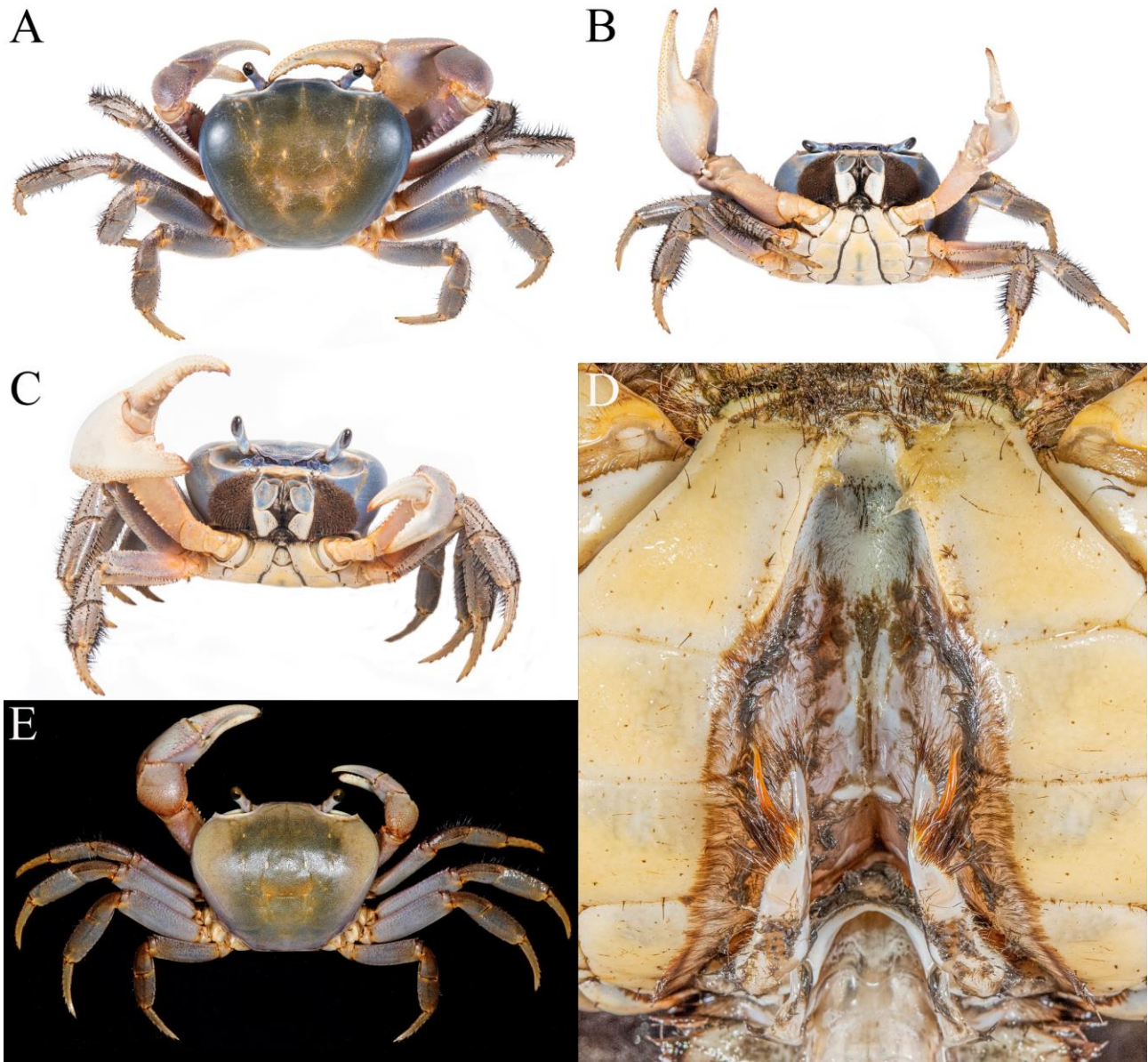


Fig. 3. *Cardisoma armatum*, colour in life. A–D, male (83.4 × 67.4 mm) (ZRC 2020.0071), Choa Chu Kang, Singapore; E, female (carapace width ca. 50 mm, not preserved), West Africa. A, E, dorsal view; B, ventral view; C, frontal view; D, sternopleonal cavity and male first gonopods in situ. (Photographs by: A–D, Paul Ng; E, Tan Heok Hui).

