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An updated and annotated checklist of marine and brackish caridean shrimps of Singapore (Crustacea, Decapoda)

Arthur Anker[1] & Sammy De Grave[2]

Abstract. The present checklist represents a synthesis of the current state of knowledge of the caridean shrimp fauna of Singapore, based mainly on the abundant material collected in the Straits of Johor and Strait of Singapore during the Comprehensive Marine Biodiversity Survey of Singapore (CMBS) in 2010–2014. Some additional caridean material from Singapore, for instance, material collected and identified by D.S. Johnson in the 1950–1960s, were also included. All reported taxa are listed with selected synonymy, as well as taxonomic, ecological and biogeographical notes; most species are also illustrated in colour, some for the first time. Many taxa, especially in the family Alpheidae, represent taxonomically challenging species complexes that may each take several years to be completely resolved. The material collected during CMBS contains a total of 128 taxa (including well-defined species, tentatively identified species (cf., aff.), and species complexes = species sensu lato) in 53 genera and 12 families. Species previously reported from Singapore but not re-collected by CMBS are included in a table summarising all caridean records from the country, totalling 219 taxa in 63 genera and 14 families; however, some of these records appear to be questionable and require confirmation. A total of 47 caridean species are recorded from Singapore for the first time, the most notable new records being, for the Alpheidae: *Alpheus ehlersii* De Man, 1909; *Automate anacanthopus* De Man, 1910; *Prionalpheus sulu* Banner & Banner, 1971; *Salmoneus seticheles* Anker, 2003 (previously known only from northern Australia); *S. alpheophilus* Anker & Marin, 2006; *Synalpheus thai* Banner & Banner, 1966; *Thuylamea camelus* Nguyên, 2001 (genus and species previously known only from Vietnam); for the Palaemonidae: *Periclimenaeus arabicus* (Calman, 1939); *P. orontes* Bruce, 1986 (previously known only from northern Australia); *Pontonides loloata* Bruce, 2005; and for the remaining families: *Latreutes anoplonyx* Kemp, 1914; *Leptochela crosnieri* Hayashi, 1995 (previously known only from New Caledonia); *Lysmata lipkei* Okuno & Fiedler, 2010 (previously known only from Japan); *Ogyrides orientalis* (Stimpson, 1860); *Philocheras pilosus* (Kemp, 1916) and *Thor marguitae* Bruce, 1978 (previously known only from eastern Australia). Taxonomic changes are made for *Alpheus dispar* Randall, 1840 (previously considered a synonym of *A. brevirostris* (Olivier, 1811)), *A. imitatrix* De Man, 1909b (previously considered a subspecies of *A. pareuchirus* Coutière, 1905) and *A. monoceros* Heller, 1862 which is herein formally considered to be a nomen dubium.

Key words. Decapoda, Caridea, shrimp, crustaceans, new records, biodiversity, South-East Asia, Strait of Singapore, Straits of Johor

INTRODUCTION

The first records of caridean shrimps from Singapore go back to Walker (1887), who listed only four species of Caridea. With the exception of a few isolated records (e.g., Nobili, 1903a; Balss, 1914; Kemp, 1916a), the caridean fauna of Singapore remained largely unstudied until two checklists published by Johnson (1962, 1979), the latter posthumously after his sudden death in 1972 (Harding, 1974). Since 1979, only a handful of publications dealt with marine or brackish-water shrimps of Singapore (e.g., Yeo & Ng, 1996, 1997; Anker, 2003a) and it can be stated that the marine caridean fauna of Singapore has not been reviewed for the past 40+ years, since Johnson (1979). On the other hand, the freshwater shrimps of Singapore and peninsular Malaysia have been studied more intensively over the last two decades (e.g., Ng, 1990; Yeo & Ng, 1996, 1997; Wowor et al., 2004; Cai et al., 2007).

The abundant caridean material collected during the Comprehensive Marine Biodiversity Survey of Singapore (CMBS) in 2010–2015, provides a solid platform for an update of Johnson's (1962, 1979) checklists. The CMBS material is deposited mainly in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum, National University of Singapore (NUS), Singapore (ZRC), and Oxford University Museum of Natural History, Oxford, the United Kingdom (OUMNH.ZC). One specimen was donated to the Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP). Where possible and/or necessary, the study of CMBS material was combined with examination of Johnson's material deposited in ZRC,

[1]Tropical Marine Science Institute (TMSI), National University of Singapore, 18 Kent Ridge Road, Singapore 119227; present address: Museu de Zoologia, Universidade de São Paulo (MZUSP), Avenida Nazaré 481, Ipiranga, SP, CEP 04263-000, Brazil; Email: arthuranker7@gmail.com

[2]Oxford University Museum of Natural History, Parks Road, OX1 3PW, Oxford, United Kingdom; Email: sammy.degrave@oum.ox.ac.uk

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especially for the family Alpheidae. Additional selected caridean material deposited in ZRC, OUMNH, and the Naturalis Biodiversity Center, Leiden, the Netherlands (RMNH.CRUS.D), was also examined.

The resulting checklist is not meant to provide an exhaustive review but rather to document the current state of knowledge of the marine caridean fauna of Singapore. Many taxa, especially in the family Alpheidae, represent taxonomically challenging species complexes that remain to be untangled; most of these taxa are reported as "species sensu lato". Some identifications are preliminary as material from Singapore is incomplete or needs to be compared to the type material or requires confirmation. The taxonomic status of all these taxa is discussed in some detail, paving the way for future research. Only three taxonomic changes are made, namely one resurrection of an old synonym, one elevation from subspecies to species rank and one formal designation as a nomen dubium, all in the genus *Alpheus* Fabricius, 1798 (Alpheidae).

All marine or brackish species of Caridea previously and presently recorded from Singapore are included in a summary table (Table 1), but only species collected during CMBS and a few additional species are treated in more detail. A selective synonymy is provided for each species treated, typically listing the original description, the most important synonyms (where these are discussed in the text), one or several references with taxonomically useful illustrations, as well as records most relevant for Singapore and South-East Asia. The records from Singapore include taxonomic literature (e.g., Walker, 1887; Kemp, 1916a; Johnson, 1962, 1979; Banner & Banner, 1966a; Anker, 2003a), accounts of symbiotic species (e.g., Johnson, 1963; Goh et al., 1999), and "incidental records", typically just photographs, in popular books and journals (e.g., Tan & Yeo, 2004; Ng et al., 2007; Tan, 2014).

Colour photographs are provided for most species treated in the text and are aimed to represent a first-step visual identification tool for caridean shrimps most commonly encountered in Singaporean waters. Most photographs were taken by the first author (AA) during CMBS workshops in 2012 and 2013 and show living shrimps or occasionally, individuals shortly after death (post-mortem). Some in situ photographs of caridean shrimps made by other photographers in Singapore or elsewhere, either intertidal or subtidal (while scuba diving), are also included, to show their typical habitat and, for symbiotic shrimps, their host associations. Several species are shown in colour for the first time.

CMBS collection data is typically given as starting with CMBS station (SW- for shallow-water, DW- for deep-water, SD- for scuba diving, etc.); for dredge and trawl stations, a position relative to the nearest land area (coast, island etc.) is provided; field collection numbers are listed at the end for each specimen between brackets. Collectors of the material are listed under "leg."; CMBS stations are abbreviated as "sta."; ovigerous females are indicated as "ov."; previous identificators are listed as "det.". Systematics follows De Grave & Fransen (2011) and De Grave et al. (2014).

SYSTEMATIC ACCOUNT

Family Alpheidae Rafinesque, 1815

Genus *Alpheus* Fabricius, 1798

Alpheus alpheopsides Coutière, 1905 sensu lato
(Fig. 1)

Alpheus alpheopsides Coutière, 1905: 901.
(?) Not *Alpheus alpheopsides* — Johnson, 1962: 52; Johnson, 1979: 34 (= *A. tenuipes* De Man, 1910).
(?) *Alpheus paracrinitus* (nec Miers, 1881) — Banner & Banner, 1982: 129 (part.?).

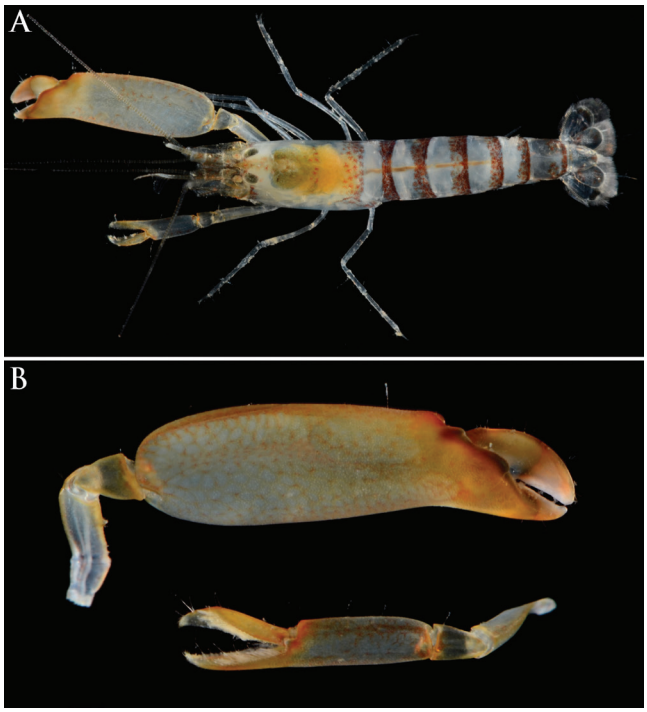

Fig. 1. *Alpheus alpheopsides* Coutière, 1905 sensu lato: A, male dredged off Kusu Island, Strait of Singapore, CMBS sta. TB158 (OUMNH.ZC. 2014-11-001); B, male from Pulau Hantu, Strait of Singapore, CMBS sta. IT120 (ZRC 2014.0618), detached chelipeds in mesial view (Photographs by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0618, sta. IT120, Pulau Hantu, intertidal, under rocks, rubble etc., leg. K.S. Koh, S.T. Ahyong et al., 31 May 2013 (SS-3271); 1 male, 1 female, OUMNH.ZC. 2014-11-001, sta. TB158, near Southern Fairway, off Kusu I., 147–160 m, rocks, laterite gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4517); 1 male, ZRC 2014.0733, sta. SAL, Pulau Salu, sand-rubble flat exposed at low tide, under rubble, leg. A. Anker et al., 09 August 2014 (SAL AA-02).

Additional material. Strait of Singapore. 1 male, OUMNH. ZC. 2014-11-002, Raffles Lighthouse, 07 May 2004 [missing minor cheliped]; 1 ov. female, ZRC 2008.0606, Sentosa,

sandy mud flat with coral debris, leg. Y. Miya, 26 February 1991 [det. Y. Miya as *A. paracrinitus*].

Distribution. Indo-west Pacific, from the Red Sea to Micronesia and Samoa (Banner & Banner, 1983; but see below).

Previous records from Singapore. Johnson (1962, 1979) (but see below).

Ecology. Coral reefs and associated sandflats wih abundant coral rubble; under coral rubble or in crevices of dead coral heads; lower intertidal and shallow subtidal to (exceptionally?) 160 m.

Remarks. *Alpheus alpheopsides* belongs to the pantropical *Alpheus paracrinitus* Miers, 1881 species complex (A. Anker, in study). The current species delimitations in this complex are blurred and most morphological characters used by previous workers (e.g., Coutière, 1905; Banner & Banner, 1982) will need to be re-evaluated. The *A. paracrinitus* complex includes, in addition to *A. paracrinitus* (amphi-Atlantic) and *A. alpheopsides* (Indo-west Pacific), at least eight further nominal taxa in the Indo-Pacific. Some of them were originally described based on a single or a few incomplete specimens, sometimes without illustrations, and are therefore pooorly known. This is also the case of *A. alpheopsides* itself, which was described based on a mutilated female specimen from Hulhulé (Malé) Atoll, missing its major cheliped, and an unknown number of specimens from Djibouti (Coutière, 1905). Coutière (1905) provided only a drawing of the minor chela and not the rest of the cheliped; fortunately, several important characters in the *A. paracrinitus* complex are found on the merus. In addition, the type series of *A. alpheopsides* deposited in the Muséum National d'Histoire Naturelle (MNHN) in Paris, France, appears to contain two different species (A. Anker, pers. obs.). Thus, all identifications under the name *A. alpheopsides* (e.g., Banner & Banner, 1983) will have to be verified, if possible, by re-examination of the material.

The Singaporean material differs from the type specimen *A. alpheopsides* illustrated by Coutière (1905), for example, by the noticeably longer rostrum. The male minor cheliped is sub-balaeniceps in some specimens (ZRC 2014.0618), but not in others (ZRC 2014.0733). A similar sub-balaeniceps condition of the male minor cheliped was illustrated for the Australian material reported as *A. paracrinitus* by Banner & Banner (1982). Since the identity of *A. alpheopsides* remains unsettled, the identification of the present material must be regarded as tentative.

Johnson's (1962, 1979) extant material of *A. alpheopsides* from Singapore (two lots with four specimens in ZRC) were re-examined and tentatively re-identified as *A. tenuipes* De Man, 1910 (see Additional material under *A. tenuipes*). Johnson also reported two other closely related taxa from Singapore: *A. bengalensis* Coutière, 1905 was found in "crevices of honeycomb rock" at Labrador Beach (Johnson, 1962), whereas *A. paralpheopsides* Coutière, 1905 was collected from "reef slopes" (Johnson, 1979). Johnson's material of these two species (ZRC) is now represented by incomplete specimens in very poor condition, and cannot be identified, but most likely is neither *A. bengalensis* nor *A. paralpheopsides* (A. Anker, pers. obs.). Therefore, the presence of these two species in Singapore cannot be confirmed at this stage.

In Singapore, *A. alpheopsides* sensu lato has been collected mostly intertidally, in the Strait of Singapore (Sentosa, Pulau Hantu, Pulau Salu, Raffles Lighthouse), although two specimens (OUMNH.ZC.2014-11-001) were apparently dredged from a much deeper area (147–160 m) off Kusu Island, if the accompanying station data can be trusted.

Alpheus bannerorum **Bruce, 1987**
(Fig. 2)

Alpheus bannerorum Bruce, 1987: 61; Bruce, 1990a: 619.
Alpheus cf. *maindroni* (nec Coutière, 1898) — Johnson, 1962: 54.
Alpheus maindroni (nec Coutière, 1898) — Johnson, 1979: 38.

Fig. 2. *Alpheus bannerorum* Bruce, 1987: male from Kusu Island, Strait of Singapore, CMBS sta. SB55 (ZRC 2014.0395) (Photograph by: Arthur Anker)

CMBS material. Strait of Singapore. 2 males, ZRC 2014.0395, sta. SB55, SW of Kusu I., 4 m, brushing of dead corals, leg. H.H. Tan, S. De Grave, D. Uyeno et al., 25 May 2013 (SS-1637); 1 male, OUMNH.ZC. 2014-11-003, sta. SB55, same collection data (SS-1590); 3 males, OUMNH. ZC. 2014-11-004, sta. SB55, same collection data (SS-1619); 2 males, 1 ov. female, ZRC 2014.0394, sta. SB132, S Kusu I., pontoon, 0–5 m, brushing of dead corals, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3768); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-005, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1591); 1 male, 1 ov. female, ZRC 2014.0393, sta. DR70, near Pulau Sudong and Pulau Semakau, 20.6–22.6 m, sandy bottom, leg. B. Richer de Forges et al., 26 May 2013 (SS-4524); 1 male, OUMNH.ZC. 2014-11-006, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SIN-235); 1 female, OUMNH.ZC. 2014-11-007, sta. IT122, Terumbu Raya, intertidal, leg. C.S. Tan et al., 30 May 2013 (SIN-224); 1 ov. female, OUMNH.ZC. 2014-11-008, sta. SD66, Pulau Hantu, ~3 m, shallow silted reef, in crinoid, leg. S. De

Grave, Z. Jaafar, H.H. Tan et al., 26 May 2013 (SIN-110); 1 male, 1 ov. female, ZRC 2014.0396, sta. SD145, W of Pulau Hantu, 11.7 m, in coral rubble, leg. S. De Grave, H.H. Tan, Z. Jaafar et al., 02 June 2013; 1 male, 1 ov. female, OUMNH.ZC. 2014-11-009, sta. SB67, W of Pulau Hantu, patch reef, 15.7 m, brushing of dead corals, leg. D. Uyeno, S. De Grave, H.H. Tan et al., 26 May 2013 (SS-1653).

Additional material. Strait of Singapore. 2 ov. females, ZRC 1979.4.3.19–20, Pulau Hantu, reef edge in crevices in coral rocks, leg. D.S. Johnson, 16 July 1957 (J8064-8065) [det. D.S. Johnson as *A. maindroni*]; 1 ov. female, between N Pulau Pawai and Pawai reef, 9–14.5 m, rocks, some gravel, gorgonians, sponges etc., in crevice in sand stone, 04 January 1969 (J9279) [det. D.S. Johnson as *A. maindroni*].

Distribution. Southern China to Singapore and northern Australia (Bruce, 1987, 1990; present study).

Previous records from Singapore. Johnson (1962, 1979, as *Alpheus maindroni* Coutière, 1898).

Ecology. Coral reefs and associated habitats rich in rubble, in crevices of dead coral heads and coral rubble; lower intertidal to at least 23 m.

Remarks. *Alpheus bannerorum* is closely related to *A. parvirostris* Dana, 1852 (see below), from which it may be distinguished by the distally unarmed merus of the third and fourth pereopods and, in life, by the presence of very conspicuous eye-like spots on the abdomen (compare Figs. 2 and 23; see also Bruce, 1987). The species is formally recorded for the first time from Singapore, although Johnson (1962, 1979) previously reported it as *A.* cf. *maindroni* and *A. maindroni*, respectively (see Additional material). In Singapore, *A. bannerorum* appears to be fairly common on patchy and silt-covered reefs around the southern islands (Pulau Hantu, Kusu Island, Pulau Semakau, Pulau Sedong).

Alpheus brevirostris (Olivier, 1811)
(Fig. 3)

Palaemon brevirostris Olivier, 1811: 664.
Alpheus brevirostris — Coutière, 1899: 230; Banner & Banner, 1982: 170; Miya, 1990: 1184; Bruce, 1994: 22.
(?) *Alpheus brevirostris* var. *angustodigitus* De Man, 1911: 385; De Man, 1924: 45.
(?) *Alpheus brevirostris angustodigitus* — Bruce, 1994: 22.
(?) *Alpheus angustidigitus* (lap. cal.) — Johnson, 1962: 53; Johnson, 1979: 35.
(?) *Alpheus angustodigitus* — Banner & Banner, 1985: 12.

CMBS material. None.

Additional material. Straits of Johor. 1 male, ZRC 2009.0815, Pulau Sekudu near Pulau Ubin (off Chek Jawa), under coral slab on sand flat, low tide, leg. S.K. Tan, 21 July 2009. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.0732, Changi Beach, beach seine at low tide, leg. N.K. Ng et al., 27 February 2003; 1 male, OUMNH.ZC. 2014-11-010, Changi Beach, leg. Z. Jaafar, 26 June 2002; 1 male,

Fig. 3. *Alpheus brevirostris* (Olivier, 1811) [?]: female or male with regenerating minor cheliped photographed in situ at Pulau Semakau, Strait of Singapore (specimen not collected) (Photograph by Ria Tan).

ZRC 2014.0651, Changi Point, beach seine, leg. H.H. Tan et al., 08 March 2001 [missing minor cheliped]; 2 males, 1 ov. female, OUMNHZ.ZC.2014-11-011, Changi Point, beach seine, leg. H.H. Tan et al., 18 October 2001; 1 male, ZRC 1979.3.29.7, Bedok, 14 January 1955 (J7256) [det. D.S. Johnson as "*A. angustidigitus*", re-det. Y. Miya as *A. brevirostris*]; 1 male, ZRC 1979.3.29.23, Labrador Beach, CLTM, 07 December 1953 (J7948) [det. D.S. Johnson as "*A. brevirostris* var. *angustidigitus*"]; 4 males, ZRC 2008.0602, Siglap, VI.1933.

Distribution. Indo-west Pacific: Australia, Papua New Guinea, Indonesia and Singapore (De Man, 1911; Johnson, 1962; Banner & Banner, 1982; present study).

Previous records from Singapore. Johnson (1962, 1979, as *A. angustidigitus*).

Ecology. Muddy sandflats, in burrows and under large rocks and rubble; lower intertidal and shallow subtidal, to about 12 m (Johnson, 1979).

Remarks. *Alpheus brevirostris* is currently known with certainty only from the extant holotype from "New Holland", i.e., from an unknown location somewhere in the southern or western half of Australia according to Banner & Banner (1982). The Indonesian and Singaporean material, which matches Olivier's description of *A. brevirostris* and figures of the cheliped published by Coutière (1899), was treated as a separate species, *A. angustodigitus* De Man, 1911, by Johnson (1962) and Banner & Banner (1985).

Bruce's (1994) concept of *A. brevirostris* was largely based on a preliminary report of Miya (1990) and Y. Miya's personal communication (1993, reproduced verbatim in Bruce, 1994). Miya (1990) examined type material of several problematic species in the *A. brevirostris* group, including *A. dispar* Randall, 1840, *A. digitalis* De Haan, 1849, *A. distinguendus* De Man, 1909c and *A. brevirostris* var. *angustodigitus* De Man, 1911, and came to the conclusion that (1) *A. distinguendus* was a synonym of *A. digitalis*; and (2) *A.*

dispar and *A. brevirostris* var. *angustodigitus* were both synonyms of *A. brevirostris* (Bruce, 1994). More recently, Hayashi & Nagata (2002) confirmed the synonymy of *A. distinguendus* with *A. digitalis*. The Singaporean material matches De Man's (1911) description of *A. brevirostris* var. *angustodigitus* from western Borneo, especially in the shape and proportions of the minor chela. The differences in the shape of the chelipeds between *A. brevirostris* and *A. angustodigitus* appear to be minor, at least based on Coutière's figures of the holotype. Therefore, *A. angustodigitus* is presently kept in the synonymy of *A. brevirostris* (see Miya, 1990; Bruce, 1994) and all material from the Sunda Shelf is tentatively assigned to *A. brevirostris*, until more evidence is available, including fresh material from Australia. On the other hand, *A. dispar* is morphologically clearly different from *A. brevirostris* and is here treated as a full species (see below).

In Singapore, Johnson (1962) reported *A. brevirostris* (as *A. angustidigitus*) mostly from intertidal habitats (Bedok, Labrador Beach, mudflats at Tanjong Penjuru), but also from a shoal west of Pulau Pawai, at 12 m. More recently, *A. brevirostris* was collected at Pulau Sekudu and Changi Point in the eastern entrance of the Straits of Johor. Although we did not find *A. brevirostris* during the CMBS survey, a large species of *Alpheus* with a general appearance of *A. brevirostris* was photographed (but not collected) on muddy sandflats of Pulau Semakau. The conspicuous colour pattern of this snapping shrimp (Fig. 3) is very different from that of *A. dispar* (Fig. 6), *A. digitalis* and *A. longiforceps* (see Hayashi & Nagata, 2002). Since colour patterns are highly diagnostic in most species of *Alpheus*, snapping shrimps with this colouration (transverse orange-brown bands and green-marbled major chela, cf. Fig. 3) should be collected and examined to confirm that they actually correspond to *A. brevirostris*.

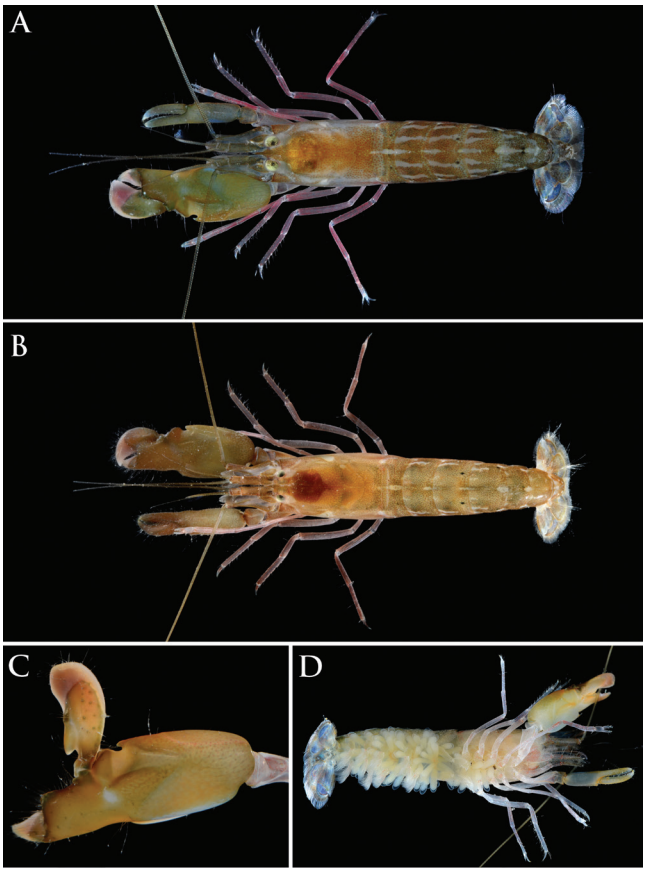

Fig. 4. *Alpheus chiragricus* H. Milne Edwards, 1837: A, male dredged off Johor coast, Straits of Johor, CMBS sta. DW129 (ZRC 2014.0422); B, male from Chenting, Straits of Johor, CMBS sta. 3822-DR1 (OUMNH.ZC. 2014-11-041); C, female from Marina South, Strait of Singapore, CMBS sta. 5314-TB1, major chela in mesial view (ZRC 2014.0538); D, female from Pulau Tekong, Straits of Johor, CMBS sta. 0523-DR3, ventral view showing infestation by a rhizocephalan, possibly *Thompsonia* sp. (OUMNH. ZC. 2014-11-013) (Photographs by Arthur Anker).

Alpheus chiragricus H. Milne Edwards, 1837
(Fig. 4)

Alpheus chiragricus H. Milne Edwards, 1837: 354; De Man, 1911: 415; Johnson, 1962: 53; Johnson, 1979: 36; Banner & Banner, 1978: 221; Banner & Banner, 1982: 267; Banner & Banner, 1985: 13; Chace, 1988: 18.
Alpheus edwardsii chiragricus — Coutière, 1905: 912.

CMBS material. Straits of Johor. 1 male, ZRC 2014.0422, sta. DW129, off Johor coast, 21.7–22.6 m, leg. B. Richer de Forges et al., 31 October 2012 (JS-2699); 1 male, OUMNH. ZC. 2014-11-041, near Chenting, 10.6–12.4 m, mud, sand, sponges, leg. S.C. Lim, A. Anker, C.K. Chim et al., 09 April 2014 (3822 DR1-AA77); 1 male, ZRC 2014.0551, sta. DW57, E of Pulau Tekong, 10.3–10.6 m, leg. B. Richer de Forges et al., 22 October 2012 (JS-1661); 1 male, 1 female, ZRC 2014.0544, sta. DW57, same collection data; 1 male, 1 female, ZRC 2014.0549, sta. DW57, same collection data; 1 male, OUMNH.ZC. 2014-11-012, sta. DW56, off Pulau Tekong, N of Beting Bronok, 6.1–8.2 m, leg. B. Richer de Forges et al., 22 October 2012; 1 male, ZRC 2014.0539, sta. DW20, N of Pulau Ubin, 10.3–10.6 m, leg. B. Richer de Forges et al., 18 October 2012 (JS-0766); 1 male, 1 ov. female, ZRC 2014.0554, sta. DW18, N of Pulau Ubin, 6.2–12.9 m, B. Richer de Forges et al., 18 October 2012; 1 ov. female, ZRC 2014.0540, sta. S16, Pulau Ubin, Chek Jawa, seagrass bed and sand flat, beach seine, leg. K.S. Tan et al., 07 March 2012; 1 female, OUMNH.ZC. 2014-11-013, E of Pulau Tekong, 10.6–10.7 m, leg. C.K. Chim, S.C. Lim, P.S.H. Wong, A. Anker et al., 25 March 2014 (0523 DR3-AA16) [infested by rhizocephalan *Thompsonia* sp.]. Strait of Singapore: 1 male, OUMNH.ZC. 2014-11-014, sta. DW128, E of Changi Naval Base, 18.3–21.8 m, mud, leg. B. Richer de Forges et al., 30 October 2012; 1 ov. female, ZRC 2014.0552, E of Bedok Jetty, 9.1–10.6 m, leg. TMSI team, 24 January 2013 (5718 DR1-001); 1 male, ZRC 2014.0542, off Marina East, 22.7–23.7 m, leg. TMSI team, 14 January 2013 (5416 TB1-034); 1 female, ZRC 2014.0555, same collection data (5416 TB1-104) [parasitised by a pair of hemiarthrine isopods]; 1 male, 1 female, ZRC 2014.0545, off Marina East, 51.1–51.7 m, leg. TMSI team, 13 May 2013 (5415 TB1-010-011); 1 female, OUMNH.ZC. 2014-11-015, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-004) [infested by rhizocephalan *Thompsonia* sp.]; 1 male, ZRC 2014.0550, Eastern Holding B, 24.4–25.4 m, leg. TMSI team,

17 May 2013 (5314 TB2-054); 1 female, ZRC 2014.0538, same collection data (5314 TB1-006); 1 male, OUMNH.ZC. 2014-11-016, Outer Shoal, 5215, 7.2–7.5 m, leg. TMSI team, 21 March 2013 (5215 TB1-003); 1 female, OUMNH.ZC. 2014-11-017, sta. DR174, near Kusu I., 79.6–135 m, reddish marine clay, gravel, shells, leg. B. Richer de Forges et al., 05 June 2013; 1 male, 1 female, ZRC 2014.0553, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-100-101) [male missing minor cheliped and infested by rhizocephalan *Thompsonia* sp.]; 1 male, ZRC 2014.0556, off Siglap, 6.9–10.9 m, leg. TMSI team, 26 February 2013 (5517 DR1-035); 1 male, ZRC 2014.0541, sta. TB72, S of Pulau Hantu, 23.1–23.6 m, leg. B. Richer de Forges et al., 26 May 2013; 2 males, ZRC 2014.0546, sta. TB99, Eastern Bunkering A, 26.7–33.7 m, bryozoan dominated silty bottom, leg. B. Richer de Forges et al., 29 May 2013; 1 male, 1 ov. female, OUMNH.ZC. 2014-11-018, sta. TB99, same collection data (SIN-196); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-019, sta. TB99, same collection data (SIN-195); 1 male, ZRC 2014.0614, Eastern Bunkering A, 12.9–14.7 m, leg. S.C. Lim, A. Anker, C.K. Chim et al., 08 April 2014 (0318 DR1 AA52); 1 male, OUMNH.ZC. 2014-11-020, sta. TB98, Eastern Bunkering A, 33.6–30.2 m, broken shells, silt, leg. B. Richer de Forges et al., 28 May 2013 (SIN-207); 1 ov. female, ZRC 2014.0547, sta. DR111, outside Eastern Boarding Ground, 125–136 m, rocks, sand, leg. B. Richer de Forges et al., 30 May 2013 (SS-3245); 1 ov. female, OUMNH.ZC. 2014-11-021, sta. TB127, beside Eastern Boarding Ground A, rocky bottom, 128–113 m, leg. S.C. Lim et al., 30 May 2013 (SIN-233A); 1 male, OUMNH.ZC. 2014-11-022, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SIN-237); 1 male, ZRC 2014.0543, sta. TB3, off Raffles Lighthouse, 40.7–40.9 m, sand, large sponges, leg. B. Richer de Forges et al., 21 May 2013 (SS-0307); 1 male, OUMNH.ZC. 2014-11-023, sta. DR174, off Kusu I., 79.6–135 m, reddish marine clay, gravel, shells, leg. B. Richer de Forges et al., 05 June 2013 (SIN-339); 1 male, OUMNH.ZC. 2014-11-024, sta. TB15, Eastern Fairway, 23.8–21.5 m, silt, gravel, leg. B. Richer de Forges et al., 21 May 2013 (SIN-020); 1 male, OUMNH.ZC. 2014-11-025, sta. TB15, same collection data (SIN-011); 1 ov. female, OUMNH.ZC. 2014-11-026, sta. TB15, same collection data (SIN-005); 1 male, OUMNH. ZC. 2014-11-027, sta. TB15, same collection data (SIN-009); 1 male, OUMNH.ZC. 2014-11-028, sta. TB15, same collection data (SIN-008) [with regenerated major cheliped, infested by rhizocephalan *Thompsonia* sp.]; 1 ov. female, OUMNH.ZC. 2014-11-029, sta. DR239, outside of Pulau Bukom staff chalet, 24.3–27.6 m, sand, gravel, some mud, leg. TMSI team, 11 December 2013 (SEA-1941).

Additional material. Straits of Johor. 2 males, 3 ov. females, ZRC 2014.0371, Pulau Ubin, Chek Jawa, leg. D.C.J. Yeo et al., 30 May 2001; 2 males, 3 ov. females, OUMNH.ZC. 2014-11-030, Pulau Ubin, NE of Chek Jawa, leg. P.K.L. Ng et al., 17 June 2003; 10 specimens (males and females), ZRC 2014.0372, Pulau Ubin, Chek Jawa, sandy mud, leg. D.C.J. Yeo et al., 30 May 2001; 13 specimens (males and females), ZRC 2011.0517, Pulau Tekong, Berting Bronok, leg. Y. Cai, 05 December 2002; 1 male, 1 female, ZRC 1979.3.29.42-43, Ponggol, under rocks near L.W.S.T., leg. B.C. Lim, 15 June 1967 (J8169-8170); 1 male, 1 ov. female, ZRC 2008.0631, Siglap, VI.1933. Strait of Singapore. 1 male, ZRC 1979.3.29.40, sta. B79, sand, stone, leg. S.R.F.R.S., 07 April 1955; 1 ov. female, ZRC 2014.0370, Changi Beach, low tide, beach seine, leg. N.K. Ng et al., 27 February 2003; 1 female, ZRC 2008.0624, off Sentosa, dredge, leg. D.G.B. Chia, Koh T.L., I.1992.

Distribution. Indo-west Pacific, from East Africa to southern China and Australia.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Sand-silt and sand-mud bottoms with abundance of shells, gravel, rocks and bryozoans; from lower intertidal to well below 100 m (deepest record in Singaporean waters around 136 m).

Remarks. *Alpheus chiragricus* is one of the most common snapping shrimps in Singapore, being especially well represented in dredges, both in the Strait of Singapore (e.g., off Kusu Island, Pulau Hantu, Pulau Bukom and Raffles Lighthouse, south of Siglap, Bedok, Marina Bay etc.) and Straits of Johor (e.g., around Pulau Ubin and Pulau Tekong), although a few specimens were collected in intertidal areas, e.g., near Chek Jawa. Johnson (1962) reported specimens collected on mud and muddy sand off Siglap (2–8 m), Tanjong Rhu (4 m) and Tanjong Stapa (nearly 50 m).

Alpheus chiragricus can be distinguished from all other Indo-west Pacific species of the *A. edwardsii* group by the sharp ventral and dorsal shoulders of the major chela (Banner & Banner, 1982), as well as by its species-characteristic colour pattern (Fig. 4). However, it must be noted that in several specimens, one or both shoulders of the major chela are bluntly protruding (Fig. 4B, C), thus approaching the condition found in *A. edwardsii* (see also remarks under *A. edwardsii*). Several dredged specimens of *A. chiragricus* were infested, some heavily, with a parasitic rhizocephalan barnacle, possibly belonging to the genus *Thompsonia* Kossmann (Thompsoniidae). The endoparasitic barnacles from this genus often form multiple externae, usually on the sternal side of the thorax and abdomen, and on the pleopods (Fig. 4D).

Alpheus digitalis De Haan, 1844 sensu lato
(Fig. 5)

Alpheus digitalis De Haan, 1844: 178; Hayashi & Nagata, 2002: 76.
Alpheus rapax De Haan, 1844: 177 (partim).
Alpheus heterocarpus Yu, 1935: 63.
Alpheus distinguendus De Man, 1909c: 155.

CMBS material. None.

Additional material. 1 male, ZRC 1979.4.2.15, Singapore, no further data (J7978) [det. D.S. Johnson as *A. distinguendus*, re-det. Y. Miya as *A. digitalis*]. Strait of Singapore. 1 male,

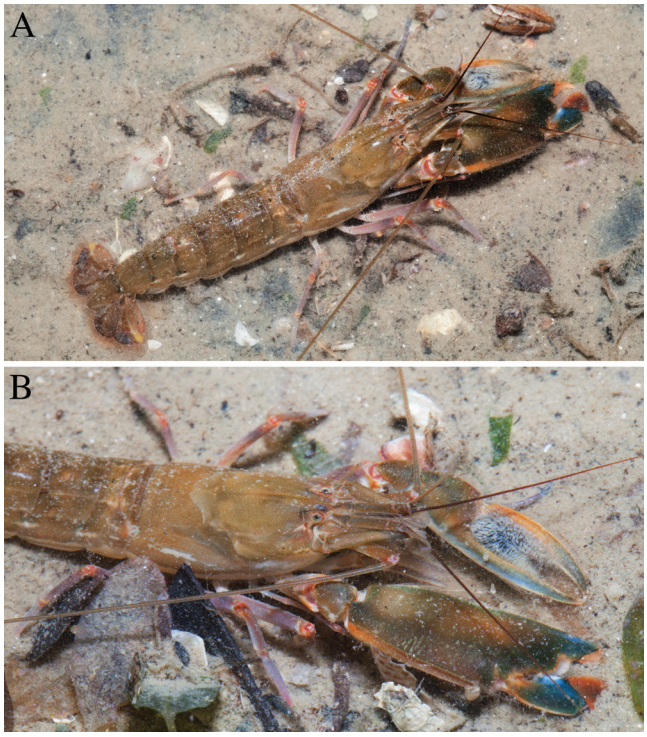

Fig. 5. *Alpheus digitalis* De Haan, 1844 [?]: A, B, male photographed in situ at Changi beach, Strait of Singapore (specimen not collected), in two different dorsolateral views (Photographs by: Marcus Ng).

ZRC 1979.4.2.14, Bedok, 27 July 1959; 2 males, OUMNH. ZC. 2014-11-031, Changi Point, beach seine, leg. H.H. Tan et al., 18 October 2001.

Distribution. Indo-west Pacific: *A. digitalis*: Japan, China, Korea (Hayashi & Nagata, 2002). *A.* cf. *digitalis* (one or several species): Vietnam, Singapore, India, Israel (A. Anker, pers. obs.).

Previous records from Singapore. Johnson (1962, as *Alpheus distinguendus* De Man, 1909c).

Ecology. Mud-sand bottoms, in burrows; lower intertidal and shallow subtidal, usually collected by beach seines at low tide.

Remarks. Johnson (1962) identified as *A. distinguendus* De Man, 1909 material collected by beach seines on mud-sand bottoms at Bedok and noted that this species was very similar to *A. rapax* Fabricius, 1798 (see below), from which it could be easily distinguished by a "beautiful and distinctive colouration". Two specimens of *A. distinguendus sensu* Johnson (1962) from an unknown Singaporean locality were later re-identified as *A. digitalis* by Y. Miya (see Additional material). These specimens were re-examined and found to be intermediate between *A. digitalis*, as redescribed by Hayashi & Nagata (2002), and *A. longiforceps* Hayashi & Nagata, 2002. These two species differ mainly by the length of the minor cheliped fingers and colour patterns, with *A. longiforceps* presenting a single crescent-shape band on the carapace (vs. two in *A. digitalis*) and a pair of large, conspicuous, dark spots on the fourth abdominal somite (vs. a pair of much smaller spots in *A. digitalis*) (see Hayashi & Nagata, 2002). The colour pattern of the Singaporean specimens examined by Johnson and Miya remains unknown. However, a relatively large (60 mm or so) snapping shrimp from the *A. digitalis* complex was recently photographed (but not collected) at Changi by M. Ng (Fig. 5); its colour pattern is different from that of *A. digitalis* and *A. longiforceps*.

The identification of non-Japanese specimens morphologically matching either *A. digitalis* or *A. longiforceps* remains a challenging problem, as pointed out by Hayashi & Nagata (2002). Therefore, the identity of *A. digitalis* from Singapore cannot be determined without a thorough revision of the entire *A. digitalis* complex.

Alpheus dispar Randall, 1840
(Figs. 6, 7)

Alpheus dispar Randall, 1840: 141; Bruce, 1994: 22.
Alpheus rapax (nec Fabricius, 1798) — Jaafar & Zeng, 2012: 1487; Jaafar & Hou, 2012: 122; Zeng & Jaafar, 2012: 693; Hou et al., 2013: 2776.

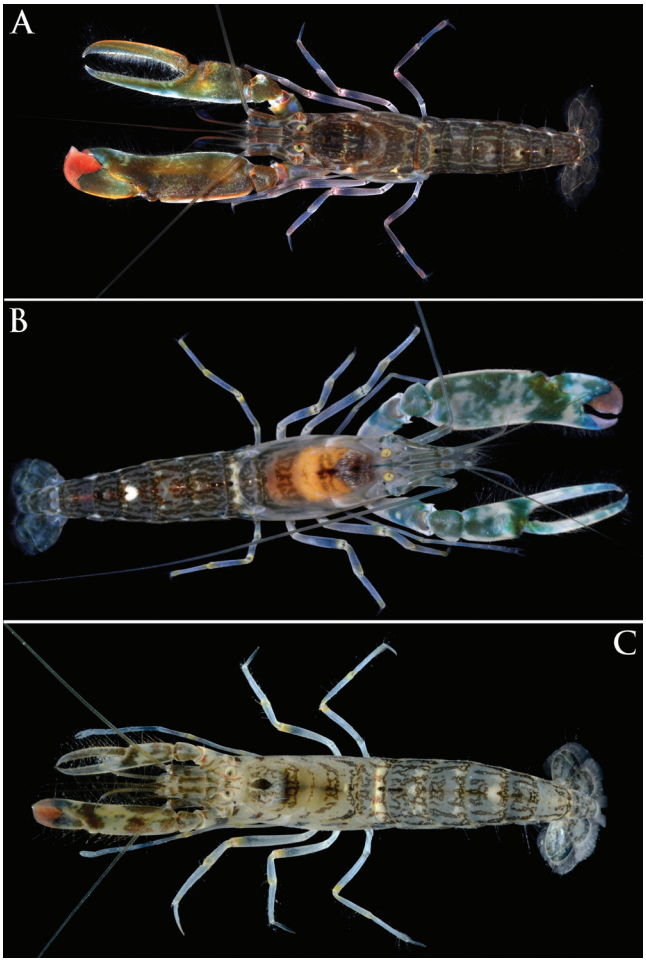

Fig. 6. *Alpheus dispar* Randall, 1840: A, male from Pulau Ubin, Straits of Johor, CMBS sta. SW13 (OUMNH.ZC. 2014-11-035); B, male from Pasir Ris, Straits of Johor (not preserved, see also Jaafar & Hou (2012), Jaafar & Zeng (2012) etc.); C, male dredged off Tengeh Reservoir, Straits of Johor, CMBS sta. 3821-DR1 (OUMNH.ZC. 2014-11-037) (Photographs by: Arthur Anker).

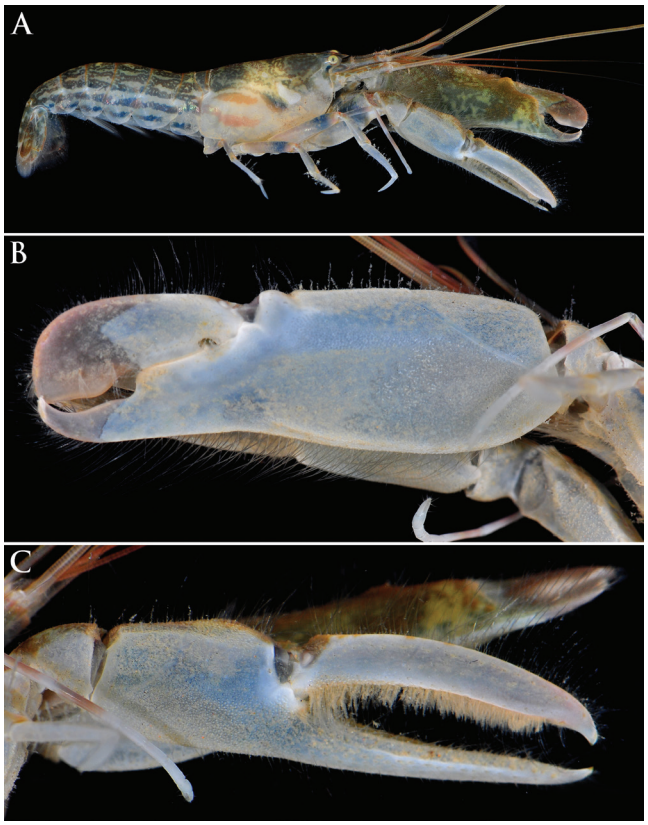

Fig. 7. *Alpheus dispar* Randall, 1840: male from Pulau Ubin, Straits of Johor, CMBS sta. SW48 (OUMNH.ZC. 2014-11-036): A, lateral view; B, major chela in lateral view; C, minor chela in lateral view (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, 1 female, OUMNH. ZC. 2014-11-032, sta. SW13, Pulau Ubin, Chek Jawa, mud flat near boardwalk, low tide, suction pump, burrows, leg. A. Anker, P.K.L. Ng et al., 17 October 2012 (JS-0749); 1 ov. female, ZRC 2014.0604, sta. SW13, same collection data (JS-0744); 1 ov. female, OUMNH.ZC. 2014-11-033, sta. SW13, same collection data (JS-0745); 1 male, OUMNH. ZC. 2014-11-034, sta. SW13, same collection data (JS-0732) [preserved together with goby]; 1 female, ZRC 2014.0602, sta. SW13, same collection data (JS-0750); 1 ov. female, ZRC 2014.0536, sta. SW13, same collection data (JS-0715); 1 male, ZRC 2014.0537, sta. SW13, same collection data (JS-0716); 1 male, OUMNH.ZC. 2014-11-035, sta. SW13, same collection data (JS-0714); 2 males, 1 ov. female, OUMNH.ZC. 2014-11-036, sta. SW48, Pulau Ubin, between OBS Camps 1 and 2, intertidal mud flat, suction pump, in burrow, leg. A. Anker et al., 20 October 2012 [female missing major cheliped]; 1 ov. female, ZRC 2014.0606, sta. MF44, Pulau Tekong, chainage 1 and 2, mud flat, leg. K.S. Tan et al., 22 December 2011 (44133) [identification tentative]; 1 male, OUMNH.ZC. 2014-11-037, off Tengeh Reservoir, 11.0–11.5 m, leg. C.K. Chim, S.C. Lim, A. Anker et al., 09 April 2014 (3821 DR1-AA82) [possibly with regenerated chelipeds, identification tentative].

Additional material. 5 males, 3 ov. females, ZRC 1991.010-017, Singapore, no further data [det. Y. Miya as *A. brevirostris*]; 2 males, 1 ov. female, ZRC 1979.3.29.8-10, Singapore, no further data (J7980-7982) [det. Y. Miya as *A. brevirostris*, material in poor condition]. Straits of Johor. 1 male, ZRC 1992.5000, Ponggol, below rocks in tide pools, leg. C.Y. Chan, 11 May 1970 [det. Y. Miya as *A. brevirostris*]. Strait of Singapore. 1 male, ZRC 1994.4367, Kallang Basin, sta. 1, dredge 1, leg. Reef Ecology Study Team, 16 December 1994.

Distribution. Philippines, Singapore (Randall 1840; present study).

Previous records from Singapore. None (see below).

Ecology. Mudflats and muddy sandflats, in burrows, sometimes associated with gobies; lower intertidal and shallow subtidal to about 12 m.

Remarks. *Alpheus dispar* was previously treated as a junior synonym of *A. brevirostris* (Miya, 1990; Bruce, 1994). However, *A. dispar* appears to be a valid species and is herein raised to species status. The species differs from *A. brevirostris* by the shape of the major chela, most importantly by a concave ventral margin of the palm (vs. a convex margin in *A. brevirostris*, cf. Fig. 6B and Coutière, 1899: 230, fig. 281). In the general shape and proportions of the chelipeds, all adult male specimens from Singapore match the male holotype of *A. dispar* from Manila, Philippines (see photograph in Bruce, 1994: fig. 6D). The two species may also differ in the live colouration (cf. Figs. 3, 6), although it must be noted that the colour pattern of *A. brevirostris* is currently only known based on a photographed but not collected specimen (Fig. 3) and thus requires confirmation.

In Singapore, *A. dispar* appears to be most common on mudflats of Pasir Ris, Pulau Ubin (Chek Jawa) and Pulau Tekong, in the eastern Straits of Johor. One young male specimen tentatively identified as *A. dispar* (Fig. 6C) was dredged on soft mud at about 11 m, in the western Straits of Johor. Another specimen possibly belonging to *A. dispar* was collected in the now heavily polluted Kallang Basin, in the 1990s.

Jaafar & Zeng (2012), Zeng & Jaafar (2012), Jaafar & Hou (2012) and Hou et al. (2013) listed material from Pasir Ris identified as *A. rapax*; however this material plainly belongs to *A. dispar*. In their general morphology, *A. dispar* and *A. rapax* are indeed quite similar, differing mainly by the proportions and shape of the major chela palm and minor chela fingers. The two species also differ by their colour patterns, especially in the arrangement of streaks and bands on the abdomen (cf. Figs. 6, 7, 26, 27).

Alpheus djeddensis Coutière, 1897 sensu lato
(Fig. 8)

Alpheus djeddensis Coutière, 1897a: 202; De Man, 1909a: 160; Johnson, 1979: 37; Banner & Banner, 1981: 17.
(?) *Alpheus djiboutensis* De Man, 1909c: 160; Holthuis, 1958: 25; Banner & Banner, 1982: 180.

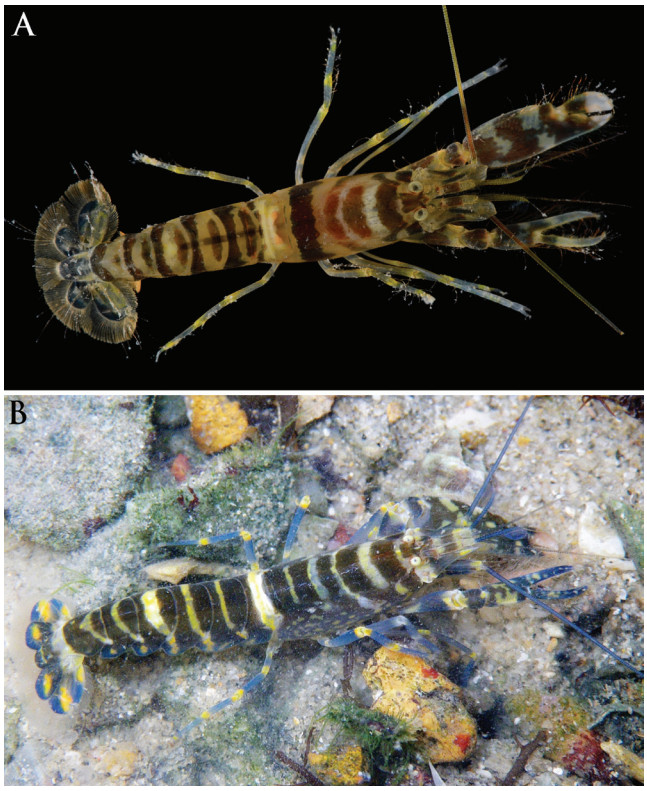

Fig. 8. *Alpheus djeddensis* Coutière, 1897 sensu lato (colour pattern matching *A. djiboutensis* De Man, 1909): A, young female from St. John's Island, Strait of Singapore, CMBS sta. YB188, (OUMNH. ZC. 2014-11-038); B, adult individual photographed in situ at Tanah Merah, Strait of Singapore (specimen not collected) (Photographs by: Arthur Anker [A], Ria Tan [B]).

CMBS material. Strait of Singapore. 1 female, OUMNH. ZC. 2014-11-038, sta. YB188, St. John's I., DRTech northern lagoon, 0–0.5 m, sand patchily mixed with rubble, in burrow, associated with goby, leg. A. Anker, 05 June 2013 (SS-4529) [shrimp and goby preserved together].

Additional material. Strait of Singapore. 1 male, ZRC 1979.3.30.11, Jurong area, prawn pond, sta. B26, leg. S.R.F.R.S., 29 June 1954 (J7993) [det. Y. Miya as *A. djeddensis*].

Distribution. Indo-west Pacific, from the Red Sea and East Africa to southern Japan, Australia and Solomon Islands (species complex, see below).

Previous records from Singapore. Johnson (1979).

Ecology. On sand-rubble flats between coral patches, in burrows made in coarse sand, often under large pieces of coral rubble, almost always associated with gobies, typically *Cryptocentrus* spp. and *Amblyeleotris* spp.; from lower intertidal to at least 20 m.

Remarks. *Alpheus djeddensis* is a problematic taxon in need of a thorough taxonomic revision. Banner & Banner's (1982) placement of *A. djiboutensis* De Man, 1909 in the synonymy of *A. djeddensis* and the three invalid names used by Karplus et al. (1981) add to the overall confusion of both taxa, which are part of a larger *A. djeddensis – A. djiboutensis* species complex (A. Anker, in study). Many previous records of *A. djeddensis* and *A. djiboutensis*, as well as numerous photographs in popular underwater guides identified with these names, refer to other species.

Johnson's (1979) record of *A. djeddensis* from Singapore is based on a single male specimen (ZRC 1979.3.30.11), almost complete and in good condition, collected in a prawn pond in the Jurong area. Miya examined this specimen in 1992 and confirmed it as *A. djeddensis*. One of us (A. Anker) re-examined it again and concluded that it belongs to the *A. djeddensis – A. djiboutensis* species complex, with most characters matching *A. djiboutensis* sensu lato in Banner & Banner (1982). The presence of *A. djeddensis* in a (brackish?) prawn pond is somewhat surprising as most species in this group are typically found on sand or mixed sand-rubble bottoms, in marine conditions, and are associated with gobies.

The CMBS material of *A. djeddensis* sensu lato is represented by a single, relatively young female collected in a small shallow lagoon on St. John's Island. Its distinctive colour pattern (Fig. 8A) matches closely that of the Red Sea specimen identified as *A. djiboutensis* by Holthuis (1958: fig. 9). In addition, an adult individual of apparently the same species was photographed (but not collected) on a sand-rubble flat near Tanah Merah (Fig. 8B). The true identity of these snapping shrimps (whether they are *A. djiboutensis*, *A. djeddensis* or a closely related species) cannot be determined at this stage.

***Alpheus edamensis* De Man, 1888**
(Fig. 9)

Alpheus hippothoë var. *edamensis* De Man, 1888a: 518.
Alpheus edamensis — De Man, 1911: 437; Banner & Banner, 1966a: 157; Johnson, 1979: 37; Banner & Banner, 1978: 222; Banner & Banner, 1982: 188; Banner & Banner, 1985: 1985: 15; Chace, 1988: 24.
Alpheus acanthomerus Ortmann, 1890: 474.

Fig. 9. *Alpheus edamensis* De Man, 1888: male from Raffles Lighthouse, Strait of Singapore, CMBS sta. IT95 (OUMNH.ZC. 2014-11-039) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0577, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble, some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013 (SS-3216); 1 male, OUMNH.ZC. 2014-11-039, sta. IT95, same collection data (SS-3223); 1 female, OUMNH.ZC. 2014-11-040, sta. IT93, Pulau Jong, sand-rock-rubble intertidal, leg. S.K. Tan, J.C. Mendoza et al., 29 May 2013 (SS-3121).