coll. P.K.L. Ng, March 2001; 1 female (ZRC 2001.0762), from aquarium shop, from West Africa, coll. P.K.L. Ng, March 2001; 1 male (ZRC 2006.0111), from aquarium in Toa Payoh, from West Africa, coll. T.H.T. Tan, 25 June 2006; 2 males (ZRC 2009.0237), from aquarium shop, from West Africa, coll. T.H.T. Tan, October 2008; 1 male (ZRC 2011.0670), from aquarium shop, from West Africa, coll. P.K.L. Ng, 2010; 2 males, 1 female (ZRC 2020.0353), Nigeria, via trade, through Sunbeam Aquarium, coll. H.H. Tan, 26 March 2010; 1 male (ZRC 2017.1395), from aquarium dealer in Java, Indonesia, from West Africa, coll. J.C.Y. Lai, 14 December 2017; 1 male (ZRC 2017.1402), from aquarium dealer in Java, Indonesia, from West Africa, coll. J.C.Y. Lai, 14 December 2017; 1 male (44.4 × 34.7 mm) (ZRC 2020.0347), from aquarium shop, from West Africa, coll. P.Y.C. Ng, August 2020.

Comparative material. *Cardisoma crassum* Smith, 1870: 1 male (39.6 × 33.2 mm), 1 female (36.9 × 29.6 mm) (ZRC 2008.0118), Puerto el Triunfo El Salvador, Pacific coast, coll. Peters, 1969.

Remarks. *Cardisoma armatum* is native to tropical West Africa and distributed from Senegal to Angola, including the islands in the Gulf of Guinea and Cape Verde Islands (Monod, 1956; Türkay, 1973). It is well known in the aquarium trade as the “harlequin” or “rainbow land crab” (see Rademacher & Mendedoht, 2011: 18) as smaller specimens (20–40 mm carapace width) are usually brightly coloured, with the carapace blue to greyish blue, the legs orange to red, the chelae white, and various parts yellow to orange (Fig. 4A–D). In the United States, it has been called the “patriot crab” because of its colour. The crab has been collected for the pet trade for many decades and is popular in Europe. It has been imported into Singapore since the mid-1990s (P.K.L. Ng, personal observation) and the museum has specimens obtained

from local aquariums since 1996. The number imported is not known but is probably in the thousands annually as it is regularly seen in various aquariums around the island most times of the year. *Cardisoma armatum* has also been sold in aquariums in Kuala Lumpur and Johor (Malaysia), west Java (Indonesia), Thailand, Taiwan, Hong Kong, mainland China, Japan, as well as many parts of Europe and the United States. There is even one record of a specimen brought into Christmas Island (Max Orchard, personal communication).

In its native habitat in West Africa, *Cardisoma armatum* usually occurs in brackish water and mangrove areas, often in large numbers, and has been known to live further upstream in freshwater habitats (Gauld, 1960; Pauly, 1975; Ameyaw-Akumfi, 1987, 1989; Oyenekan, 1995). They normally dig deep burrows over 1.5 m deep (Bruce-Chwatt & Fitz-John, 1951). Large specimens reach 175 mm in carapace width and are collected for food by locals (Bruce-Chwatt & Fitz-John, 1951).

Rademacher & Mengedoht (2011) described how these crabs are maintained in aquariums, where they do well. Some have even been known to reproduce in captivity, with complete larval development actually documented from captive animals (Cuesta & Anger, 2005). As these crabs are tropical and hardy, it is expected that some have escaped or have been released into the wild in Singapore.

Cardisoma armatum is superficially similar to *Cardisoma carnifex* and can easily be confused as their carapaces are almost identical. What is distinct in *Cardisoma armatum* is that the upper and median margins of the merus of the chelipeds are lined with distinct sharp granules, and the upper and lower margins of the palm of the chela and the dorsal margin of the fingers