Additional material. Strait of Singapore. 1 female, 2 ov. females, ZRC 1979.4.2.16-18, Pulau Salu, coral reef, under rocks etc., leg. B.C. Lim, 28 April 1967 (J6996-6998).

Distribution. Indo-west Pacific from the Red Sea and East Africa to southern China, Indonesia, Australia and French Polynesia (see below).

Previous records from Singapore. Banner & Banner (1966a); Johnson (1979).

Ecology. Sand-rubble and sand-rock flats, under rocks and large pieces of coral rubble; intertidal to 50 m.

Remarks. De Man (1911) was the first to list *Alpheus acanthomerus* Ortmann, 1890 as a junior synonym of *A. edamensis*, without providing a discussion. One of us (A. Anker) was able to examine the holotype of *Alpheus acanthomerus* Ortmann, 1890, deposited in the Musée Zoologique de l'Université de Strasbourg (MZS) in Strasbourg, France. The specimen, which was not sexed by Ortmann (1890), was indeed found to be a male of *A. edamensis*, also confirming a previous identification by Y. Miya.

Alpheus edamensis, a fairly large and conpicuous snapping shrimp with heavily setose chelipeds (Fig. 9), was recorded from Singapore for the first time by Banner & Banner (1966a). In Singapore, *A. edamensis* is not uncommon on intertidal flats with an abundance of large rocks and coral rubble, for instance Raffles Lighthouse and Pulau Jong.

Alpheus edwardsii (Audouin, 1826) sensu lato
(Figs. 10, 11)

Athanas edwardsii Audouin, 1826: 91.
Alpheus edwardsii — Banner & Banner, 1973: 1141; Banner & Banner, 1978: 222; Banner & Banner, 1982: 270; Banner & Banner, 1985: 16; Chace, 1988: 25.
(?) *Alpheus edwardsii* — De Man, 1911: 327; Johnson, 1962: 53.
(?) *Alpheus Audouini* Coutière, 1905: 911.
(?) *Alpheus audouini* — De Man, 1911: 414; Johnson, 1962: 53; Tiwari, 1965: 306; Banner & Banner, 1966a: 135; Johnson, 1979: 35.

CMBS material. Straits of Johor. 1 male, OUMNH.ZC. 2014-11-042, sta. DW6, ~400 m SE of Pulau Sekudu, 15.2 m, B. Richer de Forges et al., 17 October 2012 (JS-0782) [infested by a pair of hemiarthrine isopods]; 1 male, OUMNH.ZC. 2014-11-043, sta. DR322, off Changi Ferry Terminal, 18.3–18.6 m, leg. TMSI team, 19 March 2014 (SEA-5033). Strait of Singapore. 1 female, ZRC 2014.0595, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble and some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013 (SS-3206); 1 male, OUMNH.ZC. 2014-11-044, sta. IT95, same collection data (SS-3225); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-045, sta. IT95, same collection data (SS-3215); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-046, sta. IT95, same collection data (SS-3220); 1 male, ZRC 2014.0590, sta. IT95, same collection data (SS-3107); 1 female, OUMNH.ZC. 2014-11-047, sta. IT95, same collectionn data (SS-3227); 1 male, ZRC 2014.0600, sta. IT95, same collection data (SS-3226) [possibly with renegerated minor cheliped]; 1 ov. female, ZRC 2014.0596, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3240); 1 ov. female, ZRC 2014.0592, sta. IT108, same collection data (SS-3263); 1 ov. female, OUMNH.ZC. 2014-11-048, sta. IT108, same collection data (SS-3264); 1 male, ZRC 2014.0594, sta. IT93, Pulau Jong, sand-rock-rubble intertidal, leg. S.K. Tan, J.C. Mendoza et al., 29 May 2013 (SS-3122) [missing minor cheliped, infested with a pair of bopyrine isopods]; 1 male, OUMNH.ZC. 2014-11-049, sta. IT93, same collection data (SS-3125); 1 male, ZRC 2014.0591, sta. IT93, same

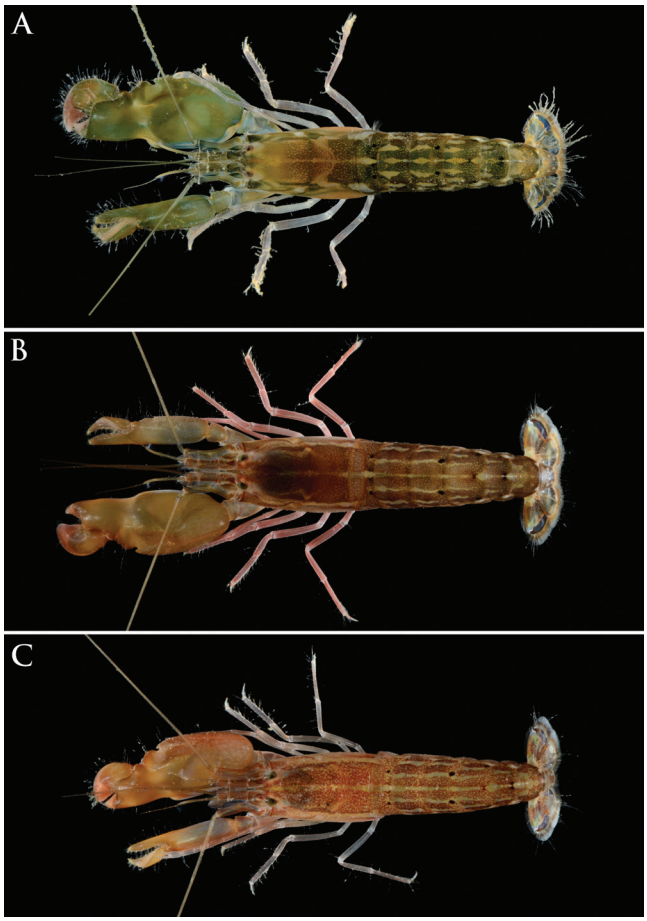

Fig. 10. *Alpheus edwardsii* (Audouin, 1826) sensu lato: A, male from St. John's Island, Strait of Singapore, CMBS sta. SW48 (OUMNH.ZC. 2014-11-054), see also Fig. 11C; B, male from Terumbu Pempang Tengah, Strait of Singapore, CMBS sta. IT103 (ZRC 2014.0559); C, male dredged at Eastern Fairway, Strait of Singapore, CMBS sta. TB15 (OUMNH.ZC. 2014-11-058) (Photographs by: Arthur Anker).

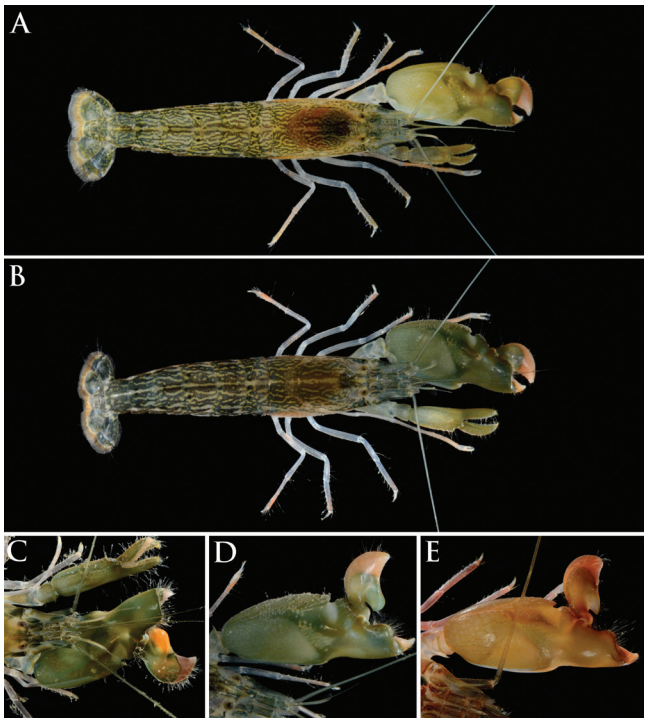

Fig. 11. *Alpheus edwardsii* (Audouin, 1826) sensu lato: A, male from Raffles Lighhouse, CMBS sta. IT95 (ZRC 2014.0600); B, female from the same locality (OUMNH.ZC. 2014-11-047); C, male from St. John's Island, Strait of Singapore, CMBS sta. SW48 (OUMNH.ZC. 2014-11-054), major chela in mesial view, showing plunger, see also Fig. 10A; D, same as B, major chela in mesial view, showing plunger; E, male from Terumbu Pempang Tengah, Strait of Singapore, CMBS sta. IT103 (ZRC 2014.0559), major chela in mesial view, showing plunger, see also Fig. 10B (Photographs by: Arthur Anker).

collection data (SS-3124); 1 ov. female, OUMNH.ZC. 2014-11-050, sta. IT93, same collection data (SS-3119); 1 ov. female, ZRC 2014.0593, sta. IT93, same collection data (SS-3112); 1 female, ZRC 2014.0598, sta. IT93, same collection data (SS-3229); 1 ov. male, OUMNH.ZC. 2014-11-051, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-142); 1 ov. female, OUMNH.ZC. 2014-11-052, sta. IT86, same collection data (SIN-146); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-053, sta. IT81, S Big Sister's I., rocky reef, intertidal, leg. Y.L. Lee et al., 26 May 2013 (SIN-134); 1 male, OUMNH.ZC. 2014-11-054, sta. SW48, St. John's I., DRTech, near northern lagoon, intertidal, under large boulders, leg. S.T. Ahyong, 24 May 2013 (SS-1604); 1 male, ZRC 2014.0559, sta. IT103, Terumbu Pempang Tengah, intertidal, leg. J.C.Y. Lai, D. Uyeno et al., 30 May 2013 (SS-3258); 1 male, OUMNH.ZC. 2014-11-055, sta. IT103, same collection data (SS-3238); 1 ov. female, ZRC 2014.0597, sta. IT124, same collection data (SS-3988); 1 male, OUMNH.ZC. 2014-11-056, sta. RF250, Tanjong Hakim, rocky shore, leg. TMSI team, 02 January 2014 (INT-0493); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-057, sta. DR70, near Pulau Sudong and Pulau Semakau, 20.6–22.6 m, sandy bottom, leg. B. Richer de Forges et al., 26 May 2013 (SS-1643); 1 male, OUMNH.ZC. 2014-11-058, sta. TB15, Eastern Fairway, 21.5–23.8 m, silt, gravel, leg. B. Richer de Forges et al., 21 May 2013 (SIN-010); 1 male, OUMNH.ZC. 2014-11-059, sta. DR209, S of Pulau Sebarok, 36.1–37.4 m, leg. TMSI team, 24 September 2013 [SEA-0908]; 1 male, OUMNH.ZC. 2014-11-060, sta. DR198, east of Gusong Boarding Ground, 29.7 m, leg. TMSI team, 10 September 2013 [SEA-0020]; 1 male, OUMNH.ZC. 2014-11-061, S of Pulau Bukom, 15.5–19.5 m, leg. TMSI team, 03 July 2012 (DR14-014); 1 male, ZRC 2014.0601, S of Pulau Bukom, 21.1–21.9 m, leg. TMSI team, 03 July 2012 (DR13-010) [missing minor cheliped].

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan and Australia; range in the western-central Pacific not clear (see below).

Previous records from Singapore. Johnson (1962, 1979, as *Alpheus audouini* Coutière, 1905 and *A. edwardsii*); however, these records are at least partly based on material later re-identified as *Alpheus crassimanus* Heller, 1862 or suggested to possibly represent *Alpheus bisincisus variabilis* De Man, 1909b (Johnson, 1979).

Ecology. Variable (species complex), typically rocky shores and mixed sand-rubble-rock bottoms, under rocks and large pieces of coral rubble; intertidal and shallow subtidal (0–3 m), occasionally at depths exceeding 20 m.

Remarks. *Alpheus edwardsii* is a problematic species complex, with several species present in Singaporean waters (CMBS material). They are distinguishable by the shape and colour of the dactylar plunger of the major chela (Fig. 11C–E), but also by the pattern of the abdomen (Figs. 10, 11). At least one form has a very short plunger (Fig. 11C), approaching the configuration found in *Alpheus chiragricus* (Fig. 4C), which is also member of the *A. edwardsii* complex. However, in this form, both dorsal and ventral shoulders of the major chela are rounded and not acutely projecting, as in *A. chiragricus*. Another shallow-water form approaches *Alpheus suluensis* Chace, 1988, described from a depth of 38 m in the Sulu Sea in the Philippines (Chace, 1988). The validity of *A. suluensis*, in particular its separation from *Alpheus haani* Ortmann, 1890 from Japan, has been questioned by Chace (1988) himself. Johnson (1979) believed that some of his Singaporean specimens could represent *Alpheus bisincisus variabilis* De Man, 1909b. All these taxonomic uncertainties and the very questionable synonymy of *Alpheus audouini* Coutière, 1905 with *A. edwardsii* (Banner & Banner, 1982) make species identfications in this species group extremely difficult.

The long overdue revision of the *A. edwardsii* complex would require re-examination of Banner & Banner's (1972) neotype of *A. edwardsii* (MNHN), Coutière's type material of *A. audouini* (if extant, in MNHN), and type material of *A. haani* (RMNH), *A. suluensus* (USNM) and *A. bisincisus variabilis* (RMNH), all falling within the variation range of *A. edwardsii* (see also Johnson, 1979; Banner & Banner, 1982; Chace, 1988). The revision of the *A. edwardsii* species complex must also include collection of fresh and photo-vouchered material at or near the type localities of *A. edwardsii* (northern Red Sea), *A. audouini* (central Indian Ocean), *A. haani* (Japan), *A. suluensis* (Philippines) and

A. bisincisus variabilis (Indonesia). For the time being, all specimens assignable to *A. edwardsii* on morphological grounds, as redescribed by Banner & Banner (1972, 1982), are best identified as *A. edwardsii* sensu lato. This species complex is common in the Strait of Singapore, especially in the rock-sand and reef intertidal habitats around the southern islands, and in deeper water on gravel-sand substrates. One specimen with some resemblance to *A. chiragricus* (but with blunt dorsal and ventral shoulders on the major chela) was dredged in the western Straits of Johor, and another one at the eastern entrance to the Straits of Johor, near Changi.

Alpheus ehlersii De Man, 1909

Alpheus ehlersii De Man, 1909a: 663.
Alpheus ehlersii (also spelled *A. ehlersi*) — Tiwari, 1965: 297; Banner & Banner, 1966a: 114; Johnson, 1979: 37; Banner & Banner, 1978: 222; Banner & Banner, 1982: 132; Banner & Banner, 1985: 16; Chace, 1988: 25.

CMBS material. None.

Additional material. Strait of Singapore. 1 female, ZRC 2014.0529, Labrador Beach, leg. P.K.L. Ng, 20 April 1991.

Distribution. Indo-west Pacific, from the Red Sea to Japan, Micronesia, Indonesia and Australia.

Previous records from Singapore. None.

Ecology. Coral reefs and sandy-rocky shores with abundance of algae and coral rubble; intertidal and shallow subtidal (usually less than 10 m).

Remarks. *Alpheus ehlersii* can be identified rather easily, in particular by the shape of the frontal margin of the carapace and several features of the major cheliped (De Man, 1909a; Banner & Banner, 1982). The species also has a distinctive colour pattern, consisting of dark-brown bands, bordered by much narrower yellow bands, across each abdominal somite, and a broad whitish longitudinal patch on the otherwise reddish-brown major chela (A. Anker, pers. obs.). *Alpheus ehlersii* appears to be extremely rare, if not extinct in Singapore, with only one specimen known to date, collected at Labrador Beach in the early 1990s.

Alpheus eulimene De Man, 1909
(Fig. 12)

Alpheus eulimene De Man, 1909b: 101; De Man, 1911: 364.
Alpheus eulimene — Miya, 1974: 146; Banner & Banner, 1978: 222; Banner & Banner, 1982: 105; Chace, 1988: 26.

CMBS material. Strait of Singapore. 1 male, OUMNH. ZC. 2014-11-062, sta. SB146, Pulau Hantu, 5–7 m, coral brushing, leg. S. De Grave, H.H. Tan et al., 02 June 2013; 1 male, ZRC 2014.0427, sta. SB146, same collection data (SS-4029) [missing minor cheliped].

Distribution. Indo-west Pacific from East Africa to Japan, Mariana Islands, Indonesia, and Australia.

Fig. 12. *Alpheus eulimene* De Man, 1909: male from Pulau Hantu, Strait of Singapore, CMBS sta. SB1461 (ZRC 2014.0427) (Photograph by: Arthur Anker).

Previous records from Singapore. None.

Ecology. Coral reefs and adjacent areas, in cryptic sponges in dead coral heads etc.; shallow subtidal (5–7 m in Singapore) to 83 m (type specimens).

Remarks. *Alpheus eulimene* belongs to the problematic *Alpheus crinitus* Dana, 1852 species group, with several species, including *A. eulimene* and *A. crinitus*, in need of thorough revisions. *Alpheus eulimene* was treated as a junior synonym of *A. styliceps* Coutière, 1905 by Banner & Banner (1983), but later treated as valid species by Chace (1988). Here we tentatively follow Chace (1988) and treat *A. eulimene* as valid until more evidence is available.

The present material was identified as *A. eulimene* based on the following criteria: (1) third pereopod with unarmed ischium, merus with sharp distoventral tooth, without spiniform setae; (2) second pereopod with the first carpal article about 0.6 times length of the second; (3) second to fifth pleura angular but not projecting in males; (4) antennal scaphocerite with a short blade; (5) frontal margin of the carapace broadly protruding, with a minute rostrum; (6) major chela ovoid, smooth, without constrictions; and (7) minor chela with fingers longer than palm, slender, slightly curved, cutting margins slightly broadened and shallowly excavated (cf. De Man, 1911; Banner & Banner, 1982). However, the Singaporean material differs from the Indonesian type specimen by the somewhat longer blade (reaching half-length of the scaphocerite), the obscurely biunguiculate dactyli of the third and fourth pereopods, and the presence of a spiniform seta on the carpus of the third pereopod (cf. De Man, 1915: fig. 76). The same differences were also reported in the Australian material of *A. eulimene* (Banner & Banner, 1982: fig. 27k, l, n). A more careful study is needed to determine whether *A. eulimene* is a single variable species, contains more than one species, or is a junior synonym of the even more variable *A. styliceps*, as suggested by Banner & Banner (1983). Colour patterns (Fig. 12) may prove to be of great importance in the discrimination of all species of the *A. crinitus* group.

Alpheus euphrosyne De Man, 1897 sensu lato

Alpheus euphrosyne De Man, 1897: 745; Johnson, 1979: 37.

Remarks. Numerous specimens of the *Alpheus euphrosyne* species complex were collected during CMBS, mainly in Sungei Buloh, Lim Chu Kang and Pulau Ubin; one specimen was dredged off the eastern entrance of the Straits of Johor. In addition, abundant materal from Singapore and other parts of South-East Asia identified as *A. euphrosyne*, was deposited in the ZRC and other museums around the world. This material corresponds to at least five species and will be reported upon separately (A. Anker, in prep.).

Alpheus facetus De Man, 1908 sensu lato
(Fig. 13)

Alpheus facetus De Man, 1908: 100; De Man, 1911: 340; Tiwari, 1965: 288; Banner & Banner, 1966a: 96; Johnson, 1979: 37; Banner & Banner, 1978: 222; Banner & Banner, 1982: 62; Banner & Banner, 1985: 17; Chace, 1988: 27.

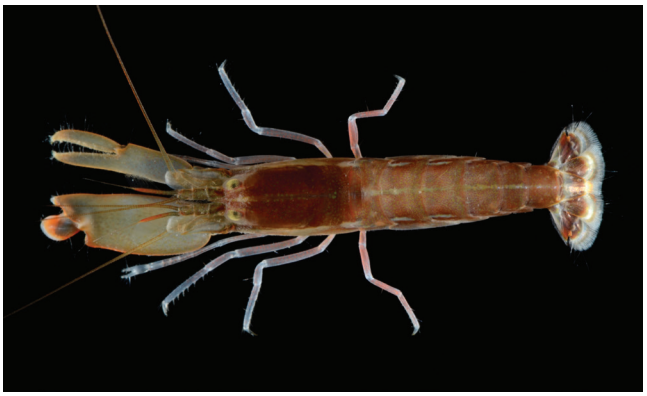

Fig. 13. *Alpheus facetus* De Man, 1908 sensu lato: male from Raffles Lighthouse, Strait of Singapore, CMBS sta. IT95 (OUMNH.ZC. 2014-11-065) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0429, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3247); 1 male, OUMNH.ZC. 2014-11-063, sta. IT108, same collection data (SS-3251); 1 female, OUMNH.ZC. 2014-11-064, sta. IT108, same collection data (SS-3249); 1 male, OUMNH.ZC. 2014-11-065, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble and some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013 (SS-3202); 1 female, OUMNH.ZC. 2014-11-066, sta. IT95, same collection data (SS-3213); 2 males, ZRC 2014.0428, sta. IT95, same collection data (SS-2748); 1 male, ZRC 2014.0430, sta. IT118, St. John's I., AVA jetty, rock-rubble shore, leg. J.K. Lowry, N. Bruce, 31 May 2013.

Distribution. Indo-west Pacific, from East Africa and Madagascar to Japan, Indonesia and Australia (species complex, see below).

Previous records from Singapore. None.

Ecology. Mixed sand-rubble-rock bottoms near coral reefs, under rocks and coral rubble, in reef crevices, dead coral heads etc.; intertidal to about 30 m.

Remarks. *Alpheus facetus* exhibits varation in morphology and colour patterns (Tiwari, 1965; Banner & Banner, 1982, 1985) and may consist of more than one pseudocryptic species. Morphologically, the Singaporean material corresponds closely to the type specimen of De Man (1908, 1911) from Indonesia and to the material of Banner & Banner (1966a) from Thailand. Most Singaporean specimens have a shallow longitudinal groove and adjacent low ridge on the dorsomesial surface of the major chela. The colour pattern of the Australian and Indonesian specimens was described, respectively, as "two longitudinal brown bands separared mid-dorsally by a pinkish tan band" and "basic olive-green colour with three darker longitudinal stripes, one down the middle of the body and one stripe on either side" (Banner & Banner, 1982, 1985). However, both of these colour descriptions are markedly different from the uniform, non-banded colour pattern of the Singaporean specimens (Fig. 13). In Singapore, *A. facetus* appears to be most common around the southern-most islands in the Strait of Singapore; all CMBS material was collected at Raffles Lighthouse and on St. John's Island.

Alpheus imitatrix De Man, 1909 stat. nov.
(Fig. 14)

Alpheus pareuchirus var. *imitatrix* De Man, 1909b: 106; De Man, 1911: 426.
Alpheus pareuchirus imitatrix — Banner & Banner, 1982: 278; Miya, 1984: 96; Banner & Banner, 1985: 27.
Alpheus pareuchirus imatrix (lap. cal.) — Banner & Banner, 1966a: 142.

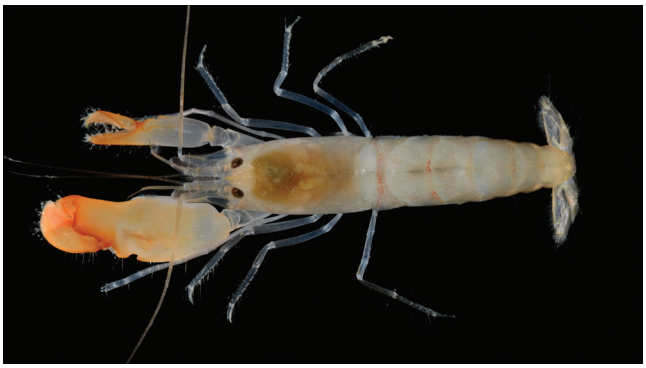

Fig. 14. *Alpheus imitatrix* De Man, 1909: female dredged near Singapore port limit, Strait of Singapore, CMBS sta. TB29 (ZRC 2014.0532) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-067, sta. DR111, outside Eastern Boarding Ground, 125–136 m, rocks, sand, leg. B. Richer de Forges et al., 30 May 2013 (SS-3254); 1 female, ZRC 2014.0532, sta. TB29, near Eastern Boarding Ground A, 98–103 m, rocks, gravel, leg. B. Richer de Forges et al., 23 May 2013 (SS-0345).

Distribution. Indonesia, Singapore and northern Australia.

Previous records from Singapore. None; most of Johnson's (1962, 1979) material reported as *A. pareuchirus* is neither *A. pareuchirus* nor *A. imitatrix*.

Ecology. Deep-water rock-sand and rock-gravel bottoms; depth range in Indonesia and Singapore 98–141 m; the two Australian specimens reported by Banner & Banner (1982) were collected from much shallower depths, one "from the growth on a pearl oyster shell" and the other dredged from about 22 m.

Remarks. *Alpheus imitatrix* was previously treated as a variety or subspecies of *A. pareuchirus* Coutière, 1905 (e.g., De Man, 1911; Banner & Banner, 1982). According to Banner & Banner (1982), *A. imitatrix* differs from *A. pareuchirus* by the presence of well-developed balaeniceps setae on the female minor chela. This difference appears to be consisent and we therefore elevate *A. imitatrix* to full species status. Both Singaporean specimens are adult females (one ovigerous) and both possess a well-developed ridge with balaeniceps setae on the dactylus of the minor chela (Fig. 14). The palm of the minor chela also has a deep dorsal transverse groove, which is slightly overhung by the adjacent dorsal shoulder (Fig. 14), a rare configuration among females in the genus *Alpheus*. The colour pattern of *A. imitatrix* is here documented for the first time (Fig. 14) and differs from the more intense red colouration of *A. pareuchirus* (A. Anker, pers. obs.).

Alpheus cf. *leptocheles* Banner & Banner, 1975

Alpheus leptocheles Banner & Banner, 1975a: 261.

CMBS material. None.

Additional material. Strait of Singapore. 1 female, ZRC 1990.8429, Kallang Basin, sta. 2, dredge, leg. Reef Ecology Study Team, 02 March 1989.

Distribution. Papua New Guinea and possibly Singapore (see comments below).

Previous records from Singapore. None.

Ecology. Mud bottoms off river mouths; depth: 3–18 m (Banner & Banner, 1975a).

Remarks. *Alpheus leptocheles* was described based on a male holotype and two female paratypes, all trawled off the mouth of the Sepik River in Papua New Guinea. The female paratypes differed markedly from the male holotype in the shape of the major and minor chelipeds. Banner & Banner (1975a) noted themselves that these differences "could either be sexual dimorphism or be indicative of separate species".

The single specimen from Kallang Basin is a young female (cl ~6.0 mm), which is very similar in the shape of the major and minor chelae to the illustrated female paratype of *A. leptocheles* (cf. Banner & Banner, 1975a: fig. 1L, M), including the presence of small pustules on the mesial surface of the major chela and slender, non-gaping fingers of the minor chela. The frontal area, the proportions of the carpal articles of the second pereopod, the proportions and shape of the propodus and dactylus of the third pereopod are also very similar. Therefore, the Singaporean specimen is tentatively identified as *A.* cf. *leptocheles*, awaiting collection of additional material from Singapore as well as confirmation of the taxonomic identity of the paratypes of *A. leptocheles*.

Johnson (1979) reported *A. sibogae* De Man, 1908, a species originally described from Indonesia (De Man, 1908, 1911), from Singapore. This species differs from *A. leptocheles* in the more concave lateral margin of the antennal scaphocerite, stronger dorsomedian carina bearing a small tubercle, more numerous spiniform setae on the propodus and shorter dactylus of the third pereopod. However, whether Johnson's record of *A. sibogae* is correct remains unknown. Another Indonesian species closely related to *A. leptocheles* is *A. lepidus* De Man, 1908, from which *A.* cf. *leptocheles* may be distinguished by the distinctly longer first carpal article of the second pereopod and longer merus of the major cheliped (cf. De Man, 1911).

Alpheus leviusculus Dana, 1852 sensu lato
(Fig. 15)

Alpheus edwardsii var. *leviusculus* Dana, 1852b: 543; Coutière, 1898a: 149.
Alpheus leviusculus — De Man, 1911: 411; Banner & Banner, 1964: 92; Banner & Banner, 1966a: 128; Banner & Banner, 1978: 223.
Alpheus leviusculus leviusculus — Banner & Banner, 1982: 246; Banner & Banner, 1985: 18; Chace, 1988: 34.
(?) *Alpheus bouvieri* var. *bastardi* Coutière, 1898b: 133.
(?) *Alpheus bastardi* — Coutière, 1905: 907; De Man, 1922: 41.

Fig. 15. *Alpheus leviusculus* Dana, 1852 sensu lato: male from Raffles Lighthouse, Strait of Singapore, with colouration described for *Alpheus bastardi* Coutière, 1898, currently in synonymy of *A. leviusculus* (specimen possibly in ZRC, not located) (Photograph by: Heok-Hui Tan).

CMBS material. Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-068, sta. DR199, along Deep-Water Route SW of Eastern Boarding Ground B, 50.6–52.7 m, leg. TMSI team, 10 September 2013 (SEA-0395).

Additional material. Strait of Singapore. 1 male, ZRC 2014.0664, Pulau Tekukor, 30 December 1986 [missing minor cheliped].

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Australia, Micronesia and Wake and Johnston Islands; East Pacific records doubtful (Kim & Abele, 1988).

Previous records from Singapore. None.

Ecology. Mixed rocky-sandy shores and coral reef flats, under rocks and coral rubble; intertidal to at least 30 m.

Remarks. *Alpheus leviusculus*, like many other species of *Alpheus*, requires an in-depth taxonomic study throughout its huge geographic range, spanning almost the entire tropical Indo-Pacific (Banner & Banner, 1982; Wicksten, 1983). Conspicuous differences in the colour pattern between specimens described as *Alpheus bastardi* Coutière, 1898, currently a synonym of *A. leviusculus*, and *A. leviusculus leviusculus*, suggest the presence of at least two pseudo-cryptic species, i.e., *A. bastardi* and *A. leviusculus*. However, a formal redefinition of *A. leviusculus* and a revalidation of *A. bastardi* are beyond the scope of the present paper and will be published elsewhere (A. Anker, in study).

The present specimens represent the first record of the *A. leviusculus* species complex for Singapore. Unfortunately, the live colour of both Singaporean specimens was not recorded. However, H.H. Tan's photograph of a specimen from Raffles Lighthouse (Fig. 15), which was not located in the ZRC, shows a uniformly bright orange snapping shrimp, a colouration described for *A. bastardi* (see Coutière, 1898b), and differing from the green-banded colouration of *A. leviusculus* (Banner & Banner, 1982).

Alpheus lobidens De Haan, 1849 sensu lato
(Figs. 16, 17)

Alpheus lobidens De Haan, 1849: 179; Banner & Banner, 1985: 19; Chace, 1988: 34; Hayashi, 1998: 394.
Alpheus lobidens lobidens — Banner & Banner, 1974: 430; Banner & Banner, 1978: 223; Banner & Banner, 1982: 252.
(?) *Alpheus lobidens polynesica* Banner & Banner, 1974: 429; Banner & Banner, 1982: 256.
(?) *Alpheus crassimanus* Heller, 1862a: 526; Johnson, 1962: 53; Tiwari, 1965: 307 (*partim*); Banner & Banner, 1966a: 138; Johnson, 1979: 36.
(?) *Alpheus inopinatus* Holthuis & Gottlieb, 1958: 42.
(?) *Alpheus audouini* (nec Coutière, 1905) — Johnson, 1962: 53 (partim, see Johnson, 1979: 36).

CMBS material. Straits of Johor. 1 male, OUMNH.ZC. 2014-11-069, off Sungei Gedong, 7.3–9.8 m, leg. S.C. Lim, C.K. Chim, A. Anker et al., 09 April 2014 (4025 DR1-AA75); 1 ov. female, ZRC 2014.0570, sta. SW13, Pulau Ubin, Chek Jawa, near boardwalk, mud-sand flat with seagrass and rocks, under rocks and from burrows, leg. A. Anker, S.K. Tan, P.K.L. Ng et al., 17 October 2012 (JS-0743); 1 ov. female, ZRC 2014.0558, sta. SW13, same collection data (JS-0751); 1 male, OUMNH.ZC. 2014-11-191, sta. SW13, same collection data (JS-0733); 1 male, ZRC 2014.0535, sta. SW13, same collection data (JS-0740); 2 males, 1 female, 1 ov. female, ZRC 2014.0581, sta. S16, Pulau Ubin, Chek Jawa, seagrass bed and mud flat, seining, leg. K.S. Tan et al., 07 March 2012; 1 male, ZRC 2014.0572, sta. SW123, Pulau Ubin, between OBS Camps 1 and 2, mud-rock intertidal, leg. P.S.H. Wong et al., 29 October 2012 (JS-2869); 1 male, ZRC 2014.0576, sta. SW71, Pulau Ubin, between OBS Camps 1 and 2, mud, triangular dredge, leg. KS Tan, MR bin Duria, 23 October 2012 (JS-1953) [infested by a pair of hemiarthrine isopods]; 1 ov. female, ZRC 2014.0563, sta. SW25, Pulau Ubin, OBS Camp 1, muddy intertidal, in burrows, suction pump, leg. A. Anker, 18 October 2012 (JS-1413); 1 male, OUMNH.ZC. 2014-11-070, sta. SW25, same collection data (JS-1412); 2 males, 1 ov. female, ZRC 2014.0575, sta. SW25, same collection data (JS-1414); 1 male, ZRC 2014.0562, sta. SW133, Pulau Ubin, OBS Camp 1, rock-mud intertidal, leg. X Li, 30 October 2012 (JS-2533); 1 male, OUMNH.ZC. 2014-11-071, sta. SW133, Pulau Ubin, OBS Camp 1, rock-mud intertidal, leg. X. Li, 30 October 2012 (JS-2532); 2 males, 2 ov. females, OUMNH.ZC. 2014-11-072, sta. SW47, Pulau Ubin, OBS Camp 1, mud-rock intertidal, A. Anker et al., 20 October 2012; 1 male, ZRC 2014.0571, sta. SW47, same collection data (JS-1652); 1 ov. female, OUMNH.ZC. 2014-11-073, sta. SW47, same collection data (JS-1651); 1 male, OUMNH.ZC. 2014-11-074, sta. SW47, same collection data (JS-1650); 1 ov. female, ZRC 2014.0564, Pulau Ubin, OBS Camp 1, mud combing, leg. R. Tan et al., 07 March 2012 (M13-063); 1 male, 3 ov. females, ZRC 2014.0579,

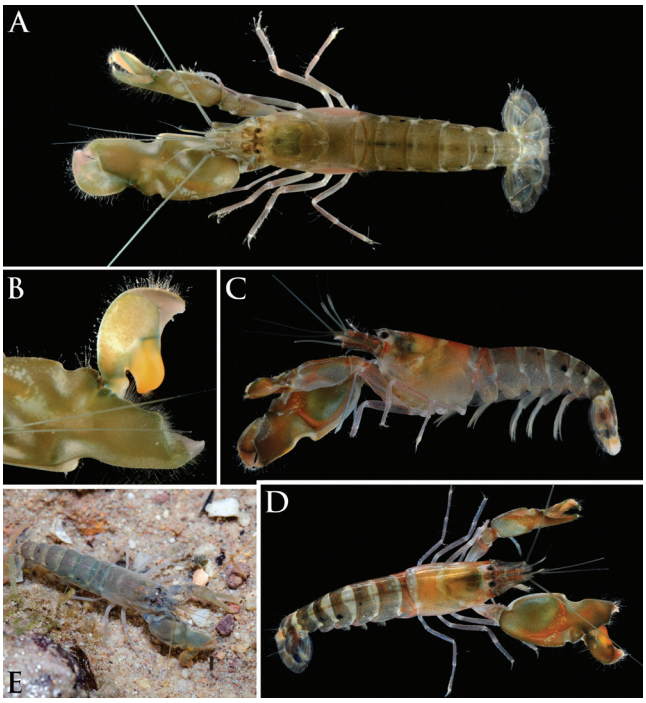

Fig. 16. *Alpheus lobidens* De Haan, 1849 sensu lato: A, male from St. John's Island, Strait of Singapore, CMBS sta. SW47 (OUMNH. ZC. 2014-11-078); B, same specimen, major chela in mesial view showing plunger; C, male from Pulau Ubin, Straits of Johor, CMBS sta. SW133 (ZRC 2014.0562); D, same specimen in lateral view; E, female photographed in situ at Sentosa, Strait of Singapore (specimen not collected). (Photographs by: Arthur Anker [A–D] and Marcus Ng [E]).

Fig. 17. *Alpheus lobidens* De Haan, 1849 sensu lato: A, ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SW75 (ZRC 2014.0557); B, female photographed in situ at Kusu Island, Strait of Singapore (specimen not collected) (Photographs by: Arthur Anker [A] and James Koh [B]).

Pulau Ubin, OBS Camp 1, mud combing, leg. R. Tan et al., 07 March 2012 (M13-059-062); 1 male, ZRC 2014.0574, Pulau Ubin, OBS Camp 1, mud combing, leg. R. Tan et al., 07 March 2012 (M13-064); 1 ov. female, ZRC 2014.0566, sta. SW122, Pulau Ketam, muddy sand, leg. P.S.H. Wong et al., 29 October 2012 (JS-2868); 1 male, 4 ov. females, ZRC 2014.0583, sta. M24, Pulau Ketam, mud combing, leg. K.S. Tan et al., 08 March 2012; 1 male, OUMNH. ZC. 2014-11-075, Sarimbun Beach, Jalan Bahtera Scouts Camp, leg. H.H. Ng, Y.L. Teo, P.S.H. Wong, 14 February 2012 (48204). Strait of Singapore. 7 specimens (males and females), ZRC 2014.0568, Pulau Semakau, N of planted mangrove, leg. HH Ng et al., 10 November 2011 (40232-40239); 1 male, 1 female, 2 ov. females, ZRC 2014.0569, Pulau Semakau landfill phase 1, leg. H.H. Tan et al., 08 August 2012; 1 male, 1 ov. female, ZRC 2014.0567, sta. MF39, Pulau Semakau landfill, southern replanted mangrove, leg. P.S.H. Wong et al., 09 October 2011 (39138-39139); 1 female, ZRC 2014.0582, sta. MF39, same collection data (39193); 1 male, ZRC 2014.0580, Pulau Sudong lagoon, leg. R. Ong, 08 July 2012 (65152); 6 specimens (mainly males), OUMNH.ZC. 2014-11-076, Pulau Serimban, leg. P.S.H. Wong et al., 10 July 2012 (66036-041) [note: one male with two major chelipeds]; 7 specimens (males and females), ZRC 2014.0578, sta. MP62, Pulau Pawai, leg. TMSI team, 10 June 2012 (61036-61042); 2 males, 1 juvenile, ZRC 2014.0565, sta. MF63, Pulau Senang, mud flat, leg. TMSI team, 30 June 2012 (63497-63499); 2 males, 1 female, 1 ov. female, OUMNH.ZC. 2014-11-077, Terumbu Bemban, intertidal, Y.L. Lee et al., 31 March 2013 (RF3002-3005); 1 female, ZRC 2014.0561, sta. IT103, Terumbu Pempang Tembah, intertidal, leg. J.C. Lai, D. Uyeno et al., 30 May 2013 (SS-3232); 1 male, ZRC 2014.0573, St. John's I., leg. TMSI team, 13 April 2012 (53046); 1 male, ZRC 2014.0559, sta. SD100, St. John's I., DRTech, off jetty, 8–15 m, under muddy rocks, leg. D. Uyeno, K. Tilbrook, 29 May 2013 (SS-3983); 1 male, OUMNH.ZC. 2014-11-078, sta. SW47, St. John's I., DRTech northern lagoon, 0–0.2 m, under muddy rocks, leg. N. Evans, 24 May 2013 (SS-1603); 2 ov. females, ZRC 2014.0560, sta. SW75, St. John's I., bay between public jetty and mangrove, muddy intertidal, 0–0.5 m, suction pump, leg. A. Anker, P.K.L. Ng, D.L. Rahayu, 26 May 2013 (SS-1655); 1 ov. female, ZRC 2014.0557, sta. SW75, same collection data (SS-1667).

Additional material. Straits of Johor. 1 male, ZRC 2014.0523, Pulau Tekong, Sungei Semenei mangroves, outer reaches including mudflats, leg. N. Sivasothi, R. Tan. J. Lai, D. Yeo, 01 November 2001; 1 female, ZRC 2014.0524, Ponggol beach, muddy sand with stones, L.W.S.T., 07 April 1969 (J11896).

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Australia and Hawaii (species complex, see below).

Previous records from Singapore. Johnson (1962, as *Alpheus audouini* Coutière, 1905); Banner & Banner (1966a); Johnson (1979) (both as *Alpheus crassimanus* Heller, 1862a).

Ecology. Variable (species complex), from rocky shores and reefs with mixed sand-rubble-rock bottoms to fine sand-silt and mud, usually under rocks and large pieces of coral rubble, also in burrows on mudflats; typically in the intertidal and shallow subtidal (0–3 m), occasionally in deeper water (10 m).

Remarks. *Alpheus lobidens* is undoubtedly a complex of several cryptic species, some common and widely distributed across the Indo-west Pacific, others possibly more restricted in their range (A. Anker, pers. obs.). The *A. lobidens* complex needs a thorough taxonomic revision, involving re-examination of the dry holotype of *A. lobidens* ,and the type material of *A. crassimanus* Heller, 1865, *A. inopinatus* Holthuis & Gottlieb, 1958 and *A. lobidens polynesica* , as well as collection of fresh photo-vouchered material from or near their respective type localities. For the time being, all specimens with the general characters of *A. lobidens* (*sensu* Banner & Banner, 1982) should be treated as *A. lobidens* sensu lato. In Singapore, at least two species are present, distinguishable in life by the presence or absence of three pairs of conspicuous black spots on the abdomen (spotted and non-spotted colour morphs, cf. Figs. 16, 17). Both species are common throughout Singapore and can be found in the rocky intertidal and on mixed sand-mud-rock bottoms, occasionally also in deeper water (10 m).

Alpheus lottini Guérin-Méneville, 1829 sensu lato
(Fig. 18)

Alpheus lottini Guérin-Méneville, 1829: pl. 3, fig. 3.
Alpheus lottini (also spelled *A. lottinii*) — Tiwari, 1965: 285; Banner & Banner, 1966a: 91; Johnson, 1979: 38; Liu & Lan, 1980: 84; Banner & Banner, 1982: 65; Banner & Banner, 1985: 19.
Alpheus ventrosus — H. Milne Edwards, 1837: 352; De Man, 1911: 339; Johnson, 1962: 51; Johnson, 1963: 288.
Alpheus laevis Randall, 1840: 141; De Man, 1888a: 499; De Man, 1902: 861.
(?) *Crangon latipes* Banner, 1953: 82.

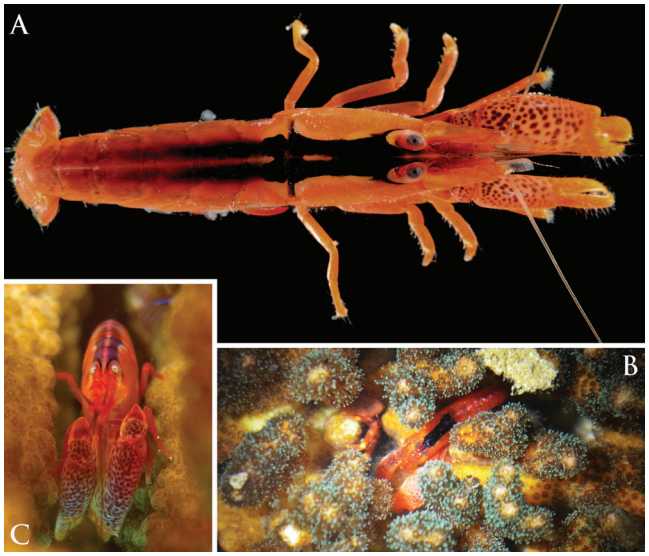

Fig. 18. *Alpheus lottini* Guérin-Méneville, 1829 sensu lato: A, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD151 (OUMNH.ZC. 2014-11-079); B, individual from Pulaua Semakau, Strait of Singapore, photographed in situ on coral host, *Pocillopora* cf. *damicornis* (L.) (specimen not collected), note a partly hidden symbiotic coral crab, *Trapezia* sp.; C, individual from Mayotte Island, southwestern Indian Ocean, photographed in situ between branches of coral host, *Pocillopora* sp (Photographs by: Arthur Anker [A], Yvon Gildas [B], Mei Lin Neo [C]).

CMBS material. Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-079, sta. SD151, SW Kusu I., 19.6 m, in *Pocillopora*, leg. S. De Grave et al., 03 June 2013 (SIN-307).

Additional material. Strait of Singapore. 2 males, 2 ov. females, ZRC 2000.1259, Kusu I., 10 m, leg. S. Teo et al., 02 July 1996; 1 male, 1 ov. female, ZRC 2000.2187, Sentosa I., coral reef (later destroyed by land reclaiming), in coral *Pocillopora* sp., leg. P.K.L. Ng, 27 May 1982; 8 specimens (males and females), ZRC 1999.0853, Pulau Seringat, leg. S.H. Tan et al., 24 July 1997; 2 males, 1 ov. female, ZRC 2014.0373, Raffles Lighthouse, leg. A. Monteiro, 12 March 1947.

Distribution. Indo-Pacific, from the Red Sea and South Africa to Japan, Australia, Hawaii, French Polynesia, Rapa Nui, Panama and Galapagos (species complex, see below).

Previous records from Singapore. Johnson (1962, as *Alpheus ventrosus* H. Milne Edwards, 1837); Banner & Banner (1966); Johnson (1979).

Ecology. Coral reefs, obligate associate of hard corals of the genera *Pocillopora* and *Seriatopora*; from lower intertidal (rare) to at least 30 m, usually at depth range 5–15 m; ecology and behaviour of *A. lottini* were studied by Castro (1971), Patton (1974), Glynn (1976), and Vannini (1985).

Remarks. *Alpheus lottini* is one of the most common, conspicuous (Fig. 18) and widespread Indo-Pacific snapping shrimps. It also has a very complex taxonomic history (see Banner & Banner, 1982), which is not completely resolved. *Alpheus lottini* was studied by Williams et al. (2001, 2002), who showed evidence of a cline between the Indian and the Pacific Oceans, and a genetic break between the Indo-west Pacific and East Pacific. Van Wormhoudt (2009) found at least five genetically more or less diverged clades, including some in sympatry in Clipperton Island and French Polynesia. Therefore, the taxonomic identity of some nominal species currently treated as junior synonyms of *A. lottini*, especially the Hawaiian *Alpheus latipes* (Banner, 1953), will need to be re-investigated. The Singaporean material represents the most common form currently identified as *A. lottini*. In Singapore, *A. lottini* is presently confined to the last remaining coral reef patches of the southern islands, e.g. around Kusu Island, Pulau Seringat, Pulau Semakau (Fig. 18B) and Raffles Lighthouse.

Alpheus macellarius Chace, 1988
(Fig. 19)

Alpheus macellarius Chace, 1988: 35; Anker et al., 2015: 306.
Alpheus sp. — Wang & Yeo, 2011: 19.

CMBS material. Straits of Johor. 1 female, ZRC 2014.0610, sta. SW41, Pulau Sekudu near Pulau Ubin (off Chek Jawa), mud-sand with seagrass, suction pump, in burrow, leg. A Anker et al., 20 October 2012 (JS-1449). Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-080, sta. IT95, Raffles Lighthouse, intertidal seagrass flat with rubble, leg. A. Anker, T.S. Tay et al., 29 May 2013 (SS-3217); 1 male, OUMNH.ZC. 2014-11-081, sta. IT95, same collection data (SIN-181); 1 female, OUMNH.ZC. 2014-11-082, sta. YB74, St. John's I., DRTech northern lagoon, 0–0.5 m, suction pump, burrow, associated with goby (*Cryptocentrus* sp.), leg. A. Anker, P.K.L. Ng, D.L. Rahayu, 26 May 2013 (SS-1662) [preserved together with goby]; 1 male, 1 ov. female, ZRC 2014.0608, sta. SW75, St. John's I., shallow bay between public jetty and small mangrove, muddy intertidal, 0–0.5 m, suction pump, leg. A. Anker, P.K.L. Ng, D.L. Rahayu, 26 May 2013 (SS-1646) [male missing major cheliped]; 1 female, ZRC 2014.0609, sta. IT124, Terumbu Pempang Laut, intertidal, leg. Y.L. Lee, I. Kwan et al., 31 May 2013 (SS-3987); 1 female, OUMNH.ZC. 2014-11-083, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-145); 1 male, OUMNH.ZC. 2014-11-084, Pulau Senang, near jetty, mud-sand flat with rocks and rubble, 0–0.2 m, in burrow, leg. A. Anker, 30 March 2014 (SEN-AA02).

Additional material. Strait of Singapore. 1 male, ZRC 1999.0792, Labrador Beach, leg. K. Lim, 1998; 1 male, ZRC 2014.0530, Changi, Kampong Mata Ikan, 0.3–0.6

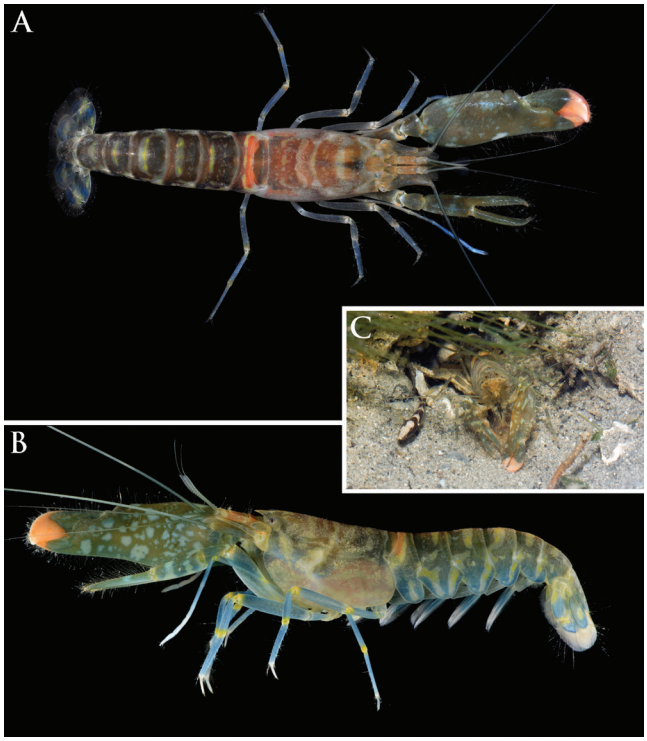

Fig. 19. *Alpheus macellarius* Chace, 1988: A, female from Pulau Sekudu near Pulau Ubin, Straits of Johor, CMBS sta. SW41 (ZRC 2014.0610); B, male from Raffles Lighthouse, Strait of Singapore, CMBS sta. IT95 (OUMNH.ZC. 2014-11-080); C, individual from Tanjong Rimau, Sentosa, Strait of Singapore, in situ with partner goby, probably *Cryptocentrus maudae* Fowler (specimens not collected) (Photographs by: Arthur Anker [A], Kenny Chua [B], Marcus Ng [C]).

m, muddy sand, beach seine, leg. D.S. Johnson, 03 March 1965 (J6773) [det. D.S. Johnson as *A. rapax*]; 1 male, ZRC 2014.0661, Pulau Semakau, natural shore, mud flat, low tide, leg. P.K.L. Ng, J.C. Mendoza, A. Windsor, 03 August 2011.

Distribution. Indo-west Pacific: Philippines, Indonesia and Singapore.

Previous records from Singapore. None (but see below).

Ecology. Sandflats with abundant seagrass, sometimes mixed with rocks or loose rubble, usually associated with gobies, *Cryptocentrus octofasciatus* Regan, *C. maudae* Fowler and *C. leptocephalus* Bleeker = *C. singapurensis* (Herre) (Fig. 19C); intertidal and shallow subtidal (0–10 m); the general ecology, population dynamics, burrowing and feeding habits, as well as some aspects of symbiotic behaviour with gobies were studied by Palomar et al. (2004, 2005), Nacorda (2008) and Holmer & Heilskov (2008).

Remarks. The present material represents the first record of *A. macellarius* for Singapore, altough some of Johnson's (1962, 1979) material was misidentified and reported as *A. rapax* Fabricius, 1798 (see under Additional material). In addition, colour photographs of *A. macellarius* identified incompletely as "*Alpheus* sp." were published in some popular books (e.g., Lim et al., 1994; Wang & Yeo, 2011). *Alpheus macellarius* can be separated from *A. rapax* by the non-gaping fingers of the minor cheliped and in life also by its distinctive colour pattern (Fig. 19, compare with *A. rapax*, Figs. 26, 27). *Alpheus macellarius* appears to be relatively common in Singapore, both in the Straits of Johor (Pulau Ubin, Pulau Sekudu, Changi area) and in the Strait of Singapore (Labrador Beach, St. John's Island, Raffles Lighthouse, Pulau Senang, Terumbu Pempang Laut, Pulau Semakau, Cyrene Reef), although it is not often collected because of its secretive habits.

Alpheus malabaricus (Fabricius, 1775) sensu lato
(Fig. 20)

Astacus malabaricus Fabricius, 1775: 415.
Alpheus malabaricus — Henderson, 1893: 434; Johnson, 1979: 39; Chace, 1988: 39.
Alpheus malabaricus malabaricus — Banner & Banner, 1966a: 145; Banner & Banner, 1985: 20.
(?) *Alpheus macrodactylus* Ortmann, 1890: 473; De Man, 1924: 50; Banner & Banner, 1982: 210; Banner & Banner, 1985: 19.
(?) *Alpheus dolichodactylus* Ortmann, 1890: 473.
(?) *Alpheus dolichodactylus* var. *leptopus* De Man, 1910: 289.
(?) *Alpheus malabaricus mackayi* Banner, 1959: 149.
Not *Alpheus malabaricus songkla* Banner & Banner, 1966a: 147 (A. Anker, in study).

Fig. 20. *Alpheus malabaricus* (Fabricius, 1775) sensu lato: ovigerous female from Pulau Senang, Strait of Singapore, CMBS sta. SEN (OUMNH.ZC. 2014-11-085) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, ZRC 2014.0389, sta. D10, Pulau Ketam, Celestial Resort jetty, mud, leg. K.S. Tan et al., 07 March 2012 (D10-072) [missing major cheliped]. Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-085, sta. SEN, Pulau Senang, near jetty, mud-sand flat with rocks and rubble, 0–0.2 m, in burrow, leg. A. Anker, 30 March 2014 (SEN-AA03).

Additional material. Strait of Singapore. 1 ov female, ZRC 1979.4.3.25, Jurong prawn pond, amongst penaeids, 28 December 1957 (J7983); 1 male, 1 female, ZRC 1979.4.3.23-24, Singapore, sta. S.R.F.R.S. B61, prawn pond, 11 January 1955 (J8084-8085); 1 ov. female, ZRC 1996.923, Kallang Basin, sta. 2/G2, leg. Reef Ecology Study Team, 28 November 1995; 1 male, 1 female, ZRC 1979.4.3.26-27, Jurong prawn ponds, no further data (J8046-8047) [both missing minor cheliped and most pereopods, female also missing major cheliped]; 1 male, ZRC 1996.927, Kallang Basin, sta. 2/G4, Reef Ecology Study Team, 28 November 1995 [missing

minor cheliped and most walking legs]; 2 males, 1 ov. female, ZRC 1991.11082-11084, Singapore River, sta. 4, dredge, leg. Reef Ecology Study Team, 06 November 1990.