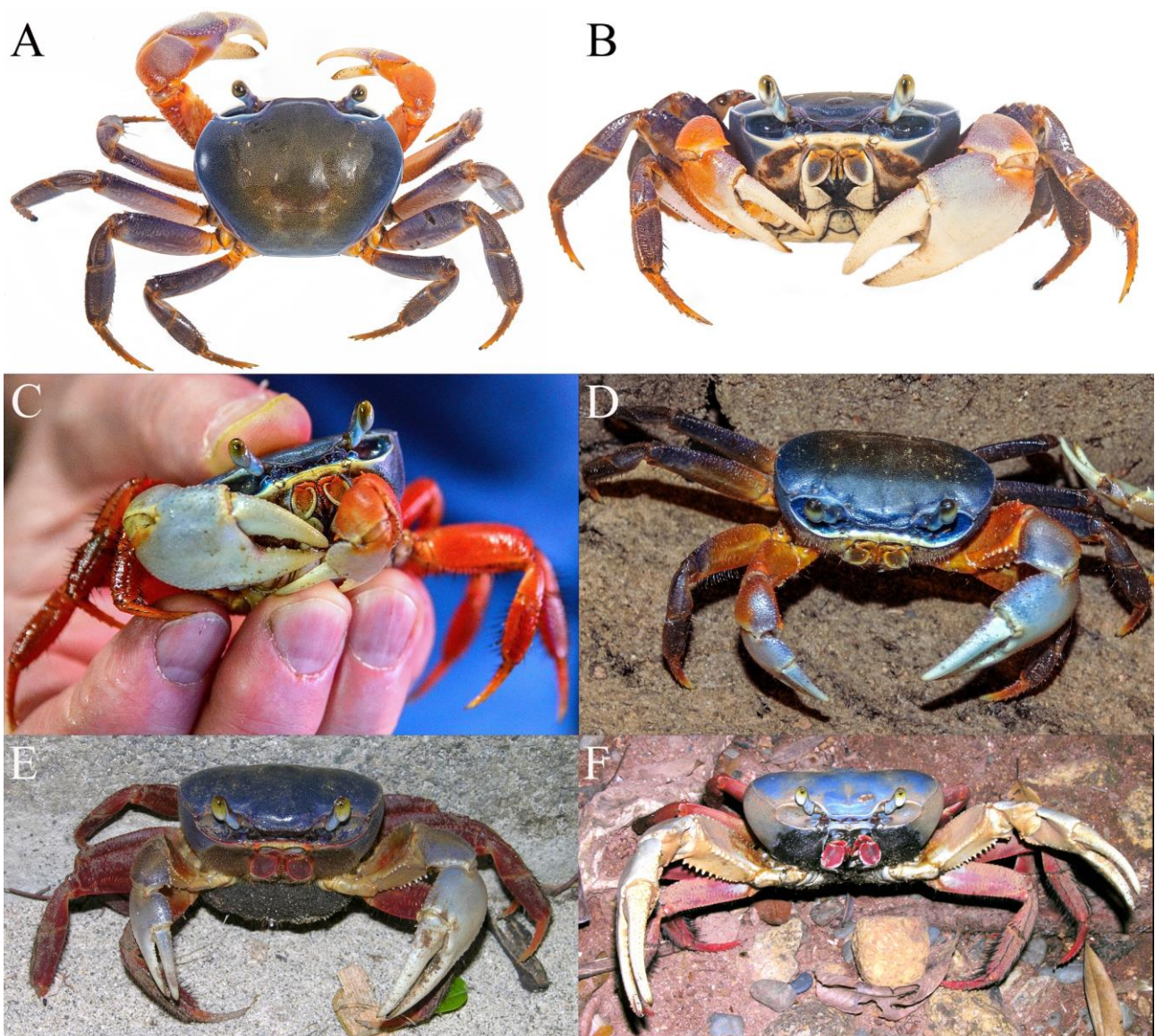


Fig. 4. A, B, *Cardisoma armatum*, male (44.4 × 34.7 mm) (ZRC 2020.0347), West Africa; C, *Cardisoma armatum*, male (in aquarium, not preserved), West Africa; D, *Cardisoma armatum*, female (in aquarium, not preserved), West Africa; E, *Cardisoma crassum*, ovigerous male (not collected), Coiba National Park, Panama; F, *Cardisoma crassum*, male (not collected), Coiba National Park, Panama. (Photographs by: A, B, Paul Ng; C, D, Oliver Mengedoht; E, F, Arthur Anker).