Distribution. Indo-west Pacific, from East Africa to Japan, Indonesia, Australia and Hawaii (species complex).

Previous records from Singapore. Banner & Banner (1966); Johnson (1979).

Ecology. Variable, especially in regard to bathymetry (species complex), typically in mangrove swamps and mudflats in or near estuaries, brackish lagoons and backwaters, usually on fine mud bottoms, sometimes on sand-mud, in self-dug burrows in mud, sometimes under rocks; intertidal to almost 300 m (289 m for *A. m. leptopus*).

Remarks. *Alpheus malabaricus* has one of the most confusing taxonomic histories of any alpheid shrimp and most likely represents a species complex. Johnson (1979) noted that "almost every local population of this species appears to be distinct and in consequence there are numerous described varieties". A least some of these varieties or subspecies have been treated as full species in the past, e.g., *A. macrodactylus* Ortmann, 1890, *A. dolichodactylus* Ortmann, 1890, and *A. mackayi* Banner, 1959. On the other hand, *A. malabaricus songkla* Banner & Banner, 1966a, previously known only from females, appears to belong to the *A. euphrosyne* species complex (A. Anker, in study). Until a full revision of the *A. malabaricus* complex, all Indo-west Pacific material should be reported as *A. malabaricus* sensu lato.

In Singapore, *A. malabaricus* typically occurs on fine mud bottoms, including black, almost anoxic soggy mud. It appears to be more common in the Straits of Johor (Pulau Ubin, Pulau Ketam, Lim Chu Kang), but has also been collected in the Strait of Singapore (Pulau Senang, historically also in Jurong and Kallang Basin).

Alpheus obesomanus Dana, 1852 sensu lato

Alpheus obeso-manus Dana, 1852a: 21.
Alpheus obesomanus — Banner & Banner, 1966a: 101; Johnson, 1979: 39; Banner & Banner, 1978: 226; Liu & Lan, 1980: 87; Banner & Banner, 1982: 89; Banner & Banner, 1985: 26; Chace, 1988: 44.
Alpheus lutini Coutière, 1905: 885.
Alpheus lutini — De Man, 1911: 346; Johnson, 1962: 52; Tiwari, 1965: 291.

CMBS material. None.

Additional material. Strait of Singapore. 1 ov. female, ZRC 1979.4.3.18, Pulau Hantu, crevices in dead coral heads, L.W.S.T., 02 February 1954 (det. D.S. Johnson as *A. lutini*).

Distribution. Indo-west Pacific from the Red Sea and South Africa to Japan, Indonesia, Australia, and French Polynesia (species complex?).

Previous records from Singapore. Johnson (1962, as *Alpheus lutini* Coutière, 1905); Johnson (1979).

Remarks. *Alpheus obesomanus* and the entire *A. obesomanus* species group, needs a thorough revision (A. Anker, pers. obs.). This endolithic, coral-boring species is either locally extinct or extremely rare in Singapore; the only presently known Singaporean specimen was collected from dead coral heads at Pulau Hantu, in the 1950s. An illustrated description of *A. obesomanus* can be found in Banner & Banner (1982).

Alpheus pacificus Dana, 1852 sensu lato

Alpheus pacificus Dana, 1852a: 21; Dana, 1852b: 544; De Man, 1911: 427; Tiwari, 1965: 315; Banner & Banner, 1966a: 143; Banner & Banner, 1978: 227; Banner & Banner, 1982: 217; Banner & Banner, 1985: 26; Chace, 1988: 45.
(?) *Alpheus gracilidigitus* Miers, 1884: 287.

CMBS material. None.

Additional material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2008.0634, Siglap, no further data, VI.1933; 1 male, ZRC 2000.1443, East Coast, leg. K.L. Yeo, 08 May 2000; 1 male, ZRC 2014.0654, Singapore sta. JL04 D206, VI.2004, no further data.

Distribution. Indo-Pacific, from the Red Sea and South Africa to Japan, Korea, Indonesia, Australia, Hawaii, French Polynesia, Rapa Nui, Clipperton, Galapagos, and Mexico to Panama.

Previous records from Singapore. None.

Ecology. Rocky shores and mixed sand-rock-rubble bottoms in shallow water, usually under rocks or in dead corals, apparently preferring well-washed clean sands of beaches exposed to wave action; most common in intertidal and shallow subtidal, sometimes down to 20 m.

Remarks. Variation in some morphological features and colour patterns in material identifiable as *Alpheus pacificus* (Banner & Banner, 1982; A. Anker, pers. obs.) suggest that this taxon is a complex of several cryptic species. Preliminary analyses of the barcoding part of the COI gene showed that *A. pacificus* is composed of three genetically well-defined clades, each most likely corresponding to a distinct species (A. Anker, in study). Thus, *A. pacificus* will need a careful taxonomic revision, with reappraisal of the status of *A. gracilidigitus* Miers, 1884, currently a junior synonym. For the time being, all Indo-Pacific material has to be identified as *A. pacificus* sensu lato.

The Singaporean material of *A. pacificus* was collected in the intertidal areas of Siglap and East Coast in the early 2000s. The species has not been collected during the more recent intertidal surveys (CMBS 2012–2014), although one ovigerous female with regenerated chelipeds was seen (but not collected) at Labrador Beach in March 2014 (A. Anker, pers. obs.). It seems that *A. pacificus* is becoming rare in Singapore due to its preference for well-washed and

clean sand-rock bottoms, which are now increasingly being replaced by silt and fine sand.

Alpheus paralcyone Coutière, 1905 sensu lato
(Fig. 21)

Alpheus paralcyone Coutière, 1905: 895; De Man, 1911: 354; Johnson, 1962: 52; Johnson, 1963: 288; Banner & Banner, 1966a: 108; Johnson, 1979: 40; Banner & Banner, 1978: 227; Banner & Banner, 1982: 113; Banner & Banner, 1985: 27; Chace, 1988: 46.
(?) *Alpheus providencei* Coutière, 1908: 208.
(?) *Crangon laysani* Edmondson, 1925: 17.

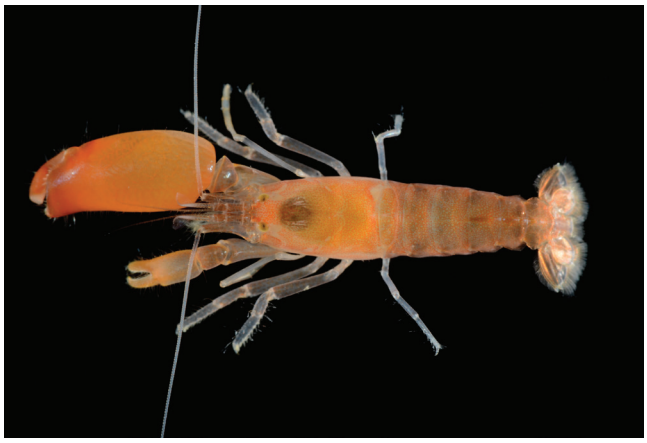

Fig. 21. *Alpheus paralcyone* Coutière, 1905 sensu lato: male from Pulau Semakau, Strait of Singapore, sta. SB41 (OUMNH.ZC. 2014-11-087) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0376, sta. TB142, SE of Changi Pier, Eastern entrance to Straits of Johor, 28.7–28.8 m, mud, gravel, shells, leg. B. Richer de Forges et al., 01 June 2013; 1 male, OUMNH.ZC. 2014-11-086, sta SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1593); 1 male, OUMNH.ZC. 2014-11-087, sta SB41, same collection data (SS-1599); 1 female, ZRC 2014.0375, sta. SB41, same collection data (SS-1601); 1 male, ZRC 2014.0374, sta DR31, outside Marina Bay, Marrina Barrage, 19.4–19.6 m, mud, gravel, leg. B. Richer de Forges et al., 23 May 2013 (SS-1572) [missing major cheliped]; 1 ov. female, OUMNH.ZC. 2014-11-088, sta. SB132, Kusu I., ~8 m, dead coral and rubble brushing, leg. S. De Grave, H.H. Tan, C.W. Lin et al., 01 June 2013 (SS-3762); 1 ov. female, OUMNH.ZC. 2014-11-089, sta. TB185, near Pulau Senang, 24.3–24.5 m, smelly mud, laterite rocks, gravel, leg. B. Richer de Forges et al., 06 June 2013 (SS-4532); 1 male, OUMNH.ZC. 2014-11-090, sta. TB17, Eastern Holding, 86.7–90.9 m, leg. B. Richer de Forges et al., 22 May 2013 (SIN-025).

Additional material. Strait of Singapore. 1 male, ZRC 1979.4.4.19, off N Pulau Semakau, fine shell gravel, 24–27.5 m, sponges, 03 January 1969 (J9275); 1 male, 1 ov. female, ZRC 1979.4.4.20-21, between N Pulau Pawai and Pawai reef, 9–14.5 m, rocks, some gravel, gorgonians, sponges etc., 04 January 1969 (J9280-9281); 2 males, ZRC 2014.0656, Selat Sinki, dredge, stones, shells, gravel, coral brash, gorgonians etc., leg. B.C. Lim et al., 14 February 1969.

Distribution. Indo-west Pacific, from Madagascar to Japan, Indonesia, Australia, Cook Islands, and Hawaii (possible species complex).

Previous records from Singapore. Johnson (1962, 1979); Banner & Banner (1966).

Ecology. Coral reef and associated rubble habitats, in dead coral heads, reef crevices, sponges; from lower intertidal to over 200 m.

Remarks. *Alpheus paralcyone* is either a morphologically variable species or a species complex. The taxonomic status of *A. providencei* Coutière, 1908 and *A. laysani* (Edmondson, 1925), both forms currently considered as synonyms (see Banner, 1953; Banner & Banner, 1982), may need a reassessment. Presently all specimens with general characters of *A. paralcyone*, especially the presence of triangular teeth on the dorsal section of the posterior margin of the sixth abdominal somite (Coutière, 1905; De Man, 1911; Banner & Banner, 1982), are assigned to this species. Johnson (1962) noted that *A. paralcyone* "appears to be associated with living sponges and corals" and that it is a "common offshore form". Johnson's material came from Selat Sinki (shell-gravel, coral-brash grounds, on living coral, ~10 m), off Pulau Tembakul east of Pulau Sakijang Pelepah (coral-reef, ~6 m), off Tanjong Rhu (mud, 4 m), several localities in the Strait of Singapore (9–70 m), as well as Johor Shoals (crinoid grounds, ~18 m). The CMBS material of *A. paralcyone* (Fig. 21) was collected in about the same area (e.g., Pulau Semakau, Pulau Senang, outside Marina Bay, and eastern entrance to Straits of Johor) and a similar depth range (5–30 m), although the species appears to be less common today.

Alpheus cf. *pareuchirus* Coutière, 1905
(Fig. 22)

Alpheus pareuchirus Coutière, 1905: 906; De Man, 1911: 418; Johnson, 1962: 54; Johnson, 1979: 40.
Alpheus pareuchirus pareuchirus — Banner & Banner, 1978: 228; Banner & Banner, 1982: 276; Banner & Banner, 1985: 27; Chace, 1988: 47.

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0533, sta. DR1, near Raffles Lighthouse, 38.3–38.5 m, gravel, shells, leg. B. Richer de Forges et al., 21 May 2013 (SS-0303).

Distribution. Indo-west Pacific, from the Red Sea and Madagascar to Indonesia, Australia and Micronesia.

Previous records from Singapore. None; Johnson's (1962, 1979) records of *A. pareuchirus* refer to other species (see below).

Fig. 22. *Alpheus* cf. *pareuchirus* Coutière, 1905: male dredged near Raffles Lighthouse, Strait of Singapore, CMBS sta. DR1 (ZRC 2014.0533) (Photograph by: Arthur Anker).

Ecology. Hard and mixed bottoms, with gravel, shells, rubble, etc., also on barrier reefs and reef flats; from lower intertidal to 90 m.

Remarks. *Alpheus pareuchirus* needs a careful taxonomic reassessment, including a reappraisal of the status of *A. pareuchirus leucothea* De Man, 1911, currently a synonym of *A. pareuchirus* (Banner & Banner, 1982). *Alpheus imitatrix* De Man, 1909b, formerly *A. pareuchirus imitatrix*, is here treated as a full species (see above), based on the balaeniceps condition of the female minor cheliped, which is not developed in *A. pareuchirus*. The single CMBS specimen tentatively identified as *A.* cf. *pareuchirus* is a relatively young male with a robust balaeniceps minor chela, which in proportions is much stouter than the female minor chela of the much larger specimens of *A. imitatrix* (cf. Figs. 14, 22). This specimen also differs, in some proportion-related features, from the type specimens of *A. pareuchirus* from the Maldives (Coutière, 1905) and from the Australian specimens illustrated by Banner & Banner (1982). In addition, its rather striking colour pattern (Fig. 22) is different from those of *A. imitatrix* (Fig. 14) and *A. pareuchirus* from Ogasawara Islands (A. Anker, pers obs.).

Johnson (1962) reported *Alpheus pareuchirus* from a reef-flat at Pulau Sudong and hard grounds in the Strait of Singapore. However, all material identified as *A. pareuchirus* by D.S. Johnson still remaining in ZRC (four lots with a total of five specimens) was found to be either incomplete and non-identifiable *Alpheus* spp. (but not *A. pareuchirus*) or species from the *A. lobidens* complex (A. Anker, pers. obs.). Therefore, the present CMBS specimen and the two specimens of *A. imitatrix* (see above) are the first confirmed records of the *A. pareuchirus* complex in Singapore.

Alpheus parvirostris Dana, 1852
(Fig. 23)

Alpheus parvi-rostris Dana, 1852a: 22; Dana, 1852b: 551.
Alpheus parvirostris — De Man, 1911: 432; Johnson, 1962: 54; Banner & Banner, 1966a: 149; Johnson, 1979: 40; Banner & Banner, 1978: 228; Liu & Lan, 1980: 106; Banner & Banner, 1982: 185; Chace, 1988: 47.
Alpheus lineifer Miers, 1875: 343.
Alpheus euchiroides Nobili, 1906: 257.
Alpheus braschi Boone, 1935: 131.

Fig. 23. *Alpheus parvirostris* Dana, 1852: male from Pulau Tekukor, Strait of Singapore, CMBS sta. SB85 (ZRC 2014.0397) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.0397, sta. SB85, SW Pulau Tekukor, 4.5 m, coral rubble brushing, leg. D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-2728); 1 male, 2 ov. females, OUMNH.ZC. 2014-11-091, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SIN-236) [male missing major cheliped]; 1 male, 1 ov. female, ZRC 2014.0398, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble and some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013 [both missing major cheliped]; 1 female, ZRC 2014.0399, sta. IT102, Big Sister's I., intertidal, in rubble, leg. KS. Koh, K. Chua et al., 30 May 2013 (SS-3136); 1 male, ZRC 2014.0400, sta. SB146, W Pulau Hantu, 5–7 m, coral rubble brushing, leg. H.H. Tan, S. De Grave et al., 02 June 2013; 1 male, 1 ov. female, OUMNH.ZC. 2014-11-092, sta. IT118, St. John's I., AVA jetty, rock-rubble shore, leg. J.K. Lowry, N. Bruce, 31 May 2013; 1 female, OUMNH.ZC. 2014-11-093, sta. SW50, St. John's I., beach near public jetty, rubble beach, 0.1 m, leg. S.T. Ahyong, 23 May 2013 (SIN-067).

Additional material. Strait of Singapore. 1 male, ZRC 1979.4.4.38, Pulau Hantu, tow netting in pools with algae and sea anemones, L.W.S.T., leg. B.C. Lim, 25 June 1967 (J8121).

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Indonesia, Australia, Samoa, Cook Islands, French Polynesia and possibly Hawaii.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Coral reefs and adjacent rubble habitats, also on mixed rock-sand and sand-rubble bottoms, typically in crevices of dead coral heads, clumps of calcareous algae,

also under algae-covered boulders, rarely in sponges and living corals (*Galaxea*, *Pocillopora*, *Acropora*, *Tubipora*) or in pearl oysters (*Pinctada*); from lower intertidal to at least 20 m.

Remarks. *Alpheus parvirostris* is one of the most common and widespread crevice-dwelling snapping shrimps in the Indo-west Pacific. Johnson (1962) stated that *A. parvirostris* was "one of the commoner littoral alpheids of the Singapore area", having collected it at Labrador Beach (crevices in honeycomb rock on lower beach), Pulau Hantu (crevices in honeycomb rock on reef-flat and in coral-rock at reef-edge), and Raffles Lighthouse (crevices in *Heliopora* heads at spring low tide and crevices in subtidal coral rocks). However, it is not clear whether all Johnson's specimens were *A. parvirostris* because of the syntopic occurrence of the closely related *A. bannerorum*. In life, the two species can be easily distinguished by their colour patterns, in particular by the absence of conspicuous ocelli on the abdomen in *A. parvirostris* (Fig. 23) vs. their presence in *A. bannerorum* (Fig. 2). The present material of *A. parvirostris* was collected both intertidally and subtidally around the southern islands of Singapore, including St. John's Island, Pulau Tekukor, Raffles Lighthouse and Pulau Hantu. The species still appears to be very common in Singapore.

Alpheus pubescens De Man, 1908
(Fig. 24)

Alpheus pubescens De Man, 1908: 109; De Man, 1911: 389; Tiwari, 1965: 300; Banner & Banner, 1982: 167; Banner & Banner, 1985: 30; Bruce, 1994: 20.
Alpheus cf. *lanceloti* (nec Coutière, 1905) — Johnson, 1962: 52.
Alpheus lanceloti (nec Coutière, 1905) — Johnson, 1979: 38.

Fig. 24. *Alpheus pubescens* De Man, 1908: male dredged near Raffles Lighthouse, Strait of Singapore, CMBS sta. DR2 (OUMNH. ZC. 2014-11-094) (Photographs by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, OUMNH. ZC. 2014-11-094, sta. DR2, Strait of Singapore near Raffles Lighthouse, 34.2–34.3 m, silt, gravel, shells, rectangular dregde, leg. B. Richer de Forges et al., 21 May 2013 (SS-0311) [missing minor cheliped].

Additional material. Strait of Singapore. 1 male, ZRC 1979.4.3.15, Pulau Sudong, 1–1.8 m, in crevices in large head of *Pavona frondifera*, 19 February 1955 (J8062) [det. D.S. Johnson as *Alpheus lanceloti* Coutière, 1905].

Distribution. Indo-west Pacific: Vietnam, Indonesia, Singapore, Australia, possibly also in Japan.

Previous records from Singapore. Johnson (1962, as *Alpheus* cf. *lanceloti* Coutière, 1905), 1979 (as *A. lanceloti*).

Remarks. The single CMBS specimen of *Alpheus pubescens* is missing its minor cheliped, but in all other morphological characters appears to correspond closely to De Man's species, including the presence of densely inserted, short, erect setae ("pubescence") on the carapace. This pubescence is very clear in Johnson's (1962, 1979) specimen from Pulau Sudong that he identified as *A. lanceloti* (ZRC 1979.4.3.14); therefore, this specimen was re-identified as *A. pubescens*. The colour pattern of the Singaporean specimen (Fig. 24) is similar to those of specimens from northern Australia identified as *A. pubescens* by Bruce (1994: fig. 5D).

Alpheus rapacida De Man, 1908 sensu lato
(Fig. 25)

Alpheus rapacida De Man, 1908: 105; De Man, 1911: 324; Johnson, 1962: 53; Tiwari, 1965: 302; Banner & Banner, 1966a: 118; Johnson, 1979: 40; Banner & Banner, 1978: 228; Banner & Banner, 1982: 160; Banner & Banner, 1985: 30; Chace, 1988: 51.

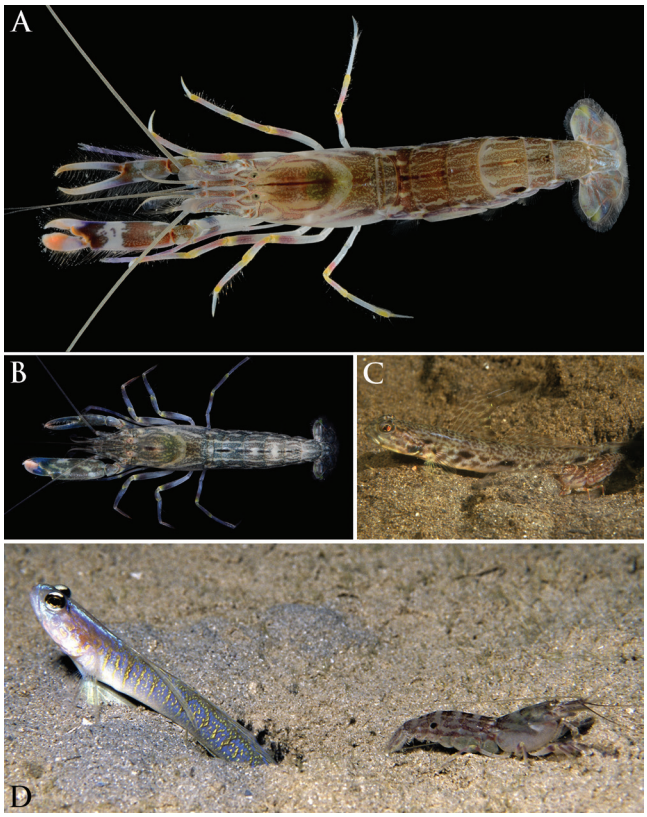

Fig. 25. *Alpheus rapacida* De Man, 1908: A, ovigerous female dredged near Eastern Bunkering A, Strait of Singapore, CMBS sta. TB98 (OUMNH.ZC. 2014-11-095); B, male from Pulau Ubin, Straits of Johor, CMBS sta. SW13 (ZRC 2014.0608); C, individual from Flores, Indonesia, in situ with partner goby, *Tomiyamichthys* sp. (specimens not collected); D, individual from Tahiti, French Polynesia, in situ with partner goby, *Vanderhorstia* sp. (specimens not collected) (Photographs by: Arthur Anker [A, B], Rudie Kuiter [C], Philippe Bacchet [D]).

CMBS material. Straits of Johor. 1 male, ZRC 2014.0608, sta. SW13, Pulau Ubin, Chek Jawa, near boardwalk, mud-sand flat with seagrass and rocks, under rocks and from burrows, leg. A. Anker, S.K. Tan, P.K.L. Ng et al., 17 October 2012 (JS-0761); 1 ov. female, ZRC 2014.0607, Changi Creek, leg. K.S. Tan et al., 12 April 2012 (52066) [with regenerated major cheliped, identification tentative]. Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-095, sta. TB98, Eastern Bunkering A, 33.6–30.2 m, broken shells, silt, leg. B. Richer de Forges et al., 28 May 2013 (SIN-206); 1 ov. female, OUMNH.ZC. 2014-11-096, sta. TB99, Eastern Bunkering A, 26.7–33.7 m, bryozoan dominated silty bottom, leg. B. Richer de Forges et al., 29 May 2013 (SIN-197).

Additional material. 4 males, 7 ov. females, ZRC 1979.2.2.1-13, Singapore, no further data [det. Y. Miya]. Straits of Johor. 1 male, 1 ov. female, OUMNH.ZC. 2014-11-097, Pulau Ubin, eastern coast, sandflats and mudflats, leg. D.C.J Yeo et al., 29 May 2001; 1 male, 1 ov. female, ZRC 2014.0634, same collection data [female missing major cheliped]. Strait of Singapore. 1 female, ZRC 1994.4386, Kallang Basin, sta. 5, dredge 1, leg. Reef Ecology Study Team, 16 December 1994; 1 female, ZRC 1994.4406, Kallang Basin, sta. 6, dredge 6, 16 December 1994 [missing major cheliped, identification tentative].

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Indonesia, Australia and Hawaii; also reported as Lessepsian migrant in the eastern Mediterranean Sea (possible species complex, see below).

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Soft bottoms, i.e., fine sand and mud, in self-made burrows, apparently often associated with gobies (*Vanderhorstia*, *Mahidolia*, *Psilogobius*, see below); from lower intertidal to at least 56 m.

Remarks. *Alpheus rapacida*, originally described from Indonesia, needs a comprehensive taxonomic revision throughout its distribution range spanning almost the entire Indo-west Pacific from the Red Sea to Hawaii. This revision should also include a re-examination of *A. quasirapacida* Chace, 1988, a species described based on two imperfect specimens dredged from 18 m in the Philippines (Chace, 1988), as well as *A. lepidus* De Man, 1908 and *A. sibogae* De Man, 1908, two deep-water species (below 50 m) closely related to *A. rapacida*, from Indonesia (De Man, 1911). Chace (1988) noted that *A. quasirapacida* may ultimately be recognised as a variation of *A. rapacida*. In addition, both *A. rapacida* and *A. quasirapacida* need to be compared with the morphologically and ecologically similar *A. digitalis* De Haan, 1849 (= *A. distinguendus* De Man, 1909c) and *A. longiforceps* Hayashi & Nagata, 2002. The identity of the eastern Mediterranean material of *A. rapacida* (Lewinsohn & Holthuis, 1964) is also unclear (A. Anker, pers. obs.). In the present contribution, all specimens morphologically corresponding to De Man's (1908, 1911) concept of *A. rapacida*, and with a very characteristic colour pattern, which includes a large dark spot on each side of the fourth abdominal somite (Fig. 25A, see also Fig. 25C, D), are assigned to *A. rapacida* sensu lato.

Alpheus rapacida was reported from Singapore by Johnson (1962, 1979), who found it "in abundance in burrows in a flat of very soft mud at about mid-tide level at Tanjong Penuru". The CMBS material was collected in the shallow waters of eastern Straits of Johor, at Chek Jawa (Pulau Ubin) and Changi Creek, and in deeper waters (below 20 m) in the Strait of Singapore. *Alpheus rapacida* (or a closely related species) is also occasionally photographed by divers, usually at the burrow entrance with various gobies, for instance, *Mahidolia* spp. and *Vanderhorstia* spp. in Indonesia and Japan (e.g., Minemizu, 2013; see also Fig. 25C, D).

Alpheus rapax Fabricius, 1798 sensu lato
(Figs. 26, 27)

Alpheus rapax Fabricius, 1798: 405; De Man, 1909c: 147; De Man, 1911: 385; Johnson, 1962: 52; Banner & Banner, 1966a: 121; Johnson, 1979: 40; Banner & Banner, 1978: 228; Banner & Banner, 1982: 174; Banner & Banner, 1985: 31.

Not *Alpheus rapax* — Jaafar & Zeng, 2012: 1487; Jaafar & Hou, 2012: 122; Zeng & Jaafar, 2012: 693; Hou et al., 2013: 2776 (= *A. brevirostris* (Olivier, 1811), see above).

Alpheus brevicristatus (nec De Haan, 1849) — Tan & Yeo, 2004: 137.

CMBS material. Straits of Johor. 1 post-ov. female, ZRC 2014.0603, sta. D10, Pulau Ketam, Celestial Resort jetty, mud, leg. KS Tan et al., 07 March 2012 (D10-073); 1 ov.

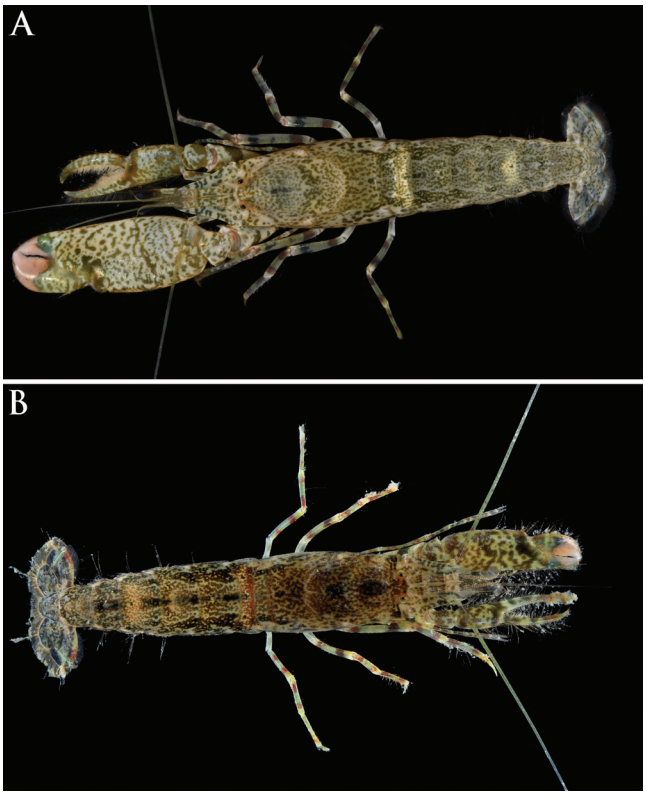

Fig. 26. *Alpheus rapax* Fabricius, 1798: A, male from Cyrene Reef, Strait of Singapore, CMBS sta. IT86 (OUMNH.ZC. 2014-11-098); B, ovigerous female from Pulau Sekudu, off Pulau Ubin, CMBS sta. SW24 (ZRC 2014.0605) (Photographs by: Arthur Anker).

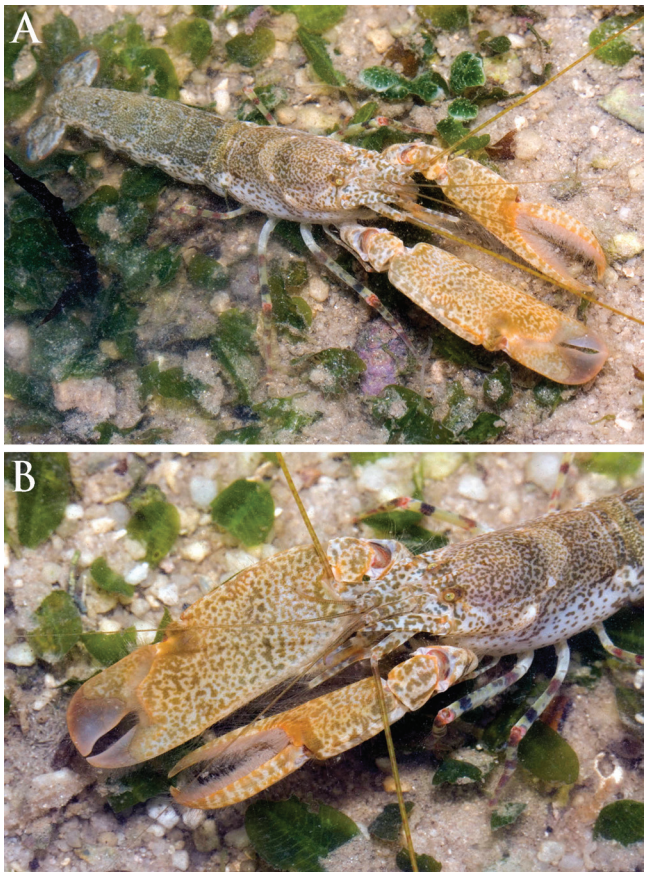

Fig. 27. *Alpheus rapax* Fabricius, 1798: A, B, male from Cyrene Reef, Strait of Singapore, photographed in situ (specimen not collected), general view (A) and close-up of the anterior region (B) (Photographs by: Marcus Ng).

female, ZRC 2014.0605, sta. SW24, Pulau Sekudu near Pulau Ubin (off Chek Jawa), intertidal sand-seagrass flat, leg. R. Tan et al., 17 October 2012 (JS-1387). Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-098, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-143); 1 male, OUMNH.ZC. 2014-11-099, Pulau Senang, near jetty, mud-sand flat with rocks and rubble, 0–0.2 m, in burrow with *Cryptocentrus inexplicatus*, leg. A. Anker, 30 March 2014 (SEN-AA01) [preserved together with goby]; 1 male, OUMNH.ZC. 2014-11-100, sta. RF251, Kusu I., big lagoon, intertidal, leg. TMSI team, 03 January 2014 (INT-0530); 1 male, ZRC 2014.0655, Pulau Hantu, leg. R. Tan, H.P. Yan, 17 November 2012 [missing major cheliped].

Additional material. 1 male, ZRC 1991.9, Singapore, no further data [det. Y. Miya]. Straits of Johor. 1 male, ZRC 2014.0652, Ponggol Beach, 07 February 1966 (J7221). Strait of Singapore. 1 male, ZRC 1995.486, Pulau Semakau, leg. J. Low, 28 December 1993; 1 male, ZRC 2000.2133, Labrador Beach, below rocky shore, leg. P.K.L. Ng, 16 January 1991; 1 male, ZRC 2008.0490, Cyrene Reef, leg. H.H. Tan et al., 25 April 2008; 1 male, ZRC 2008.0626, Changi Point, H.K. Lua, 19 December 1990; 1 male, ZRC 2014.0653, Changi Beach, 21 February 1966 (J6765).

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Indonesia, Australia, Micronesia and Hawaii.

Previous records from Singapore. Johnson (1962, 1979); Banner & Banner (1984); Tan & Yeo (2004, as *A. brevicristatus* De Haan, 1849).

Ecology. Sand and sand-mud or sand-rubble bottom, near coral reefs, seagrass beds or mangroves, occasionally associated with gobies; intertidal to at least 30 m.

Remarks. *Alpheus rapax*, like many other species of the *A. brevirostris* species group, needs a thorough revision. This taxon is morphologically very similar to *A. brevirostris* (Olivier, 1811), which also occurs in Singapore (see above), and *A. brevicristatus* De Haan, 1849, a species from northeastern Asia (China, Korea, Japan, Russia) not found in Singapore. *Alpheus rapax* can be distinguished from both of them by the colour pattern (cf. Figs 3, 26; see Marin, 2013 for photographs of *A. brevicristatus*), and morphologically, by the broader scaphocerite and shorter fingers of the minor chela (Bruce, 1994).

Alpheus rapax was first reported from Singapore by Johnson (1962), who stated that it was the "commonest large caridean prawn of Singapore beaches" and "an errant form, it is neither a burrower nor a crevice dweller, but wanders in and out with the tide". Johnson found it on many sandy beaches and reef-flats, but also on muddy beaches in Singapore, e.g., at Tanjong Gul, Labrador Beach, Bedok, Mata Ikan, Changi, Tanjong Kranji, Pulau Hantu, and Raffles Lighthouse. Most of the CMBS material of *A. rapax* was collected intertidally in the southern islands of the Strait of Singapore (Pulau Hantu, Kusu Island, Cyrene Reef) and near Pulau Ubin in the eastern Straits of Johor. The species appears to be quite common on sand-rubble flats of eastern Pulau Ubin, especially in Chek Jawa. *Alpheus rapax* is one of the largest snapping shrimps in the shallow sand-seagrass-reef habitats, with some adults reaching 23 mm CL and >60 mm TL. It may occasionally associate with shrimp gobies, such as *Cryptocentrus inexplicatus* (Herre).

Alpheus serenei Tiwari, 1964
(Fig. 28)

Alpheus serenei Tiwari, 1964: 314; Banner & Banner, 1978: 229; Banner & Banner, 1982: 196; Banner & Banner, 1985: 31; Chace, 1988: 51.

Alpheus euchirus (nec Dana, 1852) — Johnson, 1962: 54; Johnson, 1979: 37.

Alpheus hippothoe (nec De Man, 1888a) — Banner & Banner, 1966a: 151.

CMBS material. Straits of Johor. 1 ov. female, ZRC 2014.0435, sta. DW6, ~400 m SE of Pulau Sekudu, 15.2 m, B. Richer de Forges et al., 17 October 2012 (JS-0275); 1 male, ZRC 2014.0434, sta. DW6, same collection data (JS-0276); 1 male, OUMNH.ZC. 2014-11-101, sta. DW6, same collection data (JS-0282); 1 ov. female, OUMNH. ZC. 2014-11-102, sta. DW6, same collection data. Strait of Singapore. 1 male, ZRC 2014.0444, 61.7–66.8 m, E of Eastern Holding B, leg. TMSI team, 13 May 2013 (5414 TB1-003) [missing major cheliped]; 1 male, OUMNH.ZC. 2014-11-103, sta. SB152, SW Kusu I., 11 m, coral rubble

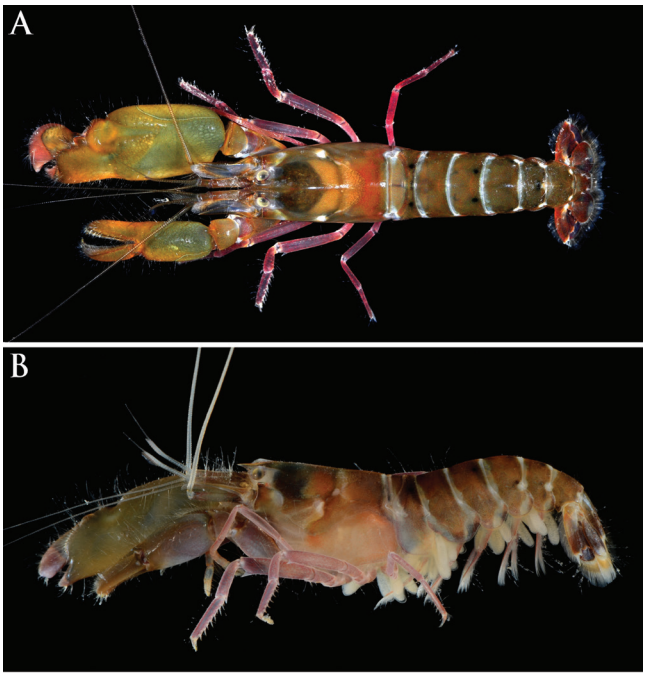

Fig. 28. *Alpheus serenei* Tiwari, 1964: A, B, male from south-east of Pulau Sekudu, Straits of Johor, CMBS sta. DW6 (OUMNH.ZC. 2014-11-101), in dorsal (A) and lateral (B) views (Photographs by: Arthur Anker).

brushing, leg. S. De Grave et al., 03 June 2013 (SIN-313); 1 ov. female, ZRC 2014.0441, sta. SB132, S Kusu I., pontoon, 0–5 m, brushing of dead corals, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3765) [infested by a pair of bopyrine isopods]; 1 male, 1 female, 4 juveniles, ZRC 2014.0446, sta. SB132, same collection data (SS-3764); 1 male, 1 ov. female, ZRC 2014.0448, sta. SD133, S Kusu I., 11 m, rubble, S. De Grave, H.H. Tan et al., 01 June 2013 (SS-4015); 1 male, 1 female, ZRC 2014.0443, sta. SB55, SW Kusu I., 4 m, brushing of dead corals, leg. H.H. Tan, S. De Grave, D. Uyeno et al., 25 May 2013 (SS-1636); 1 ov. female, ZRC 2014.0437, sta. SB55, same collection data (SS-1612); 1 male, OUMNH.ZC. 2014-11-104, sta. SB55, same collection data (SS-1616); 1 male, ZRC 2014.0438, sta. SB55, same collection data (SS-1615); 1 male, OUMNH.ZC. 2014-11-105, sta. SB55, same collection data (SS-1613); 1 male, 1 female, OUMNH.ZC. 2014-11-106, sta. SB146, W Pulau Hantu, 5–7 m, coral rubble brushing, leg. H.H. Tan, S. De Grave et al., 02 June 2013 (SIN-295) [male infested by rhizocephalan *Thompsonia* sp.]; 1 male, OUMNH.ZC. 2014-11-107, sta. TB72, S of Pulau Hantu, 23.1–23.6 m, leg. B. Richer de Forges et al., 26 May 2013 [infested by rhizocephalan *Thompsonia* sp.]; 1 male, 1 ov. female, ZRC 2014.0447, sta. SB67, W Pulau Hantu, patch reef, 15.7 m, brushing of dead corals, leg. D. Uyeno, S. De Grave, H.H. Tan et al., 26 May 2013 (SS-1656); 1 ov. female, ZRC 2014.0445, sta. SD130, St. John's I., DRTech southern lagoon, 0–6 m, scuba dive, (rubble), leg. D. Uyeno, 31 May 2013; 1 ov. female, ZRC 2014.0440, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1598); 1 female, OUMNH.ZC. 2014-11-108, sta. DR111, outside Eastern Boarding Ground, 125–136 m, rocks, sand, leg. B. Richer de Forges et al., 30 May 2013 (SS-3261); 1 male, OUMNH. ZC. 2014-11-109, sta. TB127, beside Eastern Boarding Ground A, rocky bottom, 128-113 m, leg. S.C. Lim et al., 30 May 2013 (SIN-234); 2 males, 1 ov. female, OUMNH. ZC. 2014-11-110, same collection data (SIN-233); 1 male, OUMNH.ZC. 2014-11-111, sta. DR128, beside Eastern Boarding Ground A, 75.2–83.7 m, rocks, leg. B. Richer de Forges et al., 31 May 2013 (SS-4001); 1 ov. female, ZRC 2014.0439, sta. DR128, same collection data (SS-3999); 1 male, OUMNH.ZC. 2014-11-112, sta. TB172, near Kusu I. and Eastern Boarding Ground A, 149–150 m, consolidated marine clay, leg. B. Richer de Forges et al., 05 June 2013; 1 male, OUMNH.ZC. 2014-11-113, sta. TB172, same collection data (SIN-336); 1 male, 1 ov. female, OUMNH. ZC. 2014-11-114, sta. TB172, same collection data (SIN-335); 1 male, ZRC 2014.0442, sta. TB142, eastern entrance to Straits of Johor, 28.7–28.8 m, mud, gravel, shells, leg. B. Richer de Forges et al., 01 June 2013 (SS-3769); 1 male, 1 female, ZRC 2014.0436, sta. TB158, near Southern Fairway off Kusu I., 147–160 m, rocks, laterite gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4518); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-115, sta. DR70, near Pulau Sudong and Pulau Semakau, 20.6–22.6 m, sandy bottom, leg. B. Richer de Forges et al., 26 May 2013 (SIN-121); 1 male, OUMNH.ZC. 2014-11-116, sta. DR70, same collection data (SIN-120); 1 ov. female, OUMNH.ZC. 2014-11-117, sta. DR70, same collection data (SIN-119); 1 male, OUMNH. ZC. 2014-11-118, Kusu I., in dead coral heads, leg. S. De Grave, 24 May 2013 (SIN-101) [infested by rhizocephalan *Thompsonia* sp.]; 1 male, 1 ov. female, OUMNH.ZC. 2014-11-119, sta. DR222, off W Pulau Berkas and Pulau Pawai, 17.3–18.7 m, sand, shell fragments, sponges, leg. TMSI team, 21 October 2013 (SEA-1614).

Additional material. Strait of Singapore. 1 ov. female, ZRC 2014.0658, Raffles Lighthouse, leg. S.K. Koh, 26 February 1998.

Distribution. Indo-west Pacific, from the Red Sea and Madagascar to Japan, Indonesia, Australia, and Solomon Islands.

Previous records from Singapore. Johnson (1962, 1979, as *Alpheus euchiurus* Dana, 1852); Banner & Banner (1982).

Ecology. Coral reefs and associated rubble habitats, often in heavily silted conditions, in crevices of dead corals and rocks; lower intertidal to over 150 m.

Remarks. *Alpheus serenei* was previously reported from Singapore (Johnson, 1962, 1979) as *A. euchirus* Dana, 1852, a problematic species with non-extant type material and not recollected since the original description (see Banner & Banner, 1982 for discussion). Its closest relative, *A. hippothoe* De Man, 1888a, is rather difficult to distinguish from *A. serenei* based on the currently used morphological criteria. Banner & Banner (1982) stated that the main characters separating *A. serenei* from *A. hippothoe* are "the presence of the flattened area in front of the orbital hoods and the setiferous crest on the medial side of the dactylus of the small chela, which are not found in *A. hippothoe*". However, many

specimens from Singapore do not have a setiferous crest on the minor chela fingers, while the presence of a flattened area in front of the orbital hoods is rather an ambiguous character. The presence of a minute supplementary unguis (or notch) on the dactylus of the third and fourth pereopods also appears to be variable, as already noted by Banner & Banner (1982). A molecular analysis and a more thorough comparison of morphology and colour patterns between specimens positively identified as *A. hippothoe* and *A. serenei* are highly desirable. Noteworthy, at least two individuals were infested with a parasitic barnacle, possibly *Thompsonia* sp. (Rhizocephala, Thompsoniidae).

Alpheus splendidus Coutière, 1897 sensu lato
(Fig. 29)

Alpheus splendidus Coutière, 1897b: 236; De Man, 1924: 41; De Man, 1929: 23 (partim); Johnson, 1962: 52; Johnson, 1963: 288; Bhuti et al., 1975: 292; Johnson, 1979: 41; Banner & Banner, 1978: 230; Banner & Banner, 1982: 56; Banner & Banner, 1985: 31; Chace, 1988: 54.

(?) *Alpheus pomatoceros* Banner & Banner, 1966a: 93; Johnson, 1979: 40.

CMBS material. Straits of Johor. 1 male, OUMNH.ZC. 2014-11-120, sta. DW6, ~400 m SE of Pulau Sekudu, 15.2 m, B. Richer de Forges et al., 17 October 2012 (JS-0274). Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-121, N of Pulau Jong, 40.8 m, leg. TMSI team, 15 May 2013 (4713 DR1-015); 1 male, 1 female, ZRC 2014.0452, Eastern Holding B, 24.4–25.4 m, leg. TMSI team, 17 May 2013 (5314 TB2-055-056) [both missing minor chelipeds]; 1 male, ZRC 2014.0453, sta. TB69, near Pulau Sudong and Pulau Semakau, 17.9–18.9 m, sandy bottom, leg. B. Richer de Forges et al., 26 May 2013; 1 female, ZRC 2014.0451, sta. SW10, St. John's I., DRTech, pontoon at southern lagoon, in fouling growth on pontoon, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013 (SS-0330); 1 ov. female, ZRC 2014.0450, sta. SW10, same collection data (SS-0336) [missing major cheliped]; 1 male, OUMNH.ZC. 2014-11-122, sta. SW10, same collection data (SIN-023); 2 ov. females, OUMNH.ZC. 2014-11-123, sta. SW10, same collection data (SIN-022); 1 male, ZRC 2014.0629, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1597); 1 male, ZRC 2014.0449, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3250) [missing minor cheliped]; 1 male, OUMNH.ZC. 2014-11-124, sta. IT103, Terumbu Pempang Tengah, intertidal, leg. J.C.Y. Lai, D. Uyeno et al., 30 May 2013 (SS-3257); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-125, sta. IT122, Terumbu Raya, intertidal, leg. C.S. Tan et al., 30 May 2013 (SIN-225); 1 male, OUMNH.ZC. 2014-11-126, sta. IT122, same collection data (SIN-226); 1 male, OUMNH.ZC. 2014-11-127, sta. TB28, Eastern Boarding Ground A (E of Kusu I.), 94.3–97.6 m, gravel, rocks, leg. B. Richer de Forges et al., 23 May 2013 (SIN-042) [missing minor cheliped]; 1 male, OUMNH.ZC. 2014-11-178, sta. TB96, near Eastern Bunkering A, 22.4–25.1 m, clay, leg. B. Richer de Forges et al., 29 May 2013 (SIN-211); 1 male, OUMNH.ZC. 2014-11-128, sta. TB127, beside Eastern Boarding Ground A, rocky bottom, 128-113 m, leg. S.C. Lim et al., 30 May 2013 (SIN-233B); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-129, sta. SD133, S Kusu I., 11 m, rubble, S. De Grave, H.H. Tan et al., 01 June 2013 (SIN-251); 1 male, ZRC 2014.0423, sta. SB249, Sisters Is., off Small Sister I., scuba diving, <10 m, leg. J. Teo, 26 December 2013 (SUB-0022).

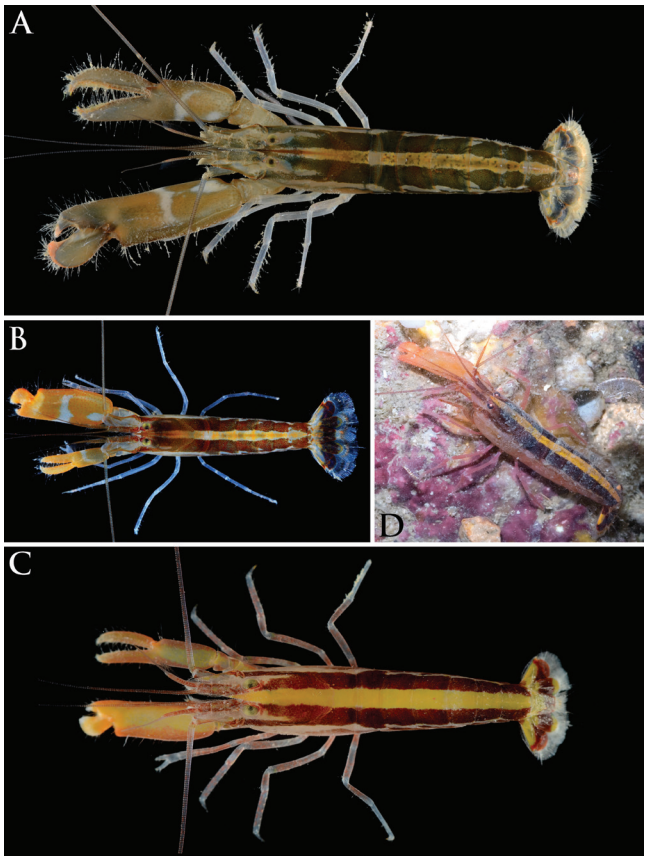

Fig. 29. *Alpheus splendidus* Coutière, 1897 sensu lato: A, male from St. John's Island, Strait of Singapore, CMBS sta. SW10 (OUMNH.ZC. 2014-11-122); B, male from south-east of Pulau Sekudu, Straits of Johor, CMBS sta. DW6 (OUMNH.ZC. 2014-11-120); C, male from Terumbu Pempang Tengah, Strait of Singapore, CMBS sta. IT103 (OUMNH.ZC. 2014-11-124); D, individual from an unknown locality in Singapore, missing minor cheliped (Photographs by: Arthur Anker [A–C], unknown photographer [D]).

Additional material. Straits of Johor. 1 male, 4 ov. females, ZRC 2011.0514, off Pulau Tekong, Beting Bronok near Pulau Unum, leg. Y. Cai, 05 December 2002 [det. Y. Cai as *Alpheus* cf. *simplex* (Banner, 1953)]; 1 ov. female, ZRC 2001.2050, off Pulau Tekong, Beting Bronok near Pulau Unum, leg. K.S. Tan, S. Teo, 2001. Strait of Singapore. 1 female, ZRC 2014.0585, Pulau Jong, in *Pavona frondifera*, 24 October 1986 [missing minor cheliped]; 1 male, ZRC 1979.4.5.9, Pulau Sudong, reef, crevices in coral rocks, leg. D.S. Johnson, 30 May 1955 (J8099) [missing major cheliped]; 1 male, ZRC 1979.4.5.8, Pulau Hantu, *Sargassum* zone, outer edge, in crevices of coral head, leg. D.S. Johnson, 21 November 1953 (J7997) [specimen in poor condition]; 1 male, ZRC 2000.2138, Pulau Hantu, 13 m, 27 August 1999 [missing minor cheliped]; 1 male, ZRC 2014.0584, Raffles Lighthouse, leg. A. Monteiro, 12 March 1947; 1 male,

1 ov. female, OUMNH.ZC. 2014-11-130, Pulau Busing, fouling community (possibly on buoy, boat or jetty), leg. B. Sigurdsson, 1 May 1987; 1 male, ZRC 2014.0525, Sisters Is., regurgitated by fish, 22 March 1999.

Distribution. Indo-west Pacific, from the Red Sea and India to the Philippines, southern China and Australia.

Previous records from Singapore. Johnson (1962); Banner & Banner (1966a, as *Alpheus pomatoceros* Banner & Banner, 1966a); Johnson (1979, as *A. splendidus* and *A. pomatoceros*).

Ecology. Coral reefs and associated rubble habitats, sometimes in silted conditions, also on rocky shores and mixed rock-rubble bottoms, in crevices of coral rubble, under dead corals and rocks etc.; lower intertidal to below 100 m, most common between 1 and 10 m.

Remarks. *Alpheus splendidus* is part of a small pantropical species complex, which includes at least three other species (A. Anker, in study). The taxonomic status of *A. pomatoceros* Banner & Banner, 1966, currently a synonym of *A. splendidus* (see Banner & Banner, 1982), needs a re-investigation. Two distinct colour patterns can be seen in the Singaporean material of *A. splendidus* (Fig. 29), strongly suggesting the presence of a second cryptic or pseudo-cryptic species in the Indo-west Pacific. Johnson (1962) reported *A. splendidus* from Singapore based on a single specimen from Pulau Tembakul (6 m). Later the same author (Johnson, 1979) listed both *A. splendidus* and *A. pomatoceros*, the latter based on Banner & Banner's (1966) species distribution table. Thus, both the validity and the presence of *A. pomatoceros* in Singapore need confirmation.

In Singapore, *A. splendidus* sensu lato occurs mainly in the Strait of Singapore, especially in silted reef and rubble habitats around the southern islands (Raffles Lighthouse, Kulu Island, Pulau Hantu, Pulau Jong, Sisters Islands etc.). Some specimens were found among fouling growth on buoys, pontoons and ships; others were dredged from deeper water (deepest record in Singapore: 113 m). The single specimen from the Straits of Johor was dredged near its eastern entrance, off Pulau Sekudu.

Alpheus spongiarum Coutière, 1897 sensu lato

Alpheus spongiarum Coutière, 1897c: 236; De Man, 1911: 362; Johnson, 1962: 52; Johnson, 1963: 283; Johnson, 1979: 41; Banner & Banner, 1978: 230; Banner & Banner, 1982: 116; Banner & Banner, 1985: 31; Chace, 1988: 54.

(?) *Alpheus paraculeipes* Coutière, 1905: 894; De Man, 1911: 356; Tiwari, 1965: 293.

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0424, S of Pulau Semakau, 16.1–17 m, leg. TMSI team, 18 July 2012 (DR4511A-014) [major cheliped missing chela]; 2 males, OUMNH.ZC. 2014-11-131, sta. DR209, S of Pulau Sebarok, 36.1–37.4 m, leg. TMSI team, 24 September 2013 (SEA-1103) [one male damaged, with minor cheliped missing chela].

Distribution. Indo-west Pacific, from Red Sea and East Africa to Japan, Papua New Guinea, and Australia.

Previous records from Singapore. Johnson (1962, 1963, 1979).

Ecology. Coral reefs and adjacent areas, associated with various sponges (*Hippospongia* sp., *Hyatella* sp., *Suberites* sp., *Hircinia* sp.); lower intertidal to 115 m (Banner & Banner, 1983).

Remarks. *Alpheus spongiarum* is another taxonomically problematic species of the *A. crinitus* species group (see also under *A. eulimene*). Differences in morphology and colour patterns, as well as associations with several different sponges suggest that *A. spongiarum* may in fact represent a species complex. The taxonomic status of *A. paraculeipes* Coutière, 1905, reduced to a synonym of *A. spongiarum* by Banner & Banner (1982), needs a reappraisal.

The material collected during CMBS was tentatively identified as *A. spongiarum* based on the following characters: (1) third pereopod with unarmed ischium, merus with a sharp distoventral tooth, without spiniform setae; (2) second pereopod with the first carpal article about 0.3 times length of the second; (3) second to fifth pleura angular but not projecting in males; (4) antennal scaphocerite with very short blade; (5) frontal margin of the carapace with a small rostrum continued by a blunt rostral carina; (6) major chela ovoid, smooth, without constrictions; and (7) minor chela with fingers shorter than palm, simple, not elongated nor expanded (cf. Banner & Banner, 1982). *Alpheus spongiarum* was previously reported from Singapore by Johnson (1962, 1963, 1979), who found it in various sponges, including *Suberites inconstans* Dendy. The present specimens were dredged in the Strait of Singapore at depths ranging between 16 and 37 m; no direct association with sponges was recorded.

Alpheus strenuus Dana, 1852 sensu lato
(Fig. 30)

Alpheus strenuus Dana, 1852a: 21; Dana, 1852b: 543; De Man, 1911: 425; Tiwari, 1964: 313; Banner & Banner, 1966a: 140; Johnson, 1979: 41; Banner & Banner, 1978: 233.

Alpheus strenuus strenuus — Banner & Banner, 1982: 225; Banner & Banner, 1985: 32; Chace, 1988: 56.

(?) *Alpheus strenuus* var. *angulatus* Coutière, 1905: 914.

CMBS material. Straits of Johor. 1 male, OUMNH.ZC. 2014-11-132, sta. SW31, Pulau Sekudu near Pulau Ubin (off Check Jawa), intertidal sand-seagrass flat, under rocks, leg. B.Y. Lee et al., 18 October 2012; 1 ov. female, OUMNH. ZC. 2014-11-133, sta. SW24, Pulau Sekudu near Pulau Ubin (off Check Jawa), intertidal sand-seagrass flat, leg. R. Tan et al., 17 October 2012 (JS-0777). Strait of Singapore. 6 specimens (mainly females), ZRC 2014.0586, Pulau Semakau landfill phase 2, leg. H.H. Tan et al., 08 August 2012; 1 male, ZRC 2014.0590, Pulau Sudong lagoon, leg. TMSI team, 08 July 2012 (65269); 1 ov. female, ZRC 2014.0587, Pulau Sudong lagoon, beach seining, leg. H.H. Ng et al., 08 July 2012 (65004); 1 male, OUMNH.ZC. 2014-11-134, sta.

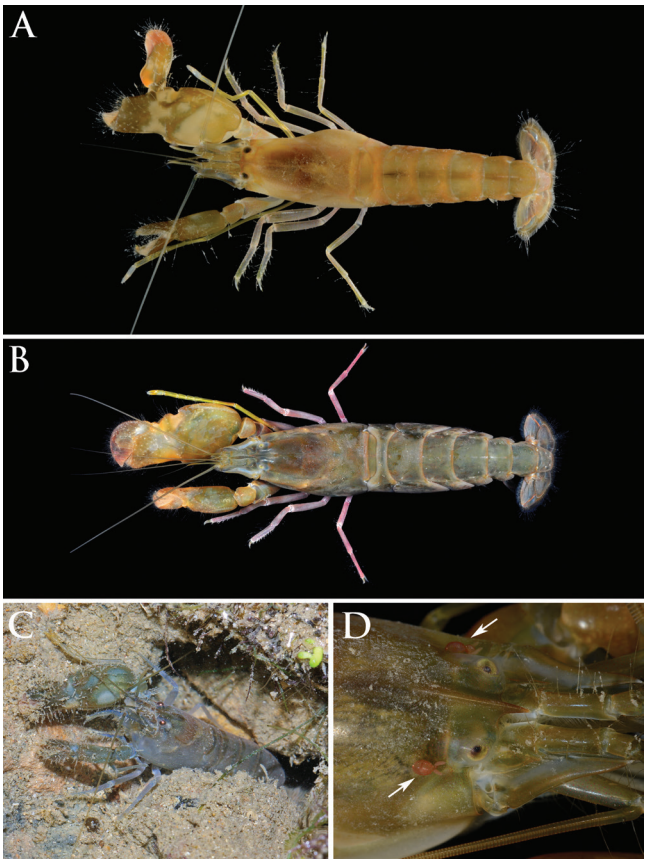

Fig. 30. *Alpheus strenuus* Dana, 1852 sensu lato: A, female from Terumbu Semakau, Strait of Singapore, CMBS sta. IT65 (OUMNH.ZC. 2014-11-141), infested with bopyrine isopods; B, ovigerous female from Pulau Sekudu, Straits of Johor, CMBS sta. SW24 (OUMNH.ZC. 2014-11-133); C, individual photographed in situ (near burrow entrance) at Big Sister's Island (specimen not collected); D, two symbiotic copepods, possibly Anthessiidae (indicated by white arrows) on a male of *A. strenuus* from Cyrene Reef, Strait of Singapore, CMBS sta. IT86 (OUMNH.ZC. 2014-11-136) (Photographs by: Arthur Anker [A, B] and.James Koh [C]).

MP61, Pulau Pawai, leg. TMSI team, 10 June 2012; 1 male, ZRC 2014.0588, sta. IT93, Pulau Jong, sand-rock-rubble intertidal, leg. S.K. Tan, J.C. Mendoza et al., 29 May 2013 (SS-3230); 1 male, ZRC 2014.0589, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3262); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-135, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble, some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013 (SS-3228); 1 male, OUMNH. ZC. 2014-11-136, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-140) [infested by a pair of bopyrine isopods); 1 female, OUMNH.ZC. 2014-11-137, sta. IT86, same collection data (SIN-141); 1 ov. female, OUMNH.ZC. 2014-11-138, sta. IT86, same collection data (SIN-144); 1 ov. female, OUMNH.ZC. 2014-11-139, sta. IT120, Pulau Hantu, intertidal, under rocks, rubble etc., leg. K.S. Koh, S.T. Ahyong et al., 31 May 2013 (SIN-222); 1 male, OUMNH.ZC. 2014-11-140, sta. IT81, S Big Sister's I., rocky reef, intertidal, leg. Y.L. Lee et al., 26 May 2013 (SIN-139); 1 female, OUMNH.ZC. 2014-11-141, sta. IT65, Terumbu Semakau, sandy-rocky beach, 0–0.5 m, leg. J.Y. Ong et al., 24 May 2013 (SIN-102) [infested by a pair of bopyrine isopods]; 1 male, ZRC 2014.0657, Terumbu Raya, 08 July 2012.

Additional material. Strait of Singapore. 1 ov. female, ZRC 1992.11127, Pulau Semakau, dredge, P.K.L. Ng et al., X.1992; 1 male, ZRC 2000.2190, Labrador Beach, leg. P.K.L. Ng et al., 30 January 1999; 1 female, ZRC 1996.60, Raffles Lighthouse, leg. D.C.J. Yeo et al., 13 November 1995.

Distribution. Indo-west Pacific, from the Red Sea to Australia and French Polynesia.

Previous records from Singapore. Johnson (1979).

Ecology. Coral reef flats and sand falts with abundant coral rubble, coral patches or rocks, also on rocky shores and mixed rock-rubble bottoms with algae, usually in burrows under rocks and rubble (Fig. 30C), younger individuals also in of crevices of dead corals, often dwelling with fire worms (*Eurythoe* spp.) and large brittlestars (*Macrophiothrix* spp.); lower intertidal to at least 20 m, but most commonly encountered between 0 and 5 m.

Remarks. *Alpheus strenuus* is a species complex in need of a taxonomic revision (Anker, 2001; A. Anker, pers. obs.). However, the uniformity of the colour patterns observed in CMBS specimens (Fig. 30A, B) suggests that only one species, possibly *A. strenuus* sensu stricto, may be present in Singapore. Although Johnson (1979) qualified *A. strenuus* as "rare" in Singapore, the species appears to be currently common on some reef flats of the eastern Straits of Johor, e.g. Pulau Sekudu (off Chek Jawa), and especially the southern islands in the Strait of Singapore, e.g. Pulau Sudong, Pulau Pawai, Pulau Jong, Pulau Semakau, Raffles Lighthouse (CMBS and older ZRC material), and Labrador Beach (A. Anker, pers. obs., 2001). *Alpheus strenuus* is one of the largest snapping shrimps in shallow reef-sand-rock habitats, with largest ovigerous females exceeding 25 mm cl and 60 mm tl. Symbiotic poecilostomatoid copepods, possibly an undescribed species in the family Anthessiidae, were found on some specimens (Fig. 30D) and are currently being studied by D. Uyeno.

Alpheus tenuipes De Man, 1910
(Fig. 31)

Alpheus tenuipes De Man, 1910: 288; De Man, 1911: 383; Banner & Banner, 1985: 33.

CMBS material. Strait of Singapore. 1 female, OUMNH. ZC. 2014-11-142, Pulau Senang, near jetty, mud-sand flat with rocks and rubble, under coral rock in muddy water, leg. A. Anker et al., 30 March 2014 (SEN-AA07); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-143, sta. SB132, S Kusu I., pontoon, 0–5 m, brushing of dead corals, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3763); 1 ov. female, ZRC 2014.0615, sta. SB67, W Pulau Hantu, patch reef, 15.7 m, brushing of dead corals, leg. D. Uyeno, S. De Grave, H.H. Tan et al., 26 May 2013 (SS-1660); 1

Fig. 31. *Alpheus tenuipes* De Man, 1910: male from Pulau Hantu, Strait of Singapore, CMBS sta. SB67 (OUMNH.ZC. 2014-11-144) (Photograph by: Arthur Anker).

male, OUMNH.ZC. 2014-11-144, sta. SB67, same collection data (SS-1651); 1 ov. female, ZRC 2014.0426, sta. SB67, same collection data (SS-1650) [missing minor cheliped]; 1 ov. female, OUMNH.ZC. 2014-11-145, sta. SB67, same collection data (SS-1649); 1 male, ZRC 2014.0425, sta. IT120, Pulau Hantu, intertidal, under rocks, rubble etc., leg. K.S. Koh, S.T. Ahyong et al., 31 May 2013 (SS-3273); 1 ov. female, OUMNH.ZC. 2014-11-146, sta. SW44, St. John's I., rocky shore, under rocks, leg. R. Tan, J.K. Lowry et al., 24 May 2013 (SS-1589).

Additional material. Strait of Singapore. 1 male, ZRC 1979.3.29.1, Pulau Hantu, in crevices of dead coral, near L.S.T. (low spring tide mark), leg. D.S. Johnson, 02 February 1954 (J 8001) [det. D.S. Johnson as *A. alpheopsides*]; 1 male, 1 ov. female, 1 female, ZRC 1979.3.29.2-4, Pulau Sudong, in crevices of large head of *Pavona frondifera*, 19 February 1955 (J 7998-8000) [det. D.S. Johnson as *A. alpheopsides*].

Distribution. Indonesia, Singapore and Japan, likely much more widespread in the Indo-west Pacific.

Previous records from Singapore. Johnson (1962, 1979, as *Alpheus alpheopsides* Coutière, 1905).

Ecology. Shallow coral reefs and rubble-sandflats, under or in coral rubble, in dead corals, in reef crevices etc.; lower intertidal to 94 m.

Remarks. *Alpheus tenuipes* belongs to the pantropical *A. paracrinitus* species complex, together with one or two morphologically similar taxa grouped here under *A. alpheopsides* (see above). The main morphological characters used in this study to separate *A. tenuipes* from *A. alpheopsides* were the sub-balaeniceps condition of the male minor cheliped (present in some specimens of *A. alpheopsides* vs. absent in *A. tenuipes*) and position of the subdistal tooth on the ventromesial margin of the cheliped meri (between 0.5 and 0.6 length of the merus in *A. alpheopsides* vs. at about 0.8 length of the merus in *A. tenuipes*). However, usage of both characters needs to be confirmed, especially in view of the heterogenous type material of *A. alpheopsides* (see above). Nevertheless, based on the presently adopted criteria, some of Johnson's (1962, 1979) material of *A. alpheopsides* appears to be attributable to *A. tenuipes*. The colour patterns of *A. alpheopsides* (Fig. 1) and *A. tenuipes* (Fig. 31) are almost identical, consisting of red or purple-brown bands across each abdominal somite.

Most Singaporean specimens were collected in the intertidal or in the scuba depth range, by brushing dead corals; specific collection localities include Pulau Senang, Pulau Hantu, Pulau Sudong, St. John's Island, and Kusu Island. De Man's type specimens from Sulawesi came from deeper water (75–94 m).

Alpheus cf. *williamsi* Bruce, 1994
(Fig. 32)

Alpheus williamsi Bruce, 1994: 19.

Fig. 32. *Alpheus* cf. *williamsi* Bruce, 1994: male dredged east of Western Holding B, Strait of Singapore, CMBS sta. 5414 TB1 (OUMNH.ZC. 2014-11-147) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0392, SW of Bedok Jetty, 6.9–12.9 m, leg. TMSI team, 26 February 2013 (5517 DR1-007); 1 male, ZRC 2014.0433, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-007) [missing minor cheliped]; 1 male, OUMNH.ZC. 2014-11-147, same collection data (5414 TB1-002); 1 ov. female, ZRC 2014.0632, sta. DR330, beside Pulau Tekong, near West Tekong Buoy, 14.0–14.8 m, leg. S.C. Lim, A. Anker, C.K. Chim et al., 20 March 2014 (SEA-4993); 2 females, OUMNH.ZC. 2014-11-148, sta. DR160, Eastern Boarding Ground A, 92.5–97.5 m, rocky gravel, leg. B. Richer de Forges et al., 03 June 2013 (SIN-315); 1 male, OUMNH.ZC. 2014-11-149, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-110); 1 male, ZRC 2014.0432, same collection data (5313 TB3-109) [missing both chelipeds and second pereopods); 1 male, OUMNH.ZC. 2014-11-150, sta. TB17, Eastern Holding, 86.7–90.9 m, leg. B. Richer de Forges et al., 22 May 2013 (SIN-024) [missing minor cheliped]; 1 male, OUMNH.ZC. 2014-11-151, sta. TB97, near Eastern Bunkering A, 22.4–22.7 m, sticky clay, leg. B. Richer de Forges et al., 28 May 2013 (SIN-199); 1 female, ZRC 2014.0431, sta. DR1, near Raffles Lighthouse, 38.3–38.5 m, gravel, shells, leg. B. Richer de Forges et al., 21 May 2013 (SS-0308); 1 female, OUMNH.ZC. 2014-11-152, sta.

TB15, Eastern Fairway, 23.8–21.5 m, silt, gravel, leg. B. Richer de Forges et al., 21 May 2013 (SIN-013); 1 male, ZRC 2014.0631, sta. DR258, W of Jurong I., 23.1–24.4 m, rocks, sand, mud, leg. TMSI team, 19 December 2013 (SEA-3983) [missing both chelipeds].

Distribution. *Alpheus williamsi* is presently known only from northern Australia; the status of the Singaporean material identified here as *A.* cf. *williamsi* requires further study (see below).

Previous records from Singapore. None.

Ecology. Gravel-shell-sand bottoms; at depths ranging from 7 m to over 79 m; the type material of *Alpheus williamsi* was trawled from a muddy substrate with abundance of soft corals and sponges, at a depth of 18–24 m (Bruce, 1994).

Remarks. Bruce's (1994) key to the Indo-west Pacific members of the *Alpheus brevirostris* group contains only two species with a dorsal transverse groove on the major chela and a light pubescence on the carapace. These species are *A. pubescens* (see above), ranging from Japan and Micronesia to Indonesia and Australia, and *A. williamsi*, presently known only from a single female specimen from Northern Territory, Australia. They differ from each other mainly by the absence (*A. pubescens*) and presence (*A. williamsi*) of the pubescence on the abdomen, as well as in some proportions, for instance, on the chelipeds. However, De Man's type material of *A. pubescens* appears to be somewhat heterogeneous and may contain more than one species (cf. De Man, 1911). The Singaporean material is closer to *A. williamsi*, for instance, in the proportions of the antennules, major and minor chelipeds, and carpal articles of the second pereopods, but differs from it by having a glabrous abdomen, as in *A. pubescens*. The presence of balaeniceps setae on the male minor cheliped of *A.* cf. *williamsi* was expected given their presence in *A. pubescens*. The colour patterns of *A.* cf. *williamsi* from Singapore and *A. williamsi* from Australia are also similar (cf. Fig. 32 and Bruce, 1994: fig. 5C), both being different from that of *A. pubescens* (cf. Fig. 24; see also Bruce, 1994: fig. 5A, mind the error in the figure legend).

Genus *Athanas* Leach, 1814 [in Leach, 1813–1814]

***Athanas dimorphus* Ortmann, 1894**
(Fig. 33)

Athanas dimorphus Ortmann, 1894: 12; Banner & Banner, 1960: 137; Banner & Banner, 1973: 313; Banner & Banner, 1978: 234; Chace, 1988.
Athanas leptocheles Coutière, 1897b: 381.
Athanas solenomerus Coutière, 1897b: 381.
Athanas dispar Coutière, 1897c: 233.
(?) *Athanas setoensis* Kubo, 1951: 265.
(?) *Athanas dimorphus seedang* Banner & Banner, 1966a: 28.
Not *Alpheus monoceros* Heller, 1862a: 274 (see Coutière, 1899) [nomen dubium].
Not *Athanas monoceros* — Johnson, 1962: 49; Johnson, 1979: 41 [nomen dubium].
Not *Athanas transitans* var. *longispina* Czerniavsky, 1884: 25 [replacement name for *A. monoceros*, thus also nomen dubium].

Fig. 33. *Athanas dimorphus* Ortmann, 1894: male from Raffles Lighthouse, Strait of Singapore, CMBS sta. IT95 (OUMNH.ZC. 2014-11-153) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0381, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble and some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013 (SS-3204); 1 male, OUMNH.ZC. 2014-11-153, sta. IT95, same collection data (SIN-187); 1 male, OUMNH.ZC. 2014-11-154, sta. IT95, same collection data (SIN-184); 1 ov. female, OUMNH.ZC. 2014-11-155, sta. RF220, Sisters Is., Small Sister I., big lagoon, leg. TMSI team, 09 September 2013 (INT-0343).

Additional material. Strait of Singapore. 1 ov. female, ZRC 1979.4.6.2, Labrador Beach, crevices of honeycomb rock, leg. D.S. Johnson, 11 July 1959 [in poor condition]; 1 ov. female, ZRC. 1997.576, Labrador Beach, leg. P.K.L. Ng et al., 22 November 1995; 2 males, ZRC. 1997.575A, same collection data; 1 male, OUMNH.ZC. 2014-11-156, St. John's I., under rocks, leg. A. Anker, 17 March 2002; >30 specimens, ZRC 2011.0511, W St. John's I., under rubble, leg. Y. Cai, 06 December 2002; 1 specimen (sex not determined), ZRC 1979.4.6.3, Pulau Sudong, large head of *Pavona frondifera*, 2–3 m, no further data [in poor condition].

Distribution. Indo-west Pacific, from the Red Sea and Madagascar to Japan, Indonesia, Australia and New Caledonia; invasive on east coast of South America (Brazil and southern Caribbean Sea, Pachelle et al., 2011).

Previous records from Singapore. Johnson (1962, 1979, as *Athanas monoceros* (Heller, 1862)).

Ecology. Reef flats, sand and sand-mudflats with rubble, rocky shores, in crevices of dead corals, under rocks and coral rubble, among seaweeds, in tide pools etc.; intertidal and shallow subtidal (0–10 m), one unusually deep record from Kenya (115 m) by Banner & Banner (1983) requires confirmation.

Remarks. *Athanas dimorphus* is one of the most common and widespread species in the genus, although the taxonomic status of two nominal forms currently considered to be junior synonyms (*A. setoensis* Kubo, 1951 and *A. dimorphus seedang* Banner & Banner, 1966) may need a reappraisal.

Johnson (1962) reported this species from Singapore as *A. monoceros* (Heller, 1862) and argued that because (1) his Singaporean specimens were "intermediate" between *A. monoceros* and *A. dimorphus*, and (2) *A. monoceros* was assumed to be a senior synonym of *A. dimorphus* by Coutière (1899), Heller's name should have priority over Ortmann's name. However, the original German text of Heller (1862a) does not allow a firm conclusion about the taxonomic identity of *A. monoceros*. Most importantly, Heller's specimen was missing both chelipeds and therefore, even with the specimen in hand, it would be difficult to doubtlessly assign it to *A. dimorphus*. Coutière's (1899) assumption is probably largely based on Heller's description of the frontal margin, which, however, is shared by *A. dimorphus* and several other species of *Athanas*. This makes *A. monoceros* a nomen dubium rather than a possible senior synonym of *A. dimorphus*. In addition, *A. dimorphus* has been used far more than *A. monoceros* in taxonomic publications, but also in larval and ecological literature, and popular underwater guides. Based on these facts, *A. monoceros* is here removed from the synonymy and formally considered to be a nomen dubium.

In Singapore, *A. dimorphus* used to be fairly common under rocks exposed at low tide, especially at Labrador Beach, in the 1990s and early 2000s (A. Anker, pers. obs.). It is still relatively common in the southern islands, e.g., St. John's Island, Pulau Sudong and Raffles Lighthouse.

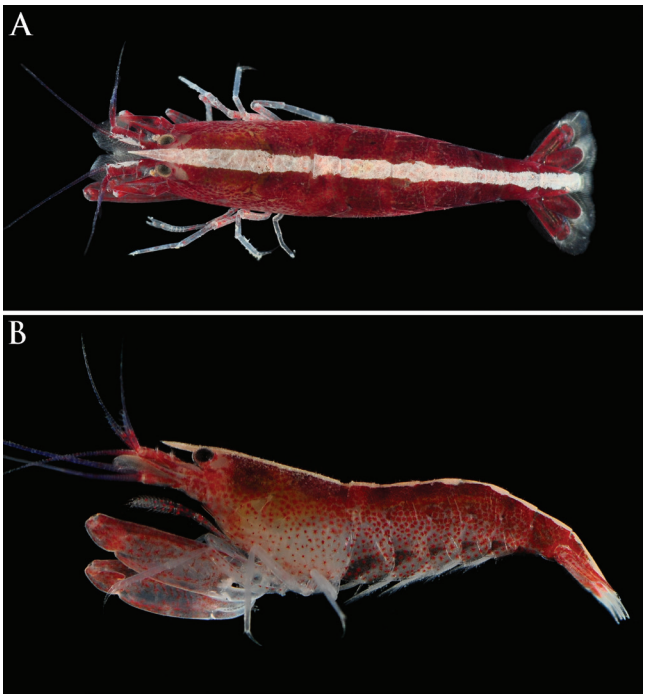

Fig. 34. *Athanas japonicus* Kubo, 1936 sensu lato: A, ovigerous female from Pulau Sekudu, Straits of Johor, CMBS sta. SW31 (ZRC 2014.0378); B, male from Pulau Ubin, Straits of Johor, CMBS sta. SW47 (OUMNH.ZC. 2014-11-158) (Photographs by: Arthur Anker).

Athanas japonicus Kubo, 1936 sensu lato
(Fig. 34)

Athanas japonicus Kubo, 1936: 43; Miya & Miyake, 1968: 139; Banner & Banner, 1973: 308; Anker, 2003a: 301; Anker et al., 2015: 309.
Athanas cf. *japonicus* — Anker, 2003a: 301.
Athanas lamellifer Kubo, 1940: 102.

CMBS material. Straits of Johor. 1 male, 1 ov. female, OUMNH.ZC. 2014-11-157, sta. SW25, Pulau Ubin, OBS Camp 1, muddy intertidal, in burrows, suction pump, leg. A. Anker, 18 October 2012 (JS-1398); 1 ov. female, ZRC 2014.0385, sta. SW25, same collection data (JS-0773); 1 male, ZRC 2014.0384, sta. SW13, Pulau Ubin, Chek Jawa, near boardwalk, mud-sand flat with seagrass and rocks, under rocks and from burrows, leg. A. Anker, S.K. Tan, P.K.L. Ng et al., 17 October 2012 (JS-0724) [missing both chelipeds]; 1 ov. female, ZRC 2014.0378, sta. SW31, Pulau Sekudu, muddy sand, seagrass, algae, low tide, leg. B.Y. Lee, 19 October 2012 (JS-1424); 2 males, 1 ov. female, OUMNH. ZC. 2014-11-158, sta. SW47, Pulau Ubin, OBS Camp 1, muddy intertidal, leg. A Anker et al., 20 October 2012 (JS-1648); 1 ov. female, OUMNH.ZC. 2014-11-159, sta. SW47, same collection data; 1 male, 1 juvenile, ZRC 2014.0383, Pulau Ketam, muddy intertidal, leg. TMSI team, 08 March 2012 (M24-098-099); 1 ov. female, ZRC 2014.0630, Sungei Loyang, mud flat, leg. TMSI team, 27 April 2012 (55036); 1 ov. female, OUMNH.ZC. 2014-11-160, sta. RF375, Punggol, at jetty, intertidal, leg. TMSI team, 20 April 2014 (INT-1064). Strait of Singapore. 1 male, ZRC 2014.0382, same collection data (M24-102); 1 male, 1 ov female, ZRC 2014.0380, sta. YB148, St. John's I., DRTech northern lagoon, 0–0.5 m, suction pump, burrow, leg. A. Anker, 02 June 2013 (SS-4020); 1 male, OUMNH.ZC. 2014-11-161, sta. MF63, Pulau Senang, mud flat, leg. P.S.H. Wong, H.H. Tan et al., 30 June 2012 (63511).

Additional material. Straits of Johor. 1 male, 1 female, ZRC 2003.0087, Lim Chu Kang, mangrove, smal shallow pool, under debris, low tide, leg. A. Anker, 16 January 2002; 1 female, 1 ov. female, ZRC 2014.0454, Pulau Ubin, east coast, sand-mud flat, leg. D.C.J. Yeo, 29 May 2001; 1 male, 1 female, 1 ov. female, ZRC 2001.1051, Pulau Tekong, Beting Bronok near Pulau Unum, leg. K.S. Tan, S. Yeo, A. Anker, 09 February 2001; 1 male, ZRC 1979.4.6.6, Ponggol Beach, near low tide mark, leg. D.S. Johnson, 07 April 1969 [det. D.S. Johnson as *A. tenuipes*]. Strait of Singapore. 1 female, ZRC 1997.575B, Labrador Beach, leg. P.K.L. Ng et al., 22 November 1995; 1 male, ZRC 1990.8434, Kallang Basin, sta. 5, Ekman grab, leg. Reef Ecology Study Team, 02 March 1989.

Distribution. Indo-west Pacific: Japan, China, Singapore, Indonesia, northern and eastern Australia (possible species complex, see Anker, 2003a and below).

Previous records from Singapore. Anker (2003a).

Ecology. Mudflats, muddy sandflats, mangroves and muddy seagrass beds, in muddy pools, under muddy rocks and commensally in burrows; intertidal and shallow subtidal, usually less than 10 m, exceptionally 50 m.

Remarks. *Athanas japonicus* remains a problematic taxon in need of a thorough revision. Anker (2003a) showed significant morphological variation, especially in the shape of the chelipeds, among specimens from Japan, Singapore and Queensland (some identified as *A.* cf. *japonicus*), suggesting that several species may be involved in a possible *A. japonicus* species complex (here *A. japonicus* sensu lato). Most of the Singaporean material of *A. japonicus* was collected on mudflats of the Straits of Johor, e.g., Lim Chu Kang, Pulau Ubin, Pulau Sekudu, Beting Bronok (Pulau Unum), Pulau Ketam and Punggol, although some specimens came from the islands in the Strait of Singapore, including St. John's Island and Pulau Senang, and the now isolated Kallang Basin.

Athanas jedanensis De Man, 1910
(Fig. 35)

Athanas jedanensis De Man, 1910: 313; De Man, 1911: 154; Johnson, 1962: 49; Johnson, 1979: 41; Banner & Banner, 1985: 34; Chace, 1988: 62.

Fig. 35. *Athanas jedanensis* De Man, 1910: male from Pulau Hantu, Strait of Singapore, CMBS sta. IT120 (OUMNH.ZC. 2014-11-162) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-162, sta. IT120, Pulau Hantu, intertidal, under rocks, rubble etc., leg. K.S. Koh, S.T. Ahyong et al., 31 May 2013 (SS-3272); 1 female, OUMNH.ZC. 2014-11-163, sta. TB15, Eastern Fairway, 23.8–21.5 m, silt, gravel, leg. B. Richer de Forges et al., 21 May 2013 (SIN-014); 1 ov. female, ZRC 2014.0612, SE of Pulau Bukom, 43.3–74.6 m, leg. TMSI team, 15 May 2013 (4713 DR3-254).

Additional material. Strait of Singapore. 1 ov. female, ZRC 1979.4.6.1, sta. B60, trawl, 38–40 m, SRFRS, 14 July 1955 [det. D.S. Johnson, incomplete specimen in poor condition].

Distribution. Indonesia, Singapore, Philippines, Australia.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Reef sandflats with abundant rubble and subtidal mixed sand-gravel bottoms; lower intertidal to 40 m.

Remarks. *Athanas jedanensis* is closely related to *A. parvus* De Man, 1910 (see below), but can be distinguished from the latter species by a few subtle morphological characters, the most important being the absence of infra-corneal teeth. The previously unknown, transversely red-white banded colour pattern of of *A. jedanensis* (Fig. 35) appears to be another diagnotic feature of this species, distinguishing it from *A. parvus*, which is characterised by a reddish background with a white mediodorsal band running from the tip of the rostrum to the telson (see colour photograph in Minemizu, 2000).

Athanas jedanensis appears to be quite rare throughout its range, with only a dozen or so specimens identified so far, including four from Singapore. Johnson (1962) reported one specimen of *A. jedanensis*, now fragmentary, dredged from "a crinoid ground with gravelly-stony bottom", at a depth of 38–40 m, in the Strait of Singapore. One of the three CMBS specimens (ovigerous female) was collected in similar conditions near Pulau Bukom; the other specimen (male) was found on a partly exposed sand flat with rubble and soft corals, at Pulau Hantu. The holotype from eastern Indonesia was collected on a sand-shell bottom, at a depth of 13 m (De Man, 1911).

Athanas parvus De Man, 1910

Athanas parvus De Man, 1910: 315; De Man, 1911: 148; De Man, 1922: 16; Banner & Banner, 1960: 141; Johnson, 1962: 49; Johnson, 1979: 41; Chace, 1988: 63.
(?) *Athanas sibogae* De Man, 1910: 314; De Man, 1911: 151.
(?) *Athanas sibogae* — Banner & Banner, 1973: 321; Johnson, 1979: 41; Banner & Banner, 1978: 237; Banner & Banner, 1982: 308; Banner & Banner, 1985: 34.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0731, sta. SB67, W Pulau Hantu, patch reef, 15.7 m, brushing of dead corals, leg. D. Uyeno, S. De Grave, H.H. Tan et al., 26 May 2013 (SS-1648); 1 ov female, OUMNH. ZC. 2014-11-164, Outer Shoal, 7.2–7.5 m, leg. TMSI team, 21 March 2013 (5215 TB1-105).

Additional material. Strait of Singapore. 1 female (?), ZRC 1979.4.6.5, Outer Shoal, mud, stones, shells, 11 m, leg. SRFRS, 24 June 1954 [immature specimen, identification tentative].

Distribution. Indo-west Pacific, from the Red Sea and Madagascar to Japan, Indonesia, Australia and Samoa.

Previous records from Singapore. Johnson (1962); Johnson (1979, both as *A. parvus* and *A. sibogae* De Man, 1910).

Ecology. Coral reefs and associated reef flats with coarse or fine sand, abundant coral rubble, rocks and algae, also on rocky shores, in rubble crevices, among algae and sponge growth, under rocks in tide pools; intertidal to at least 70 m, usually found in the depth range 1–20 m.

Remarks. *Athanas parvus* is fairly common in coral reef and adjacent habitats throughout the Indo-west Pacific, most often collected from dead coral heads overgrown by algae and sponges. In Singapore, the species appears to be rather uncommon and is restricted to subtidal mixed coral-rubble-

sand substrates in the Strait of Singapore (e.g. Pulau Hantu, Outer Shoals). Johnson (1979) reported both *A. parvus* and *A. sibogae* De Man, 1910 (now a synonym of *A. parvus*, see Banner & Banner, 1960, 1973; Chace, 1988) from Singapore, believing that *A. sibogae* was "distinct from the last [*A. parvus*] despite the views of Banner and Banner (1960)". However, Johnson did not elaborate further on this issue and no material identified as *A. sibogae* was found in the ZRC collection. The synonymy of *A. sibogae* with *A. parvus* proposed by Banner & Banner (1960) requires confirmation.

Athanas polymorphus Kemp, 1915 sensu lato
(Fig. 36)

Athanas polymorphus Kemp, 1915: 295; Bruce & Coombes, 1997: 325; Anker, 2003a: 294; Anker et al., 2015: 312.
Athanas near *polymorphus* — Banner & Banner, 1966a: 24.

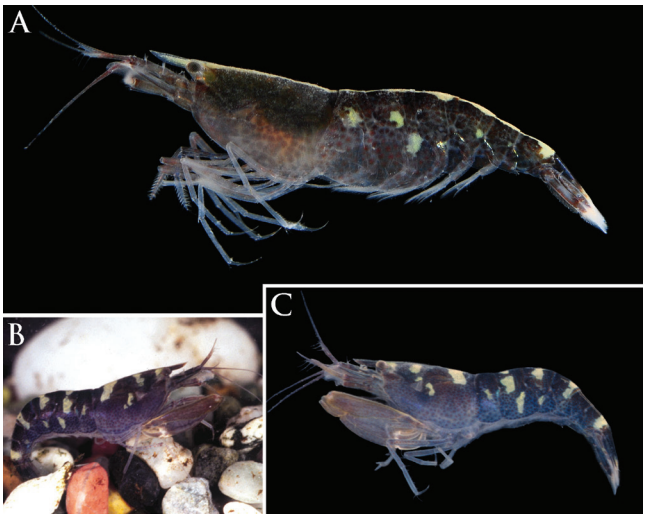

Fig. 36. *Athanas polymorphus* Kemp, 1915 sensu lato: A, ovigerous female from Pulau Ubin, Straits of Johor, CMBS sta. SW48 (ZRC 2014.0379); B, C, two males from Sungei Buloh, Straits of Johor, reported in Anker (2003) (Photographs by: Arthur Anker [A], Yixiong Cai & Arthur Anker [B, C]).

CMBS material. Straits of Johor. 2 males, ZRC 2014.0377, Pulau Ketam, leg. K.S. Tan et al., 08 March 2012 (M24-100-101); 1 ov female, ZRC 2014.0379, sta. SW48, Pulau Ubin, between OBS Camps 1 and 2, intertidal mud flat, suction pump, in burrow, leg. A. Anker et al., 20 October 2012 (JS-1647) [missing major cheliped]; 2 males, 1 female, OUMNH.ZC. 2014-11-165, Pulau Tekong opposite Pulau Unum, leg. K.S. Tan et al., 08 February 2012 (47006-47008); 1 male, OUMNH.ZC. 2014-11-166, same collection data (47001).

Additional material. Straits of Johor. 1 male, 1 ov. female, OUMNH.ZC. 2014-11-167, Sungei Buloh, right main stream, sta. KR4, leg. Y.L. Teo, 03 March 2004 (Singapore-025); 1 ov. female, OUMNH.ZC. 2014-11-168, Sungei Buloh, east channel, leg. N Sivasothi, Y.L. Teo, 13 February 2004 (Singapore-028); 2 females, ZRC 2014.0455, Sungei Buloh, left main stream, sta. KR4, leg. Y.L. Teo, 18 March 2004 (Singapore-023); 1 male, OUMNH.ZC. 2014-11-169, Sungei Buloh, left main stream, sta. KR4, leg. Y.L. Teo, 05 March 2004 (Singapore-020); 6 specimens (males and females), ZRC 2014.0456, Sungei Buloh, sta. KR3, leg. N. Sivasothi, Y.L. Teo, 12 March 2004 (Singapore-064); 2 males, 1 female, ZRC 2014.0457, Sungei Buloh, sta. KR3, leg. Y.L. Teo, 13 March 2004 (Singapore-062); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-170, Sungei Buloh, right main stream, sta. KR4, leg. Y.L. Teo, 03 March 2004 (Singapore-035); 2 females, ZRC 2004.0501, Sarimbun, Poyan, leg. H.H. Tan et al., 13-20 January 2004 [identification tentative, specimens with more slender P3–4 dactyli].

Distribution. India, Thailand, Singapore, northern Australia (possibly more than one species, see below).

Previous records from Singapore. Anker (2003a).

Ecology. Mudflats of brackish lagoons and mangroves, in muddy pools, under mangrove wood and debris, occasionally in burrows of other animals; intertidal and shallow subtidal (probably less than 5 m).

Remarks. *Athanas polymorphus* is known with absolute certainty only from its type locality, Chilika (= Chilka) Lake, Orissa, India. All subsequent records of this species (Banner & Banner, 1966a, as *A.* near *polymorphus*; Bruce & Coombes 1997; Anker 2003a, both as *A. polymorphus*) need to be confirmed by a direct comparison with the Indian type series. Kemp (1915) and Anker (2003a) illustrated important variation in the development, shape, and degree of asymmetry of the chelipeds, which makes *A. polymorphus* one of the most variable alpheid species. Banner & Banner (1960) and Anker (2003a) also noted some morphological differences between their material from Thailand and Singapore, respectively, and the type material from India; according to Anker (2003a), some of these differences could be important. On the other hand, the colour pattern of the Indian specimens described in great detail by Kemp (1915) corresponds perfectly to that of the South-East Asian specimens (Fig. 36; see also Anker, 2003a: fig. 20e, f; Anker et al., 2015: fig. 8). Thus, it still remains unknown whether the material from Singapore and Thailand corresponds to *A. polymorphus* (sensu stricto) or represent a different, closely related species. All material from Singapore, including CMBS material, is here referred to as *A. polymorphus* sensu lato.

Genus *Automate* De Man, 1888a

Automate anacanthopus De Man, 1910
(Fig. 37)

Automate anacanthopus De Man, 1910: 317; De Man, 1911: 142; Banner & Banner, 1985: 34; Bruce, 1990a: 628; Anker et al., 2015: 315.

CMBS material. Straits of Johor. 1 ov. female, OUMNH.ZC. 2014-11-171, sta. SW48, Pulau Ubin, between OBS Camps 1 and 2, intertidal mud flat, suction pump, in burrow, leg. A. Anker et al., 20 October 2012 (JS-1642); 1 female (?), ZRC 2014.0491, sta. SW48, same collection data (JS-1640); 1 male, OUMNH.ZC. 2014-11-172, sta. SW41, Pulau Sekudu near Pulau Ubin (off Chek Jawa), mud-sand with

Fig. 37. *Automate anacanthopus* De Man, 1910: ovigerous female from Pulau Ubin, Straits of Johor, CMBS sta. SW48 (OUMNH. ZC. 2014-11-171) (Photograph by: Arthur Anker).

seagrass, suction pump, in burrow, leg. A Anker et al., 20 October 2012 (JS-1447); 1 female (?), ZRC 2014.0390, sta. SW32, Pulau Ubin, northern part of Chek Jawa, intertidal and shallow subtidal, sand-mud, beach seine, leg. R. Tan, B. Ludt et al., 19 October 2012 (JS-1425).

Distribution. Indo-west Pacific, from Madagascar to Indonesia, Singapore, and China.

Previous records from Singapore. None.

Ecology. Mud and sand bottoms, probably living "commensally" in burrows of other animals; lower intertidal to 70 m.

Remarks. *Automate anacanthopus* is herewith recorded for the first time from Singapore (Pulau Ubin, Pulau Sekudu). All Singaporean specimens of *A. anacanthopus* were collected either with a suction pump or by a beach seine, in the lower intertidal - upper subtidal area of sand-mudflats, where it appears to live commensally in burrows of larger burrowing animals (e.g., mud or ghost shrimps, enteropneusts, echiurans etc.) (see also Anker et al., 2015). The two type specimens of *A. anacanthopus* from Indonesia were dredged from 22 and 75 m, respectively. Interestingly, the more common and widespread *Automate dolichognatha* De Man, 1888a, which is present throughout Indonesia, including in polluted areas (Banner & Banner, 1985), has not yet been collected in Singapore waters.

Genus *Potamalpheops* Powell, 1979

Potamalpheops johnsoni Anker, 2003

Potamalpheops johnsoni Anker, 2003a: 290.
Potamalpheops tigger (nec Yeo & Ng, 1997) —Yeo & Ng, 1997: 182 (partim).

CMBS material. None.

Additional material. Straits of Johor. 1 male, paratype, ZRC 2000.2182, Sungei Buloh, mangrove mud flat, under rotten wood and in muddy pools at low tide, leg. A. Anker, Y. Cai, 10 February 2000.

Distribution. Presently known only from Singapore.

Previous records from Singapore. Anker (2003a).

Ecology. Mangrove mudflats, typically dwelling under rotten wood, debris, rocks, also in small water holes and muddy pools; intertidal and perhaps shallow subtidal.

Remarks. *Potamalpheops johnsoni* is presently known only from Singapore's side of the Straits of Johor (Sungei Buloh, Lim Chu Kang and Mandai mangroves), where it appears to be less common than its congener, *P. tigger* Yeo & Ng, 1997 (see below).

Potamalpheops tigger Yeo & Ng, 1997
(Fig. 38)

Potamalpheops tigger Yeo & Ng, 1997: 182; Anker, 2003a: 288.

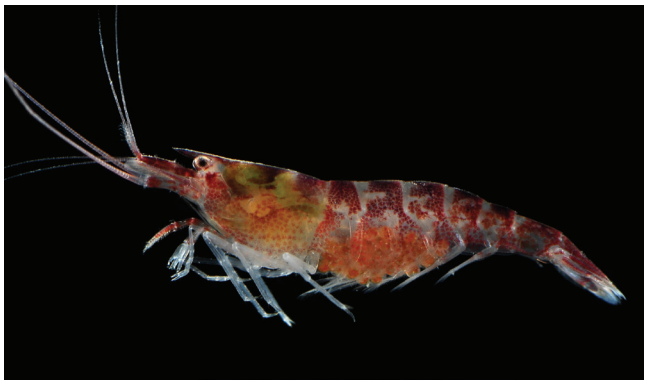

Fig. 38. *Potamalpheops tigger* Yeo & Ng, 1997: ovigerous female from Sungei Buloh, Straits of Johor, CMBS sta. SW136 (OUMNH. ZC. 2014-11-175) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, ZRC 2014.0387, sta. SW136, Sungei Buloh, back mangrove, under logs near small stream, leg., B.Y. Lee, K.S. Koh, 30 October 2012 (JS-3004); 1 ov. female, ZRC 2014.0388, sta. SW136, same collection data (JS-3002); 1 ov. female, OUMNH.ZC. 2014-11-173, sta. SW136, same collection data (JS-3005); 1 male, 2 ov. females, OUMNH.ZC. 2014-11-174, sta. SW136, same collection data (JS-3007); 1 ov. female, OUMNH.ZC. 2014-11-175, sta. SW136, same collection data (JS-3003); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-176, sta. SW136, same collection data; 2 specimens (not sexed), ZRC 2014.0386, Sarimbun Beach, near Jalan Bahtera Scouts Camp, H.H. Ng, T.L. Yeo, P.S.H. Wong, 14 February 2012 (48202-48203).

Distribution. Singapore and northern Australia.

Previous records from Singapore. Yeo & Ng (1997); Anker (2003a).

Ecology. Mangrove mudflats, in mud under rotten wood, various debris, rocks etc., also in small water holes, muddy pools and among mangrove roots; intertidal and possibly shallow subtidal.

Remarks. *Potamalpheops tigger* is more common than the closely related *P. johnsoni* Anker, 2003 (see above), the two species occurring syntopically, sometimes in small mixed groups, in the mangroves of Sungei Buloh in Sungapore. In addition to Sungei Buloh, *P. tigger* is also found on mangrove-adjacent mudflats of Lim Chu Kang and Sarimbun, in Singapore, and near Darwin, Northern Territory, Australia (Anker, 2003a). In addition to *P. tigger* and *P. johnsoni*, both marine-brackish water shrimps, a purely freshwater species, *P. amnicus* Yeo & Ng, 1997, may be occasionally found in small streams of the Central Catchment Area of Singapore (see Yeo & Ng, 1997).

Genus *Prionalpheus* Banner & Banner, 1960

Prionalpheus sulu Banner & Banner, 1971

Prionalpheus sulu Banner & Banner, 1971: 268; Banner & Banner, 1978: 238; Miya, 1980: 125; Chace, 1988: 70.

CMBS material. None.

Additional material. Strait of Singapore. 1 male, ZRC 2014.0741, Raffles Lighthouse, 07 May 2004.

Distribution. Indo-west Pacific: Madagascar, Seychelles, Singapore, Philippines, Japan (Banner & Banner, 1983; Chace, 1988; present study).

Previous records in Singapore. None.

Ecology. Coral reefs and adjacent habitats; in or under coral rubble, dead coral heads, bases of living corals (*Acropora*); lower intertidal to 5–10 m (Miya, 1980).

Remarks. *Prionalpheus sulu* is one of two species of *Prionalpheus* characterised by the carpus of the second pereopod subdivided into four articles, the other being *P. brachytomeus* Banner & Banner, 1971 from Fiji. The Singaporean specimen agrees very well with the original description and illustrations of *P. sulu* in Banner & Banner (1971) and the complementary description of the Japanese material in Miya (1980). The species seems to be generally quite uncommon and was found in Singapore only once, near Raffles Lighthouse. The colour of living *P. sulu* remains unknown, but may be similar to that of some closely related species of the genus (see Anker, 2010).

Genus *Racilius* Paulson, 1875

Racilius compressus Paulson, 1875
(Fig. 39)

Racilius compressus Paulson, 1875: 107; Banner & Banner, 1966a: 159; Bruce, 1972: 92; Banner & Banner, 1973: 350; Bruce, 1974: 1; Banner & Banner, 1985: 40; Bruce, 1985: 11.

CMBS material. Strait of Singapore. 1 male, 1 ov. female, OUMNH.ZC. 2014-11-177, sta. SD56, off S Pulau Jong, 17 m, in coral *Galaxea* sp., leg. S. De Grave et al., 24 May 2013 (SIN-096); 1 male, ZRC 2014.0730, sta. SD68, off SW Pulau Tekukor, 10 m, in coral *Galaxea* sp., leg. S. De Grave et al., 25 May 2013 (SIN-117).

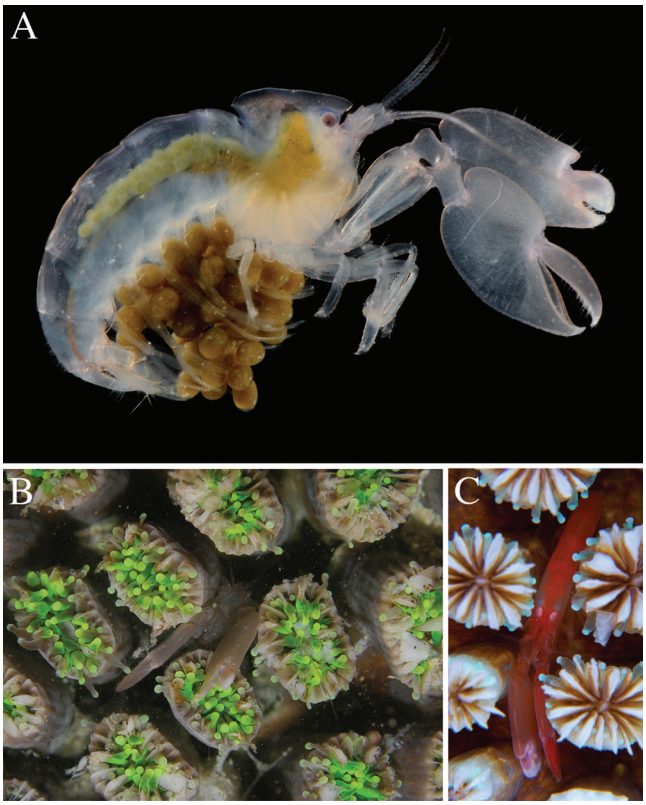

Fig. 39. *Racilius compressus* Paulson, 1875: A, ovigerous female from Pulau Jong, Strait of Singapore, CMBS sta. SD56 (OUMNH.ZC. 2014-11-177); B, male from Nosy-Bé, Madagascar, photographed in situ on coral host, *Galaxea* cf. *fascicularis* (L.) (specimen deposited in the collections of Florida Museum of Natural History, Gainesville, USA); C, individual from Okinawa, southern Japan, photographed in situ among polyps of coral host, *Galaxea* sp. (specimen not collected) (Photographs by: Arthur Anker [A, B], Yusuke Yamada [C]).

Additional material. Strait of Singapore. 2 males, 1 ov. female, ZRC 1979.4.6.7-13, Singapore, no further data (J7324-7330).

Distribution. Indo-west Pacific, from the Red Sea to South Africa, Japan, Micronesia, Indonesia and Australia (Banner & Banner, 1973, 1985; Bruce, 1985).

Previous records in Singapore. Banner & Banner (1966a); Johnson (1979).

Ecology. Coral reefs, obligate associate of corals of the genus *Galaxea*, mainly *G. fascicularis* (L.) (Fig. 39B, C), rarely *G. clavus* Dana (Bruce, 1972; Banner & Banner, 1973); approximate depth range: 1–30 m.

Remarks. *Racilius compressus* is a morphologically and ecologically highly distinctive snapping shrimp, characterised by the extreme lateral compression of the body and chelipeds – one of the main adaptations to the deep narrow channels between the polyps of *Galaxea*. Other distinguishing features are the unusually strong carapacial mid-dorsal crest, the

ventrally rounded cheliped claws that are almost equal in size (Fig. 39A, C), and the uropod bearing a laterally projecting tooth. The species was previously known from Singapore (Banner & Banner, 1966a; Johnson, 1979), however, without a precise locality. Thus, the present material represents the first vouchered record of *R. compressus* in Singapore, where it appears to be restricted to coral reef patches around some southern islands, e.g., Pulau Jong and Pulau Tekukor and very likely also Raffles Lighthouse.

Genus *Salmoneus* Holthuis, 1955

Salmoneus alpheophilus Anker & Marin, 2006
(Fig. 40)

Salmoneus alpheophilus Anker & Marin, 2006: 310; Anker et al., 2015: 323.

Fig. 40. *Salmoneus alpheophilus* Anker & Marin, 2006: ovigerous specimen from St. John's Island, Strait of Singapore, CMBS sta. SW75 (ZRC 2014.0739) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. specimen, 1 non-ov. specimen, OUMNH.ZC. 2014-11-179, sta. YB165, St. John's I., lagoon next to public ferry jetty (swimming area), near rock bound, shallow subtidal flat, 0–0.5 m, mud and muddy sand, suction pump, in burrows, leg. A. Anker, J.C. Mendoza, 04 June 2013 (SS-4513) [one infested by a pair of hemiarthrine isopods]; 1 ov. specimen, ZRC 2014.0739, sta. SW75, St. John's I., between public ferry jetty and small mangrove, shallow subtidal flat, 0–0.5 m, mud and muddy sand, suction pump, in burrows, leg. A. Anker, P.K.L. Ng, D.W. Rahayu, 26 May 2013 (SS-1642); 1 ov. specimen, OUMNH.ZC. 2014-11-180, Raffles Lighthouse, shallow flat, under rocks in muddy sand, leg. A. Anker et al., 29 May 2013 (SS-3203); 1 non-ov. specimen, ZRC 2014.0613, Pulau Senang, near jetty, mud-sand flat with rocks and rubble, under coral rock in muddy water, leg. A. Anker, 30 March 2014 (SEN-AA05).

Distribution. Presently known only from Vietnam, central Indonesia and Singapore.

Previous records in Singapore. None.

Ecology. Muddy sandflats, often with coral rubble and seagrass, typically associated with burrows of *Alpheus* spp., especially *A. rapacida*, and possibly also *A. rapax* and *A. macellarius* (A. Anker, pers. obs.); intertidal and shallow subtidal.

Remarks. *Salmoneus alpheophilus* was previously known only from Nha Trang Bay, Vietnam (Anker & Marin, 2006), and Lombok, Indonesia (Anker et al., 2015). The species is here recorded for the first time from Singapore, where it appears to be fairly common on shallow mud-sandflats dominated by burrows of *Alpheus* spp., for example, around St. John's Island, Raffles Lighthouse, and Pulau Senang.

Salmoneus hilarulus (De Man, 1910)

Jousseaumea hilarula De Man, 1910: 304; De Man, 1911: 160.
Salmoneus hilarulus — Johnson, 1961: 49 (*partim*); Johnson, 1979: 42 (*partim*); Banner & Banner, 1985: 40.

CMBS material. None.

Additional material. Strait of Singapore. 1 non-ovigerous specimen, ZRC 1979.4.6.14, Selat Sinki, off Pulau Bukom, dead coral, leg. D.S. Johnson, 14 April 1952.

Distribution. Presently known only eastern Indonesia (between Pulau Misool and Papua) and Singapore (De Man, 1910; Johnson, 1962; present study).

Ecology. The holotype was dredged on a sand-shell bottom, at 32 m (De Man, 1911); the Singaporean specimen came from "dredgings on the shell-gravel and coral-brash grounds".

Remarks. *Salmoneus hilarulus* appears to be a highly uncommon species and is presently known only from two older specimens, De Man's holotype from eastern Indonesia and Johnson's specimen from Singapore (see below); it has not been collected (or at least identified) in the past 50 years, probably because it is confined to deep-water coral-shell-gravel bottoms.

Johnson (1962) reported *S. hilarulus* from mudflats at Tanjong Penjuru and dredges in Selat Sinki, in the Strait of Singapore. However, the single extant specimen from Tanjong Penuru was reidentified and described by Anker (2003a) as *S. singaporensis* Anker, 2003 (see below). The Selat Sinki specimen was only recently located in the ZRC collection and upon re-examination confirmed as *S. hilarulus sensu* De Man (1910). It is in reasonably good condition, with an intact major cheliped and most pereopods still attached to the body. The two most diagnostic features of *S hilarulus* are the very short, stout dactylus of the third to fifth pereopods and the armature of the major chela fingers consising of four-five relatively large teeth.

Salmoneus cf. *pusillus* Anker & Marin, 2006

Salmoneus pusillus Anker & Marin, 2006: 307.

CMBS material. Straits of Johor. 1 non-ov. specimen, ZRC 2014.0737, Pulau Sekudu – Malang Papan, dredge in shallow water (less than 10 m), leg. K.S. Tan et al., 07 March 2012 (D15-701) [missing major cheliped].

Distribution. *Salmoneus pusillus* is presently known with certainty only from the type locality in southern Vietnam (Anker & Marin, 2006); the presence of the species in Singapore requires confirmation (see below).

Previous records from Singapore. None.

Ecology. On subtidal sand-mud bottoms, presumably under rocks, rubble and other shelters; depth range of the type series: 14–16 m.

Remarks. Unfortunately, the single non-ovigerous specimen of *Salmoneus* dredged in the eastern Straits of Johor and tentatively assigned to this species, is missing its major cheliped, a diagnostic appendage in most alpheid shrimps. In most other characters (frontal region, minor cheliped, second and third pereopods, telson), this specimen resembles *S. pusillus* Anker & Marin, 2006, a species presently known only from southern Vietnam (Anker & Marin 2006). In view of slight differences in the proportions and absence of the major cheliped, it is identified as *S.* cf. *pusillus*, awaiting collection of additional material.