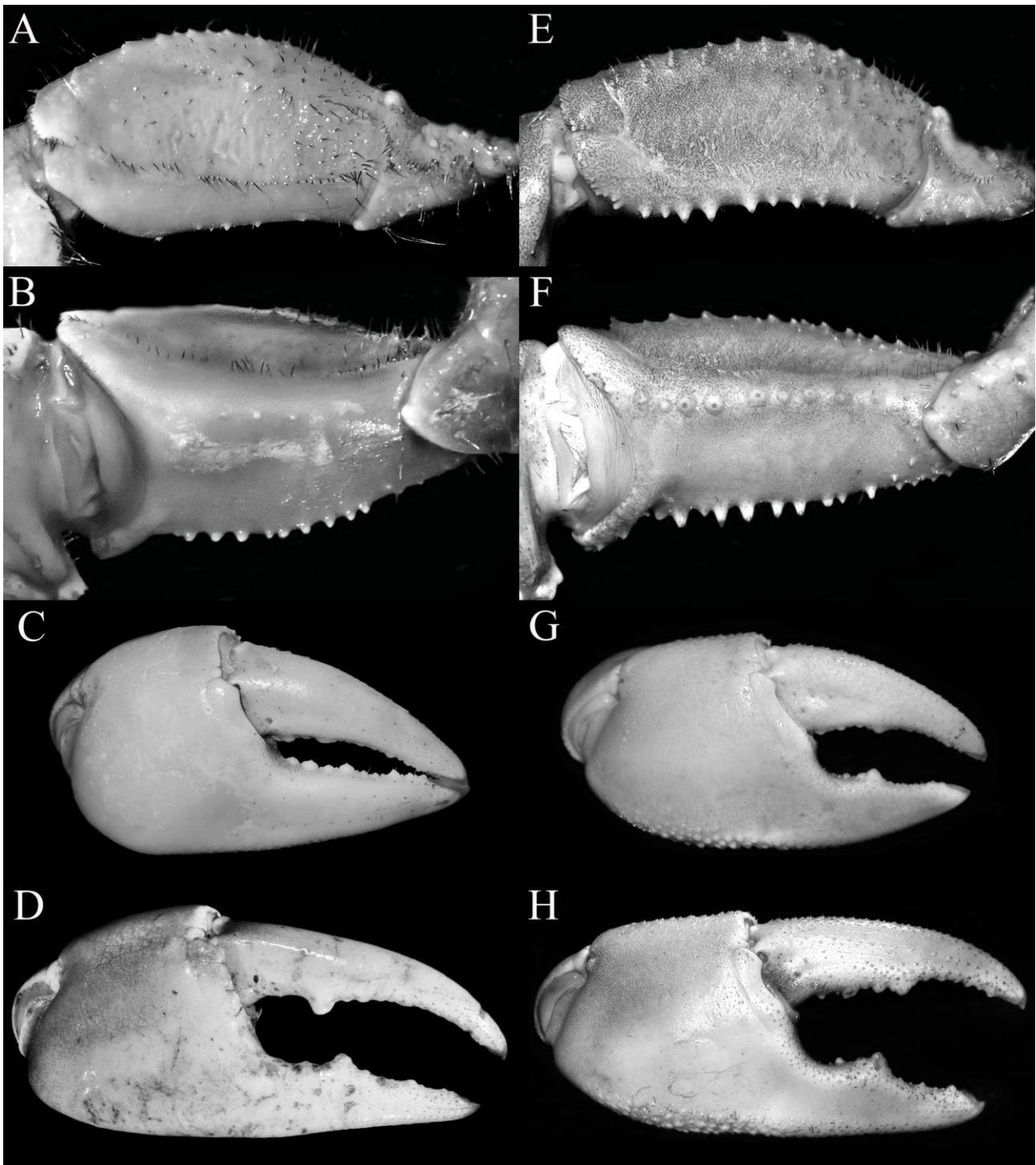


Fig. 5. Right cheliped. A–C, *Cardisoma carnifex*, female (51.5 × 42.0 mm) (ZRC 1999.1449), Phuket, Thailand; D, *C. carnifex*, male (86.6 × 72.0 mm) (ZRC 2020.0356), Palau; E, F, H, *C. armatum*, male (83.4 × 67.4 mm) (ZRC 2020.0071), Choa Chu Kang, Singapore; G, *C. armatum*, male (44.4 × 34.7 mm) (ZRC 2020.0347), West Africa. A, E, dorsal view of merus; B, F, inner lateral view of merus; C, D, G, H, outer view of chela.

are covered with small granules and striae, giving the surfaces a very rugose appearance (Fig. 5E–H). This immediately distinguishes the two species, even in females or small specimens; in *Cardisoma carnifex*, the upper and median margins of the palm of the chela are almost smooth (or at most with scattered, very low granules) and the dorsal margin of the fingers are smooth or covered only with very small granules (Fig. 5A–D). In *Cardisoma armatum*, the ventral margin of the merus of the cheliped is always lined with large spines (Fig. 5F); in *Cardisoma carnifex*, the row of granules is prominently lower (Fig. 5B). In large specimens of *Cardisoma carnifex*, all the margins of the merus of the cheliped appear almost smooth (Fig. 1B, C, E, F).