Salmoneus serratidigitus (Coutière, 1897) sensu lato
(Fig. 41)

Jousseaumea serratidigitus Coutière, 1897b: 382.
Salmoneus serratidigitus — Banner & Banner, 1981: 58 (*partim*); Banner & Banner, 1985: 40; Chace, 1988: 71.
(?) *Jousseaumea sibogae* De Man, 1910: 303; De Man, 1911: 158.
(?) *Salmoneus sibogae* — Banner & Banner, 1978: 239; Banner & Banner, 1982: 305.

Fig. 41. *Salmoneus serratidigitus* Coutière, 1897 sensu lato: ovigerous specimen dredged south of Sisters Islands, Strait of Singapore, CMBS sta. DR112 (ZRC 2014.0738) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. specimen, ZRC 2014.0738, sta. DR112, Southern Fairway S of Sisters Is., 33.6–34.4 m, shells, coral rubble, leg. B. Richer de Forges et al., 30 May 2013 (SS-3259).

Distribution. Indo-Pacific, from the Red Sea and Madagascar to Japan, Indonesia, Australia, Micronesia, French Polynesia, Mexico and Galapagos (probably species complex, see below).

Previous records from Singapore. None.

Ecology. Coral reefs and associated rubble flats, also on rocky shores and mixed sand-rock bottoms, typically dwelling under rocks and coral rubble or deep in rubble crevices; intertidal to at least 35 m.

Remarks. *Salmoneus serratidigitus*, the type species of *Salmoneus*, is currently one of the most problematic taxa in this genus. The taxonomic status of *Salmoneus sibogae* (De Man, 1910) placed in the synonymy of *S. serratidigitus* by Banner & Banner (1982) needs to be re-investigated. *Salmoneus serratidigitus* also needs to be contrasted to some closely related species, such as *S. mauiensis* (Edmondson, 1930), *S. latirostris* (Coutière, 1897), and *S. tafaongae* Banner & Banner, 1966, to ascertain their distinguishing characters and thereby confirm their validity. The single Singaporean specimen differs in some characteristics from the neotype of *S. serratidigitus*, as redescribed by Banner & Banner (1981) based on a type specimen ("neotype") from Djibouti, and appears to be closer to *S. sibogae*. Nevertheless, awaiting a comprehensive revision of *S. serratidigitus* and a possible formal revalidation of *S. sibogae*, the Singaporean specimen is best referred to as *S. serratidigitus* sensu lato.

Salmoneus setichelles Anker, 2003

Salmoneus setichelles Anker, 2003b: 102.

CMBS material. None.

Additional material. Straits of Johor. 1 non-ov. specimen, ZRC 2014.0740, Sungei Buloh, burrow on mud flat, suction pump, leg. Y Cai, 02 March 2004.

Distribution. Presently known only from northern Australia and Singapore.

Previous records from Singapore. None.

Ecology. Mudflats, probably associated with burrows of larger burrowing animals; intertidal and possibly shallow subtidal.

Remarks. *Salmoneus setichelles* was until now known only from the type material collected near Darwin, Northern Territory, Australia (Anker, 2003b). The collection of a single individual of *S. setichelles* on mudflats of Sungei Buloh, represents the first record of this interesting alpheid for Singapore and a significant extension of its geographic range.

Salmoneus singaporensis Anker, 2003

Salmoneus singaporensis Anker, 2003a: 284.
(?) *Salmoneus* cf. *singaporensis* — Anker et al., 2015: 329.
Salmoneus hilarulus (nec De Man, 1910) — Johnson, 1962: 49 (partim); Johnson, 1979: 42 (partim).

CMBS material. None.

Additional material. Strait of Singapore. 1 non-ovigerous specimen, holotype, ZRC 1979.4.6.15, Jurong, Tanjong Penuru, intertidal mud flat, leg. Honours, University of Malaya, 24 June 1959 [det. D.S. Johnson as *S. hilarulus*].

Distribution. Presently known with certainty only from Singapore, with a possible record from Indonesia (see below).

Ecology. Mudflats, usually with soft soggy mud, possibly associated with burrows of *Alpheus rapacida* De Man, 1908 (Johnson, 1962; Anker 2003a); intertidal and possibly shallow subtidal.

Remarks. *Salmoneus singaporensis* was described based on a single holotype specimen collected in the late 1950s on intertidal mudflats of Tanjong Penjuru, a non-extant locality (destroyed by land reclamation) in the Jurong area of Singapore. The species was misidentified and reported by Johnson (1962) as *S. hilarulus* De Man, 1910, which morphologically is very different from *S. singaporensis* (cf. De Man, 1911; Anker, 2003a). Johnson (1962) mentioned several other specimens from Tanjong Penjuru, however, none of them were located in the ZRC collection. Whether these specimens were also *S. singaporensis* remains unknown, in view of several other burrow-associated species of *Salmoneus* present in the area. On the other hand, Johnson's (1962) single specimen of *S. hilarulus* from Selat Sinki was found and confirmed to be *S. hilarulus* (see above). The identity of a young specimen from Lombok, Indonesia, tentatively identified as *S.* cf. *singaporensis* by Anker et al. (2015), also needs confirmation.

As noted by Anker (2003a), *S. singaporensis* is closely related to *S. rostratus* Barnard, 1962, a widespread Indo-west Pacific species (De Grave & Wilkins, 1997; Anker & Marin, 2006) that has not yet been found in Singapore. Fresh material of *S. singaporensis* is needed to confirm its presence in Singapore today and to document morphological variation of the species.

Salmoneus sp.

CMBS material. None.

Additional material. Straits of Johor. 1 non-ov. specimen, ZRC 2014.0736, Sungei Buloh, burrow on mud flat, suction pump, leg. Y Cai, 18 March 2004 [missing chelipeds and several other pereopods].

Distribution. Singapore.

Ecology. Mangrove mudflats, in burrows of unknown hosts; intertidal.

Remarks. Unfortunately, the single specimen from Sungei Buloh is incomplete, missing both chelipeds, second pereopod, most ambulatory pereopods, and also having a damaged telson. This specimen may represent an undescribed species morphologically close to *S. alpheophilus* (see above), from which it differs by the absence of a post-rostral tubercle (vs. present in *S. alpheophilus*) and the presence of a strong conical tubercle on the anterior margin of each eyestalk (vs. with a much weaker tubercle in *S. alpheophilus*). More material of *Salmoneus* from the Sungei Buloh area is needed to conclude about its status.

Genus *Synalpheus* Spence Bate, 1888

Synalpheus bispinosus De Man, 1910

Synalpheus bispinosus De Man, 1910: 302; De Man, 1911: 280; Banner & Banner, 1975b: 346 (partim?); Johnson, 1979: 42; Banner & Banner, 1985: 40.

CMBS material. None.

Additional material. Strait of Singapore. 1 male, ZRC 1979.4.6.18, Ajax Sultan Shoal, "stone" (= rocks), 16 m, sta. B31, leg. S.R.F.R.S., 07 July 1954 (J7201).

Distribution. Indo-west Pacific, from the Red Sea (?) to Indonesia, Singapore, Philippines, and Australia.

Previous records from Singapore. Johnson (1979).

Ecology. Subtidal mixed (rock-rubble-shell) bottoms; depth range about 2–30 m (Banner & Banner, 1975b).

Remarks. *Synalpheus bispinosus* is presently known from Singaporean waters from only a single specimen collected on Ajax Sultan Shoal (near present-day Karimbon Terembu) in the 1950s. The species is morphologically close to the more common and widespread *S. coutierei* Banner, 1953 (see below), from which it can be distinguished by the acutely produced, spiniform posterolateral angles of the sixth abdominal somite (De Man, 1911; Banner & Banner, 1975b).

Synalpheus bituberculatus De Man, 1910
(Fig. 42)

Synalpheus bituberculatus De Man, 1910: 294; De Man, 1911: 276; Johnson, 1962: 51; Banner & Banner, 1966a: 66; Banner & Banner, 1975b: 307; Johnson, 1979: 42; Banner & Banner, 1978: 240; Banner & Banner, 1985: 40; Chace, 1988: 76.

CMBS material. Straits of Johor. 1 ov. female, ZRC 2014.0473, sta. DW17, Pulau Ubin, off OBS Camp 1 and Serangoon Harbour between OBS Camp 1 and Punggol, depth unknown, gill net and tangle net, leg. H.H. Ng and local fishermen, 16 October 2012 (JS-0748); 1 male, OUMNH.ZC. 2014-11-181, sta. DW17, same collection data; 1 male, ZRC 2014.0474, sta. DW58, E of Pulau Tekong,

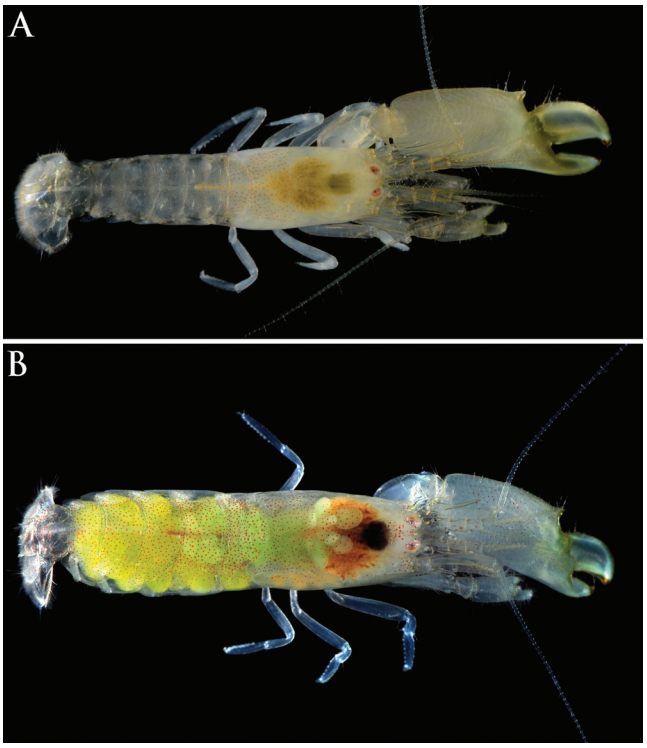

Fig. 42. *Synalpheus bituberculatus* De Man, 1910: A, male from St. John's Island, Strait of Singapore, CMBS sta. SW10 (OUMNH. ZC. 2014-11-188); B, ovigerous female from Pulau Ubin, Straits of Johor, CMBS sta. DW17 (ZRC 2014.0473) (Photographs by: Arthur Anker).

10.9–11.3 m, laterite gravel, leg. B. Richer de Forges et al., 22 October 2012. Strait of Singapore. 1 ov. female, ZRC 2014.0461, Pulau Semakau landfill phase 2, leg. H.H. Tan et al., 08 August 2012; 1 ov. female, ZRC 2014.0475, between Pulau Semakau and Pulau Jong, leg. H.H. Ng, S.C. Lim, M. Ng et al., 28 August 2012 (4712A DR-020); 1 male, ZRC 2014.0467, sta. SB85, SW Pulau Tekukor, 4.5 m, coral rubble brushing, leg. D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-2738); 3 males, ZRC 2014.0468, sta. SB85, same collection data (SS-2736); 1 ov. female, OUMNH.ZC. 2014-11-182, sta. SB85, same collection data (SS-2739); 1 ov. female, ZRC 2014.0465, sta. SB85, same collection data (SS-2732); 1 ov. female, ZRC 2014.0460, sta. SB85, same collection data (SS-2731); 4 specimens (sex not determined), ZRC 2014.0469, sta. SB85, same collection data (SS-2721A); 1 male, ZRC 2014.0464, sta. SB85, same collection data (SS-2735); 1 ov. female, OUMNH.ZC. 2014-11-183, sta. 85, same collection data (SS-2734) [identification tentative, see below]; 1 ov. female, OUMNH.ZC. 2014-11-184, sta. SW10, St. John's I., DRTech, pontoon at southern lagoon, in fouling growth, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013 (SS-0320); 1 male, OUMNH.ZC. 2014-11-185, sta. SW10, same collection data (SS-0321); 1 ov. female, ZRC 2014.0463, sta. SW10, same collection data (SS-0319); 1 male, OUMNH.ZC. 2014-11-186, sta. SW10, same collection data (SIN-027); 1 male, OUMNH.ZC. 2014-11-187, sta. SW10, same collection data (SIN-029); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-188, sta. SW10, same collection data (SIN-032); 1 female, OUMNH.ZC. 2014-11-189, sta. SW131, St. John's I., DRTech facility, pontoon at southern lagoon, snorkelling, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3996); 1 male, ZRC 2014.0476, sta. SD145, W of Pulau Hantu, 11.7 m, coral rubble, leg. S. De Grave, H.H. Tan, Z. Jaafar et al., 02 June 2013; 1 ov. female, ZRC 2014.0466, sta. SB146, Pulau Hantu, 5–7 m, coral brushing, leg. S. De Grave, H.H. Tan et al., 02 June 2013 (SS-4028); 1 male, 1 ov. female, ZRC 2014.0470, sta. SB55, SW Kusu I., 4 m, brushing of dead corals, leg. H.H. Tan, S. De Grave, D. Uyeno et al., 25 May 2013 (SS-1638); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-190, sta. SB55, same collection data (SS-1614); 1 male, ZRC 2014.0459, sta. SB55, same collection data (SS-1618); 1 ov. female, ZRC 2014.0458, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1600); 1 male, OUMNH.ZC. 2014-11-192, sta. SB67, W Pulau Hantu, patch reef, 15.7 m, brushing of dead corals, leg. D. Uyeno, S. De Grave, H.H. Tan et al., 26 May 2013 (SS-1652); 1 male, ZRC 2014.0462, 8.10–11.8 m, leg. TMSI team, 04 January 2013 (5114 TB1-032); 1 ov. female, ZRC 2014.0471, between Pulau Sudong and Pulau Semakau, 13.1–13.7 m, leg. TMSI team, 13 March 2013 (4412 TB1-032); 1 male, ZRC 2014.0469, sta. TB158, near Southern Fairway off Kusu I., 147–160 m, rocks, laterite gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4516); 1 ov. female, ZRC 2014.0472, sta. TB158, same collection data; 1 female, OUMNH.ZC. 2014-11-193, sta, TB17, Eastern Holding, 86.7–90.9 m, leg. B. Richer de Forges et al., 22 May 2013 (SIN-025A).

Additional material. Straits of Johor. 1 male, ZRC 2011.0538, Pulau Tekong, Beting Bronok, leg. Y. Cai, 28 March 2002; 1 male, ZRC 2011.0575B, Pulau Tekong, Beting Bronok, leg. Y Cai, 30 May 2002; 3 males, 3 ov. females, ZRC 2001.1051A, Pulau Tekong, Beting Bronok near Pulau Unum, leg. K.S. Tan, S Yeo, 09 February 2001; ~10 specimens (including males and ovigerous females), ZRC 2014.0640, Pulau Tekong, Beting Bronok, leg. K.L. Yeo, 15 July 2003; 1 male, 1 ov. female, OUMNH.ZC. 2014-11-194, Pulau Tekong, Beting Bronok, in sponge, leg. K.L. Yeo, 15 July 2003; 1 male, 1 ov. female, ZRC 2014.0643, Pulau Tekong, Beting Bronok, in incrusting sponge, leg. Y. Cai et al., 27 March 2002; 1 male (?), 1 ov. female, ZRC 2009.0632, S Pulau Tekong, gill netting, leg. H.H. Tan, 17 November 2009. Strait of Singapore. 1 male, ZRC 2014.0647, Pulau Jong, in *Pavona frondifera*, 24 October 1986; 1 ov. female, ZRC 1991.9606, Pulau Semakau, sledge 1, leg. Reef Ecology Study Team, 18 April 1990; 1 male, ZRC 1979.4.6.22, Pulau Hantu, in coral rock crevices, leg. D.S. Johnson, 16 July 1957 (J8078); 1 male, 1 ov. female, ZRC 1979.4.6.23-24, Tanjong Gul, in living corals just below L.W.S.T., leg. W.K. Patton, no date (J7231); 1 ov. female, ZRC 1979.4.6.21, Labrador Beach, crevices in honey comb rock, leg. D.S. Johnson, 11 July 1959 (J8079); 2 males, ZRC 1979.4.6.19-20, Labrador Beach, crevices in dead coral rocks, leg. D.S. Johnson, 07 February 1955 (J8074-8075); 1 ov. female, ZRC 1979.4.7.38, between Pulau Sudong and Pulau Pawai, reef, 0–1 m, in *Galaxea* sp., leg. D.S. Johnson, 23 May 1965 (J8071) [det. D.S. Johnson as "*S.* sp. nov. ? *quadriarticulatus*", identification tentative, see below].

Distribution. Indo-west Pacific, from Reunion Island to Japan, Indonesia, Australia and Hawaii.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Coral reefs and associated habitats with abundant sponge growth, sand-silt bottoms with rubble, sponges, algae and corals, associated with sponges (e.g., *Halichondria* sp.) and soft corals (e.g., *Leptastrea*, *Dendronephthya*); lower intertidal to 160 m, most commonly encountered between 1 and 20 m.

Remarks. *Synalpheus bituberculatus* is most easily recognised by the presence of two blunt tubercles on the distodorsal surface of the major chela. This species is one of the most common species of *Synalpheus* in Singapore, occurring in the Straits of Johor, along Singapore's southern coast, and around southern islands in the Strait of Singapore. Most of the Singaporean material of *S. bituberculatus* was collected from sponge and fouling growth (aufwuchs) on buoys, by breaking and/or brushing coral rubble, and also by dredges and trawls. Specific collection localities include Pulau Ubin, Pulau Tekong – Pulau Unum area (e.g., Beting Bronok), Labrador Beach, Kusu Island, Pulau Semakau, Pulau Hantu, St. John's and Lazarus Islands, Pulau Tekukor and others. The colouration of *S. bituberculatus* (Fig. 42) is here shown for the first time.

Two female specimens tentatively identified as *S. bituberculatus* appear to represent aberrant individuals of that species. The female from Pulau Tekukor (OUMNH.ZC. 2014-11-183) has only a few unusually large eggs and only one well-developed distodorsal tubercle on the major chela palm, instead of the typical two; this varation has also been noted in Australian material (Banner & Banner, 1975b). The small ovigerous female found by D.S. Johnson on a reef between Pulau Sudong and Pulau Pawai (ZRC 1979.4.7.38) has only four instead of the typical five carpal articles in the second pereopod, but in most other features (including major chela palm with two tubercles distally) agrees well with *S. bituberculatus*.

***Synalpheus coutierei* Banner, 1953**
(Fig. 43)

Synalpheus coutierei Banner, 1953: 36; Banner & Banner, 1966a: 62; Banner & Banner, 1975b: 343; Banner & Banner, 1978: 241; Banner & Banner, 1985: 41; Chace, 1988: 77.
(?) *Synalpheus biunguiculatus* var. *exilipes* Coutière, 1905: 874.
(?) *Synalpheus exilipes* — Johnson, 1962: 51; Johnson, 1979: 43.

CMBS material. Straits of Johor. 1 female, ZRC 2014.0622, sta. MF13, Pulau Ubin, Mamam Beach, leg. H.H. Ng et al., 07 June 2011 (13127). Strait of Singapore. 1 male, OUMNH. ZC. 2014-11-195, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1602); 1 ov. female, OUMNH.ZC. 2014-11-196, sta. DR112, Southern Fairway S of Sisters Is., 33.6–34.4 m, shells, coral rubble, leg. B. Richer de Forges et al., 30 May 2013 (SS-3260); 1 male, ZRC 2014.0621,

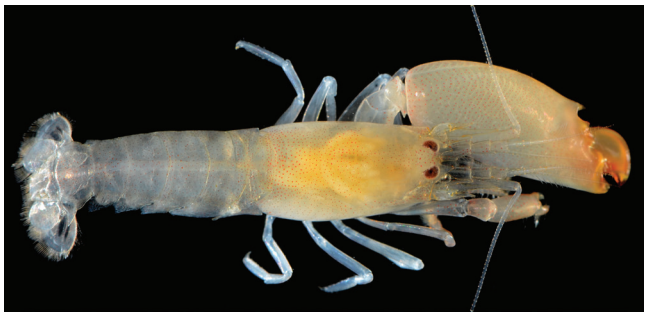

Fig. 43. *Synalpheus coutierei* Banner, 1953: male from Pulau Semakau, Strait of Singapore, CMBS sta. SB41 (OUMNH.ZC. 2014-11-195) (Photograph by: Arthur Anker).

S of St. John's I., off public jetty, 23.3–26.3 m, leg. TMSI team, 16 April 2013 (5113 DR1-079).

Additional material. Strait of Singapore. 1 male, ZRC 2014.0527, Tanah Merah Besar, under crust on rocks in less than 20 cm water at low tide, leg. D.S. Johnson, 08 April 1969 (J11883); 1 ov. female, ZRC 1979.4.7.31, Pulau Pawai, 1.8–3.2 m, leg. D.S. Johnson, 30 December 1954 [det. D.S. Johnson as *S. mushaensis* Coutière, 1909, identification tentative].

Distribution. Indo-west Pacific, from the Red Sea to Japan, Indonesia, Micronesia, Solomon Islands, and Australia.

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus exilipes* Coutière, 1905).

Remarks. *Synalpheus coutierei* needs a taxonomic and nomenclatural revision. If found to be identical with the taxon Coutière (1905) described as *S. biunguiculatus* var. *exilipes* Coutière, 1905, the latter name takes priority over *S. coutierei* Banner, 1953 (see Johnson, 1979). The species appears to be widespread in the Indo-west Pacific, but is rare in Singapore; specific collection locations include Pulau Ubin, Tanah Merah, Pulau Semakau and off Sister Islands. *Synalpheus coutierei* is closely related to *S. bispinosus* De Man, 1910, from which it can be separated by the blunt posterolateral angles of the sixth abdominal somite (vs. acutely pointed in *S. bispinosus*). The Singaporean record of the latter species (Johnson, 1979) requires confirmation.

***Synalpheus demani* Borradaile, 1900**

Synalpheus demani Borradaile, 1900: 416; De Man, 1911: 257; Banner & Banner, 1975b: 324; Monod, 1976: 139; Banner & Banner, 1985: 41; Chace, 1988: 77.
Alpheus triunguiculatus (nec Paulson, 1875) De Man, 1888a: 504.
Synalpheus triunguiculatus (nec Paulson, 1875) — Johnson, 1962: 50; Johnson, 1979: 44.
Alpheus spiniger — Spence Bate, 1888: 560.
Synalpheus brockii Nobili, 1901: 2.

CMBS material. None.

Additional material. 1 male, 1 ov. female, ZRC 2014.0648, Singapore (?), D13-A, D200, no further data. Strait of

Singapore. 1 male, ZRC 1979.4.9.20, Outer Shoal buoy, 12 m, "commensal with bushy spiky alcyonacean", III.1956 (J8073).

Distribution. Indo-west Pacific, from the Red Sea to Japan, Australia, Marshall Islands and New Caledonia.

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus triunguiculatus* (Paulson, 1875)).

Ecology. Coral reefs, associated with various shallow-water crinoids (*Comanthus* spp., *Comanthina* spp.); typical depth range 5–30 m; an association of *S. demani* with nephthyid alcyonaceans, as reported by Johnson (1962, 1979, as *S. triunguiculatus*), is rather unlikely.

Remarks. *Synalpheus demani* was not recorded during the CMBS survey, despite thorough examination of numerous crinoids. The presence of *S. demani* in Singapore is based on a single specimen from the Outer Shoal collected in the 1950s (Johnson, 1962) and a male-female pair from an uncertain locality (labeled only D13-A D200), possibly within Singaporean waters. *Synalpheus demani* is not closely related to *S. stimpsonii* (De Man, 1888a) (see below) or any other species of the *S. comatularum* (Haswell, 1882) species group. In life, *S. demani* can be recognised by the uniform either whitish or dark-brown to almost black colour (see Minemizu, 2000; Debelius, 2001).

Johnson (1962) misidentified the specimen from the Outer Shoal as *S. triunguiculatus*, a species described from the Red Sea (Paulson, 1875). However, *S. triunguiculatus* can be easily separated from *S. demani* by the presence of spines along the entire ventral margin of the third pereopod propodus. In contrast, in *S. demani*, the propodal spines are restricted to the distal-most part of the ventral margin (Banner & Banner, 1975b).

Synalpheus fossor (Paulson, 1875) sensu lato
(Fig. 44)

Alpheus fossor Paulson, 1875: 103.
Synalpheus fossor — Banner & Banner, 1975b: 335; Banner & Banner, 1978: 242; Banner & Banner, 1985: 41; Chace, 1988: 78.
(?) *Synalpheus fossor* var. *propinqua* De Man, 1909b: 121; De Man, 1911: 250.
(?) *Synalpheus trionyx* Coutière, 1908: 196.
(?) *Synalpheus bakeri* Coutière, 1908: 199.
(?) *Synalpheus bakeri* var. *stormi* De Man, 1911: 253.
(?) *Synalpheus bakeri stormi* — Banner & Banner, 1966a: 53.
(?) *Synalpheus stormi* — Johnson, 1962: 50; Johnson, 1979: 43.

CMBS material. Strait of Singapore. 4 males, 2 ov. females, ZRC 2014.0477, Pulau Semakau landfill phase 2, in yellow sponge, leg. S.K. Tan, 06 August 2012; 1 male, OUMNH.ZC. 2014-11-197, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1592); 1 ov. female, ZRC 2014.0698, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3246) [identification tentative]; 1 male, OUMNH.ZC. 2014-11-198, sta. SW10, St. John's I., DRTech, pontoon at southern lagoon, in fouling growth, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013 (SS-0316); 1 male, ZRC 2014.0700, sta. SW10, same collection data (SS-0331); 1 male, OUMNH.ZC. 2014-11-199, sta. SW10, same collection data (SS-0322); 1 ov. female, OUMNH.ZC. 2014-11-200, sta. SW10, same collection data (SS-0317); 1 male, ZRC 2014.0699, sta. SB85, SW Pulau Tekukor, 4.5 m, coral rubble brushing, leg. D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-2721); 1 male, ZRC 2014.0696, sta. SB85, same collection data (SS-2733); 1 male, ZRC 2014.0697, sta. SB85, same collection data (SS-2715); 1 male, ZRC 2014.0694, sta. SB85, same collection data (SS-2740); 1 male, ZRC 2014.0695, sta. SB85, same collection data (SS-2737); 1 female, OUMNH.ZC. 2014-11-201, sta. TB157, near Southern Fairway off Kusu I., 147–160 m, rocks, gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4515); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-202, sta. SW6, St. John's I., DRTech, south lagoon, under pontoon, leg. S. De Grave & K. Tilbrook, 20 May 2013 (SIN-278).

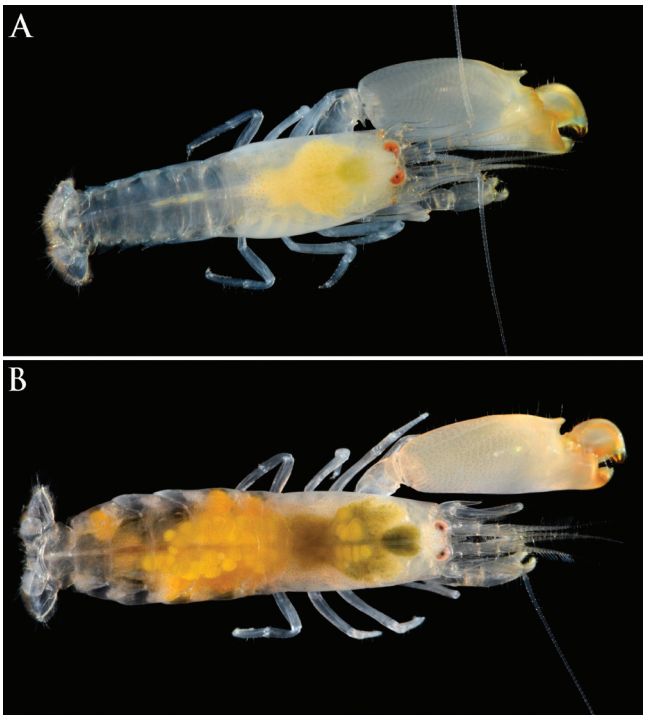

Fig. 44. *Synalpheus fossor* (Paulson, 1875) sensu lato: A, male from Pulau Semakau, Strait of Singapore, CMBS sta. SB41 (OUMNH. ZC. 2014-11-197); B, ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SW10 (OUMNH.ZC. 2014-11-200) (Photographs by: Arthur Anker).

Additional material. Strait of Singapore. 1 male, ZRC 2011.0535, Lower Shoal buoy, fouling growth, leg. Y. Cai, 21 June 2002; 1 ov. female, OUMNH.ZC. 2014-11-203, Southern Islands, fouling growth on ship, leg. J.B. Sigurdsson, XII.1986; 1 ov. female, ZRC 2014.0641, Pulau Seringat, leg. S.H. Tan, 22 August 1997; 1 female (?), ZRC 2011.0534, sta. D058, buoy growth, leg. Y Cai, 27 December 2002; 1 male, ZRC 2014.0642, South Angler Buoy near Changi, leg. Y. Cai et al., 03 September 2002; 1 male, 1 ov. female, ZRC 2009.0836A, Sinki Fairway off Jurong I., CC2 Buoy,

buoy growth, leg. S. Teo et al., 30 July 2009; 1 male (?), ZRC 1993.793, Pulau Semakau, sledge 1, leg. Reef Ecology Study Team, 1992; 1 ov. female, ZRC 1979.4.9.13, Sultan Shoal, among soft corals, corals, barnacles etc. growing on lighthouse pier, below L.W.S.T., 07 March 1953 (J8106) [det. D.S. Johnson as *S. stormi*].

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Indonesia, and Australia.

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus stormi* De Man, 1911).

Ecology. Coral reefs and associated habitats with abundant rubble and sponge growth, usually in sponges or in crevices of coral rubble and dead coral heads; lower intertidal to 160 m, most common between 1 and 50 m.

Remarks. *Synalpheus fossor*, as redefined by Banner & Banner (1975b), probably represents more than one species. The taxonomic status of several nominal taxa currently treated as synonyms of *S. fossor*, especially *S. bakeri* var. *stormi* De Man, 1911, needs a reassessment. All material identified as *S. fossor*, *S. bakeri* or *S. bakeri stormi* from southern Australia (e.g., Coutière, 1908; Banner & Banner, 1975b) is with high probability not *S. fossor*. The status of the Singaporean material is also unclear, although most specimens agree very well with the description and illustrations of *S. bakeri* var. *stormi* in De Man (1911). In fact, Johnson (1962, 1979) reported this species as *S. stormi* based on scarce material from Pulau Sudong. However, only a thorough revision of the entire *S. fossor* complex (*S. fossor* sensu lato) will reveal if *S. stormi* is a valid species or a junior synonym of *S. fossor*. In Singapore, *S. fossor* appears to be most common along the southern shore and islands in the Strait of Singapore; specific localities include Pulau Sudong, Pulau Semakau, Pulau Tekukor, St. John's Island, Kusu Island, Pulau Seringat, Jurong Island, Lower Shoal, etc. It is most commonly found in subtidal coral rubble and dead coral heads, aufwuchs on buoys and occasionally also in dredges and trawls (exceptionally down to 160 m).

Synalpheus hastilicrassus Coutière, 1905 sensu lato
(Fig. 45)

Synalpheus hastilicrassus Coutière, 1905: 875; De Man, 1911: 263; Banner & Banner, 1975b: 353; Banner & Banner, 1978: 242; Banner & Banner, 1985: 42; Chace, 1988: 79.

(?) *Synalpheus hastilicrassus* var. *acanthitelsoniformis* De Man, 1920: 108; De Man, 1922: 29.

(?) *Synalpheus acanthitelsonis* Coutière, 1905: 875; De Man, 1911: 265; Johnson, 1962: 51; Banner & Banner, 1966a: 58; Johnson, 1979: 42.

CMBS material. Straits of Johor. 1 male, 1 female, ZRC 2014.0482, sta. DW58, E of Pulau Tekong, 10.9–11.3 m, laterite gravel, leg. B. Richer de Forges et al., 22 October 2012 (JS-1818); 1 ov. female, ZRC 2014.0714, sta. DW58, same collection data; 1 male, ZRC 2014.0489, sta. DW58, same collection data; 1 male, ZRC 2014.0717, sta. DW119, between Changi Point Ferry Terminal and Pulau Sekudu,

Fig. 45. *Synalpheus hastilicrassus* Coutière, 1905 sensu lato: ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SW10 (ZRC 2014.0705) (Photographs by: Arthur Anker).

17.3–18.2 m, sandy bottom, leg. B. Richer de Forges et al., 30 October 2012 (JS-2679); 1 male, OUMNH.ZC. 2014-11-204, sta. DW119, same collection data (JS-2686); 1 male, ZRC 2014.0712, sta. DW17, Pulau Ubin, off OBS Camp 1 and Serangoon Harbour between OBS Camp 1 and Punggol, depth unknown, gill net and tangle net, leg. H.H. Ng and local fishermen, 16 October 2012 (JS-0752); 1 male, 1 female, 2 ov. females, OUMNH.ZC. 2014-11-205, sta. DW17, same collection data; 1 ov. female, ZRC 2014.0719, sta. DW17, same collection data; 1 male, OUMNH.ZC. 2014-11-206, same collection data; 1 female, ZRC 2014.0481, sta. DW6, ~400 m SE of Pulau Sekudu, 15.2 m, B. Richer de Forges et al., 17 October 2012 (JS-0709); 1 male, 1 ov. female, ZRC 2014.0487, off Western Catchment, 10.2–13.2 m, leg. TMSI team, 27 June 2012 (3923 TR12-105-106); 1 ov. female, ZRC 2014.0486, same collection data (3923 TR12-232); 1 male, ZRC 2014.0479, same collection data (3923 TR12-241). Strait of Singapore. 1 female, 2 ov. females, ZRC 2014.0709, off NW Sentosa, 17.7–20.1 m, leg. TMSI team, 11 January 2013 (4815 TB1-102-104); 1 male, 1 ov. female, ZRC 2014.0483, same collection data (4815 TB1-090-091); 1 ov. female, ZRC 2014.0715, same collection data (4815 TB1-060); 1 male, ZRC 2014.0485, same collection data (4815 TB1-059); 1 ov. female, ZRC 2014.0718, SW of Sentosa, 19.1–20.8 m, 12 January 2013 (4914 DR1-039); 1 ov. female, ZRC 2014.0480, N of Pulau Seringat, 8.10–11.8 m, leg. TMSI team, 04 January 2013 (5114 TB1-120); 1 male, ZRC 2014.0513, near Pasir Panjang Terminal, 24 m, 13 June 2012 (DR09-068); 1 male, ZRC 2014.0490, sta. TB99, Eastern Bunkering A, 26.7–33.7 m, bryozoan dominated silty bottom, leg. B. Richer de Forges et al., 29 May 2013; 1 post-ov. female, ZRC 2014.0478, N of Pulau Jong, 40.8 m, leg. TMSI team, 15 May 2013 (4713 DR1-077); 1 ov. female, ZRC 2014.0711, N of Pulau Jong, 43.3–74.6 m, leg. TMSI team, 15 May 2013 (4713 DR3-190); 1 male, OUMNH.ZC. 2014-11-207, sta. DR174, near Kusu I., 79.6–135 m, reddish marine clay, gravel, shells, leg. B. Richer de Forges et al., 05 June 2013; 1 male, ZRC 2014.0716, sta. TB157, near Southern Fairway off Kusu I., 147–160 m, rocks, gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4515A); 1 ov. female, ZRC 2014.0488, sta. DR128, beside Eastern Boarding Ground A, 75.2–83.7 m, rocks, leg. B. Richer de Forges et al., 31 May 2013;

1 female, OUMNH.ZC. 2014-11-208, sta. TB16, outside Eastern Boarding Ground A, 89.5–98 m, in *Xestospongia* sp., leg. B. Richer de Forges et al., 22 May 2013; 1 ov. female, ZRC 2014.0708, sta. TB17, Eastern Holding, 86.7–90.9 m, leg. B. Richer de Forges et al., 22 May 2013 (SS-0333); 1 male OUMNH.ZC. 2014-11-209, sta. TB17, same collection data (SIN-025B); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-210, sta. DR161, near St. John's I., 41.2–44.4 m, gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4514); 1 ov. female, ZRC 2014.0704, sta. SB132, S Kusu I., pontoon, 0–5 m, brushing of dead corals, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3767); 2 males, ZRC 2014.0703, sta. SB132, same collection data (SS-3766); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-211, sta. SW10, St. John's I., DRTech, pontoon at southern lagoon, in fouling growth, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013 (SS-0329); 1 male, 1 ov. female, ZRC 2014.0705, sta. SW10, same collection data (SS-0327); 1 male, ZRC 2014.0710, sta. SW10, same collection data (SS-0323A); 1 ov. female, OUMNH.ZC. 2014-11-212, sta. SW10, same collection data; 1 ov. female, ZRC 2014.0713, sta. SB85, SW Pulau Tekukor, 4.5 m, coral rubble brushing, leg. D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-2721B); 1 male, 1 post-ov. female, ZRC 2014.0484, sta. SD145, W of Pulau Hantu, 11.7 m, coral rubble, leg. S. De Grave, H.H. Tan, Z. Jaafar et al., 02 June 2013; 1 male, ZRC 2014.0707, sta. SW131, St. John's I., DRTech, pontoon at southern lagoon, snorkeling, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3997); 1 female, ZRC 2014.0702, sta. SW131, same collection data (SS-3998); 1 male, ZRC 2014.0701, sta. SB41, W Pulau Semakau, 5 m, brushing of dead corals, leg. H.H. Tan, Z. Jaafar, D. Uyeno et al., 24 May 2013 (SS-1607); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-213, sta. SD133, S Kusu I., 11 m, rubble, S. De Grave, H.H. Tan et al., 01 June 2013 (SIN-266); 1 ov. female, OUMNH.ZC. 2014-11-214, sta. SB55, SW Kusu I., 4 m, brushing of dead corals, leg. H.H. Tan, S. De Grave, D. Uyeno et al., 25 May 2013 (SS-1632); 1 ov. female, ZRC 2014.0706, sta. SB55, same collection data (SS-1635); 1 ov. female, OUMNH.ZC. 2014-11-215, Kusu I., dead coral heads, leg. S. De Grave, 22 May 2013 (SIN-071); 1 ov. female, OUMNH.ZC. 2014-11-216, same collection data (SIN-075); 1 male, 3 ov. females, OUMNH. ZC. 2014-11-217, sta. SW6, St. John's I., DRTech, south lagoon, under pontoon, leg. S. De Grave & K. Tilbrook, 20 May 2013 (SIN-278B).

Additional material. Straits of Johor. 5 ov. females, ZRC 2011.0575A, Pulau Tekong, Beting Bronok, leg. Y. Cai, 30 May 2002; 3 males, 2 ov. females, ZRC 2001.1051B, Pulau Tekong, Beting Bronok near Pulau Unum, leg. K.S. Tan, S. Yeo, 09 February 2001; 1 male (?), ZRC 2011.0477, Pukau Tekong, Beting Bronok, leg. Y. Cai, 28 March 2002; >10 specimens (including males and ovigerous females), ZRC 2014.0644, Pulau Tekong, Beting Bronok, leg. K.L. Yeo, 15 July 2003; 1 female, ZRC 2014.0645, Pulau Ubin, Chek Jawa, sand, mud, leg. D.C.J. Yeo, 30 May 2001; 1 male, 1 ov. female, ZRC 2014.0659, Tengeh Buoy, in sponge among buoy growth, leg. Y. Cai, S.C. Lim, 04 December 2003; 1 ov. female, ZRC 2011.0574, E Buran Buoy, buoy growth, leg. Y. Cai, 27 December 2002. Strait of Singapore. 1 male, ZRC 1997.577A, Sentosa, leg. D.G.B. Chia, Z.L. Xu, I.1992; 10 specimens (including males and ov. females), ZRC 2014.0649, Southern Islands, fouling growth on ship, leg. J.B. Sigurdsson, XII.1986; 1 male, ZRC 2009.0836B, Sinki Fairway off Jurong I., CC2 Buoy, buoy growth, leg. S. Teo et al., 30 July 2009; 2 males, 1 ov. female, ZRC 1992.5856-58, Pulau Semakau, sledge 1, leg. Reef Evology Study Team, 21 April 1992; 1 ov. female, ZRC 2014.0636, South Angler Buoy near Changi, leg. Y. Cai et al., 03 September 2002.

Distribution. Indo-west Pacific, from Somalia and Madagascar to Japan, Indonesia, Australia and Fiji.

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus acanthitelsonis* Coutière, 1905).

Ecology. Coral reefs and associated habitats with abundant rubble and sponges, usually in interstices of dead and living coral heads, in sponges, in coral rubble crevices etc.; lower intertidal to 160 m, but typically found at a depth range of about 3–20 m.

Remarks. *Synalpheus hastilicrassus*, as redefined by Banner & Banner (1975b), most likely represents more than one species. The taxonomic status of *S. acanthitelsonis* Coutière, 1905 and *S. hastilicrassus* var. *acanthitelsoniformis* De Man, 1920, both currently synonyms of *S. hastilicrassus* (see Banner & Banner, 1975b) needs a reappraisal. The vast majority of specimens from Singapore match *S. acanthitelsonis*, which was separated from *S. hastilicrassus* by the much more produced posterolateral angles of the telson, among other characters (Coutière, 1905). Johnson (1962) reported this species as *S. acanthitelsonis*, being "one of the commonest species of *Synalpheus* in the Singapore area ... generally distributed on beaches below mid-tide level and in shallow offshore waters wherever the bottom has crevices in which it can live". Johnson's material came from Labrador Beach (intertidal, crevices in honeycomb rock), Pulau Sudong (coral heads at 1–2 m), Johor Shoals (crinoid grounds at ~18 m) and Kuala Johor off Angler Bank (18–27 m). The abundant CMBS material was collected at many shallow and deep-water stations in the Strait of Singapore and eastern and western Straits of Johor. *Synalpheus hastilicrassus* (= *S. acanthitelsonis* of Johnson) is today one of the most common snapping shrimps of Singapore.

***Synalpheus iocasta* De Man, 1909**
(Fig. 46)

Synalpheus iocasta De Man, 1909b: 119; De Man, 1911: 235.
Synalpheus iocasta — Banner & Banner, 1975b: 368; Johnson, 1979: 43; Banner & Banner, 1978: 243; Banner & Banner, 1985: 42; Chace, 1988: 80; Bruce, 1988: 233; Bruce, 1990a: 634.

CMBS material. Straits of Johor. 1 male, ZRC 2014.0517, sta. DW40, opposite Changi chalet radar, 15.6–21 m, leg. B. Richer de Forges et al., 20 October 2012; 1 ov. female, ZRC 2014.0515, sta. DW120, between Changi Point Ferry Terminal and Pulau Ubin, 20.6 –21.4 m, leg. B. Richer de Forges et al. 30 October 2012 (JS-2680); 1 male, 1 ov.

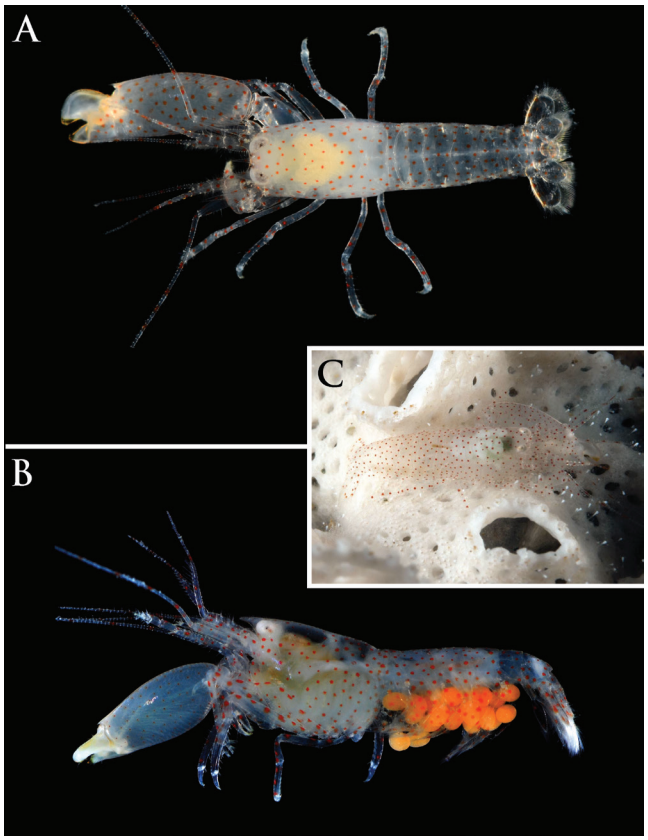

Fig. 46. *Synalpheus iocasta* De Man, 1909: A, male dredged south of Eastern Holding A, Strait of Singapore, CMBS sta. 5514 TB1 (ZRC 2014.0522); B, ovigerous female dredged south-west of Tanah Merah Ferry Terminal, Strait of Singapore, CMBS sta. 5818 DR1 (ZRC 2014.0518); C, male from Ambon, Indonesia, photographed in situ on a lace coral bryozoan, possibly *Triphyllozoon* sp. (specimen not collected). (Photographs by: Arthur Anker [A, B], Andrei Ryanskiy [C]).

female, ZRC 2014.0519, sta. DW57, E of Pulau Tekong, 10.3–10.6 m, leg. B. Richer de Forges et al., 22 October 2012 (JS-1673A). Strait of Singapore. 1 ov. female, ZRC 2014.0514, N of Pulau Seringat, 8.10–11.8 m, leg. TMSI team, 04 January 2013 (5114 TB1-054); 1 ov. female, ZRC 2014.0518, SW of Tanah Merah Ferry Terminal, 7.7–11.4 m, leg. TMSI team, 24 January 2013 (5818 DR1-005); 1 male, ZRC 2014.0520, near Pasir Panjang Terminal, ~24 m, leg. TMSI team, 12 June 2012 (4516 DR09-070); 1 ov. female, OUMNH.ZC. 2014-11-218, sta. TB15, Eastern Fairway, 23.8–21.5 m, silt, gravel, leg. B. Richer de Forges et al., 21 May 2013 (SIN-015); 1 ov. female, ZRC 2014.0521, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-041); 1 male, ZRC 2014.0522, S of Eastern Holding A, 55.8–58.8 m, leg. TMSI team, 13 May 2013 (5514 TB1-001); 1 ov. female, OUMNH.ZC. 2014-11-219, sta. TB169, near Pulau Sudong and Pulau Semakau, sandy bottom, 17.9–18.9 m, leg. B. Richer de Forges et al., 25 May 2013 (SIN-125); 2 females, 1 ov. female, ZRC 2014.0516, N of Pulau Jong, 43.3–74.6 m, leg. TMSI team, 15 May 2013 (4713 DR3-186-188); 2 males, 3 ov. females, OUMNH.ZC. 2014-11-220, sta. DR161, near St. John's I., 41.2–44.4 m, gravel, leg. B. Richer de Forges et al., 04 June 2013 (SIN-346); 2 males, 2 ov. females, OUMNH.ZC. 2014-11-221, sta. TB113, Southern Fairway, S of Sisters Is., 29.3–30.5 m, rocky bottom, leg. B. Richer de Forges et al., 29 May 2013 (SIN-246); 1 male, OUMNH.ZC. 2014-11-222, sta. DR125, near Sister Is., 25.3–30.8 m, sand, laterite gravel, leg. B. Richer de Forges et al., 31 May 2013; 1 male, OUMNH.ZC. 2014-11-223, sta. DR91, Southern Fairway, near St. John's I., 46.1–72.0 m, rocky bottom, leg. B. Richer de Forges et al., 27 May 2013 (SIN-171); 1 male, OUMNH.ZC. 2014-11-224, sta. DR174, near Kusu I., 79.6–135 m, reddish marine clay, gravel, shells, leg. B. Richer de Forges et al., 05 June 2013; 2 males, 2 females, OUMNH.ZC. 2014-11-225, sta. TB172, near Kusu I. and Eastern Boarding Ground A, 149–150 m, consolidated marine clay, leg. B. Richer de Forges et al., 05 June 2013; 1 male, OUMNH.ZC. 2014-11-226, sta. TB96, near Eastern Bunkering A, 22.4–25.1 m, clay, leg. B. Richer de Forges et al., 29 May 2013; 1 female, 1 ov. female, OUMNH.ZC. 2014-11-227, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3252); 1 ov. female, OUMNH.ZC. 2014-11-228, sta. SW10, St. John's I., DRTech, pontoon at southern lagoon, in fouling growth, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013; 2 males, 3 ov. females, OUMNH.ZC. 2014-11-229, sta. SW136, Lazarus I., jetty, 0–0.5 m, fouling growth, leg. K. Tilbrook et al., 31 May 2013 (SIN-297); 1 male, OUMNH.ZC. 2014-11-230, sta. DR256, between Pulau Bukom and Terumbu Pempang Laut, 17.2–18.4 m, rocks, sand, barrel sponges, leg. TMSI team, 18 December 2013 (SEA-3024) [infested by both bopyrine and hemiarthrine isopods].

Additional material. Strait of Singapore. 1 ov. female, ZRC 1997.577B, Sentosa, leg. D.G.B. Chia, Z.L. Xu, I.1992; 1 ov. female, ZRC 1979.4720, Outer Shoal, mud, stones, shells, 11 m, SRFRS B25, 24 June 1954; 1 male, 1 ov. female, ZRC 1991.9661-62, Pulau Semakau, sledge 1, leg. Reef Ecology Study Team, 18 April 1990; 1 ov. female, ZRC 1991.9659, Pulau Semakau, sledge 2, leg. Reef Ecology Study Team, 18 April 1990; 1 female (?), ZRC 1991.9498, Pulau Semakau, sledge 2, leg. Reef Ecology Study Team, 13 March 1989; 1 female, ZRC 2014.0646, off Pulau Semakau, dredge, leg. D. Lane, P.K.L. Ng, S.H. Tan, 03 February 1994; 6 specimens (both sexes, incl. 1 ov. female), ZRC 2014.0528, Selat Sinki, commensal on "*Retepora* sp.", leg. C.F. Lim, 26 July 1971 [two specimens infested by hemiarthrine isopods].

Distribution. Indo-west Pacific: southern China, Indonesia, Singapore, Philippines and Australia.

Previous records from Singapore. Johnson (1979).

Ecology. Subtidal soft bottoms (sand and sand with mud), with sponges, soft corals and bryozoans, often associated with lace corals, e.g., *Triphyllozoon* sp.; lower intertidal (rare) to 135 m, typical depth range around 5–50 m (CMBS material).

Remarks. *Synalpheus iocasta* is one of the most common species of *Synalpheus* in Singapore and can be easily recognised by (1) the peculiarly elongate and distally minutely bifid dactylus of the third to fifth pereopods, and (2) the red "polka-dot" spots evenly distributed over the entire body and

appendages, including the major chela (Fig. 46). In addition, this species is frequently found associated with lace corals of the genus *Triphyllozoon* (Fig. 46C). In Singapore, *S. iocasta* occurs mainly in the Strait of Singapore, e.g., around Kusu Island, Pulau Jong, Pulau Semakau, Sister Islands, Raffles Lighthouse, Selat Sinki etc., and the eastern entrance to the Straits of Johor.

One male specimen of *S. iocasta* (OUMNH.ZC. 2014-11-230) was infested by two species of parasitic isopods from the family Bopyridae. The left flank of the carapace of this individual was grossly deformed by a very large female of Bopyrinae, whereas a smaller female of Hemiarthrinae was fixed on the sternal side of the anterior abdominal somites; both females were accompanied by miniature males. To our knowledge, a double infestation by bopyrids belonging to these two morphologically different groups is extremely rare in snapping shrimps.

Synalpheus iphinoe De Man, 1909
(Fig. 47)

Synalpheus iphinoë De Man, 1909b: 116; De Man, 1911: 219.
Synalpheus iphinoe — Johnson, 1962: 50; Johnson, 1963: 287; Johnson, 1979: 43; Banner & Banner, 1985: 43.
(?) *Synalpheus* cf. *gravieri* (nec Coutière, 1905) — Goh et al., 1999: 269.
(?) *Synalpheus* sp. — Ng & Goh, 1996: 659.

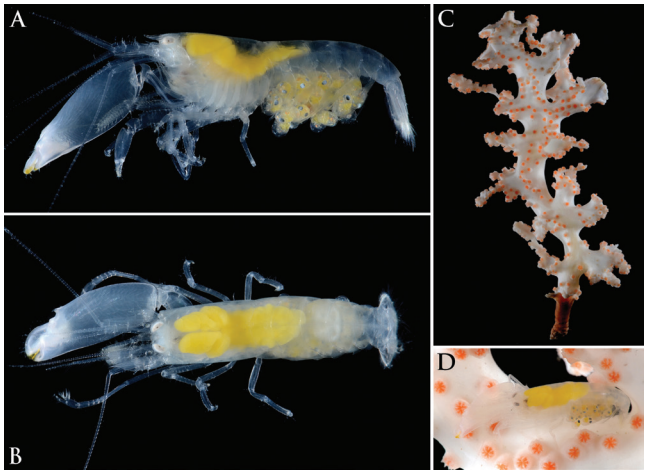

Fig. 47. *Synalpheus iphinoe* De Man, 1909: ovigerous female dredged off Changi Naval Base, Strait of Singapore, CMBS sta. 0218 DR2 (OUMNH.ZC. 2014-11-231): A, B, shrimp in lateral (A) and dorsal (B) views; C, hollow-steam gorgonian, *Solenocaulon* sp., host of *S. iphinoe*; D, shrimp together with host (Photographs by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, OUMNH. ZC. 2014-11-231, SE of Changi Naval Base, 10.9–17.5 m, sand, gravel, associated with *Solenocaulon* sp., leg. S.C. Lim, A. Anker, C.K. Chim et al., 08 April 2014 (0218 DR2-AA49).

Additional material. Strait of Singapore. 1 male, 1 ov. female, ZRC 1979.4.7, between N of Pulau Pawal and Pawal reef, in hollow-stem gorgonian, 04 January 1969 (J9277-9278); 1 male, ZRC 1979.4.7.23, off SE Pulau Bukum, in alcyonarian, 20 m, leg. L. Harris, 18 February 1968; 1 male, 1 ov. female, ZRC 1979.4.7.21-22, Johor Shoals, sand, small stones, shells, crinoids and alcyonaceans, 17 June 1954.

Distribution. Indo-west Pacific: southern Japan, Indonesia and Singapore.

Previous records from Singapore. Johnson (1962, 1979); probably also Ng & Goh (1996, as *Synalpheus* sp.) and Goh et al. (1999, as *Synalpheus* cf. *gravieri* Coutière, 1905).

Ecology. Deeper parts of coral reefs and adjacent soft sediment bottoms with abundance of gorgonians, possibly obligate associate of hollow-stem gorgonians of the genus *Solenocaulon* (misidentified as *Telesto* sp., see below); depth range: 9–70 m (De Man, 1911).

Remarks. *Synalpheus iphinoe* is morphologically very close to *S. neomeris* (De Man, 1897) (see below), differing from it in some subtle details, e.g., the proportions of the dactylus on the third and fourth pereopods and the position of dorsal spines on the telson. The two species also differ ecologically: *S. iphinoe* associates with hollow-stem gorgonians, *Solenocaulon* spp. (Fig. 47C, D), whilst *S. neomeris* lives symbiotically on spiny soft corals, *Dendronephthya* spp. The record of *S. iphinoe* from "*Telesto* sp." (Johnson, 1962) is a misidentification of the host, which is the same as for the porcellanid crab *Aliaporcellana telestophila* (Johnson, 1958) (see Ng & Goh, 1996). The snapping shrimp reported as *Synalpheus* sp. by Ng & Goh (1996) and *S.* cf. *gravieri* Coutière, 1905 by Goh et al. (1999) most likely corresponds to *S. iphinoe* as it was found on "*Solenocaulon* sp. B". In Singapore, *S. iphinoe* appears to be rather uncommon, possibly due to the rarity of its hosts. The presently available material consists of only a few specimens collected off Changi and Johor Shoals and north of Pulau Pawai.