Their male first gonopods are also completely different, with the chitinous distal part short and truncate in *Cardisoma carnifex* (see Fig. 6A, B; Türkay, 1974: fig. 3) but elongate, slender and hook-like in *Cardisoma armatum* (Fig. 6C–E; Türkay, 1973: fig. 1). The life colours of small *Cardisoma armatum* (20–40 mm carapace width) are distinctive, with the legs red or orange,



Fig. 6. Male first gonopod. A, B, *Cardisoma carnifex*, male (90.5 × 74.5 mm) (ZRC 2016.0305), Pulau Ubin, Singapore; C, D, *C. armatum*, male (83.4 × 67.4 mm) (ZRC 2020.0071), Choa Chu Kang, Singapore; E, *C. armatum*, male (51.9 × 41.3 mm) (ZRC 1999.0026), aquarium, West Africa; F, *C. crassum*, male (39.6 × 33.2 mm) (ZRC 2008.0118), Pacific coast El Salvador. A, C, left structure, ventral view, denuded; B, left structure, dorsal view; D, left structure, dorsal view, denuded; E, left structure; F, right structure, denuded (laterally transposed for comparisons).

while in young *Cardisoma carnifex* the legs are never red, at most having joints and ventral surfaces that are bright orange or with patches of pale blue (Fig. 1G, H). The striking colours of *Cardisoma armatum*, however, are lost when they reach large sizes (carapace widths in excess of 45 mm), becoming a drabber greenish-brown to light blue overall (Fig. 3).

The recent male specimen (ZRC 2020.0071) was found at Old Choa Chu Kang Road “clambering out of one of the topiary bushes” near a lodge (Duraimi Faezal, personal communication, 6 July 2020) (Fig. 2B). Despite its relatively drab colours, it is clearly an adult male of *Cardisoma armatum*.

The specimen reported as “*Cardisoma carnifex*” by Lee et al. (2016) is now reidentified as *Cardisoma armatum*. The specimen (probably a female) that was photographed (but not collected) at the Nanyang Technological University Jurong Campus was large (estimated 80 mm carapace width) and found against the edge of a drain, and few characters except the carapace were clearly visible (Fig. 2A). Although the authors suspected it might be *Cardisoma armatum*, the specimen was without the distinctive red and blue markings on the legs. The present specimen from Choa Chu Kang (ZRC 2020.0071) is also large (over 80 mm in carapace width) and at this size, all the red markings are gone. Re-examining the photograph, it is clear that the merus of the cheliped has the distinct row of granules on the margin that characterise *Cardisoma armatum*. The site where the specimen was found is inland and far from the sea or rivers, and it seems more likely that the specimen was an escaped pet that survived and grew in the wild.

There is another photographic record of *Cardisoma armatum* sent to the first author by a resident in Serangoon (Fig. 2C, D): “Earlier I found a crab at a grass patch in front of a block at Hougang Capeview next to the Serangoon Park Connector. It probably disappeared into one of holes when I came back for it after getting someone to come and help me bring it to the river as I thought it might have lost its way. We combed the small grass patch but could not find it anymore.” (Naomi Kim, personal communication, 23 December 2019). The photograph of what appears to be a male crab does not show the granulated merus, but the outer face of the chela appears to be more rugose and granulated compared to that of *Cardisoma carnifex*. In addition, the ocular peduncle is a uniform blue (Fig. 2C, D), a character often observed on *Cardisoma armatum* (Figs. 3A–C, 4A–D). In *Cardisoma carnifex*, the ocular peduncle is usually grey although it may have patches of pale blue, but never uniformly blue (Fig. 1C, F).