Synalpheus jedanensis De Man, 1909

Synalpheus jedanensis De Man, 1909b: 117; De Man, 1911: 222; De Man, 1922: 27; Johnson, 1962: 50; Johnson, 1979: 43; Banner & Banner, 1985: 43; Hayashi, 1996: 309.

CMBS material. None.

Additional material. Straits of Johor. 1 male, ZRC 1979.4.7.29, Johor Shoals, ~18 m, sand, small stones, shells, crinoids, 17 June 1954. Strait of Singapore. 1 ov. female, ZRC 1979.4.7.30, Outer Shoal, 11 m, mud, stones, shells, sta. B25, leg. S.R.F.R.S., 24 June 1957 (J7275).

Distribution. Indo-west Pacific: southern Japan to Indonesia and Singapore.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Poorly known, probably deeper silty parts of coral reefs; known depth range: 11–18 m.

Remarks. The taxonomic status of *S. jedanensis* is somewhat problematic. The species was placed in the synonymy of *S. iphinoe* by Banner & Banner (1985: 43), but considered as valid by Hayashi (1996). As already mentioned for *S. iphinoe*, the entire *S. neomeris* complex needs a thorough revision.

Synalpheus neomeris (De Man, 1897) sensu lato
(Fig. 48)

Alpheus neomeris De Man, 1897: 734 (part).
Synalpheus neomeris — De Man, 1911: 186; Johnson, 1962: 50; Banner & Banner, 1975b: 357; Johnson, 1979: 43; Banner & Banner, 1978: 243; Banner & Banner, 1985: 51; Chace, 1988: 81.
(?) *Synalpheus gravieri* Coutière, 1905: 870; De Man, 1911: 216.
(?) *Synalpheus gravieri* — Johnson, 1962: 50; Johnson, 1963: 287; Banner & Banner, 1966a: 48; Johnson, 1979: 43.
(?) *Synalpheus miscellaneus* De Man, 1909b: 118; De Man, 1911: 224.

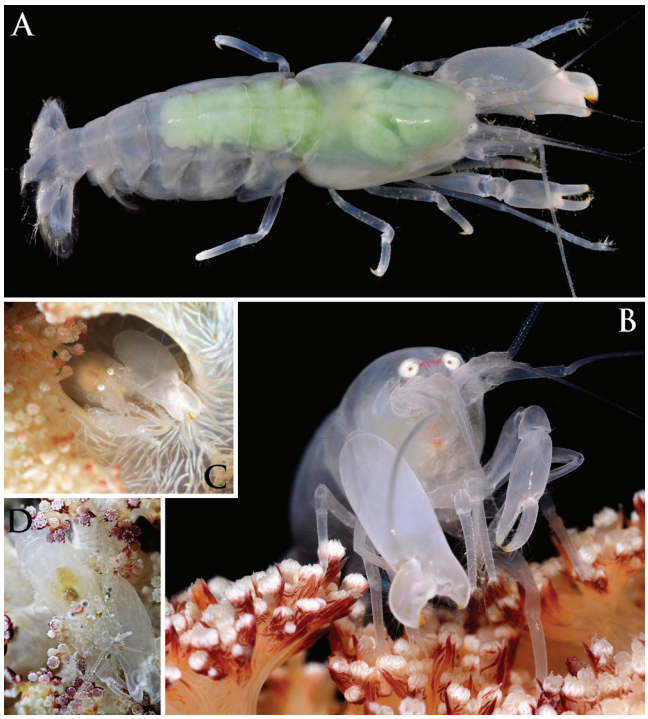

Fig. 48. *Synalpheus neomeris* (De Man, 1897) sensu lato: A, ovigerous female dredged off Pulau Sekudu, Straits of Johor, CMBS sta. DW7 (OUMNH.ZC. 2014-11-419); B, ovigerous female dredged near near Sungei Gedong, Straits of Johor, CMBS sta. 4025 DR1 (OUMNH.ZC. 2014-11-232), photographed in vitro on soft coral host, *Dendronephthya* sp.; C, D, two males from Pulau Hantu, Strait of Singapore, photographed in situ on soft coral host, *Dendronephthya* sp. (specimens not collected) (Photographs by: Arthur Anker [A, B], Heng Pei Yan [C] and Kelvin Pung [D]).

CMBS material. Straits of Johor. 3 males, ZRC 2014.0402, Pulau Tekong, Beting Bronok, in *Dendronephthya* sp., leg. C.K. Chim, J.Y. Ong, 04 August 2012 (NC001-003); 2 males, ZRC 2014.0403, off Western Catchment, leg. TMSI team, 27 June 2012 (3923 TR12-001-002); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-232, near Sungei Gedong, 7.3–9.8 m, mud, sand, sponges, in *Dendronephthya* sp., leg. C.K. Chim, A. Anker, S.C. Lim et al., 09 April 2014 (4025 DR1-AA71-72); 1 ov. female, ZRC 2014.0611, same collection data (4025 DR1-AA73); 1 male, 1 female, OUMNH.ZC. 2014-11-233, near Chenting, 10.6–12.4 m, mud, sand, sponges, in *Dendronephthya* sp., leg. C.K. Chim, A. Anker, S.C. Lim et al., 09 April 2014 (3822 DR1-AA88); 1 post-ov. female, OUMNH.ZC. 2014-11-234, same collection data (3822 DR2-AA89); 1 post-ov. female, OUMNH.ZC. 2014-11-419, sta. DW7, ~400 m SE of Pulau Sekudu, 6.1–9.8 m, leg. B. Richer de Forges et al., 17 October 2012 (JS-0706). Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-420, off NW Sentosa, 17.7–20.1 m, in *Dendronephthya* sp., leg. TMSI team, 11 January 2013 (4815 TB1-020); 1 male, ZRC 2014.0735, between Pulau Semakau and Pulau Bukom, 21.1–21.9 m, leg. TMSI team, 03 July 2012 (D13-018); 1 male, ZRC 2014.0401, near Pasir Panjang Terminal, 24 m, 13 June 2012 (DR09-069); 1 male, ZRC 2014.0404, sta. TB71, NE of Pulau Sudong, 21.1–22.6 m, leg. B. Richer de Forges et al., 26 May 2013; 1 ov. female, ZRC 2014.0405, sta. TB71, same collection data; 1 male, OUMNH.ZC. 2014-11-236, sta. SD179, Terumbu Raya, 9.8 m, in *Dendronephthya* sp., leg. S. De Grave et al., 05 June 2013 (SIN-358).

Additional material. Straits of Johor. 1 ov. female, ZRC 2011.0539, Pulau Tekong, Beting Bronok, leg. Y. Cai, 07 February 2003; 1 ov. female, ZRC 2000.1492, Pulau Tekong, S.M. Sin, R. Teo, 27 January 1994. Strait of Singapore. 1 female, ZRC 1979.4.7.32, sta. B75, leg. S.R.F.R.S., 31 March 1955 (J7099).

Distribution. Indo-west Pacific, from the Red Sea and Madagascar to Japan, Korea, Indonesia, Australia and Fiji (possibly species complex).

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus gravieri* Coutière, 1905 and *S. neomeris*).

Ecology. Deeper parts of coral reefs and adjacent soft bottom habitats with abundance of soft corals, usually associated with spiny soft corals of the genus *Dendronephthya*, records of associations with other hosts rather doubtful (see below); depth range in Singapore 35–70 m according to Johnson (1962), however, most CMBS material was collected at 17.5–24 m.

Remarks. Morphological variation and diversity of hosts reported for *Synalpheus neomeris* suggest that this taxon may include more than one species. Two nominal species, *S. gravieri* Coutière, 1905 and *S. miscellaneus* De Man, 1909b, which are currently in the synonymy of *S. neomeris* (Banner & Banner, 1975b), may need a taxonomic re-evaluation. Johnson (1962, 1979) treated *S. gravieri* as distinct from *S. neomeris*, reporting both species from about the same depth range (30–70 m) in the Strait of Singapore. However, whether Johnson's identifications are correct and more generally, whether *S. neomeris* and *S. gravieri* indeed represent two species presently remains unknown. *Synalpheus neomeris* belongs to a larger Indo-west Pacific species complex, which also includes *S. iphinoe* De Man, 1909b and *S. jedanensis* De Man, 1909b. A thorough revision of the entire *S. neomeris* complex (*S. neomeris*, *S. gravieri*, *S. miscellaneus*, *S. iphinoe* and *S. jedanensis*) is needed in order to ascertain the taxonomic status of the Singaporean material.

Most host records for *S. neomeris* and *S. gravieri* refer to nephthyid alcyonaceans of the genus *Dendronephthya*, commonly known as spiny soft corals or carnation corals. Indeed, all Singaporean specimens of *S. neomeris* were found associated with *Dendronephthya* spp. [tentative identification] (Fig. 47B), usually in male-female pairs, although shrimps are often dislodged from their hosts in dredges. Other host records for *S. neomeris* include the soft coral *Xenia hicksoni* Ashworth (Xeniidae), the hollow-stem gorgonian *Solenocaulon* sp. (Anthotheliidae), and sponges and bryzoans (Miya, 1972; Banner & Banner, 1975b, 1978; Bruce, 1988a). However, records from *Solenocaulon* sp. may refer to the closely related *S. iphinoe* (see above), which can be easily confused with *S. neomeris*, whereas records from sponges and bryzoans may be due to shrimps dislodged from their original hosts.

Synalpheus neptunus (Dana, 1852) sensu lato

Alpheus neptunus Dana, 1852a: 22; Dana, 1852b: 553.
(?) *Alpheus minus*, var. *neptunus* — Walker, 1887: 112.
Synalpheus neptunus — Johnson, 1962: 51; Johnson, 1979: 43; Chace, 1988: 82.
Synalpheus neptunus neptunus — Banner & Banner, 1972: 24; Banner & Banner, 1975b: 317; Banner & Banner, 1978: 244; Banner & Banner, 1985: 52.

CMBS material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.0628, sta. TB187, near Raffles Lighthouse, 39.5–40.2 m, sponges, rocks, gravel, leg. B. Richer de Forges et al., 06 June 2013; 1 ov. female, OUMNH.ZC. 2014-11-237, sta. DR223, W of Pulau Senang and Raffles Lighthouse, 39.8–41.7 m, leg. TMSI team, 29 October 2013 (SEA-1502).

Distribution. Indo-west Pacific, from the Red Sea and Mascarene Islands to Japan, Australia and Fiji.

Previous records from Singapore. Walker (1887) (unconfirmed record); Banner & Banner (1966a, as *Synalpheus theano* De Man, 1910); Johnson (1979).

Ecology. Coral reefs and associated habitats, in dead coral heads and various sponges; known depth range: 2–20 m.

Remarks. Banner & Banner (1975b) established the nominal subspecies *S. neptunus neptunus*, from which they separated *S. neptunus germanus* Banner & Banner, 1975. However, *S. neptunus neptunus* still remains a morphologically and biologically variable taxon, probably containing more than one species (A. Anker, pers. obs.). In addition, *S. neptunus* was often confused with *S. theano* De Man, 1910 (see below), including by Banner & Banner (1966a), who misidentified and reported the Singaporean material of *S. neptunus* as *S. theano*. In view of the very poor taxonomic knowledge of *Synalpheus* in the 19th century, the true identity of Walker's (1887) record of *S. neptunus* from Singapore is highly questionable.

The CMBS material of *S. neptunus* sensu lato is represented by three specimens trawled or dredged from a depth of about 40 m off Raffles Lighthouse in the Singapore Strait. This material differs in several characters from the neotype of *S. neptunus* (see Banner & Banner, 1972). The male-female pair (ZRC 2014.0628) approaches *S. neptunus* in most features, except for the more projecting and more pointed distal tooth on the palm of the major chela, and the more anteriorly positioned spiniform setae (e.g., both pairs anterior to telson mid-length in the female). The ovigerous female (OUMNH. ZC. 2014-11-237) differs from the other specimens (and typical *S. neptunus*) in having four (instead of five) articles in the carpus of the right second pereopod, the left presenting four articles with an indication of the fifth (incomplete division). It must be noted that the number of carpal articles (four vs. five) is a character of great importance in the genus *Synalpheus* (e.g., Banner & Banner, 1975b; Ríos & Duffy, 2007); however, with only a single specimen available, no further conclusions can be drawn at this stage. Even if this specimen corresponds to an undescribed taxon, the latter should only be described within a revisionary framework of the entire *S. neptunus* species complex (including *S. neptunus neptunus*, *S. neptunus germanus* and *S. theano*).

Synalpheus quadriarticulatus Banner & Banner, 1975

Synalpheus quadriarticulatus Banner & Banner, 1975b: 297; Banner & Banner, 1982: 309; Chace, 1988: 84.
Synalpheus pescadorensis (nec Coutière, 1905) — Johnson, 1962: 51; Johnson, 1979: 43.

CMBS material. None.

Additional material. Strait of Singapore. 1 ov. female, ZRC 1979.4.7.37, Pulau Sudong, about 1–1.8 m, in large head of *Pavona frondifera*, leg. D.S. Johnson, 19 February 1955 (J7202) [det. D.S. Johnson as *S. pescadorensis* Coutière, 1905].

Distribution. Indo-west Pacific: Australia, Philippines, Singapore.

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus pescadorensis* Coutière, 1905).

Ecology. Coral reefs, in cryptic sponges in dead coral heads; depth range: 1–18 m (Chace, 1988; present study).

Remarks. *Synalpheus quadriarticulatus* is one of the few Indo-west Pacific species of the genus with four articles in the carpus of the second pereopod. In addition, in *S. quadriarticulatus*, the rostro-orbital process is absent and the minor cheliped of has deeply excavated, spoon-shaped fingers, two features shared with *S. pescadorensis* Coutière, 1905. This may be the reason why Johnson (1962, 1979) misidentified his single specimen from Pulau Sudong as *S. pescadorensis*.

Synalpheus quadrispinosus De Man, 1910
(Fig. 49)

Synalpheus quadrispinosus De Man, 1910: 298; De Man, 1911: 285; Johnson, 1962: 51; Johnson, 1963: 288; Johnson, 1979: 43; Banner & Banner, 1985: 53; Chace, 1988: 84.
(?) *Synalpheus quadridens* De Man, 1910: 299; De Man, 1911: 284.

Fig. 49. *Synalpheus quadrispinosus* De Man, 1910: male dredged off Pulau Ubin, Straits of Johor, CMBS sta. DW20 (OUMNH.ZC. 2014-11-240) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 2 males, ZRC 2014.0408, sta. D23, Pulau Ubin, N of OBS Camp 1, 5.2–5.5 m, among sea pens, leg. TMSI team, 08 March 2012; 1 male, 1 ov. female, ZRC 2014.0409, sta. D23, same collection data (D23-456-457); 1 ov. female, ZRC 2014.0407, sta. D23, same collection data (D23-458); 1 male, OUMNH.ZC. 2014-11-238, sta. DW18, N of Pulau Ubin, 6.2–12.9 m, B. Richer de Forges et al., 18 October 2012; 1 ov. female, OUMNH. ZC. 2014-11-239, sta. DW21, off N Pulau Ubin, 13.8–16.2 m, leg. B. Richer de Forges et al., 18 October 2012 (JS-1411); 1 male, OUMNH.ZC. 2014-11-240, sta. DW20, off N Pulau Ubin, 10.3–10.6 m, leg. B. Richer de Forges et al., 18 October 2012 (JS-0770); 1 ov. female, ZRC 2014.0406, sta. DW117, ~100 m from shore off Changi beach (towards CAFHI jetty), 5.3–9.9 m, mud, leg. B. Richer de Forges et al., 30 October 2012 (JS-2688). Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-241, sta. DR184, near Raffles Lighthouse, 31.6–35.4 m, rocks, gravel, sand, shells, leg. B. Richer de Forges et al., 06 June 2013.

Additional material. Straits of Johor. 1 ov. female, ZRC 1979.4.9.1, Johor Shoals, sand, small stones and shells, commensal on crinoids (?), leg. D.S. Johnson, 17 June 1954 (J8014). Strait of Singapore. 1 male, ZRC 1979.4.9.2, Tanjong Rhu, mud, 4 m, sta. B50, leg. S.R.F.R.S., 28 October 1954 (J7202).

Distribution. Indo-west Pacific: Singapore, Indonesia, Philippines, Papua New Guinea and Micronesia.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Subtidal muddy and sand-gravel bottoms with various sessile invertebrates, sometimes found among sea pens (present material) or on crinoid grounds (Johnson, 1962); depth range in Singapore based on present material: 5–35 m, in the Philippines: 38–55 m (Chace, 1988), maximum depth recorded in Indonesia: 128 m (Banner & Banner, 1985).

Remarks. *Synalpheus quadrispinosus* can be distinguished from all other species of *Synalpheus* present in Singapore waters by the presence of four sharp, posteriorly projecting teeth on the sixth abdominal somite and the distally pinkish major chela (Fig. 49). The species is moderately common in Singapore, with most material collected in moderately deep water in the eastern Straits of Johor (off Pulau Ubin and Changi), Johor Shoals, and off Tanjong Rhu (historically) and Raffles Lighthouse in the Strait of Singapore. Johnson (1962) stated that *S. quadrispinosus* "appears to be commensal of crinoids", although there is presently no evidence for such an association; for instance, some CMBS specimens were found among sea pens.

Synalpheus stimpsonii (De Man, 1888) sensu lato
(Fig. 50)

Alpheus stimpsoni De Man, 1888a: 513.
Synalpheus stimpsonii (or *S. stimpsoni*) — Johnson, 1962: 50; Johnson, 1963: 288; Banner & Banner, 1966a: 46; Banner & Banner, 1975b: 292; Johnson, 1979: 43; Banner & Banner, 1978: 246; Banner & Banner, 1985: 54; Chace, 1988: 86; VandenSpiegel et al., 1998: 186.
(?) *Synalpheus stimpsoni* var. *maldivensis* Coutière, 1905: 878.
(?) *Alpheus amboinae* Zehntner, 1894: 202.
(?) *Synalpheus amboinae* — De Man, 1911: 203; De Man, 1922: 26; Johnson, 1962: 50; Johnson, 1963: 288; Johnson, 1979: 42.
(?) *Alpheinus tridens* Borradaile, 1900: 415.
(?) *Alpheus comatularum* (nec Haswell, 1882) — Walker, 1887: 112.

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0414, sta. SD89, off Small Sister I., ~14.7 m, silted reef, in crinoid, leg. S. De Grave, D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-0272); 1 male, ZRC 2014.0417, sta. SD66, Pulau Hantu, ~3 m, shallow silted reef, on crinoid, leg. S. De Grave, Z. Jaafar, H.H. Tan et al., 26 May 2013 (SS-1644); 1 male, ZRC 2014.0416, sta. SD25, SW St. John's I., ~7.6 m, silty reef, on crinoid, leg. D. Uyeno, H.H. Tan et al., 23 May 2013 (SS-1574); 1 ov. female, ZRC 2014.0415, sta. SD45, channel between Lazarus I. and St. John's I., ~16.2 m, leg. H.H. Tan. Z. Jaafar et al., 24 May 2013; 1 male, OUMNH.ZC. 2014-11-242, sta. SD45, same collection data (SIN-061); 1 ov. female, OUMNH.ZC. 2014-11-243, sta. SD56, off S Pulau Jong, 17 m, on crinoid *Phanogenia typica*, leg. S. De Grave et al., 24 May 2013 (SIN-090); 1 female, ZRC 2014.0418, sta. SD54, SW Kusu I., ~7.8 m, silty reef, in crinoid, leg. S. De Grave, D. Uyeno, H.H. Tan et al., 25 May 2013 (SS-2046); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-244, sta. SD133, S Kusu I., ~11 m, on crinoid, leg. S. De Grave et al., 31 May 2013 (SIN-261); 1 male, OUMNH.ZC. 2014-11-245, sta. SD167, SW Pulau Jong, ~15.4 m, on crinoid *Phanogenia typica*, leg. H.H. Tan et al., 04 June 2013 (SIN-345); 1 male, 1 ov. female, OUMNH. ZC. 2014-11-246, sta. SD179, Terumbu Raya, ~9.8 m, leg. S. De Grave et al., 05 June 2013 (SIN-359); 1 male, ZRC 2014.0419, sta. SD178, Terumbu Pempang Tengah, ~9.6 m, silty reef, on crinoid, leg. S. De Grave, C.W. Lin, H.H. Tan

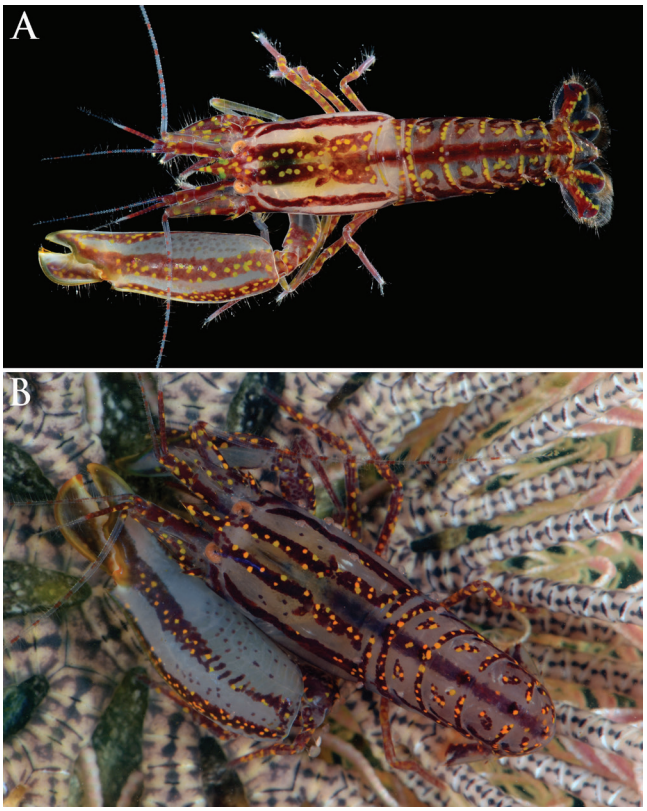

Fig. 50. *Synalpheus stimpsonii* (De Man, 1888) sensu lato: A, male from Pulau Semakau, Strait of Singapore, CMBS sta. SB41 (OUMNH.ZC. 2014-11-197); B, female dredged off Kusu Island, Strait of Singapore, CMBS sta. TB157 (OUMNH.ZC. 2014-11-201), photographed in vitro on crinoid host, note five symbiotic copepods on right dorsolateral surface of the carapace (Photographs by: Arthur Anker).

et al., 06 June 2013; 1 male, 2 ov. females, ZRC 2014.0420, sta. TB69, near Pulau Sudong and Pulau Semakau, 17.9–18.9 m, sandy bottom, leg. B. Richer de Forges et al., 26 May 2013 [females without chelipeds]; 1 male, ZRC 2014.0421, sta. TB72, S of Pulau Hantu, 23.1–23.6 m, leg. B. Richer de Forges et al., 26 May 2013; 1 male, OUMNH.ZC. 2014-11-247, sta. SD150, SW Kusu I., 10.7 m, on crinoid, leg. S. De Grave et al., 01 June 2013.

Additional material. Strait of Singapore. 1 ov. female, ZRC 1993.519, Pulau Hantu, crinoid, leg. D. Van den Spiegel, V.1992; 1 ov. female, ZRC 1979.4.9.8, Ajax-Sultan Shoal, 16 m, leg. S.R.F.R.S., 7 July 1954 (J7200); 1 male, 1 ov. female, ZRC 1979.4.6.16-17, same collection data (J7100-7101) [det. D.S. Johnson as *S. amboinae* (Zehntner, 1894)].

Distribution. Indo-west Pacific, from Kenya and Madagascar to Japan, Indonesia, Philippines, Micronesia, and Australia (species complex).

Previous records from Singapore. Johnson (1962, 1979, as *Synalpheus consobrinus* De Man, 1909b, *S. amboinae* (Zehntner, 1894), and *S. stimpsonii*; see also below); possibly also Walker (1887, as *Alpheus comatularum* Haswell, 1882).

Ecology. Coral reefs and associated habitats with abundance of crevices and other crinoid shelters, associated with crinoids, mainly in the family Comatulidae (*Comanthus* spp. *Comanthina* spp., *Phanogenia* spp., but see comments below); shallow subtidal to 155 m (Banner & Banner, 1983), most Singaporean specimens found at a depth range of 3–24 m.

Remarks. *Synalpheus stimpsonii* and the entire *S. comatularum* (Haswell, 1882) species group, to which it belongs, are in need of a thorough taxonomic revision. Some nominal species currently treated as junior synonyms of the supposedly morphologically variable *S. stimpsonii* (Banner & Banner, 1975b), such as *S. amboinae* (Zehntner, 1894) and *S. brucei* Potts, 1915, may actually be valid. The rather narrow host specificity of *S. stimpsonii* shown by Van den Spiegel et al. (1998), as well as variation in the colour patterns (A. Anker, pers. obs.) and genetic data (Hultgren et al., 2014) all suggest that *S. stimpsonii* is a species complex.

Johnson (1962, 1979) reported both *S. stimpsonii* and *S. amboinae* from Singapore, but did not comment how he was able to distinguish between them. Johnson's (1979) material identified as *S. stimpsonii* came from Raffles Lighthouse, and as *S. amboinae* from Johor and Ajax-Sultan Shoals (17–18 m) and several localities in the Strait of Singapore (down to 70 m). Under *S. consobrinus*, Johnson noted "I agree with Banner and Banner (1966a) in regarding this as a synonym of *S. stimpsonii* de Man" and "Singapore material spans the gap between the two supposed forms". Therefore, and because of the invalidation of *S. consobrinus* and *S. amboinae* proposed by Banner & Banner (1966, 1975b) and accepted in all later studies (e.g., Banner & Banner, 1983, 1985; Chace, 1988), all material from Singapore must be referred to as *S. stimpsonii* sensu lato. Walker's (1887) earlier record of *S. comatularum* (Haswell, 1882) from Singapore may also refer to *S. stimpsonii* sensu lato.

During CMBS, most crinoids containing *S. stimpsonii* were collected by scuba diving on silted reefs of Singapore's southern islands (e.g., Pulau Hantu, Sister Islands, St. John's Island, Kusu Island, Pulau Jong, Terumbu Raya, Terumbu Pempang Tengah) or trawled / dredged from crinoid-rich grounds, e.g., near Pulau Sudong. Two of the hosts were identified as *Phanogenia typica* Lovén (C. Messing, pers. comm.). A small group of symbiotic poecilostomatoid copepods was found associated with one individual of *S. stimpsonii* (visible in Fig. 50B); these copepods are currently being studied by D. Uyeno.

***Synalpheus streptodactylus* Coutière, 1905 sensu lato**
(Fig. 51)

Synalpheus neomeris var. *streptodactylus* Coutière, 1905: 870.
Synalpheus streptodactylus — De Man, 1911: 226; Banner & Banner, 1975b: 362; Johnson, 1979: 43; Banner & Banner, 1978: 246; Banner & Banner, 1985: 55; Chace, 1988: 87.
Synalpheus streptodactylus streptodactylus — Banner & Banner, 1966a: 50.
Synalpheus streptodactylus hadrungus Banner & Banner, 1966b: 158.
Synalpheus metaneomeris Coutière, 1921: 414.
Synalpheus metaneomeris var. *streptodactylus* Coutière, 1921: 414.
Synalpheus neomeris (nec De Man, 1897) — (?) De Man, 1902: 891; Coutière, 1905: 869.

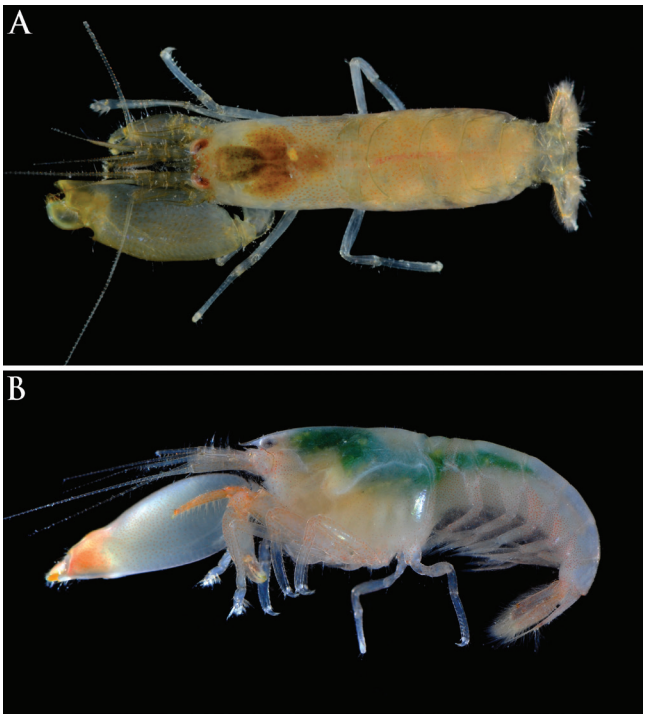

Fig. 51. *Synalpheus streptodactylus* Coutière, 1905 sensu lato: A, ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SW10 (OUMNH.ZC. 2014-11-258); B, female dredged off Sentosa, Strait of Singapore, CMBS sta. 4815 TB1 (ZRC 2014.0499) (Photographs by: Arthur Anker).

(?) *Synalpheus streptodactyloides* De Man, 1909b: 114; De Man, 1911: 230.

CMBS material. Straits of Johor. 1 male, OUMNH.ZC. 2014-11-248, off Tengeh Reservoir, 12.2–13.3 m, leg. C.K. Chim, S.C. Lim, A. Anker et al., 09 April 2014 (3821 DR2-AA85). Strait of Singapore. 1 ov. female, ZRC 2014.0500, off NW Sentosa, 17.7–20.1 m, leg. TMSI team, 11 January 2013 (4815 TB1-019); 1 female, ZRC 2014.0499, same collection data (4815 TB1-058); 1 female, OUMNH.ZC. 2014-11-250, N of Pulau Seringat, 8.1–11.8 m, leg. TMSI team, 04 January 2013 (5114 TB1-053); 1 male, ZRC 2014.0492, E of Bedok Jetty, 6.0–7.5 m, leg. TMSI team, 24 January 2013 (5718 TB1-036); 1 male, ZRC 2014.0498, same collection data (5718 TB1-086); 1 male, ZRC 2014.0491, E of Bedok Jetty, 9.1–10.6 m, leg. TMSI team, 24 January 2013 (5718 DR1-041); 1 female, ZRC 2014.0497, between Pulau Sudong and Pulau Semakau, 9.4–11.6 m, leg. TMSI team, 13 March 2013 (4412 DR1-011); 1 male, ZRC 2014.0507, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-010); 2 females, ZRC 2014.0511, near Pasir Panjang Terminal, 24 m, 13 June 2012 (DR09-160-161); 2 ov. females, ZRC 2014.0503, S of Pulau Semakau, 16.1–17 m, leg. TMSI team, 18 July 2012, 18 July 2012 (TR4511A-018-019); 1 ov. female, ZRC 2014.0494, sta. TB28, Eastern Boarding Ground A (E of Kusu I.), 94.3–97.6 m, gravel, rocks, leg. B. Richer de Forges et al., 23 May 2013 (SS-1573); 6 specimens (sex not determined), ZRC 2014.0502, sta TB99, Eastern Bunkering A, 26.7–33.7 m, bryozoan dominated silty bottom, leg. B. Richer de Forges et al., 29 May 2013; 1 male, ZRC 2014.0505, sta. DR183, near Raffles Lighthouse, 39.7–42.1 m, rocks, gravel, sand, shells, leg. B. Richer de Forges et al., 06 June 2013; 2 males, ZRC 2014.0506, sta. DR184, near Raffles Lighthouse, 31.6–35.4 m, rocks, gravel, sand, shells, leg. B. Richer de Forges et al., 06 June 2013; 2 males, OUMNH.ZC. 2014-11-251, sta. DR161, near St. John's I., 41.2–44.4 m, gravel, leg. B. Richer de Forges et al., 04 June 2013 (SIN-346A); 1 ov. female, ZRC 2014.0509, sta. DR174, near Kusu I., 79.6–135 m, reddish marine clay, gravel, shells, leg. B. Richer de Forges et al., 05 June 2013; 1 male, 1 female, OUMNH.ZC. 2014-11-252, sta. DR174, same collection data; 1 male, ZRC 2014.0501, N of Pulau Jong, 40.8 m, leg. TMSI team, 15 May 2013 (4713 DR1-078); 1 male, OUMNH.ZC. 2014-11-253, sta. TB15, Eastern Fairway, 23.8–21.5 m, silt, gravel, leg. B. Richer de Forges et al., 21 May 2013 (SIN-017); 2 males, OUMNH.ZC. 2014-11-254, sta. TB113, Southern Fairway, S of Sisters Is., 29.3–30.5 m, rocky bottom, leg. B. Richer de Forges et al., 29 May 2013 (SIN-246A); 1 male, OUMNH.ZC. 2014-11-255, sta. TB16, outside Eastern Boarding Ground A, 89.5–98 m, in *Xestospongia* sp., leg. B. Richer de Forges et al., 22 May 2013; 1 male, 1 ov. female, ZRC 2014.0508, sta. SB85, SW Pulau Tekukor, 4.5 m, coral rubble brushing, leg. D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-2721C); 1 male, ZRC 2014.0495, sta. SB85, same collection data (SS-2730); 1 ov. female, OUMNH.ZC. 2014-11-256, Pulau Semakau landfill phase 2, leg. H.H. Tan et al., 08 August 2012; 1 ov. female, OUMNH.ZC. 2014-11-257, sta. IT118, St. John's I., AVA jetty, rock-rubble shore, leg. J.K. Lowry, N. Bruce, 31 May 2013; 1 ov. female, OUMNH.ZC. 2014-11-258, sta. SW10, St. John's I., DRTech, pontoon at southern lagoon, in fouling growth, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013 (SS-0318); 1 male ZRC 2014.0493, sta. SW10, same collection data (SS-0323); 1 ov. female, ZRC 2014.0504, sta. SW10, same collection data (SS-0331A); 1 male, ZRC 2014.0496, sta. SW10, same collection data (SS-0315); 1 male, OUMNH.ZC. 2014-11-259, sta. SW10, same collection data (SIN-034); 1 male, OUMNH.ZC. 2014-11-260, sta. SW10, same collection data (SIN-028); 1 male, OUMNH.ZC. 2014-11-261, sta. SW10, same collection data (SIN-029A); 1 male, 1 ov. female, ZRC 2014.0512, sta. IT95, Raffles Lighthouse, intertidal sand flat with rocks, coral rubble and some living corals, under large rocks at low tide, leg. A. Anker et al., 29 May 2013; 1 female, ZRC 2014.0510, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3252A); 3 males, 1 female, 2 ov. females, OUMNH.ZC. 2014-11-262, sta. SW6, St. John's I., DRTech, south lagoon, under pontoon, leg. S. De Grave & K. Tilbrook, 20 May 2013 (SIN-278C).

Additional material. Strait of Singapore. 1 male, ZRC 1979.4.7.19, W of Pulau Pawal, shell, gravel, XII.1952 [tentative re-identification, det. D.S. Johnson as *S. hilarulus* De Man, 1910]; 1 male, 2 ov. females, ZRC 1979.4.9.15-17, off Selat Sinki, dredge, ~23 m, stones, shells, gravel, gorgonians, in reteporid bryozoan, leg. B.C. Lim, C.F. Lim, 24 February 1969 (J9268-9270); 1 male, 2 ov. females, ZRC 2014.0639, near RSYC (Republic of Singapore Yacht Club), leg. S.H. Tan, 07 July 2009; 1 male, ZRC 2000.1395, Labrador Beach leg. KL Yeo, 21 April 1991.

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan, Australia and French Polynesia (possibly species complex, see below).

Previous records from Singapore. Johnson (1979).

Ecology. Coral reefs and rubble flats, in crevices of dead corals and sponges; intertidal to 135 m (CMBS material).

Remarks. *Synalpheus streptodactylus* may need a more careful taxonomic study, as morphological variability of this taxon (Banner & Banner, 1975b) suggests that it may be a species complex. It is one of the most abundant alpheid shrimps in Singapore, found in the mixed rock-sand-rubble intertidal (Raffles Lighthouse, St. John's Island, Labrador Beach, Pulau Semakau, etc.); shallow subtidal, on silted reefs (1–10 m, e.g. Pulau Tekukor) and also in deeper subtidal habitats to at least 135 m (many stations throughout Strait of Singapore).

Synalpheus thai Banner & Banner, 1966

Synalpheus thai Banner & Banner, 1966a: 61; Banner & Banner, 1975b: 427; Johnson, 1979: 44; Banner & Banner, 1978: 246; Banner & Banner, 1985: 56; Chace, 1988: 87; Kazmi et al., 1991: 322.

CMBS material. Straits of Johor. 1 male, OUMNH.ZC. 2014-11-263, sta. DW17, Pulau Ubin, off OBS Camp 1 and Serangoon Harbour between OBS Camp 1 and Punggol, depth unknown, gill net and tangle net, leg. H.H. Ng and local fishermen, 16 October 2012. Strait of Singapore. 1 ov. female, ZRC 2014.0633, sta. DR264, outside of Punggol Jetty, 11.2–11.3 m, sand, mud, leg. TMSI team, 16 January 2014 (SEA-3637).

Additional material. Strait of Singapore. 1 ov. female, ZRC 1979.4.9.23, Pulau Hantu, crevices at coral base, C.L.S.T., leg. D.S. Johnson, 21 November 1953 [det. D.S. Johnson as *Synalpheus* sp. *laevimanus* group]; 1 male, ZRC 1979.4.9.24, Labrador Beach, crevices in dead coral rock, leg. D.S. Johnson, 07 February 1955 (J8082) [det. D.S. Johnson as *Synalpheus* sp.].

Distribution. Indo-west Pacific: Pakistan, Thailand, Philippines, Singapore and Hawaii.

Previous records from Singapore. Johnson (1979).

Ecology. Subtidal mud and mud-sand bottoms with dead corals and sponges, in crevices of dead coral heads and in sponges; lower intertidal and shallow subtidal, to at least 11 m (maximum depth currently known).

Remarks. *Synalpheus thai* is one of the most easily recognisable members of the genus, characterised by the posterolateral angles of the telson produced into very long sharp teeth (Banner & Banner, 1966a: fig. 19L). Johnson (1979) recorded *S. thai* for the first time from Singapore, without specifying an exact locality; however, examination and re-identification of Johnson's material in ZRC revealed that *S. thai* was collected by him in Pulau Hantu and Labrador Beach, in the Strait of Singapore. The CMBS material of *S. thai* was collected in the western Straits of Johor, in the channel separating Pulau Ubin from mainland Singapore. The male was extracted from substrata (probably sponges and coral rubble) brought up by gill and tangle nets, whereas the female was dredged from a depth of about 11 m. Unfortunately, the living colour of this very interesting species was not recorded.

Synalpheus theano De Man, 1910
(Fig. 52)

Synalpheus theano De Man, 1910: 296; De Man, 1911: 293.
Synalpheus theano — (?) Johnson, 1962: 50; Banner & Banner, 1972: 20; Banner & Banner, 1975b: 314; (?) Johnson, 1979: 44; Banner & Banner, 1985: 56; Chace, 1988: 88.
Not *Synalpheus theano* — Banner & Banner, 1966a: 69 (= *S. neptunus* Dana, 1852).

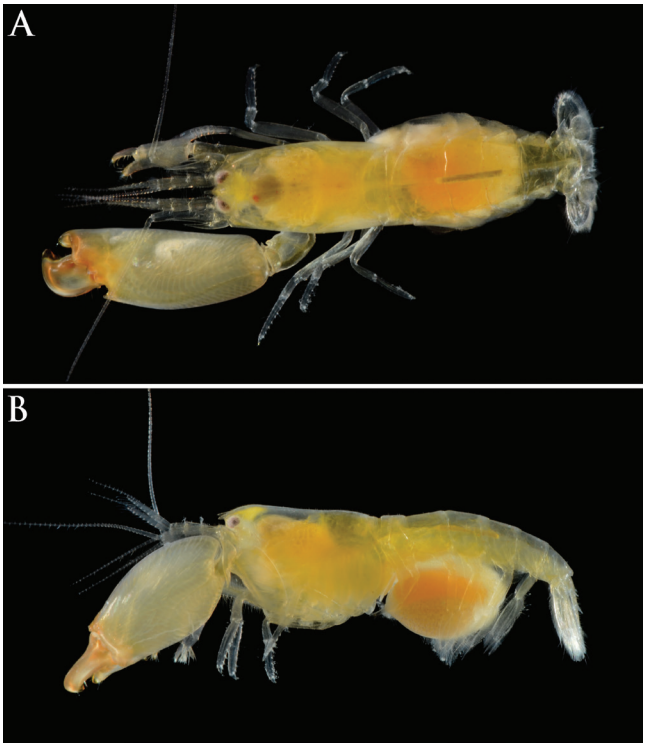

Fig. 52. *Synalpheus theano* De Man, 1910: female from Pulau Hantu, Strait of Singapore, CMBS sta. SB146 (OUMNH.ZC. 2014-11-266), in dorsal (A) and lateral (B) views, infested by a pair of hemiarthrine isopods (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, OUMNH. ZC. 2014-11-264, sta. DW55, near mouth of Pasir River, 11.6–13.0 m, laterite gravel, dead shells, leg. B. Richer de Forges et al., 23 October 2012; 1 male, ZRC 2014.0412, river mouth of Sungei Puaka, mud combing in shallow water, leg. TMSI team, 06 March 2012 (M02-309). Strait of Singapore. 1 male, ZRC 2014.0413, SW of Sentosa, 19.1–20.8 m, 12 January 2013 (4914 DR1-038); 1 female, ZRC 2014.0411, same collection data (4914 DR1-047); 1 male, ZRC 2014.0410, N of Pulau Jong, 43.3–74.6 m, leg. TMSI team, 15 May 2013 (4713 DR3-189); 1 male, OUMNH.ZC. 2014-11-265, sta. DR125, near Sisters Is.,

25.3–30.8 m, sand, laterite gravel, leg. B. Richer de Forges et al., 31 May 2013; 1 female, OUMNH.ZC. 2014-11-266, sta. SB146, Pulau Hantu, 5–7 m, coral brushing, leg. S. De Grave, H.H. Tan et al., 02 June 2013 (SS-4030) [infested by a pair of hemiarthrine isopods]; 1 female, OUMNH.ZC. 2014-11-267, sta. SB146, same collection data.

Additional material. Strait of Singapore. 1 male, ZRC 2008.0625, off Sentosa, dredge, leg. D.G.B. Chia, K.S. Tan, I.1992; 1 male, ZRC 2014.0650, Sinki Fairway off Jurong I., CC2 Buoy, buoy growth, leg. S. Teo et al., 30 July 2009; 1 ov. female, ZRC 1979.4.9.18, off Pulau Sudong, 18–27 m, shell, gravel, 17 October 1953 (J8107); 1 male, ZRC 1979.4.9.19, Outer Shoal, 11 m, mud, stones, sta. B25, leg. S.R.F.R.S., 24 June 1954 (J7186).

Distribution. Indo-west Pacific: Japan, Philippines, Indonesia, Singapore, Papua New Guinea, and Australia.

Previous records from Singapore. Johnson (1962, 1979) (but see below).

Ecology. Subtidal mud and mud-sand bottoms with gravel, rocks, dead corals and sponges, probably associated with cryptic sponges lining interstices of dead corals, occasionally also among fouling growth on buoys; shallow subtidal to 62 m in the Philippines (Chace, 1988) and 75 m in Singapore (CMBS material).

Remarks. *Synalpheus theano* can be most easily distinguished from *S. neptunus* (Dana, 1852) (see above) and most other species of *Synalpheus* present in Singapore waters, by the apex of the third maxilliped furnished with long stiff setae, instead of the typical crown of stout spiniform setae (Banner & Banner, 1972, 1975). Most specimens of *S. theano* were erroneously identified as *S. neptunus* prior to the study of Banner & Banner (1972), but Johnson's (1962) identifications appear to be correct. Based on the present (mainly CMBS) material, *S. theano* occurs patchily both in the Straits of Johor (off Sungei Puaka and Pasir River) and in the Strait of Singapore (Pulau Hantu, Pulau Sudong, Sisters Islands, Sentosa, Jurong). One individual of *S. theano* was infested by a pair of hemiarthrine parasites (Fig. 52).

Synalpheus tumidomanus (Paulson, 1875) sensu lato
(Fig. 53)

Alpheus tumido-manus Paulson, 1875: 101.
Synalpheus tumido-manus — Coutière, 1905: 876.
Synalpheus tumidomanus — De Man, 1911: 196; Johnson, 1962: 51; Banner & Banner, 1966a: 56; Banner & Banner, 1975b: 377; Johnson, 1979: 44; Banner & Banner, 1978: 247; Banner & Banner, 1985: 63.
(?) *Alpheus (tumido-manus)* var. *Alph. gracili-manus* Paulson, 1875: 102.
(?) *Synalpheus hululensis* Coutière, 1908: 202.
(?) *Synalpheus hululensis hululensis* Crosnier & Forest, 1966: 297.
(?) *Synalpheus mac-cullochi* Coutière, 1908: 203.
(?) *Synalpheus theophane* De Man, 1910: 292; De Man, 1911: 261.
(?) *Synalpheus anisocheir* Stebbing, 1915: 86.
(?) *Synalpheus japonicus* Yokoya, 1936: 133.

Fig. 53. *Synalpheus tumidomanus* (Paulson, 1875) sensu lato: A, male from Pulau Ubin, Straits of Johor, CMBS sta. SW75 (OUMNH.ZC. 2014-11-268); B, ovigerous female from the same locality (ZRC 2014.0623) (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, ZRC 2014.0626, sta. SW75, Pulau Ubin, off OBS Camp jetty, abandoned cage on mud, leg. H.H. Ng, D.L. Rahayu, 24 October 2012 (JS-1951); 1 ov. female, ZRC 2014.0623, sta. SW75, same collection data (JS-1958); 1 male, ZRC 2014.0625, sta. SW75, same collection data (JS-1956) [major cheliped regenerated]; 1 male, ZRC 2014.0627, sta. SW75, same collection data (JS-1957); 1 male, OUMNH.ZC. 2014-11-268, sta. SW75, same collection data (JS-1955); 1 male, 1 juvenile, ZRC 2014.0624, sta. SW75, same collection data (JS-1952); 1 ov. female, OUMNH.ZC. 2014-11-269, sta. SW75, same collection data (JS-1830); 1 male, OUMNH.ZC. 2014-11-270, sta. SW75, same collection data (JS-1829). Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-271, Outer Shoal, 7.2–7.5 m, leg. TMSI team, 21 March 2013 (5215 TB1-018).

Additional material. Straits of Johor. 1 male, 1 ov. female, OUMNH.ZC. 2014-11-272, Tengeh Buoy, in sponge among buoy growth, leg. Y. Cai, S.C. Lim, 04 December 2003; 1 male, ZRC 2014.0660, same collection data; 3 males, 4 ov. females, ZRC 2014.0635, same collection data; 1 male, ZRC 2011.0595, Tanjong Pergana, leg. S. Teo et al., 02 April 2002; 1 ov. female, ZRC 2014.0526, Ponggol, L.W.S.T., 07 April 1969 (J11897) [missing major cheliped, det. D.S. Johnson as *S. acanthitelsonis*]. Strait of Singapore. 1 male (?), ZRC 1991.9663, Pulau Semakau, sledge 1, leg. Reef Ecology Study Team, 1990; 1 male, OUMNH.ZC. 2014-11-273, sta. RF207, Tuas, intertidal, leg. TMSI team, 20 September 2013 (INT-0247); 1 ov. female, ZRC 1979.4.9.21, Pulau Hantu, crevice at base of coral rock, C.L.S.T., leg. D.S. Johnson,

21 November 1953 (J8069); 1 ov. female, ZRC 1979.4.9.22, between Pulau Sudong and Pulau Pawai, reef, 0–1 m, in *Galaxea* sp., leg. D.S. Johnson, 23 May 1965 (J8070).

Distribution. Indo-west Pacific, from the Red Sea to Japan, Australia, French Polynesia and Hawaii (species complex).

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Coral reefs, rocky and mixed rocky-sandy shores, sand and mudflats with abundant rocks, rubble, sponges, fouling growth etc., also in deeper water among soft corals, bryozoans, in dead coral heads, sponges etc.; intertidal and subtidal to about 50 m.

Remarks. *Synalpheus tumidomanus* is currently one of the most problematic taxa in the family Alpheidae. The previously reported morphological variation (Banner & Banner, 1975b) and complex synonymy suggests that more than one species is involved in what appears to be a *S. tumidomanus* species complex. Some specimens seem to correspond to *S. theophane* De Man, 1910, currently a junior synonym of *S. tumidomanus* (Banner & Banner, 1975b). Most CMBS specimens are characterised by a strong, sharp, distodorsal tooth on the major chela, although one specimen (OUMNH.ZC. 2014-11-229) has a much shorter, blunt tooth. The colour pattern of *S. tumidomanus* consists of red chromatophores evenly distributed over the body (Fig. 53), however, differing from the pattern of *S. iocasta* (Fig. 46) in the smaller size and greater density of the red chromatophores and their lesser conspicuousness on the major chela. Awaiting a comprehensive revision of the *S. tumidomanus* complex, all Singaporean material is best referred to as *S. tumidomanus* sensu lato. Although Johnson (1979) reported *S. tumidomanus* as common in Singapore, most CMBS material was collected at a single station in Pulau Ubin, in the Straits of Johor; additional specimens were collected in the western Straits of Johor and around southern islands (Pulau Semakau, Pulau Hantu).

Genus *Thuylamea* Nguyên, 2001

Thuylamea camelus Nguyên, 2001

Thuylamea camelus Nguyên, 2001: 218.

CMBS material. None.

Additional material. Strait of Singapore. 1 male, ZRC 1994.4387, Kallang Basin, sta. 5, dredge 1, leg. Reef Ecology Study Team, 16 December 1994.

Distribution. Presently known only from southern Vietnam and Singapore.

Previous records from Singapore. None.

Ecology. Subtidal muddy bottoms near estuaries; depth range 5–9 m.

Remarks. *Thuylamea camelus* was hitherto known only from the type series from southern Vietnam (Vung Tau south of Ho Chi Minh). The present material represents the second record of this rare species, also being the first record for Singapore, more than 1000 km south of the type locality. The Singaporean specimen is a relatively young male (carapace length 4.2 mm, total length ~12 mm) with two poorly developed posterior crests on the carapace (these crests become more prominent in adults, cf. Nguyên 2001: fig. 1A). In all other characters it agrees well with *T. camelus*.

Family Crangonidae Haworth, 1825

Genus *Aegaeon* Agassiz, 1846

Aegaeon orientalis Henderson, 1893
(Fig. 54)

Aegeon orientalis Henderson, 1893: 446.
Pontocaris orientalis — Johnson, 1962: 60; Johnson, 1979: 47.
Aegaeon orientalis — Chan, 1996: 284.

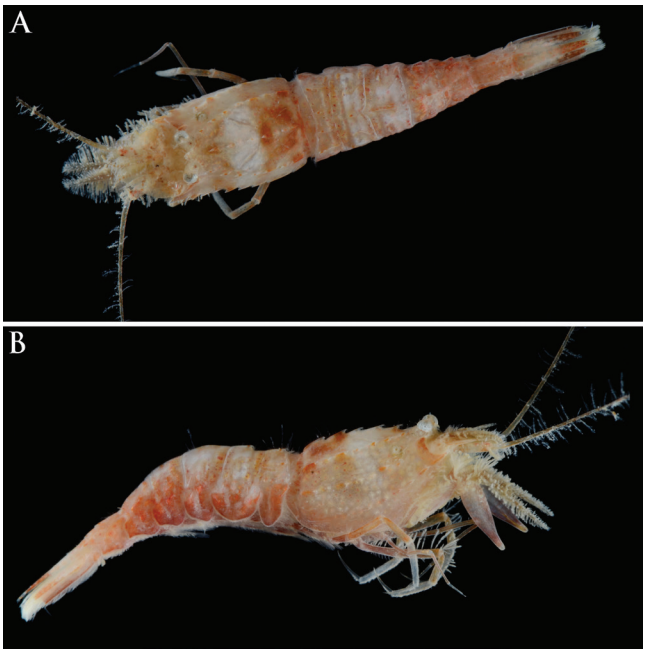

Fig. 54. *Aegaeon orientalis* Henderson, 1893: female dredged east of Eastern Holding B area, Strait of Singapore, CMBS sta. 5414 TB1 (ZRC 2014.0863), in dorsal (A) and lateral (B) views (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 female, OUMNH.ZC. 2014-11-274, sta. TB141, Eastern Straits of Johor, 28.3–28.4 m, sunken wood, charcoal, rocks, mud, leg. S.C. Lim et al., 31 May 2013 (SIN-272); 1 female, ZRC 2014.0863, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-008). Strait of Singapore. 2 females, ZRC 2014.0864, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-102-103).

Distribution. Indo-west Pacific, from the Gulf of Aden to the Philippines and New Caledonia.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. On soft mud and mixed mud-rock bottoms; depth range: 12–107 m, exceptionally to 300 m.

Remarks. *Aegaeon orientalis* appears to be relatively uncommon in Singapore waters, with only four specimens trawled during CMBS.

Genus *Philocheras* Stebbing, 1900

Philocheras angustirostris (De Man, 1918)

Pontophilus angustirostris De Man, 1918: 163; De Man, 1920: 279; Johnson, 1962: 60; Johnson, 1979: 47.
Philocheras angustirostris — Chace, 1984: 40.

CMBS material. Straits of Johor. 1 ov. female, ZRC 2014.0865, sta. DR264, outside Punggol jetty, 11.3 m, sand, mud, leg. S.C. Lim et al., 16 January 2014 (SEA-3609); 1 male, ZRC 2014.0866, sta. DR264, same collection data (SEA-3420); 1 female, ZRC 2014.0867, sta. TB97, near Eatsern Bunkering A, 22 m, sticky clay, leg. S.C. Lim et al., 28.05.2013. Strait of Singapore. 1 female, OUMNH.ZC. 2014-11-275, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-212); 1 female, ZRC 2014.0868, sta. DR57, S of Bedok, 46.2 m, leg. S.C. Lim et al., 24 May 2013 (SIN-098); 1 female, OUMNH.ZC. 2014-11-276, sta. DR258, W of Jurong I., 24.4 m, rock, sand, mud, leg. S.C. Lim et al., 19 December 2013 (SEA-3401); 1 ov. female, OUMNH.ZC. 2014-11-277, sta. DR258, same collection data (SEA-3333).

Distribution. Indo-west Pacific, from the Arabian Sea and Bay of Bengal to Indonesia and Singapore.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Usually on shell-gravel grounds; shallow subtidal down to 125 m.

Remarks. The present records extend the bathymetric range of the species from 83 m (Chace, 1984) down to 125 m.