Cardisoma armatum is actually closest to another species, *Cardisoma crassum* Smith, 1870, from the Pacific coast of Central and South America (Türkay, 1970, 1973), and it is not easy to separate them based on the carapace or even the gonopods; even their colours in life are almost the same (Fig. 4E, F). There are, however, subtle but distinct differences in the structure of the male first gonopod (see Türkay, 1973). That of *Cardisoma armatum* is proportionately stouter overall, the inner finger-like projection is relatively shorter, and the chitinous distal curved structure gradually tapers to a relatively sharper point (Fig. 6C–E). In *Cardisoma crassum*, the male first gonopod is slenderer especially along its basal part, the inner finger-like projection is much longer, and the chitinous distal curved structure is not tapering with the tip truncate (Fig. 6F). The material from Singapore and aquaria all conform with *Cardisoma armatum* as defined. Significantly, we do not know of *Cardisoma crassum* being imported to Singapore as part of the aquarium trade.

It is doubtful if *Cardisoma armatum* has established itself in Singapore. The only three reliable records of wild specimens are all in urban areas. It seems likely that the specimens are escapees or were released but have managed to survive and grow in the wild. As the aquarium trade prefers small specimens with bright colours, large specimens are rarely brought in for sale. The largest specimen we have seen on sale is only 50–60 mm in carapace width (Fig. 3E). As long as there is moist soil for it to burrow in and vegetation for food, there is no reason why specimens cannot survive locally, especially since its native habitat is along the same latitude as Singapore. It would be a challenge for the species to be naturalised here because like all gecarcinid land crabs, regardless of how terrestrial they may be, they must return to the sea to release their free-swimming planktotrophic larvae. The complete larval development for *Cardisoma armatum* is known (Cuesta & Anger, 2005), with the authors recording six zoeal and one megalopal stages. This is similar to that known for *Cardisoma carnifex* (see Kannupandi et al., 1980) and the Caribbean *Cardisoma guanhumi* Latreille, in Latreille, Le Peletier, Serville & Guérin, 1828 (see Costlow & Bookhout, 1968). The zoeae develop in more saline waters, although in the case of *Cardisoma armatum*, they are able to survive in lower salinity waters, indicating that their larval export strategy is probably of a more limited nature (Cuesta & Anger, 2005). As such, a resident population of both sexes will need to be established

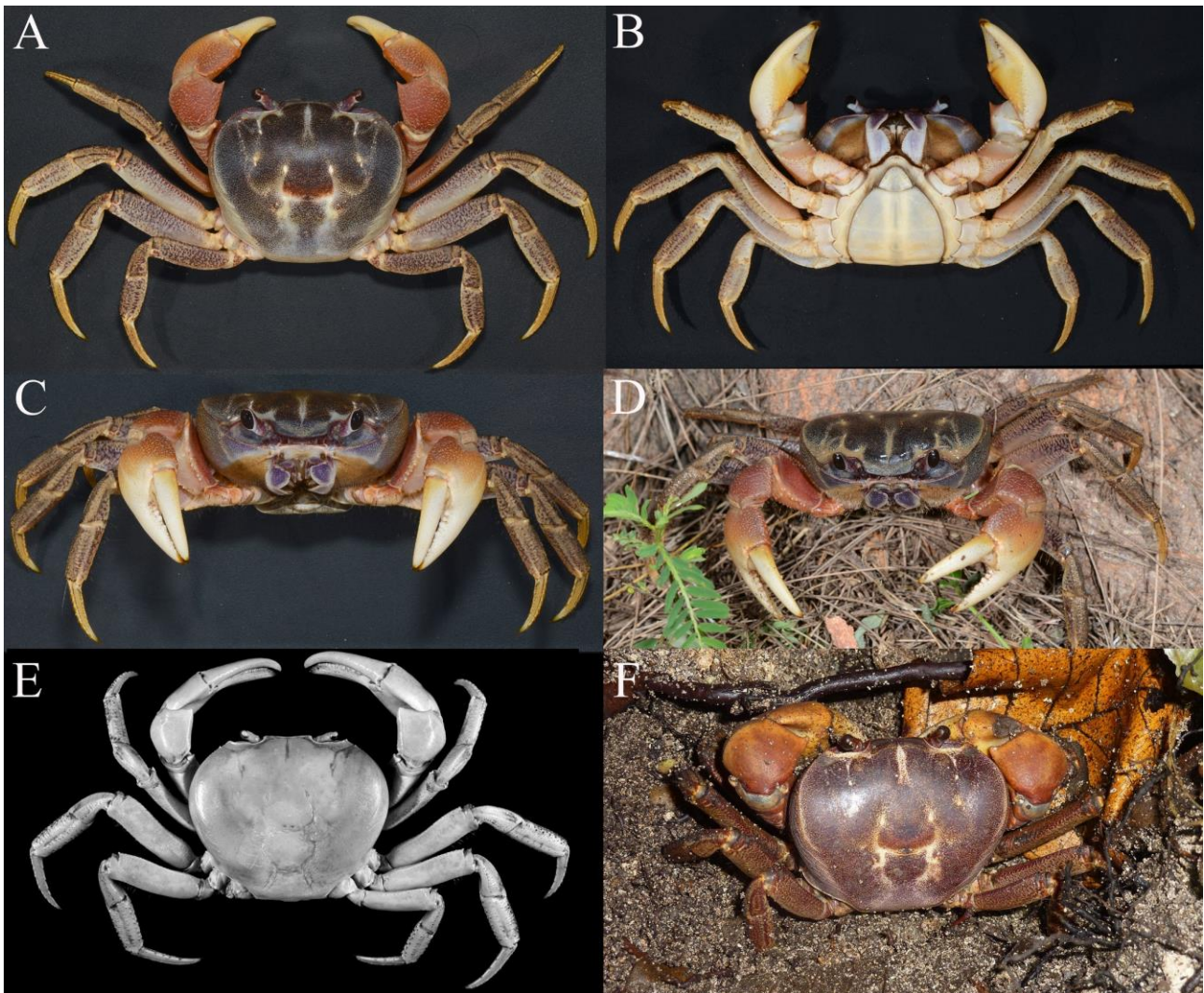


Fig. 7. *Tuerkayana hirtipes*. A–D, female (51.3 × 42.0 mm) (ZRC 2015.0355), St. John's Island; E, female (91.9 × 76.0 mm) (ZRC 1965.12.1.10), Paya Lebar, Singapore; F, male (not collected), Nikoi Island, Pulau Bintan. A, E, F, dorsal view; B, ventral view; C, D, frontal view. (Photographs by: A–D, Tan Heok Hui; E, Lee Bee Yan; F, Norman Lim).

in a habitat (e.g., mangroves or near streams) that is connected to or near the open sea. It would then be possible for the larvae to complete their metamorphosis in the Straits of Johor and adjacent waters, returning to land afterwards.

***Tuerkayana hirtipes* (Dana, 1851)**

(Fig. 7)

Cardisoma hirtipes Dana, 1851: 253; Yang, 1979: 54.

Discoplax hirtipes – Wang & Ng, 2011: 357–358; Ng & Davie, 2012: 91; Khew, 2015: B12.

Material examined. 1 female (91.9 × 76.0 mm) (ZRC 1965.12.1.10), Paya Lebar, Singapore, coll. July 1938; 1 female (51.3 × 42.0 mm) (ZRC 2015.0355), St John’s Island, Singapore, coll. K.S. Tan, 10 July 2015.

Remarks. *Tuerkayana hirtipes* is a widespread species in Southeast Asia and reaches up to Fiji and southern Japan in the Pacific, although it is not yet known from Australia (Türkay, 1974; Ng & Shih, 2014). The species was originally described as a *Cardisoma* and remained in this genus for most of the 20th century (Türkay, 1974) until it was transferred to *Discoplax* A. Milne-Edwards, 1867, by Ng & Guinot (2001). Ng & Davie (2012) and Ng & Shih (2015) clarified the taxonomy of this species, treating the “blue population” from Christmas Island as a new species (*Discoplax celeste*) and the population in the eastern Indian Ocean as a separate new taxon, *Discoplax magnum*, respectively. Most recently, Guinot et al. (2018) argued that four species of *Discoplax*: *Discoplax hirtipes*, *Discoplax celeste*, *Discoplax magnum* and *Discoplax rotundum* (Quoy & Gaimard, 1824), had diagnostic characters of the male sternum and should be placed in their own new genus, *Tuerkayana*.

Both Singapore specimens, including the recent one from St John’s Island, are females, but all their characters agree with what is known for *Tuerkayana hirtipes* and we are certain they are this species. The live colouration of the St John’s Island specimen (ZRC 2015.0355) agrees very well with material from other parts of its range in Southeast Asia (Fig. 7F; Ng & Shih, 2014: figs. 1, 2A–F).