Philocheras parvirostris (Kemp, 1916)
(Fig. 55)

Pontophilus parvirostris Kemp, 1916b: 372; Johnson, 1962: 60.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0869, sta. DR360, N of Changi Naval Base, 15.7–17 m, coarse sand (near reclaimed area), leg. A. Anker et al., 08 April 2014 (0220 DR1-AA29); 1 ov. female, OUMNH. ZC. 2014-11-278, sta. DR349, between Changi and S Pulau Tekong, 6.9–7.1 m, mud, some sand, leg. A. Anker et al., 26 March 2014 (0420 DR2-AA46).

Distribution. Presently known only from the Gulf of Mannar (between India and Sri Lanka) and Singapore.

Fig. 55. *Philocheras parvirostris* (Kemp, 1916): ovigerous female dredged north of Changi Naval Base, Strait of Singapore (near eastern entrance to Straits of Johor), CMBS sta. sta. DR360 (ZRC 2014.0869) (Photographs by: Arthur Anker).

Previous records from Singapore. None (but see below).

Ecology. Sand and mud bottoms; shallow subtidal to 90 m.

Remarks. Johnson (1962) recorded this species from an unspecified Malay locality, which he considers to be unlikely within Singapore waters, but (erroneously) attributed to Singapore in Komai (2008). The present material confirms the species' presence in Singapore.

Philocheras pilosus (Kemp, 1916)
(Fig. 56)

Pontophilus pilosus Kemp, 1916a: 367.

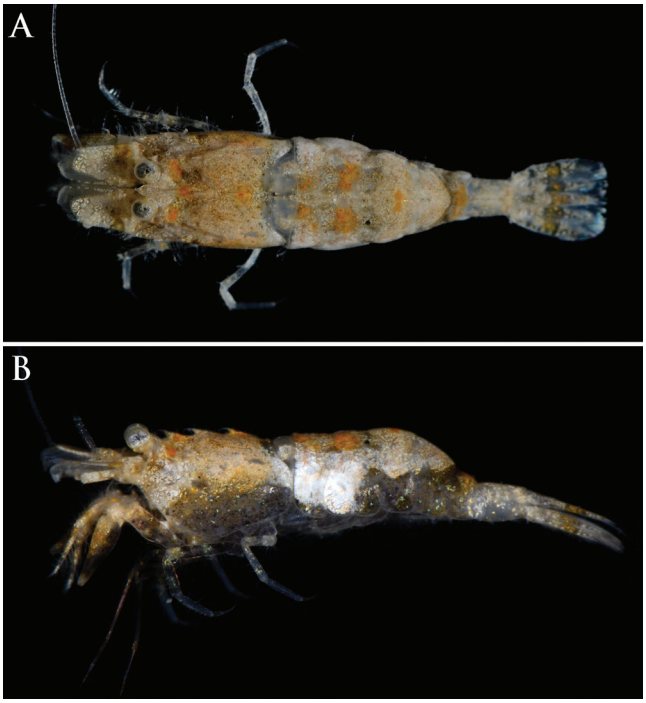

Fig. 56. *Philocheras pilosus* (Kemp, 1916): female dredged near Eastern Boarding Ground, Strait of Singapore, CMBS sta. DR111 (ZRC 2014.0870), in dorsal (A) and lateral (B) views (Photographs by: Arthur Anker [A] and Kenny Chua [B]).

CMBS material. Strait of Singapore. 1 female, ZRC 2014.0870, sta. DR111, outside Eastern Boarding Ground, 125–136 m, rocks, sand, leg. B. Richer de Forges et al., 30 May 2013 (SS-3255).

Distribution. Indo-west Pacific: Persian Gulf (Qatar), India, Singapore, Australia (Northern Territory) and New Caledonia (but see below).

Previous records from Singapore. None.

Ecology. Sand and rock bottoms; shallow subtidal to 136 m.

Remarks. The present specimen is the first record of *Philocheras pilosus* in Singapore and the Sunda Shelf. The material reported under this name from Mozambique (Barnard, 1955) and Madagascar (Ledoyer, 1969) belongs to a different, undescribed species (S. De Grave, pers. obs.).

Genus *Pontocaris* Spence Bate, 1888

Pontocaris arafurae (Bruce, 1988)
(Fig. 57)

Pontocheras arafurae Bruce, 1988b: 213.
Pontocaris arafurae — Chan, 1996: 297.

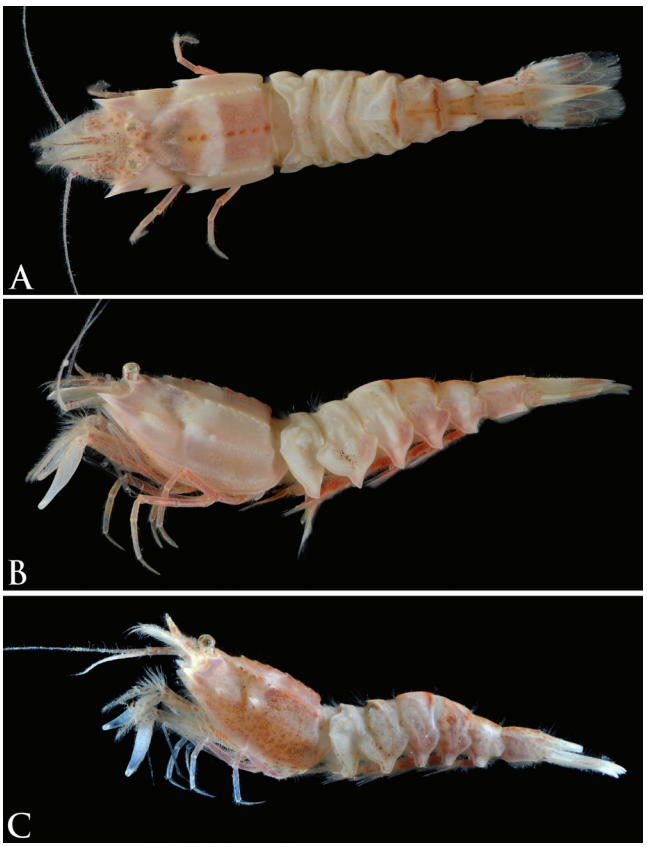

Fig. 57. *Pontocaris arafurae* (Bruce, 1988): A, B, male dredged at Eastern Bunkering A, Strait of Singapore, CMBS sta. TB98 (OUMNH.ZC. 2014-11-281), in dorsal (A) and lateral (B) views; C, female dredged off Johor coast, Straits of Johor, CMBS sta. DW129 (ZRC 2014.0871), in lateral view. (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 female, ZRC 2014.0871, sta. DW129, off Johor coast, 21.7–22.6 m, leg. B. Richer de Forges et al., 31 October 2012 (JS-2698). Strait of Singapore. 1 male, ZRC 2014.0872, sta. DW130, between Changi and Pulau Tekong, sand, epibenthic sledge, leg. B. Richer de Forges et al., 30 October 2012 (JS-2871); 1 female, OUMNH.ZC. 2014-11-279, off Marina East, 22.7–23.7 m, leg. TMSI team, 14 January 2013 (5416 TB1-094); 1 male, ZRC 2014.0873, sta. TB69, near Pulau Sudong and Pulau Semakau, 17.9–18.9 m, sand, leg. S.C. Lim et al., 25 May 2013 (SIN-123); 1 female, OUMNH.ZC. 2014-11-280, sta. 93, off PA Campsite, mud, 8.9–9.1 m, leg. H.H. Ng et al., 24 January 2013 (5818 TB1-005); 1 male, OUMNH.ZC. 2014-11-281, sta. TB98, Eastern Bunkering A, 30.2–33.6 m, broken shells, silt, leg. S.C. Lim et al., 28 May 2013 (SIN-208).

Additional material. Strait of Singapore. 1 ov. female, ZRC.2014.0734, Sultan Shoal, leg. A. Montero, 03 November 1931.

Distribution. Northern Australia (Arafura Sea), Indonesia, Singapore, Philippines and Thailand.

Previous records from Singapore. None.

Ecology. On variety of bottoms, typically dominated by sand and sand-rubble-shells; depths range: 10–200 m.

Remarks. The present material represents the first record of *Pontocaris arafurae* in Singaporean waters, where it appears to be the most common crangonid species.

Family Hippolytidae Spence Bate, 1888

Genus *Gelastocaris* Kemp, 1914

Gelastocaris paronae (Nobili, 1905)
(Fig. 58)

Latreutes paronae Nobili, 1905: 2.
Gelastocaris paronae — Kemp, 1914: 107; Johnson, 1962: 48; Monod, 1969: 212; Johnson, 1979: 44; Chace, 1997: 66.

CMBS material. Strait of Singapore. 1 female, ZRC 2014.0874, sta. SD179, Terumbu Raya, 9.8 m, on sponge *Pseudoceratina purpurea*, leg. S. De Grave et al., 05 June 2013 (SIN-364); 1 female, OUMNH.ZC. 2014-11-282, same collection data, 05 June 2013 (SIN-367).

Additional material. Strait of Singapore. 1 ov. female, RMNH.CRUS.D.57002, northern side of Pulau Semakau, 8 m, on sponge *Echinodictyum asperum*, leg. N. de Voogd, 27 March 2006 (SIN04/27036/008).

Distribution. Indo-west Pacific, from East Africa and the Persian Gulf to the Philippines, Japan and New Caledonia.

Previous records from Singapore. Johnson (1962, 1979).

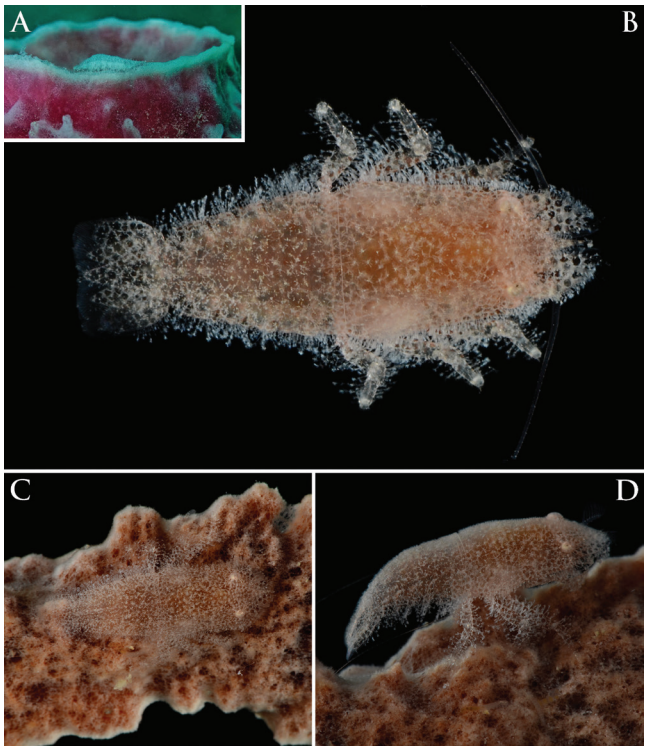

Fig. 58. *Gelastocaris paronae* (Nobili, 1905): A, individual from Sisters Islands, Singapore, photographed in situ on a large barrel sponge, *Xestospongia testudinaria* (Lamarck) (specimen not collected); B–D, female from Terumbu Raya, Strait of Singapore, CMBS sta. SD179 (ZRC 2014.0874), in general dorsal view (B) and in vitro on host sponge, *Pseudoceratina purpurea* (Carter) (C, D) (Photographs by: Stephen Beng [A] and Arthur Anker [B–D]).

Ecology. Coral reefs and associated habitats, associated with a variety of sponges, including *Pseudoceratina purpurea* (Carter) and *Echinodictyum asperum* Ridley & Dendy; shallow subtidal to 44 m.

Remarks. *Gelastocaris paronae* is a very distinctive shrimp associated with sponges and mimicking its host colour and texture (Fig. 58). The species appears to be rare in Singaporean waters as it was extensively searched for during the second CMBS workshop at numerous locations, but was only found on a single sponge at Terumbu Raya.

Genus *Hippolyte* Leach, 1814 [in Leach, 1813–1814]

Hippolyte ventricosa H. Milne Edwards, 1837 sensu lato

(Fig. 59)

Hippolyte ventricosus H. Milne Edwards, 1837: 371.
Hippolyte ventricosa — Holthuis, 1947: 55; Johnson, 1962: 48; Johnson, 1968: xxi; Johnson, 1979: 45; Tirmizi & Kazmi, 1984: 313; Chace, 1997: 66; d'Udekem d'Acoz, 1999: 66.

CMBS material. Strait of Singapore. 25 specimens (males and females), ZRC 2014.0875, sta. SW7, St. John's I., DRTech pontoon at south lagoon, fouling growth on pontoon, 0–0.5 m, leg. H.H. Tan, J.C. Mendoza, 20 May 2013 (SIN-001); 1 ov. female, 1 male, OUMNH.ZC. 2014-11-283, sta. SW10, St. John's I., DRTech pontoon at southern lagoon, fouling growth on pontoon, leg. D. Uyeno, J.C. Mendoza et al., 22 May 2013 (SS-0337); 1 female, ZRC 2014.0879, sta. SW06, St. John's I., DRTech pontoon at southern lagoon, fouling growth on pontoon, leg. S. De Grave, 20 May 2013 (SS-0314); 1 ov. female, OUMNH.ZC. 2014-11-284, sta. RF250, St. John's I., Tanjong Hakim, rocky-sandy intertidal, leg. P.S.H. Wong et al., 02 January 2014 (INT-0482); 1 male, OUMNH.ZC. 2014-11-285, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-151); 2 females, ZRC 2014.0876, same collection data (SIN-152); 1 male, 4 ov. females, 2 females, OUMNH.ZC. 2014-11-286, sta. IT86, same collection data (SIN-157); 4 ov. females, 2 females, 1 male, ZRC 2014.0877, sta. IT86, same collection data (SIN-160); 24 specimens (males and females), OUMNH.ZC. 2014-11-287, sta. IT86, same collection data (SIN-163a); 7 specimens (males and females), ZRC 2014.0878, sta. IT95, Raffles Lighthouse, intertidal, leg. S. De Grave et al., 28 May 2013 (SIN-177a).

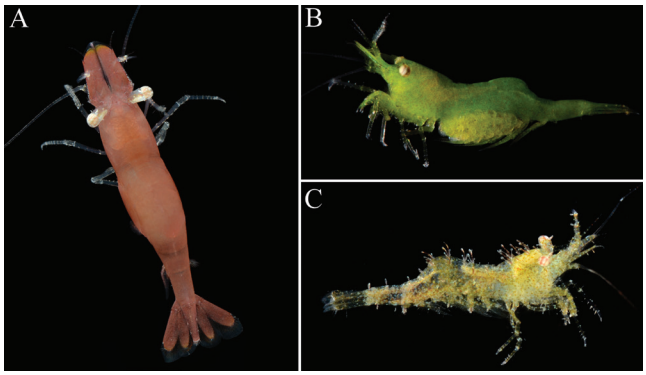

Fig. 59. *Hippolyte ventricosa* H. Milne Edwards, 1837 sensu lato: A, male from Cyrene Reef, Strait of Singapore, CMBS sta. IT86 (OUMNH.ZC. 2014-11-285); B, ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SW10 (OUMNH.ZC. 2014-11-283); C, female from St. John's Island, CMBS sta. SW06 (ZRC 2014.0879) (Photographs by: Arthur Anker).

Distribution. Numerous records from across Indo-west Pacific, although known with certainty only from India (d'Udekem d'Acoz, 1999) (see below).

Previous records from Singapore. Johnson (1962, 1968, 1979).

Ecology. Seagrass and algal beds, also in aufwuchs (algae, sponges etc.) on jetties and pontoons; intertidal and shallow subtidal.

Remarks. *Hippolyte ventricosa* likely represents a species complex according to d'Udekem d'Acoz (1999), who redescribed the species based on H. Milne-Edwards' type material from southern India. This author concluded that most Indo-west Pacific records of *H. ventricosa* outside of India and Pakistan (Tirmizi & Kazmi, 1984) may be based on other species. In Singapore, *H. ventricosa* is particularly common in fouling growth on pontoons, jetties, buoys, or among algae on intertidal reef flats in the Strait of Singapore. The colouration of this species is extremely variable, although it usually comes in two main varieties, green and brown,

depending on the shrimp's association with seagrass or brown algae (Fig. 59).

Genus *Latreutes* Stimpson, 1860

Latreutes anoplonyx Kemp, 1914
(Fig. 60)

Latreutes anoplonyx Kemp, 1914: 104; Holthuis, 1947: 60; Bruce, 1995: 61; Chace, 1997: 69.

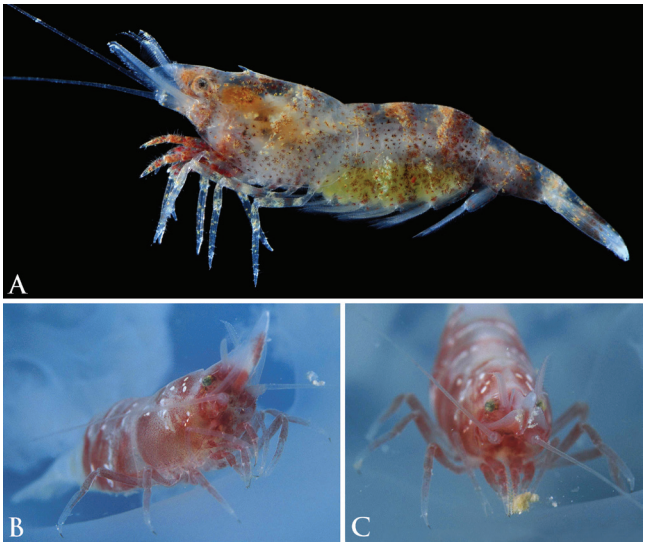

Fig. 60. *Latreutes anoplonyx* Kemp, 1914: A, ovigerous female from Pulau Ubin, Straits of Johor, CMBS sta. SW32 (OUMNH. ZC. 2014-11-288); B, C, female from Kapalai, eastern Borneo, photographed in situ on jellyfish host (specimen not collected) (Photographs by: Arthur Anker [A] and Sergey Parinov [B, C]).

CMBS material. Straits of Johor. 1 ov. female, ZRC 2014.0880, sta. DR296, near Sungei Buloh and Lim Chu Kang, 10 m, mud, leg. C.K. Chim et al., 12 February 2014 (SEA-4767); 1 ov. female, ZRC 2014.0881, SE of Pulau Bukom, 43.3–74.6 m, leg. TMSI team, 15 May 2013 (4713 DR3-220); 1 ov. female, OUMNH.ZC. 2014-11-288, sta. SW32, Pulau Ubin, northern Chek Jawa, intertidal and shallow subtidal (less than 1 m), sand-mud, beach seine, possibly associated with large jellyfish, leg. R. Tan, B. Ludt et al., 19 October 2012 (JS-1388). Strait of Singapore. 1 female, OUMNH.ZC. 2014-11-289, sta. TB96, near eastern Bunkering A, 25.1–22.4 m, clay, leg. S.C. Lim et al., 28 May 2013.

Distribution. Indo-west Pacific, from India to Japan, Indonesia and Australia.

Previous records from Singapore. None.

Ecology. Sand-mud bottoms, with algae or seagrass, often associated with scyphozoans (Fig. 60B), e.g., *Mastigias papua* Lesson, *Phyllorhiza punctata* von Lendenfelt, *Versuriga anadynomene* (Maas), *Rhizostoma* sp.?, *Acromitus flagellatus* (Haeckel) and *Rhopilema esculenta* (Kishinouye) (see Bruce, 1995 and references therein).

Remarks. Johnson (1962, 1979) recorded *Latreutes anoplonyx* from Malaysia (south of Penang), but not from Singapore, the present material (Fig. 60A) thus representing the first record for the country.

Latreutes porcinus Kemp, 1916
(Fig. 61A)

Latreutes porcinus Kemp, 1916b: 397; Johnson, 1962: 48; Johnson, 1979: 45; Chace, 1997: 69.

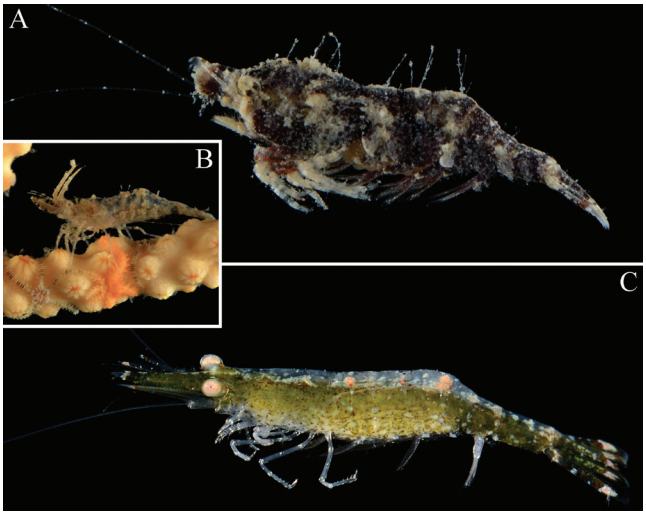

Fig. 61. *Latreutes porcinus* Kemp, 1916: A, ovigerous female from Terumbu Semakau, Strait of Singapore, CMBS sta. IT65 (ZRC 2014.0882). *Latreutes pymoeus* Nobili, 1904: B, ovigerous female from the channel between Lazarus and St. John's islands, Strait of Singapore, CMBS sta. SD45 (ZRC 2014.0885); C, female from Small Sister's Island, CMBS sta. SD89 (ZRC 2014.0886), on coral host. (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 ov. female, ZRC 2014.0883, sta. SW13, Pulau Ubin, Chek Jawa, low tide, mud-sand flat with seagrass near boardwalk, leg. A. Anker, P.K.L. Ng et al., 17 October 2012 (JS-0727); 1 ov. female, OUMNH.ZC. 2014-11-290, sta. SW24, Pulau Sekudu, intertidal sand-seagrass flat, leg. R. Tan et al., 17 October 2012 (JS-1383). Strait of Singapore. 1 ov. female, ZRC 2014.0882, sta. IT65, Terumbu Semakau, sandy-rocky beach, 0–0.5 m, leg. J.Y. Ong et al., 24 May 2013 (SIN-104); 1 ov. female, OUMNH.ZC. 2014-11-291, sta. MF32, St. John's I., rocky shore, intertidal, leg. R. Tan et al., 22 May 2013.

Distribution. Andaman Islands, Singapore, Thailand, Australia and southern Japan, likely more widespread in the Indo-west Pacific.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Seagrass and algal beds; intertidal and shallow subtidal.

Remarks. A fairly common species throughout its range, usually encountered in intertidal or shallow subtidal seagrass beds.

Latreutes pymoeus Nobili, 1904
(Fig. 61B, C)

Latreutes pymoeus Nobili, 1904: 231; Johnson, 1962: 48; Johnson, 1979: 45; De Grave, 1999: 22.

CMBS material. Straits of Johor. 1 male, ZRC 2014.0884, sta. SW13, Pulau Ubin, Chek Jawa, low tide, mud flat with seagrass near boardwalk, leg. A. Anker, P.K.L. Ng et al., 17 October 2012 (JS-0730). Strait of Singapore. 1 ov. female, ZRC 2014.0885, sta. SD45, channel between Lazarus and St. John's Is., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-055); 1 male, 1 female, OUMNH.ZC. 2014-11-292, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-163b); 1 female, ZRC 2014.0886, sta. SD89, off S Small Sisters' I., 14.7 m, leg. S. De Grave et al., 27 May 2013 (SIN-169); 1 female, OUMNH.ZC. 2014-11-293, sta. DR297, 8.3 m, mud, leg. C.K. Chim et al., 12 February 2014 (SEA-4540); 1 female, ZRC 2014.0887, sta. SD143, off eastern Pulau Hantu, 12 m, leg. H.H. Tan et al., 31 May 2013 (SIN-280).

Distribution. Indo-west Pacific, from the Red Sea and East Africa to Australia, Japan, and Kiribati.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Typically in seagrass and algal beds; intertidal and shallow subtidal.

Remarks. Johnson (1962) considered *Latreutes pymoeus* to be restricted to *Enhalus* and *Sargassum* beds in Singapore, but the present records demonstrate a greater habitat choice, with several specimens collected from smaller algal stands and others found associated with deep-water gorgonians (Fig. 61B).

Genus *Saron* Thallwitz, 1891

Saron marmoratus (Olivier, 1811)
(Fig. 62)

Palaemon marmoratus Olivier, 1811: 665.
Saron marmoratus — Holthuis, 1947: 25; Johnson, 1962: 47; Miyake & Hayashi, 1966: 143; Johnson, 1979: 45; Chace, 1997: 89.

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0888, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-162); 1 male, OUMNH.ZC. 2014-11-294, sta. IT81, S Big Sister's I., intertidal rocky reef, leg. Y.L. Lee et al., 26 May 2013 (SIN-130); 1 ov. female, OUMNH. ZC. 2014-11-295, sta. IT80, Terumbu Bemban, intertidal rocky reef, leg. C.S. Tan et al., 26 May 2013 (SIN-128); 1 female, ZRC 2014.0889, Kusu I., in dead coral head, leg. S. De Grave, 22 May 2013 (SIN-063).

Distribution. Indo-west Pacific, from the Red Sea and South Africa to Japan and French Polynesia.

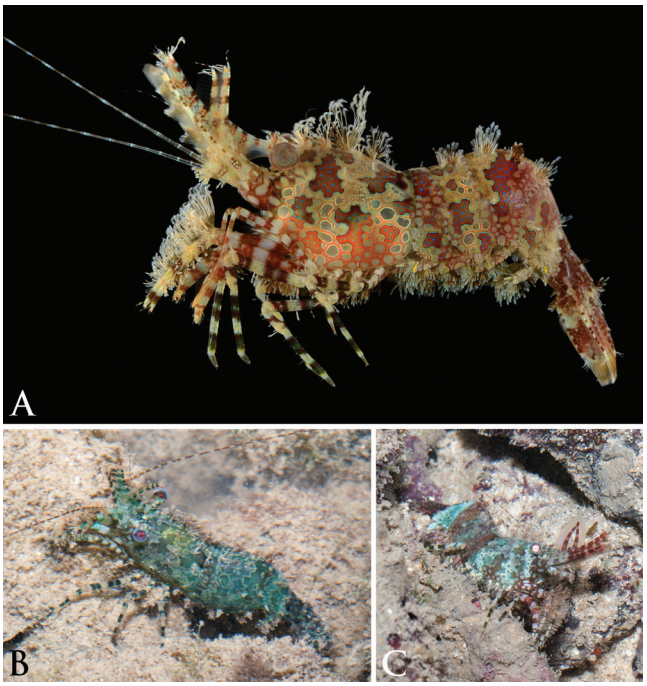

Fig. 62. *Saron marmoratus* (Olivier, 1811): A, female from Kusu Island, Strait of Singapore, CMBS sta. CH (ZRC 2014.0889); B, C, two individuals from Tanah Merah, Strait of Singapore, photographed in situ at night (specimens not collected). (Photographs by: Arthur Anker [A]. Ria Tan [B, C]).

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Coral reefs, usually hiding in crevices of corals and coral rubble by day and active at night; from lower intertidal to at least 50 m.

Remarks. *Saron marmoratus* appears to be a species complex based on the diversity of colour patterns encountered, some of them consistent across large geographic areas (e.g., Minemizu et al., 2000, 2013; Debelius, 2001). The colour pattern of the Singaporean specimens (Fig. 62) is the most often encountered type (A. Anker, S. De Grave, pers. obs.) and most likely corresponds to *S. marmoratus* sensu stricto. Johnson (1962) also recorded a single specimen of the closely related *S. neglectus* De Man, 1902, from a reef flat at Pulau Sudong; however, no specimens of *S. neglectus* have been collected in Singapore during the most recent surveys.

Genus *Tozeuma* Stimpson, 1860

Tozeuma lanceolatum Stimpson, 1860
(Figs. 63, 64)

Tozeuma lanceolatum Stimpson, 1860: 27; Wickstead, 1961: 112; Johnson, 1962: 48; Johnson, 1979: 46; Bruce, 1990b: 594; Chace, 1997: 95.
? *Tozeuma armatum* — Stephensen, 1927: 296.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0890, sta. TB69, near Pulau Sudong and Pulau Semakau, 17.9–18.9 m, sand, leg. B. Richer de Forges et al., 26 May 2013 (SS-2125); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-296, sta. SD151, SW Kusu I., 19.6 m, leg. S. De Grave

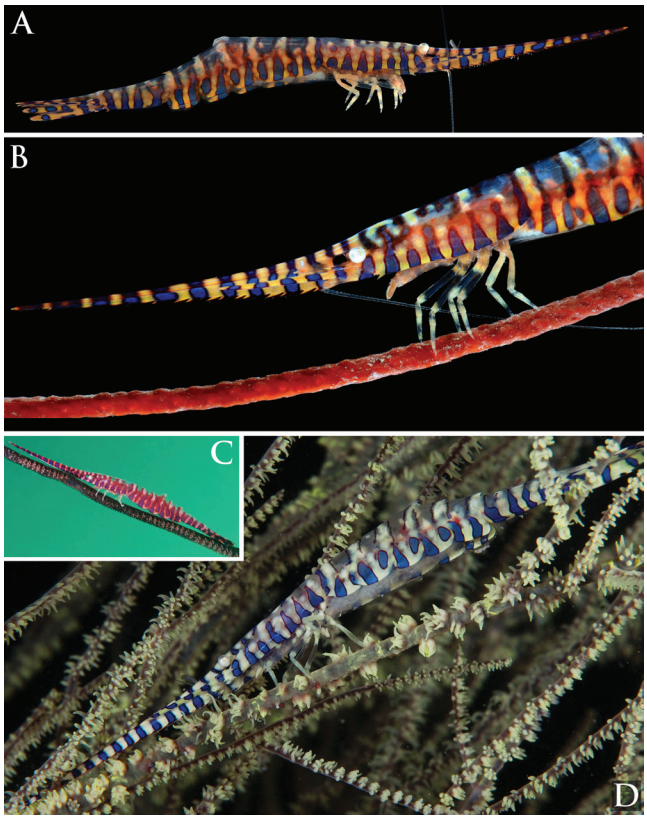

Fig. 63. *Tozeuma lanceolatum* Stimpson, 1860: A, B, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD133 (OUMNH.ZC. 2014-11-298), in general lateral view (A) and in vitro on gorgonian host (B); C, female from Sisters Islands, Strait of Singapore, photographed in situ on gorgonian host (specimen not collected); D, ovigerous female from Pulau Hantu, Strait of Singapore, photographed in situ on antipatharian host (specimen not collected) (Photographs by: Arthur Anker [A, B], Stephen Beng [C], Kelving Pung [D]).

et al., 03 June 2013 (SIN-304); 1 male, OUMNH.ZC. 2014-11-297, sta. SD151, same collection data (SIN-310); 1 ov. female, OUMNH.ZC. 2014-11-298, sta. SD133, S Kusu I., 11 m, leg. S. De Grave et al., 31 May 2013 (SIN-252); 1 female, MZUSP 31099, sta. SD133, same collection data (SIN-253); 1 female, ZRC 2014.0891, sta. SD100, St. John's I., DRTech jetty, 8–15 m, leg. D. Uyeno, K.Tilbrook, 28 May 2013 (SIN-213); 1 female, ZRC 2014.0893, sta. TB97, near Eastern Bunkering A, 22.4–22.7 m, sticky clay, leg. S.C. Lim et al., 28 May 2013 (SIN-198); 1 ov. female, OUMNH.ZC. 2014-11-299, sta. CMBS-D05, Henderson Shoal, 7 m, sand, mud, leg. TMSI team, 06 March 2012 (DO5-273); 1 male, ZRC 2014.0892, sta. 81, Outer Shoal, 8.4–16 m, mud, leg. H.H. Ng et al., 04 January 2013; 1 male, not deposited (location of specimen unknown), Eastern Boarding Ground A (E of Kusu I.), 57.2–65.3 m, leg. TMSI team, 17 May 2013 (5313 TB1-005).

Distribution. Known with certainty from Hong Kong, Singapore and the Philippines, likely more widely distributed in the Indo-west Pacific.

Previous records from Singapore. Stephensen (1927), Johnson (1962, 1979), Ng (2009, 2011, as *Tozeuma* sp.).

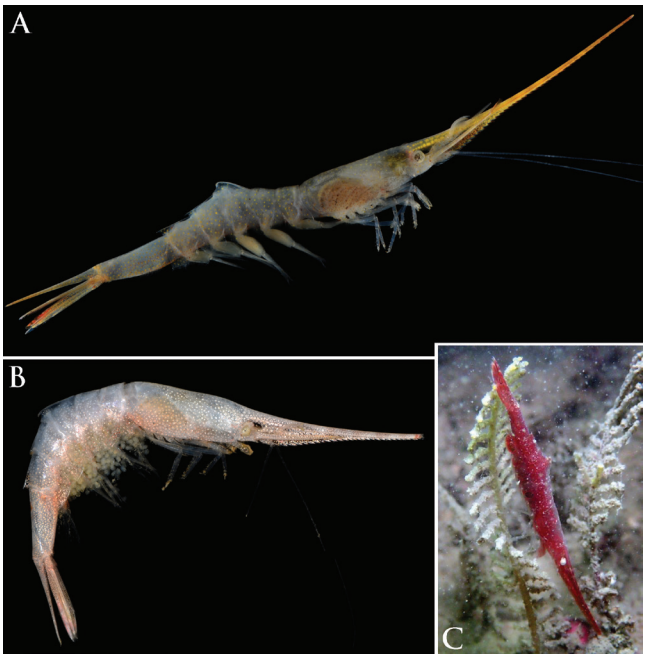

Fig. 64. *Tozeuma lanceolatum* Stimpson, 1860: A, male dredged east of Kusu Island, CMBS sta. 5313 TB1 (not deposited); B, ovigerous female dredged near Pulau Sudong and Pulau Semakau, Strait of Singapore, CMBS sta. TB69 (ZRC 2014.0890); C, ovigerous female from Pulau Hantu, Strait of Singapore, photographed in situ (specimen not collected) (Photographs by: Arthur Anker [A, B], Pei Yan Heng [C]).

Ecology. Various soft (sand, mud) or mixed (rubble-mud) bottoms, obligate associate of gorgonians; shallow subtidal to 80 m.

Remarks. All Singaporean specimens are assigned to *Tozeuma lanceolatum* on account of the dorsal carina of the third pleonite being flattened and terminating in three teeth, thus corresponding to the redescription of topotypic specimens from Hong Kong (Bruce, 1990). It should be noted that this dorsal carina is often damaged, making positive identification solely based on this feature rather difficult. The status of the closely related species, *Tozeuma armatum* Paulson, 1875 from the Red Sea, remains unclear. Chace (1997) distinguished *T. armatum* from *T. lanceolatum* on the basis of the dorsal carina terminating in a large, curved tooth, based on Paulson's (1875) drawing. No recent material from the Red Sea is available to verify the accuracy of Paulson's description and illustrations. As several of the herein examined specimens have the dorsal carina medially elongated into a curved tooth, but with two smaller, lateral teeth, it seems likely that *T. armatum* will ultimately prove to be a junior synonym of *T. lanceolatum*. Johnson (1962) considered that Stephensen's (1927) record of *T. armatum*, collected in 1903 from an unspecified location in Singapore, almost certainly refers to *T. lanceolatum*.

Most specimens identified here as *T. lanceolatum* present conspicuous transverse bands of blue or blue-purple colour on a bright golden yellow background (Fig. 63). However, several specimens photographed shortly after death have no such bands (Fig. 64A, B), whilst underwater photographs of non-collected specimens from Pulau Hantu show a different

colour pattern, dominated by uniformly distributed dark red chromatophores and with a blackish spot on the pleuron of the second abdominal somite (Fig. 64C). In contrast to the blue-banded individuals, all of which were found associated with gorgonians or antipatharians (Fig. 63B–D), the dark-red shrimps appear to be associated with algae (Fig. 64C).

Family Lysmatidae Dana, 1852

Genus *Lysmata* Risso, 1816

***Lysmata kuekenthali* (De Man, 1902)**
(Fig. 65)

Hippolyte kükenthali De Man, 1902: 850.
Hippolysmata kukenthali — Kemp, 1914: 115.
Hippolysmata (*Hippolysmata*) *kukenthali* — Holthuis, 1947: 69.
Lysmata kuekenthali — Chace, 1997: 74.

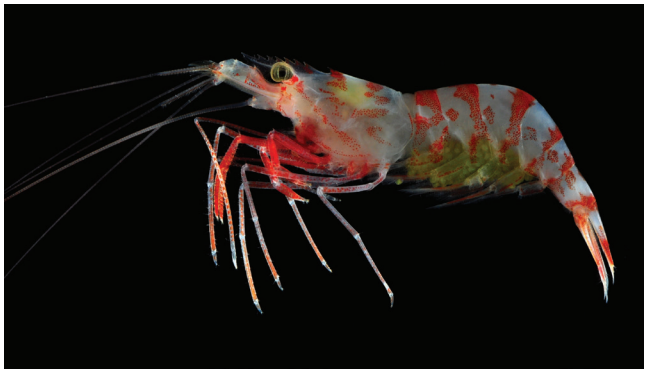

Fig. 65. *Lysmata kuekenthali* (De Man, 1902): ovigerous hermaphrodite dredged near mouth of Pasir River, Straits of Johor (not deposited) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 ov. hermaphrodite, OUMNH.ZC. 2014-11-300, sta. CMBS-S16, Chek Jawa, intertidal seagrass and sand flat, beach seine, leg. H. H. Ng et al., 07 March 2012; 1 ov. hermaphrodite, ZRC 2014.0894, sta. CMBS-D09, W Ketam Channel, 10 m, leg. K.S. Tan et al., 07 March 2012; 1 ov. hermaphrodite, ZRC 2014.0895, sta. DW89, between Pulau Ubin (Chek Jawa) and Pulau Tekong, 20.5–22.1 m, leg. B. Richer de Forges et al., 25 October 2012 (JS-1983); 1 ov. hermaphrodite, not deposited (location of specimen unknown), sta. DW55, near mouth of Pasir River, 11.6–13.0 m, laterite gravel, dead shells, leg. B. Richer de Forges et al., 23 October 2012 (JS-1658). Strait of Singapore. 1 hermaphrodite., ZRC 2014.0896, sta. 81, Outer Shoal, 8.4–16 m, muddy, leg. H.H. Ng et al., 04 January 2013; 1 ov. female, OUMNH.ZC. 2014-11-301, sta. TB127, beside Eastern Boarding Ground A, 128–113 m, rocks, leg. S.C. Lim et al., 30 May 2013 (SIN-232); 1 hermaphrodite, OUMNH.ZC. 2014-11-302, sta. TB127, same collection data (SIN-229); 1 hermaphrodite, ZRC 2014.0897, sta. TB15, Eastern Fairway, silty gravel, 21.5–23.8 m, leg. S.C. Lim et al., 21 May 2013 (SIN-018); 1 ov. hermaphrodite, OUMNH.ZC. 2014-11-303, sta. TB15, same collection data (SIN-019); 1 ov. hermaphrodite, OUMNH.ZC. 2014-11-304, sta. TB29, near Eastern Boarding Ground A, gravel, rocks, 98–103 m, leg. S.C. Lim et al., 22 May 2013 (SIN-052); 1 ov. hermaphrodite, ZRC 2014.0898, Eastern Boarding Ground A, 67.9–79.3 m, leg. TMSI team, 17 May 2013 (8313 TB3-007).

Distribution. Indo-west Pacific, from South Africa and the Seychelles to Sri Lanka, Philippines, Indonesia and Japan.

Previous records from Singapore. None.

Ecology. Various soft and mixed soft-hard bottoms, often with a predominant mud and silt component; shallow subtidal (1 m) to 128 m (new bathymetric record).

Remarks. Although recorded from a wide geographic area, *Lysmata kuekenthali* may in fact represent a complex of several cryptic species that are extremely difficult to separate without knowing the colour pattern (Fig. 65). The status of the South African *Hippolysmata marleyi* Stebbing, 1919, currently a synonym of *L. kuekenthali* requires further study as it may well be a valid species. The Hawaiian material assigned to *L. kuekenthali* by Edmondson (1946) was re-identified by Chace (1997) as *Lysmata anchisteus* Chace, 1972, a western Atlantic taxon, which seems rather unlikely.

***Lysmata lipkei* Okuno & Fiedler, 2010**
(Figs. 66, 68)

Lysmata lipkei Okuno & Fiedler, 2010: 599.

CMBS material. Strait of Singapore. 1 ov. hermaphrodite, ZRC 2014.0899, sta. SAL, Pulau Salu, intertidal sand-mud flat with abundance of rocks and coral rubble, partly exposed at low tide, leg. A. Anker et al., 09 August 2014 (SAL-AA01).

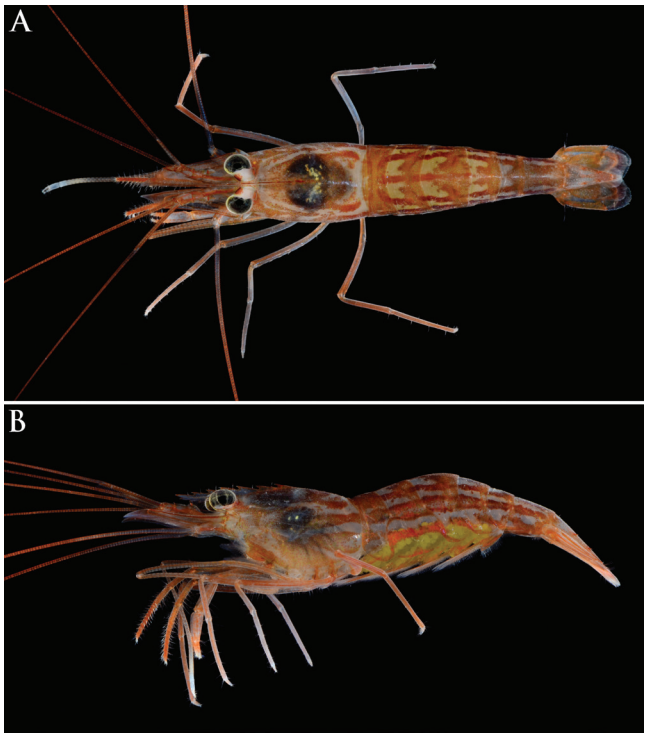

Fig. 66. *Lysmata lipkei* Okuno & Fiedler, 2010: A, B, ovigerous hermaphrodite from Pulau Salu, CMBS sta. SAL (ZRC 2014.0899), in dorsal (A) and lateral (B) views (Photographs by: Arthur Anker).

Distribution. Southern Japan (Ryukyu Islands) and Singapore.

Previous records from Singapore. None.

Ecology. Rocky shores; intertidal down to at least 15 m.

Remarks. This is the first record of *Lysmata lipkei* outside of Japan. The colour pattern of the single Singaporean specimen (Fig. 66), which was collected during a nocturnal low tide at Pulau Salu, matches perfectly that of the type specimens (Okuno & Fiedler, 2010: fig. 4). The present specimen is an ovigerous hermaphrodite, carrying bright yellow-green eggs (Fig. 66B). The colour of eggs, which can be important in the recognition of some species of *Lysmata*, was previously unknown for *L. lipkei*.

Lysmata vittata (Stimpson, 1860)
(Figs. 67, 68)

Hippolysmata vittata Stimpson, 1860: 26.
Hippolysmata (*Hippolysmata*) *vittata* — Johnson, 1962: 48; Johnson, 1979: 44.
Lysmata vittata — Bruce, 1990b: 601; Chace, 1997: 78.

CMBS material. Straits of Johor. 1 ov. hermaphrodite, ZRC 2014.0900, near Sungei Gedong, 7.3–9.8 m, mud, sand, sponges, soft corals (*Dendronephthya* sp.), leg. C.K. Chim, A. Anker, S.C. Lim et al., 09 April 2014 (4025 DR1 AA78); 1 hermaphrodite, OUMNH.ZC. 2014-11-305, sta. DW120, between Changi Point Ferry Terminal and Pulau Ubin, 20.6–21.4 m, leg. B. Richer de Forges et al. 30 October 2012 (JS-2399). Strait of Singapore. 1 hermaphrodite, OUMNH. ZC. 2014-11-306, sta. TB3, off Raffles Lighthouse, 40.7–40.9 m, sand, large sponges, leg. B. Richer de Forges et al., 21 May 2013 (SS-0305); 1 ov. hermaphrodite, OUMNH. ZC.2014-11-307, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3237); 1 ov. hermaphrodite, 1 hermaphrodite, ZRC 2014.0901, sta. IT81, S Big Sister's I., rocky reef, intertidal, leg. Y.L. Lee et al., 26 May 2013 (SIN-131); 2 hermaphrodites, ZRC 2014.0902, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-005-006); 1 hermaphrodite, OUMNH.ZC. 2014-11-308, sta. SD164, Lazarus I., near pontoon, 0–0.5 m, leg. S. De Grave & K. Tilbrook, 03 June 2013 (SIN-319); 1 ov. female, OUMNH.ZC. 2014-11-309, sta. DR161, beside St. John's I., gravel, 41.2–44.4 m, leg. S.C. Lim et al., 03 June 2013 (SIN-316); 1 hermaphrodite, not deposited (location of specimen unknown), S of St. John's I., off public jetty, 23.3–26.3 m, leg. TMSI team, 16 April 2013 (5113 DR1-017); 3 specimens, OUMNH.ZC. 2014-11-310, sta. DR111, outside Eastern Boarding Ground, 125–136 m, rocks, sand, leg. B. Richer de Forges et al., 30 May 2013 (SS-3253); 1 ov. hermaphrodite, ZRC 2014.0903, sta. TB28, Eastern Boarding Ground A (E of Kusu I.), gravel, rocks, 94.3–97.6 m, leg. S.C. Lim et al., 22 May 2013 (SIN-036); 1 hermaphrodite, ZRC 2014.0905, sta. TB29, near Eastern Boarding Ground A, 98–103 m, rocks, gravel, leg. B. Richer de Forges et al., 23 May 2013; 6 hermaphrodites, ZRC 2014.0906, Eastern Boarding Ground A, 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-114-119); 17 (some ov.) hermaphrodites, ZRC 2014.0907, sta. TB127, beside Eastern Boarding Ground A, rocks, 113–128 m, leg. S.C. Lim et al., 30 May 2013 (SIN-230); 2 ov. hermaphrodites, OUMNH.ZC. 2014-11-311, sta. TB127, same collection data (SIN-228); 21 (some ov.) hermaphrodites, OUMNH.ZC. 2014-11-312, sta. DR111, outside Eastern Boarding Ground A, rocks, 125–136 m, leg. S.C. Lim et al., 29 May 2013 (SIN-240); 1 ov. female, ZRC 2014.0910, sta. DR111, same collection data (SS-3248); 12 (some ov.) hermaphrodites, ZRC 2014.0908, sta. DR174, next to Eastern Boarding Ground A, reddish marine clay, gravel, dead shells, 79.6–135 m, leg. S. De Grave et al., 04 June 2013 (SIN-338); 1 hermaphrodite, OUMNH.ZC. 2014-11-313, sta. TB98, Eastern Bunkering A, broken shells, silt, 30.2–33.6 m, leg. S.C. Lim et al., 28 May 2013 (SIN-204); 7 (5 ov.) hermaphrodites, ZRC 2014.0904, sta. DR91, Southern Fairway near St. John's I., rocks, 46.1–72.0 m, leg. S.C. Lim et al., 27 May 2013 (SIN-170); 2 hermaphrodites, OUMNH. ZC. 2014-11-314, sta. TB157, near Southern Fairway, off Kusu I., 147–160 m, rocks, gravel, leg. B. Richer de Forges et al., 04 June 2013; 8 (5 ov.) hermaphrodites, OUMNH.

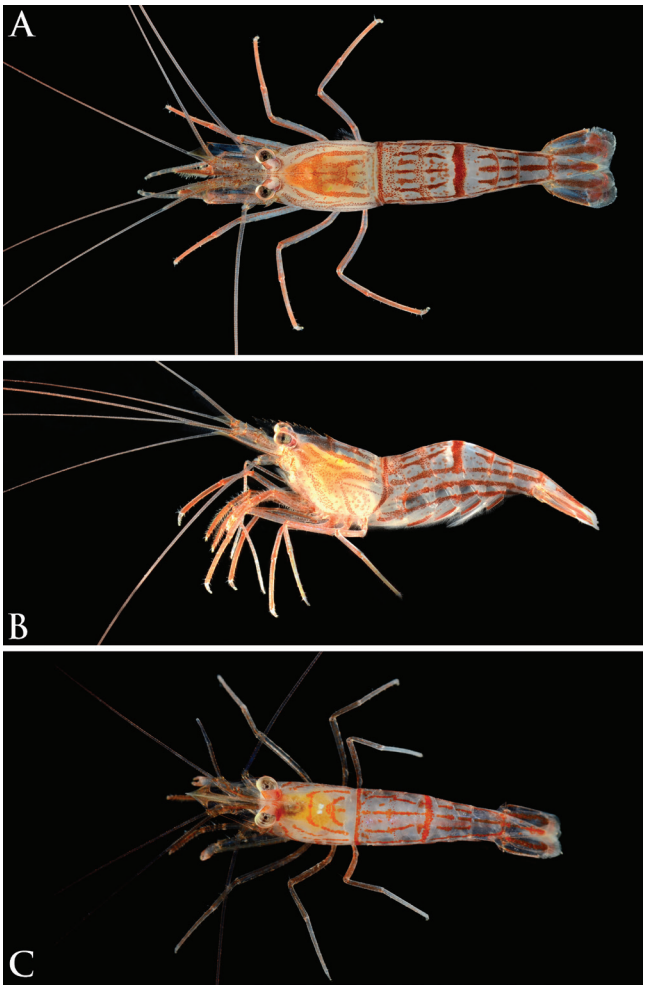

Fig. 67. *Lysmata vittata* (Stimpson, 1860): A, B, hermaphrodite from Lazarus Island, Strait of Singapore, CMBS sta. SD164 (OUMNH.ZC. 2014-11-308), in dorsal (A) and lateral (B) views; C, hermaphrodite dredged south of St. John's Island, Strait of Singapore, CMBS sta. 5113 DR1 (not deposited) (Photographs by: Arthur Anker).

Fig. 68. Two species of *Lysmata* co-occurring in the intertidal of St. John's Island, Strait of Singapore: *L. vittata* (Stimpson, 1860) (above) and *L. lipkei* Okuno & Fiedler, 2010 (below) (Photograph by: Marcus Ng).

ZC. 2014-11-315, sta. TB15, Eastern Fairway, silty gravel, 21.5–23.8 m, leg. S.C. Lim et al., 21 May 2013 (SIN-003); 2 ov. hermaphrodites, OUMNH.ZC. 2014-11-316, sta. TB15, same collection data (SIN-021); 1 ov. hermaphrodite, ZRC 2014.0909, sta. TB15, same collection data (SIN-007).

Distribution. Indo-west Pacific, from East Africa to Japan, Australia and New Zealand; possibly introduced into Brazil (see below).

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Various rocky and mixed rock-sand-rubble substrates; intertidal down to 160 m.

Remarks. It seems likely that a species complex is involved under the name *Lysmata vittata* as the species in its current definition appears to be quite variable (Chace, 1997). The Singaporean material is morphologically indistinguishable from the topotypic specimen from Hong Kong described and illustrated in detail by Bruce (1990b). Soledade et al. (2013) reported *L. vittata* from Brazil by synonymising the Brazilian species, *L. rauli* Laubenheimer & Rhyne, 2010, based on morphological and genetic comparisons. However, only descriptions of *L. vittata* in literature (e.g., Bruce, 1990b; Chace, 1997) were used and it is not clear which specimens of *L. vittata* and from where, were used in their genetic analyses (Soledade et al. 2013: fig. 3). Nevertheless, the colour pattern of the Singaporean specimens of *L. vittata* (Fig. 67) matches well that of *L. rauli* (cf. Laubenheimer & Rhyne, 2010: fig. 3).

In Singapore, both *Lysmata vittata* and *L. lipkei* are found in shallow intertidal and deeper subtidal waters around the southern islands and sometimes co-occur together, as documented by a photograph taken by M. Ng in a tide pool on St. John's Island (Fig. 68). The two species can be easily distinguished in the field by the presence (in *L. vittata*) or absence (in *L. lipkei*) of a dark-red, transverse, crescent-shaped band on the abdomen.

Genus *Lysmatella* Borradaile, 1915

Lysmatella prima Borradaile, 1915
(Fig. 69)

Lysmatella prima Borradaile, 1915: 209; Holthuis, 1947: 72; Johnson, 1962: 49; Johnson, 1963: 287; Johnson, 1979: 44; Chace, 1997: 78.

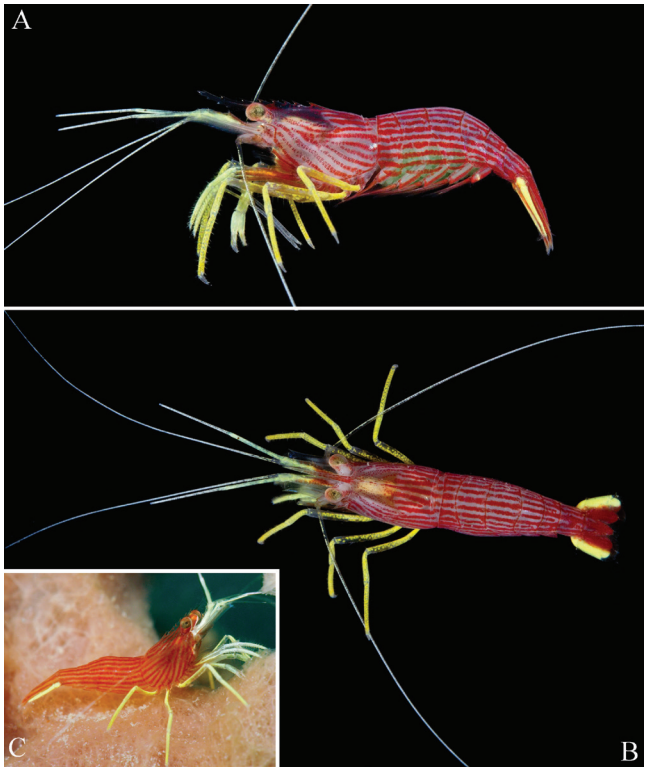

Fig. 69. *Lysmatella prima* Borradaile, 1915: A, B, ovigerous hermaphrodite dredged between Pulau Sudong and Pulau Semakau, Strait of Singapore CMBS sta. 4412 TB1 (not deposited), in lateral (A) and dorsal (B) views; C, hermaphrodite from the Perhentian Islands, Malaysia, photographed in situ (specimen not collected). (Photographs by: Rene Ong [A, B], Brian Mayes [C]).

CMBS material. Strait of Singapore. 1 hermaphrodite, ZRC 2014.0911, Eastern Holding B, 24.4–25.4 m, leg. TMSI team, 17 May 2013 (5314 TB1-007); 1 ov. hermaphrodite, not deposited (location of specimen unknown), between Pulau Sudong and Pulau Semakau, 13.1–13.7 m, leg. TMSI team, 13 March 2013 (4412 TB1-002).

Distribution. Indo-west Pacific: Maldives, Andaman Islands, Philippines, Indonesia and Singapore, likely more widespread.

Previous records from Singapore. Johnson (1962, 1963, 1979).

Ecology. Hard bottoms with rocks and mud, facultatively associated with sponges and soft corals; shallow subtidal down to 62 m.