DISCUSSION

Land crabs do not appear to be common or widely distributed in Singapore. This is not surprising especially since the pace of development on the island has been substantial and many of their preferred coastal areas would have been developed over the years. It is a good sign that *Cardisoma carnifex* has been found in Pulau Ubin and, as the island is now partially protected, there is a good chance that the population there will grow. Its preferred habitat, the edge of mangroves and muddy coastal areas, is abundant on Pulau Ubin. *Tuerkayana hirtipes* is a separate challenge as the species likes forested coastal areas with karst formations, burrowing in the soft earth around the hard substrates. Although karst habitats are rare, their discovery on St John’s Island is not surprising as there are scattered limestone areas near the sea. However, they are not extensive. It is possible that the species can become more established in St. John’s and other southern islands over time.

Another native species should be expected from Singapore. That is the purple land crab *Gecarcoidea lalandii* H. Milne Edwards, 1837 (see Türkay, 1974; Lai et al., 2017), a species typically associated with drier karst forests where it hides in burrows. It is often found together with *Tuerkayana hirtipes* but prefers the drier parts in the main forest. *Gecarcoidea lalandii* has been found together with *Tuerkayana hirtipes* in Nikoi Island (Fig. 7F), a small island east of Pulau Bintan in the Riau Archipelago only about 90 km southeast of Singapore (Fig. 8).

Conservation challenges. *Cardisoma armatum* is the first non-native land crab found in the wild in Singapore. As discussed earlier, what is surprising is that although *Cardisoma armatum* has been imported into Singapore for over 25 years, no wild specimens have been reported until recently. Globally, over 70 species of non-native brachyuran and anomuran species have been reported, most of them marine taxa (see Brockerhoff & McLay, 2011; McLay, 2015; Ng et al., 2018; Wong et al., in press), although it is believed that the real numbers are much higher (see Yeo et al., 2011). At least 14 alien crab species have been reported from an oil rig docked in Singapore, but none are known to occur or have been established in marine or terrestrial habitats (see Yeo et al., 2009, 2011; Yeo & Chia, 2010; Jaafar et al., 2012). For inland and terrestrial ecosystems, no crab has yet been reported; the only non-indigenous and invasive taxa are crayfish and freshwater prawns (Ng, 1990; Yeo, 2010).

The pet trade presents major challenges for conservation as more crab species get traded and exported globally (e.g., see Belle et al., 2011; McLay, 2015; Weiperth et al., 2019; Shy et al., 2020). Invariably, no risk-assessments are done before importation (Zeng et al., 2015). If *Cardisoma armatum* becomes established in Singapore as the result of escapees and/or releasees, it may pose a threat to *Cardisoma carnifex*. While *Cardisoma carnifex* is now only known for certain from Pulau Ubin, it should be able to expand its range as more mangrove and coastal areas are protected and set aside for conservation. Zeng et al. (2019) highlighted problems with potential competition between two fully aquatic species, the invasive Australian crayfish *Cherax quadricarinatus* (von Martens, 1868) (Parastacidae) and the native freshwater crab *Parathelphusa maculata* De Man, 1879 (Gecarcinucidae). This may well also be the case for *Cardisoma armatum* and *Cardisoma carnifex* in the future, especially if *Cardisoma armatum* becomes established.



Fig. 8. *Gecarcoidea lalandii*, male (not collected), Nikoi Island, Pulau Bintan. (Photograph by: Norman Lim).

While *Cardisoma armatum* is one of the main species in the aquarium trade, it is not the only one. Other *Cardisoma* species, including the similarly coloured *Cardisoma crassum* from central America, are not known to be exported for the trade. American species of *Gecarcinus*, mainly *Gecarcinus lateralis* (Guérin, 1832), *Gecarcinus quadratus* Saussure, 1853, and *Gecarcinus ruricola* (Linnaeus, 1758), are often exported to Europe (see Rademacher & Mengedoht, 2011). Some colourful species from Southeast Asia are exported to Japan, China and Europe, with stock sometimes being sold in Singapore and Malaysia. *Gecarcoidea lalandii* H. Milne Edwards, 1837, is the more common species sold, but over the last decade, large numbers of *Gecarcoidea humei* (Wood-Mason, 1874) and *Tuerkayana magnum* have been collected from southern Java and exported to Europe, with some going to China and Japan. The export of tropical species to temperate areas, however, does not pose serious threats for the native fauna there as land crabs are unlikely to survive the winters in those areas.

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