Remarks. *Lysmatella prima* appears to be relatively rare in Singapore waters, especially compared to both *L. kuekenthali*

and *L. vittata*. The unique colour pattern of *L. prima* (Fig. 69) differs from all the known colour patterns in *Lysmata*, including the three Singaporean species (cf. Figs. 65–68), thus allowing for an easy field identification. However, some differences in the colour pattern between *L. prima* from the southwestern Indian Ocean and *L. prima* from the western Pacific (including Singapore, Indonesia and Malaysia) potentially suggests that more than one species may be involved (A. Anker, pers. obs.).

Genus *Mimocaris* Nobili, 1903

Mimocaris heterocarpoides Nobili, 1903
(Fig. 70)

Mimocaris heterocarpoides Nobili, 1903b: 6; Johnson, 1962: 48; Johnson, 1979: 45; Chace, 1997: 81; Nguyên, 2000a: 858.

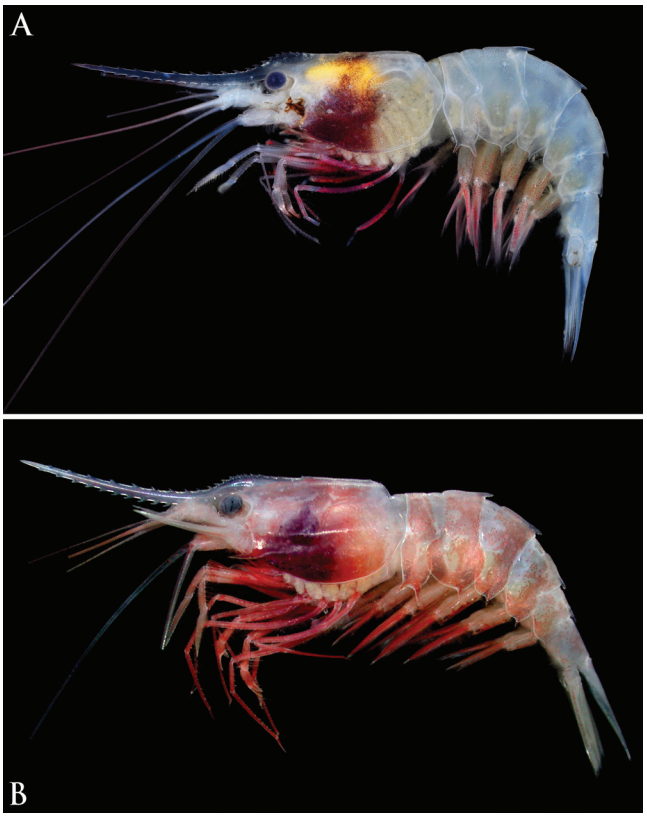

Fig. 70. *Mimocaris heterocarpoides* Nobili, 1903: A, female dredged near Changi Naval Base, Strait of Singapore, CMBS sta. DW128 (ZRC 2014.0913); B, male dredged off Pulau Pawai, Strait of Singapore (ZRC 2015.0008) (Photographs by: Arthur Anker [A], Peter K.L. Ng [B]).

CMBS material. Straits of Johor. 1 female, OUMNH.ZC. 2014-11-317, Pulau Ubin, OBS Camp 1, jetty, leg. P.S.H. Wong, 29.X.2012 (JS-2706). Strait of Singapore. 1 female, ZRC 2014.0912, sta. DW128, E of Changi Naval Base, 18.3–21.8 m, mud, leg. B. Richer de Forges et al., 30 October 2012 (JS-0232); 1 female, ZRC 2014.0913, sta. DW128, same collection data (JS-2866); 1 male, ZRC 2015.0008, off Pulau Pawai, swarming, less than 20 m, leg. C.S. Tan, 15 November 2014.

Distribution. Malaysia (Sarawak), Indonesia (Sumatra), Singapore and Vietnam.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Estuarine areas, on sandy-muddy bottoms; depth range: 4–10 m.

Remarks. *Mimocaris heterocarpoides* is a rather uncommon but quite distinctive shrimp (Fig. 70). This species was previously known from Singapore based on only seven specimens collected at an unknown location prior to 1951 (Johnson, 1962). The present material suggests that *M. heterocarpoides* occurs in Singapore on muddy bottoms at the eastern entrance to the Straits of Johor, e.g., off Pulau Ubin and Changi, but also in the southern islands, e.g., around Pulau Pawai. Local fishermen sometimes use the species as bait.

Family Ogyrididae Holthuis, 1955

Ogyrides orientalis (Stimpson, 1860)
(Fig. 71)

Ogyris orientalis Stimpson, 1860: 36.
Ogyrides orientalis — Bruce, 1990b: 586.

Fig. 71. *Ogyrides orientalis* (Stimpson, 1860): ovigerous female dredged off Changi Naval Base, Strait of Singapore (near eastern entrance to Straits of Johor), CMBS sta. DR366 (ZRC 2014.0914) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0914, sta. DR366, near Changi Naval Base, 12–16 m, fine silt, leg. A. Anker, S.C. Lim, C.K. Lim et al., 08 April 2014.

Distribution. Indo-west Pacific: India, Indonesia, Singapore, Philippines, China and Japan (although some of these records may refer to related species).

Previous records from Singapore. None.

Ecology. Sand or sand-silt bottoms; depth range: 9–54 m.

Remarks. The single CMBS specimen (Fig. 71) represents the first record of *Ogyrides orientalis* in Singapore and the Sunda Shelf. It matches well with the description and illustrations of the topotypic material in Bruce (1990).

Family Palaemonidae Rafinesque, 1815

Genus *Anchistus* Borradaile, 1898

***Anchistus custoides* Bruce, 1977**
(Fig. 72)

Anchistus custoides Bruce, 1977: 50; Chace & Bruce, 1993: 72.

Fig. 72. *Anchistus custoides* Bruce, 1977: male from Terumbu Raya, Strait of Singapore, CMBS sta. IT122 (OUMNH.ZC. 2014-11-318) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, 1 female, OUMNH.ZC. 2014-11-318, sta. IT122, Terumbu Raya, intertidal, in bivalve *Pinna atropurpurea*, leg. C.S. Tan et al., 30 May 2013 (SIN-221); 1 female, ZRC 2014.0915, sta. IT122, same collection data (SIN-249).

Distribution. Indo-west Pacific: Indonesia, Singapore, Vietnam, Palau, Australia, and southern Japan.

Previous records from Singapore. None.

Ecology. Rocky-muddy and rocky-sandy bottoms, obligate associate of large bivalves of the genera *Magnavicula*, *Pinna* and *Atrina*; intertidal to 15 m.

Remarks. *Anchistus custoides* is reported to be associated with several bivalve hosts (Chace & Bruce, 1993). The present specimens were found inside large fan clams, *Pinna atropurpurea* Sowerby, on an intertidal sand flat at Terumbu Raya, in the Strait of Singapore. The colour pattern of the Singaporean specimens (Fig. 72) generally corresponds to that of the Vietnamese specimens in Marin & Savinkin (2007), although the photographed Singaporean male specimen appears to be much paler.

***Anchistus custos* (Forskål, 1775)**
(Fig. 73)

Cancer custos Forskål 1775: 94.
Anchistus custos — Holthuis, 1952: 105; Johnson, 1962: 59; Johnson, 1963: 288; Johnson & Liang, 1966: 433; Johnson, 1979: 31.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0916, sta. SD40, W Pulau Semakau, 7.5 m, in bivalve *Pinna atropurpurea*, leg. S. De Grave et al., 23 May 2013 (SIN-053); 1 male, ZRC 2014.0917, sta. SD40, same collection data (SIN-054); 1 male, 1 ov. female, 1 female, OUMNH.ZC. 2014-11-319, sta. SD40, same collection data (SIN-066); 1 male, 1 female, ZRC 2014.0918, sta. SW117, St. John's I., DRTech, northern lagoon, intertidal, in *P. atropurpurea*, leg. P.K.L.Ng et al., 30 May 2013 (SIN-215); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-320, sta. IT122, Terumbu Raya, intertidal, in *P. atropurpurea*, leg. C.S. Tan et al., 30 May 2013 (SIN-220); 5 specimens, OUMNH.ZC. 2014-11-322, sta. SD179, Terumbu Raya, 9.8 m, in *P. atropurpurea*, leg. S. De Grave et al., 05 June 2013 (SIN-366); 3 females, ZRC 2014.0919, sta. IT140, Pulau Tekukor, intertidal, in *P. atropurpurea*, leg. Y.L. Lee et al., 31 May 2013 (SIN-283); 1 female, ZRC 2014.0920, same collection data (SIN-284).

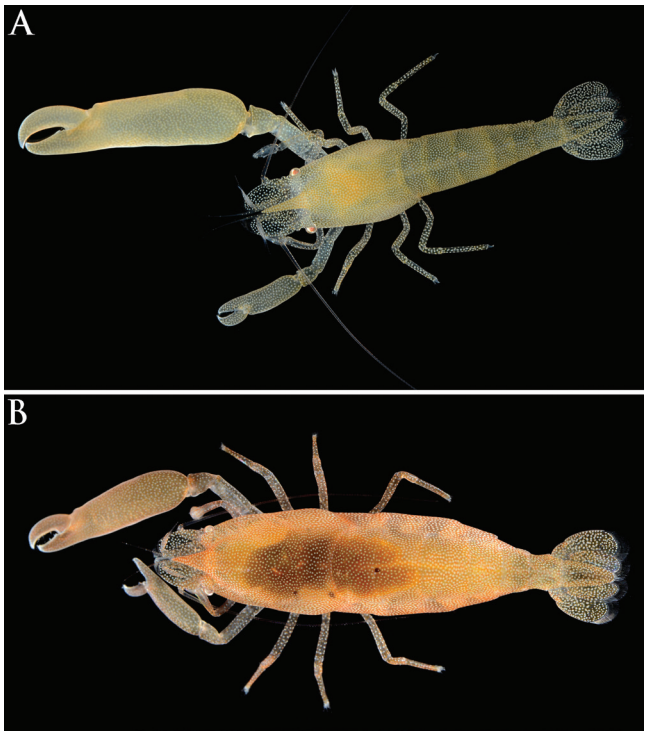

Fig. 73. *Anchistus custos* (Forskål, 1775): A, male from Pulau Semakau, Strait of Singapore, CMBS sta. SD40 (ZRC 2014.0917); B, female from Pulau Tekukor, Strait of Singapore, CMBS sta. IT140 (ZRC 2014.0920) (Photographs by: Arthur Anker [A], Kenny Chua [B]).

Additional material. Strait of Singapore.1 male, 2 females, OUMNH.ZC. 2014-11-323, Changi Beach, leg. TMSI team, 03 August 2012.

Distribution. Indo-west Pacific, from the Red Sea and eastern Africa through to Fiji.

Previous records from Singapore. Johnson (1962, 1963, 1979), Johnson & Liang (1966).

Ecology. Rocky-sandy or sandy-muddy bottoms, sometimes near seagrass, obligate associate of large bivalves of the genus *Pinna*; intertidal down to 20 m.

Remarks. All CMBS specimens of *Anchistus custos* were found inside large fan clams, *Pinna atropurpurea*. Johnson &

Liang (1966) studied the biology of this species in Singapore; however, since the closely related *A. custoides* (see above) was described a decade later, it is likely that both species were confused in their study. The colour patterns of *A. custos* and *A. custoides* are indeed very similar (Figs. 72, 73). In Singapore, *A. custos* is still relatively common in the southern islands of the Strait of Singapore, e.g., Pulau Semakau, St. John's Island, Pulau Tekukor and Terumbu Raya.

Anchistus miersi (De Man, 1888)

Harpilius Miersi De Man, 1888b: 274.
Anchistus miersi — Holthuis, 1952: 110; Johnson, 1962: 59; Johnson, 1963: 288; Johnson, 1979: 31; Chace & Bruce, 1993: 72.

CMBS material. None.

Additional material. Strait of Singapore. 1 female, ZRC 2013.0791, Raffles Lighthouse, in giant clam *Tridacna squamosa*, leg. M.L. Neo et al., 25 April 2013; 1 female, ZRC 2013.0792, same collection data.

Distribution. Indo-west Pacific, from the Red Sea and eastern Africa through to French Polynesia.

Previous records from Singapore. Johnson (1962, 1963, 1979), Neo et al. (2014).

Ecology. Coral reefs and associated rubble flats, obligate associate of large bivalves, mainly *Tridacna* and *Hippopus*; intertidal down to 20 m.

Remarks. *Anchistus miersi* is rare in Singapore today, as a direct consequence of the increasing rarity of giant clams. Both specimens were collected on a reef flat at Raffles Lighthouse in the Singapore Strait (Neo et al., 2014).

Genus *Ancylomenes* Okuno & Bruce, 2010

Ancylomenes holthuisi (Bruce, 1969)
(Figs. 74, 75A, B)

Periclimenes holthuisi Bruce, 1969: 258; Bruce, 1979b: 205; Bruce, 1982a: 244.
Ancylomenes holthuisi — Okuno & Bruce, 2010: 98; Ng, 2011: 144; Toh, 2013: 126.
Periclimenes aesopius (nec Spence Bate, 1863) — Johnson, 1979: 33.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0921, between Pulau Sudong and Pulau Semakau, 13.1–13.7 m, leg. TMSI team, 13 March 2013 (4412 TB1-006); 1 ov. female, ZRC 2014.0922, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, associated with sea anemone *Heteractis magnifica*, leg. S. De Grave et al., 23 May 2013 (SIN-078); 1 male, 1 female, OUMNH.ZC. 2014-11-324, sta. SD151, SW Kusu I., 19.6 m, associated with *H. magnifica*, leg. S. De Grave et al., 03 June 2013 (SIN-308).

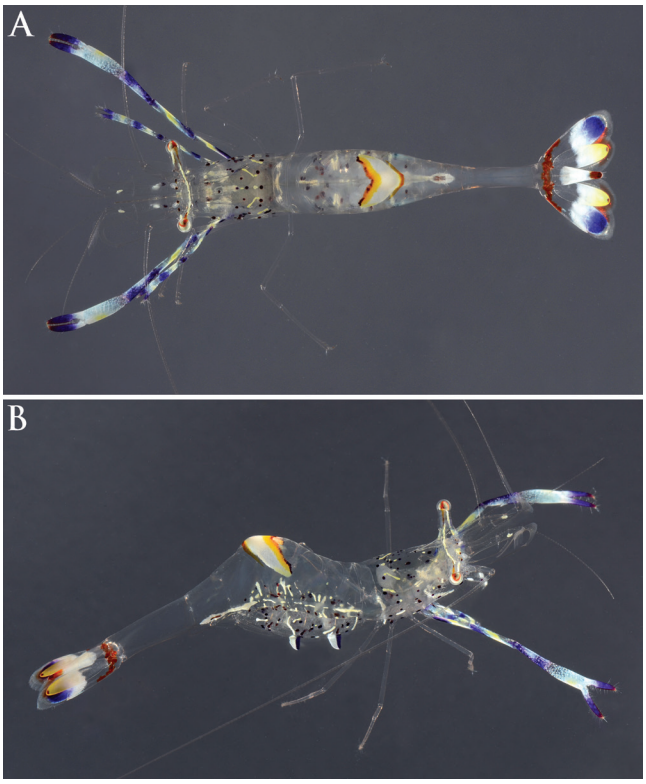

Fig. 74. *Ancylomenes holthuisi* (Bruce, 1969): A, B, female from Kusu Island, Strait of Singapore, CMBS sta. SD151 (OUMNH. ZC. 2014-11-324), in dorsal (A) and lateral (B) views (Photographs by: Arthur Anker).

Distribution. Widely distributed in the Indo-Pacific.

Previous records from Singapore. Johnson (1962, 1979, as *Periclimenes aesopius* Spence Bate, 1863), Bruce (2003), Ng (2011), Toh (2013).

Ecology. In various habitats, usually with reef or rock-rubble component, typically associated with a variety of sea anemones (Fig. 75A, B), rarely with scleractinian corals or jellyfishes; lower intertidal down to 36 m.

Remarks. Bruce (1998) listed Singapore under the distribution of *Ancylomenes holthuisi* (as *Periclimenes holthuisi*) in a key, without further details. Evidently, this record was based on specimens associated with the tube anemone *Cerianthus* shown to him by D.S. Johnson (see Bruce, 2003). These specimens were previously reported under the name *Periclimenes aesopius* in Johnson (1962), although the majority of Johnson's material reported under that name is actually *Phycomenes sulcatus* (Ďuriš et al., 2008) (see below). Clearly, this knowledge exchange must have taken place in the late 1960s, as Johnson (1979) listed this taxon under the name *Periclimenes aesopius sensu* Holthuis, 1952 and treated it separately from *P. aesopius sensu* Johnson, 1962, which he considered questionably identical to *P. indicus* Kemp (see below). In Singapore, *A. holthuisi* typically associates with the sea anemone *Heteractis magnifica* (based on the present material), but may also be found on different hosts, e.g., *Actinostephanus haeckeli* Kwietniewski (Fig. 75B).

***Ancylomenes magnificus* (Bruce, 1979)**
(Fig. 75C, D)

Periclimenes magnificus Bruce, 1979b: 195.
Ancylomenes holthuisi — Okuno & Bruce, 2010: 99.

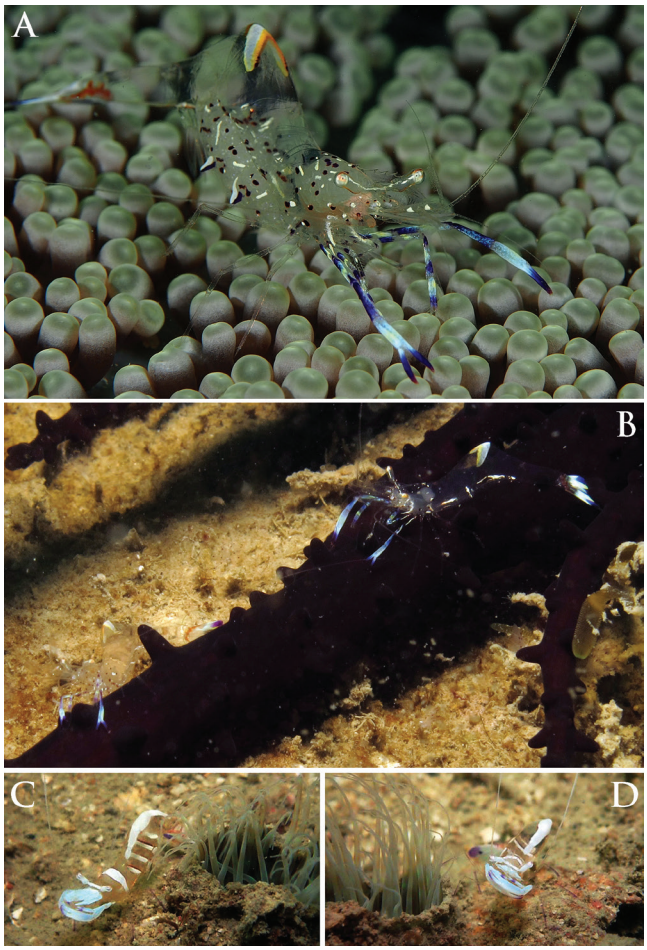

Fig. 75. *Ancylomenes holthuisi* (Bruce, 1969): A, ovigerous female from Pulau Hantu, Strait of Singapore, photographed in situ on sea anemone host, *Stichodactyla* sp. (specimen not collected); B, male-female pair from Pulau Hantu, Strait of Singapore, photographed in situ on sea anemone host, *Actinostephanus haeckeli* Kwietniewski (specimens not collected). *Ancylomenes magnificus* (Bruce, 1979): C, D, ovigerous female from Pulau Hantu, photographed in situ near a small cerianthid (specimen not collected) (Photographs by: Kelvin Dung [A], Jeffrey Low [B], Pei Yan Heng [C, D]).

CMBS material. None (photographic record only, see below).

Distribution. Indo-west Pacific from Australia to Vietnam and Japan.

Previous records from Singapore. None.

Ecology. In various habitats, usually with reef or rock-rubble component, typically associated with a variety of cnidarians, including corals, sea anemones, cerianthids (Fig. 75C, D) and octocorals, rarely also with hydroids; lower intertidal down to 32 m.

Remarks. This common, widespread and conspicuous species is now recorded for the first time from Singapore based on underwater photographs recently taken by P.Y. Heng while scuba diving off Pulau Hantu (Fig. 75C, D).

Genus *Brucecaris* Marin & Chan, 2006

***Brucecaris tenuis* (Bruce, 1969)**
(Fig. 76)

Periclimenes tenuis Bruce, 1969a: 272; Chace & Bruce, 1993: 123.
Brucecaris tenuis — Marin & Chan, 2006: 525.

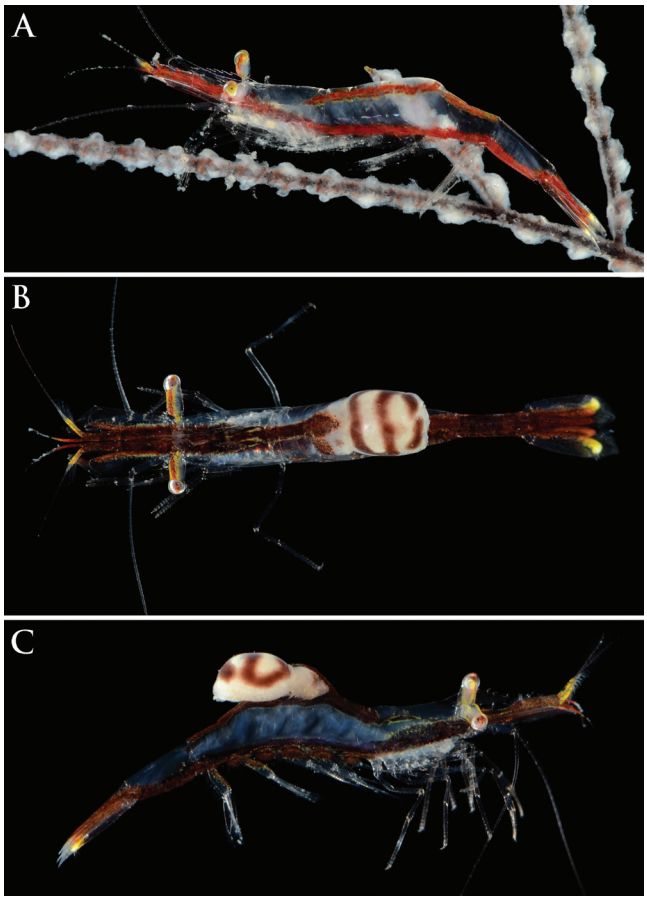

Fig. 76. *Brucecaris tenuis* (Bruce, 1969): A, male from Pulau Hantu, Strait of Singapore, CMBS sta. SD143 (OUMNH.ZC. 2014-11-326); B, C, male from the channel between Lazarus and St. John's island, CMBS sta. SD45 (specimen will be deposited by D. Uyeno), in dorsal (B) and lateral (C) views, showing infestation by an unusual parasitic isopod (Dajidae) (Photographs by: Arthur Anker).

CMBS material. Strait of Singapore. 1 female, ZRC 2014.0923, sta. SD25, SW St. John's I., 7.6 m, associated with crinoid, leg. S. De Grave et al., 22 May 2013 (SIN-039); 2 males, 2 ov. females, OUMNH.ZC. 2014-11-325, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, associated with crinoid, leg. S. De Grave et al., 23 May 2013 (SIN-069); 1 ov. female, ZRC 2014.0924, sta. SD56, S Pulau Jong, 17 m, associated with crinoid, leg. S. De Grave et al., 24 May 2013 (SIN-093); 1 male, OUMNH.ZC. 2014-11-326, sta. SD143, E Pulau Hantu, 12 m, associated with crinoid, leg. H.H. Tan et al., 31 May 2013 (SIN-285); 1 female, OUMNH.ZC. 2014-11-283, sta.

SD166, SW Kusu I., 19.1 m, associated with crinoid, leg. H.H. Tan et al., 03 June 2013 (SIN-332a); 2 males, 1 ov. female, 2 females, ZRC 2014.0925, sta. SD167, SW Pulau Jong, 15.4 m, associated with crinoid, leg. H.H. Tan et al., 04 June 2013 (SIN-344); 1 male (in study, will be deposited by D. Uyeno), sta. SD54, SW Kusu I., ~7.8 m, silty reef, on crinoid, leg. S. De Grave, D. Uyeno, H.H. Tan et al., 25 May 2013 (SIN-062, SS-1605) [infested with dajid isopod].

Distribution. Indo-west Pacific, from the Red Sea and East Africa to Indonesia, Japan, Australia and the Marshall Islands.

Previous records from Singapore. None.

Ecology. Coral reefs and associated habitats, obligate associate of crinoids (see below); shallow subtidal to about 20 m.

Remarks. The present specimens represent the first record of *Brucecaris tenuis* in Singaporean waters. They were found associated with the following crinoids: *Stephanometra tenuipinna* (Hartlaub), *Stephanometra indica* forma *spicata* Carpenter, *Pontiometra andersoni* (Carpenter) and *Himenometra robustapinna* (Carpenter) (host identifications provided by C. Messing, pers. comm.). The species appears to be relatively common on crinoid grounds and reefs in the Strait of Singapore, e.g., around St. John's and Lazarus Islands, Kusu Island, Pulau Jong and Pulau Hantu. Interestingly, one individual of *B. tenuis* was infested by a parasitic isopod of the family Dajidae, possibly an undescribed taxon (D. Uyeno, in study); the parasite was attached to the dorsal surface of the third abdominal somite of the shrimp (Fig. 76B, C).

Genus *Climeniperaeus* Bruce, 1995

Climeniperaeus sp.
(Fig. 77)

CMBS material. Strait of Singapore. 1 female, ZRC 2014.0926, sta. SB146, W Pulau Hantu, 5–7 m, coral rubble brushing, leg. S. De Grave et al., 01 June 2013 (SIN-294).

Distribution. Currently known only from Sulawesi and Singapore (see below).

Previous records from Singapore. None.

Ecology. Coral reefs; the Sulawesi specimens were found in a sponge; the host of the single Singaporean specimen is unknown.

Remarks. This undescribed species of *Climeniperaeus* (Fig. 77) is currently being studied by C.H.J.M. Fransen (pers. comm.) based on material from Sulawesi.

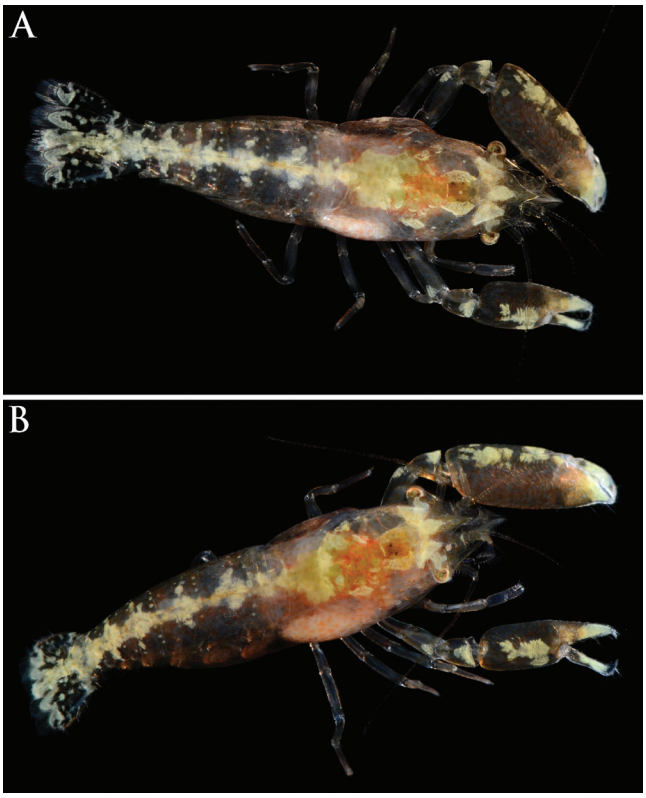

Fig. 77. *Climeniperaeus* sp.: female from Pulau Hantu, Strait of Singapore, CMBS sta. SB146 (ZRC 2014.0926), in dorsal (A) and dorsolateral (B) views (Photographs by: Arthur Anker).

Genus *Conchodytes* Peters, 1852

Conchodytes placunae (Johnson, 1967)
(Fig. 78)

Chernocaris placunae Johnson, 1967: 500; Johnson, 1979: 31; Marin & Savinkin, 2007: 177.
Conchodytes placunae — Fransen & Reijen, 2012: 43.

Fig. 78. *Conchodytes placunae* (Johnson, 1967): female from Lazarus Island, Strait of Singapore, CMBS sta. IT115 (OUMNH. ZC. 2014-11-328), posterior abdomen not shown (heavily damaged). (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 female, OUMNH. ZC. 2014-11-328, sta. IT115, Lazarus I. (Seringat-Kias), artificial lagoon, muddy sand and seagrass, in bivalve *Placuna ephippium*, leg. J.D. Taylor, E.A. Glover, 30 May 2013 (SIN-268) [posterior abdomen damaged].

Distribution. Singapore, NW Australia (Arafura Sea) Indonesia (Kepulauan Seribu), and Vietnam (Nha Trang Bay).

Previous records from Singapore. Johnson (1967, as *Chernocaris placunae*).

Ecology. Mixed rubble-sand or rubble-mud bottoms, with seagrass, obligate associate of the bivalves *Placuna ephippium* (Philipsson) (Johnson 1967, as *Placuna sella* (Gmelin)) and *Placuna placenta* (L.); intertidal to 27 m.

Remarks. The genus *Chernocaris* Johnson, 1967 has been recently synonimised with *Conchodytes* Peters, 1852 based on morphological and molecular data (Fransen & Reijen, 2012). The single specimen collected during the CMBS was unfortunately damaged during its extraction from the host clam; however, it was quickly photographed while still alive (Fig. 78) and preserved.

Genus *Coralliocaris* Stimpson, 1860

Coralliocaris graminea (Dana, 1852)
(Fig. 79)

Oedipus graminea Dana, 1852a: 25.
Coralliocaris graminea — Johnson, 1962: 60; Johnson, 1979: 32; Chace & Bruce, 1993: 77.

CMBS material. None.

Additional material. 2 males, 1 ov. female, OUMNH. ZC.2011-02-004, Raffles Lighthouse, reef flat at low tide, in corals (*Acropora* sp.), leg. L.K. Wang, 13 July 2010.

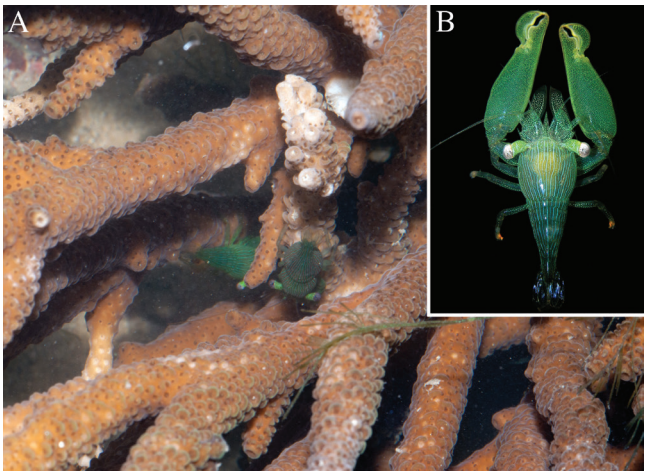

Fig. 79. *Coralliocaris graminea* (Dana, 1852): A, two individuals from Sentosa Island, Strait of Singapore, photographed in situ on coral host, *Acropora* sp. (specimens not collected); B, male specimen from Viti Levu, Fiji (specimen deposited in the Natural History Museum of Los Angeles) (Photographs by: Ria Tan [A], Arthur Anker [B]).

Distribution. Probably throughout Indo-west Pacific from the Red Sea to Japan and Samoa; exact distribution unknown due to confusion with closely related species.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Coral reefs, obligate associate of corals of the genus *Acropora*; lower intertidal to 30 m.

Remarks. *Coralliocaris graminea* was recorded by Johnson (1962) from Raffles Lighthouse in the Strait of Singapore, with the present specimens and recent photographs (example in Fig. 79A) confirming its continued existence, for instance in *Acropora* colonies at Pulau Hantu, Kusu Island, Sisters Islands, Cyrene Reef, Sentosa Serapong, and Tanah Merah (A. Anker, pers. obs. based on photographs by R. Tan, J. Koh, and L.K. Sheng). The shrimps are capable of producing a fairly strong snapping sound by rapidly closing the fingers of both second pereopods, usually as a defensive reaction.

Genus *Cuapetes* Clark, 1919

Cuapetes amymone (De Man, 1902)
(Fig. 80)

Periclimenes amymone De Man, 1902: 829; Bruce, 1979a: 218; Chace & Bruce, 1993: 102.
Periclimenes (*Harpilius*) *amymone* — Holthuis, 1952: 82; Johnson, 1962: 58; Johnson, 1963: 288; Johnson, 1979: 33.
Kemponia amymone — Bruce, 2004: 11.

Fig. 80. *Cuapetes amymone* (De Man, 1902): male from the channel between Lazarus and St. John's islands, Strait of Singapore, CMBS sta. SD45 (ZRC 2014.0927) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0927, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, in corals, leg. S. De Grave et al., 23 May 2013 (SIN-083); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-329, sta. SD56, S Pulau Jong, 17 m, in corals, leg. S. De Grave et al., 24 May 2013 (SIN-095); 1 male, OUMNH. ZC. 2014-11-330, sta. IT95, Raffles Lighthouse, intertidal, in corals, leg. S. De Grave et al., 28 May 2013 (SIN-180); 1 female, ZRC 2014.0928, sta. SD179, Terumbu Raya, 9.8 m, in corals, leg. S. De Grave et al., 05 June 2013 (SIN-361).

Distribution. Indo-west Pacific, Nicobar Islands to Japan and Samoa.

Previous records from Singapore. Johnson (1962, 1963, 1979), Bruce (1979a).

Ecology. Coral reefs, obligate associate with corals (*Acropora*, *Pocillopora*, *Seriatopora* and *Stylophora*); lower intertidal to 30 m.

Remarks. *Cuapetes amymone* appears to be a common associate of intertidal and subtidal corals on the reefs around Singapore's southern islands, e.g., Pulau Jong, Terumbu Raya, St. John's Island and Raffles Lighthouse. The present material (Fig. 80) was collected from *Pocillopora damicornis* (L.), *Stylophora pistillata* Esper and *Acropora* spp.

Cuapetes elegans (Paulson, 1875)
(Fig. 81A)

Anchistia elegans Paulson, 1875: 113.
Periclimenes (*Harpilius*) *elegans* — Holthuis, 1952: 81.
Periclimenes elegans — Johnson, 1962: 59; Johnson, 1979: 33; Chace & Bruce, 1993: 110.
Kemponia elegans — Bruce, 2004: 14.

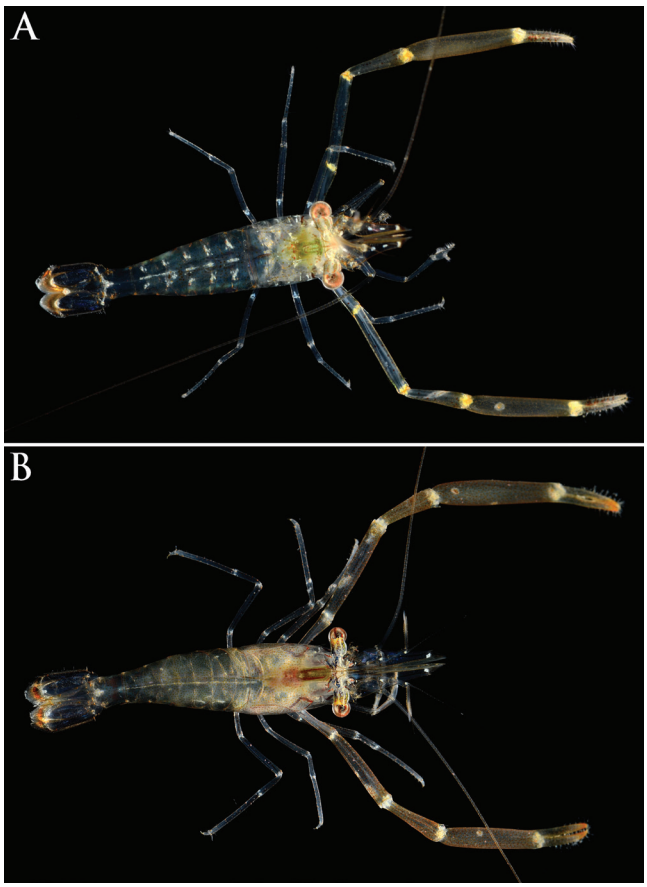

Fig. 81. *Cuapetes elegans* (Paulson, 1875): A, male from Cyrene Reef, Strait of Singapore, CMBS sta. IT86 (OUMNH.ZC. 2014-11-334); B, male from Lazarus Island, Strait of Singapore, CMBS sta. SD164 (OUMNH.ZC. 2014-11-335) (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 2 males, 1 ov. female, 1 female, ZRC 2014.0929, sta. D15, Sekudu - Malang Papan beacon, leg. K.S. Tan et al., 07.03.2012 (D15681–15698). Strait of Singapore. 1 female, OUMNH.ZC.2014-11-331 sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-056); 1 male, OUMNH.ZC. 2014-11-332, sta. IT81, S Big Sister's I., rocky reef, intertidal, leg. Y.L. Lee et al., 26 May 2013 (SIN-133); 1 male, ZRC 2014.1075, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-150); 1 male, OUMNH.ZC. 2014-11-333, sta. IT86, same collection data (SIN-159); 1 male, OUMNH.ZC. 2014-11-334, sta. IT86, same collection data (SIN-149); 3 ov. females, 1 male, ZRC 2014.0930, sta. IT94, Cyrene Reef, intertidal, leg. A. Anker et al., 28 May 2013 (SIN-186); 2 females, ZRC 2014.0931, sta. SD164, Lazarus I., pontoon, 0–0.5 m, leg. S. De Grave & K. Tilbrook, 03 June 2013 (SIN-318); 1 male, OUMNH.ZC. 2014-11-335, same collection data (SIN-320); 1 female, OUMNH.ZC. 2014-11-336, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-331); 1 female, ZRC 2014.0932, sta. SD167, SW Pulau Jong, 15.4 m, leg. H.H. Tan et al., 04 June 2013 (SIN-341); 1 female, OUMNH.ZC. 2014-11-337, sta. SD177, SW Kusu I., 16.3 m, leg. H.H. Tan et al., 04 June 2013 (SIN-350); 1 female, OUMNH.ZC. 2014-11-338, sta. DR374, near Second Link (Causeway), 13.3 m, laterite gravel, mud, shells, leg. C.K. Chim et al., 09 April 2014 (SEA-7152); 5 specimens, ZRC 2014.0933, sta. IT108, Raffles Lighthouse, intertidal, leg. Y.L. Lee et al., 29 May 2013 (SIN-239).

Distribution. Indo-west Pacific, from East Africa to Hawaii.

Previous records from Singapore. Johnson (1962, 1979)

Ecology. Coral reefs and other reef habitats, intertidal down to 53 m.

Remarks. Although Johnson (1962) only recorded a single specimen of *Cuapetes elegans*, the present records amply demonstrate it to be common in the southern islands of the Strait of Singapore.

Cuapetes grandis (Stimpson, 1860)

Anchistia grandis Stimpson, 1860: 39.
Periclimenes (*Ancylocaris*) *grandis* — Kemp, 1922: 210.
Periclimenes grandis — Johnson, 1962: 58; Johnson, 1979: 33; Chace & Bruce, 1993: 112.
Kemponia grandis — Bruce, 2004: 16.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0934, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-042); 1 female, OUMNH.ZC. 2014-11-339, Eastern Fairway, 53.0–54.7 m, sandy, leg. S. Cheng et al., 10 September 2013 (SEA-0410); 2 ov. females, ZRC 2014.0935, sta. IT80, Terumbu Bemban, rocky reef, intertidal, leg. C.S. Tan et al., 26 May 2013 (SIN-126); 5 specimens, ZRC 2014.936, sta. IT81, S Big Sister's I., rocky reef, intertidal, leg. Y.L. Lee et al., 26 May 2013 (SIN-132); 2 ov. females, OUMNH.ZC. 2014-11-340, sta. IT82, Beting Bemban Besar, intertidal, leg.

K.S. Koh et al., 26 May 2013 (SIN-136b); 12 specimens, ZRC 2014.0937, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-161); 16 specimens, OUMNH.ZC. 2014-11-341, sta. IT95, Raffles Lighthouse, intertidal, leg. S. De Grave et al., 28 May 2013 (SIN-176); 1 male, 2 ov. females, OUMNH.ZC. 2014-11-342, sta. IT120, Pulau Hantu, intertidal, leg. K.K. Siong et al., 30 May 2013 (SIN-223); 1 ov. female, OUMNH.ZC. 2014-11-343, sta. IT140, Pulau Tekukor, intertidal, leg. Y.L. Lee et al., 31 May 2013 (SIN-271c); 1 female, ZRC 2014.0939, sta. SD177, SW Kusu I., 16.3 m, leg. H.H. Tan et al., 04 June 2013 (SIN-351); 7 specimens, ZRC 2014.938, sta. MF39, Semakau Landfill, southern part of replanted mangrove, intertidal mud flat, leg. Y.L. Lee et al., 09 October 2011; 4 specimens, ZRC 2014.1074, sta. IT95, Raffles Lighthouse, intertidal, leg. C.S. Tan et al., 28 May 2013 (SIN-182).

Distribution. Widely distributed across the Indo-Pacific.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Coral reef and other reef-associated habitats; intertidal down to at least 16 m.

Remarks. *Cuapetes grandis* may well be a junior synonym of *Cuapetes ensifrons* (Dana, 1852), as the development of the distal carpal teeth varies between individuals, from absent to two being present (Bruce, 2004).

Cuapetes platycheles (Holthuis, 1952)
(Fig. 82)

Periclimenes (*Harpilius*) *platycheles* Holthuis, 1952: 85.
Periclimenes platycheles — Bruce, 1992: 62.
Kemponia platycheles — Bruce, 2004: 9.

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0940, sta. SD150, SW Kusu I., 10.7 m, leg. S. De Grave et al., 01 June 2013 (SIN-301); 1 female, ZRC 2014.0941, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-327); 1 male, 1 female, 1 ov. female, OUMNH.ZC. 2014-11-344, sta. SD166, same collection data (SIN-334); 1 male, OUMNH.ZC. 2014-11-345, sta. SD179, Terumbu Raya, 9.8 m, leg. S. De Grave et al., 05 June 2013 (SIN-357).

Distribution. Known with certainty from Indonesia, Australia, Papua New Guinea and Palau, likely more widespread in the Indo-west Pacific.

Previous records from Singapore. None.

Ecology. Coral reefs and associated habitats, presumably free-living (Fig. 82B); shallow subtidal to 57 m.

Remarks. Although the key for the genus (as *Kemponia*) in Bruce (2004) mentions two strong, distal carpal teeth for *Cuapetes platycheles*, all Singaporean specimens have only one tooth and a pronounced sharp lobe, as is the case for most specimens from elsewhere. *Cuapetes platycheles* can be easily recognised by the second pereopods (chelipeds)

Fig. 82. *Cuapetes platycheles* (Holthuis, 1952): A, female from Kusu Island, Strait of Singapore, sta. SD166 (ZRC 2014.0941); B, male (?) from Sisters Islands, Strait of Singapore, photographed *in situ* (specimen not collected); C, male from Terumbu Raya, Strait of Singapore, CMBS sta. SD179 (OUMNH.ZC. 2014-11-345), details of the second pereopod (cheliped) fingers (Photographs by: Arthur Anker [A, C]; Jeffrey Low [B]).

bearing short brown-orange bands on the distal portions of the ischium and merus, short purple band or patch on the distal portion of the carpus and palm, as well as red-brown, spatulate fingers (Fig. 82).

Cuapetes seychellensis (Borradaile, 1915)
(Fig. 83)

Periclimenes (*Falciger*) *seychellensis* Borradaile, 1915: 212.
Periclimenes (*Ancylocaris*) *seychellensis* — Kemp, 1922: 176.
Periclimenes seychellensis — Johnson, 1962: 58; Johnson, 1968: xxi; Johnson, 1979: 33; Bruce, 1979a: 228; Chace & Bruce, 1993: 121.

Fig. 83. *Cuapetes seychellensis* (Borradaile, 1915): ovigerous female from Raffles Lighthouse, Strait of Singapore, CMBS sta. IT95 (ZRC 2014.0942) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0942, sta. IT95, Raffles Lighthouse, intertidal, leg. S. De Grave et al., 28 May 2013 (SIN-188).

Distribution. Widespread in the Indo-Pacific.

Previous records from Singapore. Johnson (1962, 1968, 1979), Bruce (1979a).

Ecology. Seagrass and algal beds with coral rubble and rocks; intertidal and shallow subtidal.

Remarks. *Cuapetes seychellensis*, although relatively common elsewhere in the Indo-west Pacific, appears to be rare in Singapore. The single specimen, an ovigerous female (Fig. 83) was collected from a large intertidal pool with a sparse seagrass and algal cover.

Genus *Dasycaris* Kemp, 1922

Dasycaris zanzibarica Bruce, 1973
(Fig. 84)

Dasycaris zanzibarica Bruce, 1973: 247; Ng, 2009: 106; Ng, 2011: 144.

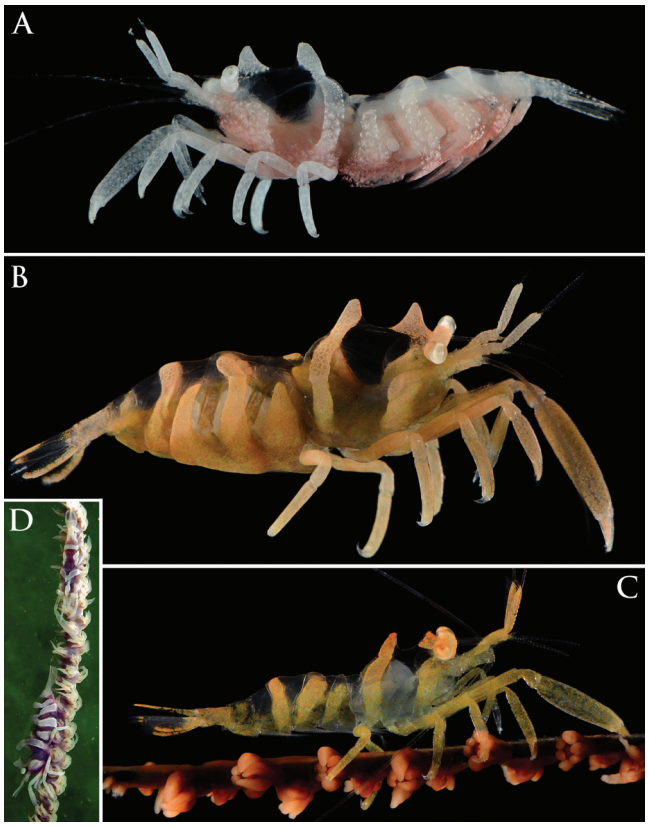

Fig. 84. *Dasycaris zanzibarica* Bruce, 1973: A, ovigerous female from Lazarus Island, Strait of Singapore, CMBS sta. SD34 (ZRC 2014.0943); B, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD151 (OUMNH.ZC. 2014-11-346); C, male from the same locality (OUMNH.ZC. 2014-11-346); D, male-female pair from Terumbu Pempang, Strait of Singapore, photographed *in situ* on black coral host, *Cirrhipates* sp. (specimens not collected) (Photographs by: Arthur Anker (A–C), Jeffrey Low (D).\

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0943, sta. SD34, N Lazarus I., 14 m, on sea whip, leg. H.H. Tan et al., 22 May 2013 (SIN-044); 1 male, ZRC 2014.0944, same collection data (SIN-045); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-346, sta. SD151, SW Kusu I., 19.6 m, on sea whip, leg. S. De Grave et al., 03 June 2013 (SIN-305); 1 ov. female, OUMNH.ZC. 2014-11-347, same collection data (SIN-306).

Distribution. Previously known from East Africa, Australia, Taiwan, Japan, Papua New Guinea, the Philippines and New Caledonia.

Previous records from Singapore. Ng (2009, 2011).

Ecology. Deeper areas of coral reefs, obligate associate of sea whips, *Cirripathes* spp. and *Antipathes* spp. (Fig. 84); exact depth range unknown, usually found around or below 15 m.

Remarks. The present specimens were obtained from an undetermined sea whip, presumably of the genus *Cirripathes* (Fig. 84C).

Genus *Hamodactylus* Holthuis, 1952

Hamodactylus boschmai Holthuis, 1952

Hamodactylus boschmai Holthuis, 1952: 209; Johnson, 1979: 32; Chace & Bruce, 1993: 80; Goh et al., 1999: 270.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0945, sta. SD68, SW Pulau Tekukor, 10 m, on gorgonians, leg. S. De Grave et al., 25 May 2013 (SIN-114); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-348, sta. SD89, S Small Sisters' I., 14.7 m, on gorgonians, leg. S. De Grave et al., 27 May 2013 (SIN-168); 1 female, ZRC 2014.0946, sta. SD123, St. John's I., lagoon next to public jetty, 5–13 m, on gorgonians, leg. C.-W. Lin, D. Uyeno, 30 May 2013 (SIN-219); 1 female, OUMNH.ZC. 2014-11-349, sta. SD133, S Kusu I., 11 m, on gorgonians, leg. S. De Grave et al., 31 May 2013 (SIN-254a); 1 female, ZRC 2014.0947, sta. SD150, SW Kusu I., 10.7 m, on gorgonians, leg. S. De Grave et al., 01 June 2013 (SIN-302); 1 female, OUMNH.ZC. 2014-11-350, sta. SD151, SW Kusu I., 19.6 m, on gorgonians, leg. S. De Grave et al., 03 June 2013 (SIN-309b).

Distribution. Known from scattered locations throughout the Indo-Pacific, from East Africa to Vietnam.

Previous records from Singapore. Johnson (1979), Goh et al. (1999).

Ecology. Deeper portions of coral reefs and associated habitats, obligate associate of gorgonians; exact depth range unknown, usually found below 10 m.

Remarks. Within Singaporean waters, Goh et al. (1999) recorded the species from *Melithea robusta* (Shann) (as *Acabaria robusta*), *Ctenocella pectinata* (Pallas) and *Echinogorgia* sp. The hosts from which the present specimens were collected were not identified.

Hamodactylus noumeae Bruce, 1970
(Fig. 85)

Hamodactylus noumeae Bruce, 1970: 539; Chace & Bruce, 1993: 80; Goh et al., 1999: 270.

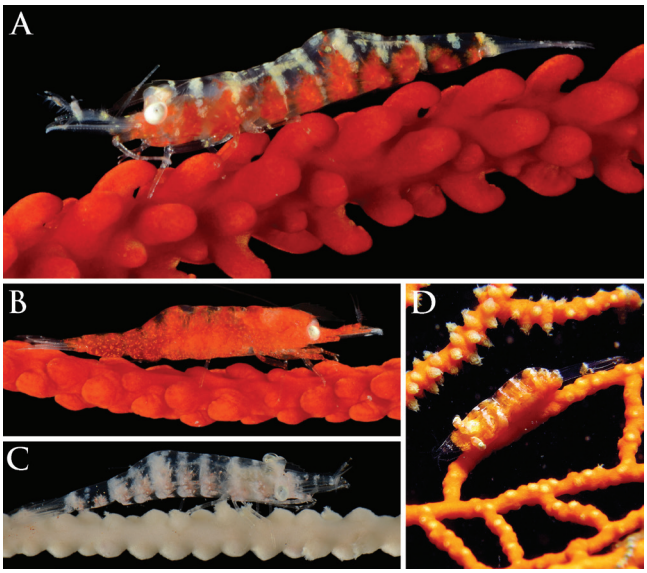

Fig. 85. *Hamodactylus noumeae* Bruce, 1970: A, female from Pulau Hantu, Strait of Singapore, CMBS sta. SD143 (OUMNH.ZC. 2014-11-353); B, ovigerous female from Pulau Tekukor, Strait of Singapore, CMBS sta. SD84 (OUMNH.ZC. 2014-11-352); C, female from Pulau Tekukor, CMBS sta. SD68 (ZRC 2014.0949); all photographed *in vitro* on various gorgonian hosts; D, ovigerous female of *Hamodactylus* sp. (presumably *H. noumeae*) from Sisters Islands, Strait of Singapore, photographed in situ on gorgonian host (specimen not collected) (Photographs by: Arthur Anker (A–C) and Jeffrey Low (D).

CMBS material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.0948, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, on gorgonians, leg. S. De Grave et al., 23 May 2013 (SIN-079); 3 ov. females, OUMNH.ZC. 2014-11-351, same collection data (SIN-081); 2 females, ZRC 2014.0949, sta. SD68, SW Pulau Tekukor, 10 m, on gorgonians, leg. S. De Grave et al., 25 May 2013 (SIN-115); 1 ov. female, OUMNH.ZC. 2014-11-352, sta. SD84, SW Pulau Tekukor, 8 m, on gorgonians, leg. H.H. Tan et al., 27 May 2013 (SIN-164); 2 ov. females, ZRC 2014.0950, sta. SD133, S Kusu I., 11 m, leg. S. De Grave et al., 31 May 2013 (SIN-254b); 1 female, OUMNH.ZC. 2014-11-353, sta. SD143, E Pulau Hantu, 12 m, on gorgonians, leg. H.H. Tan et al., 31 May 2013 (SIN-286); 1 ov. female, ZRC 2014.0951, sta. SD145, W Pulau Hantu, 11.7 m, on gorgonians, leg. S. De Grave et al., 01 June 2013 (SIN-288); 1 male, 2 ov. females, OUMNH.ZC. 2014-11-354, same collection data (SIN-289b); 1 female, ZRC 2014.0952, sta. SD151, SW Kusu I., 19.6 m, on gorgonians, leg. S. De Grave et al., 03 June 2013 (SIN-309c); 1 male, 1 ov. female, 1 female, OUMNH.ZC. 2014-11-355, sta. SD177, SW Kusu I., 16.3 m, on gorgonians, leg. H.H. Tan et al., 04 June 2013 (SIN-354); 2 males, 1 female, ZRC 2014.0953, sta. SD179, Terumbu Raya, 9.8 m, on gorgonians, leg. S. De Grave et al., 05 June 2013 (SIN-362).

Distribution. Indo-west Pacific, from East Africa to Vietnam and New Caledonia.

Previous records from Singapore. Goh et al. (1999)

Ecology. Deeper portions of coral reefs and associated habitats, obligate associate of gorgonians; depth range around 10–50 m.

Remarks. *Hamodactylus noumeae* was previously known from Singapore on the basis of a single specimen collected from an unknown locality (Goh et al., 1990). The present records confirm the species to be a reasonably abundant in the Strait of Singapore (Fig. 85). The species can co-occur with its congener on the same host colony, as a single colony of an undetermined gorgonian at Kusu Island demonstrates, as well as with *Manipontonia paeneglabra* Bruce, 2012 (see below).

Genus *Harpilius* Dana, 1852

Harpilius consobrinus De Man, 1902
(Fig. 86)

Harpilius consobrinus De Man, 1902: 836; Bruce, 2004: 6.
Periclimenes consobrinus — Chace & Bruce, 1993: 107.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0954, sta. SD166, SW Kusu I., 19.1 m, in coral *Pocillopora damicornis*, leg. H.H. Tan et al., 03 June 2013 (SIN-326).

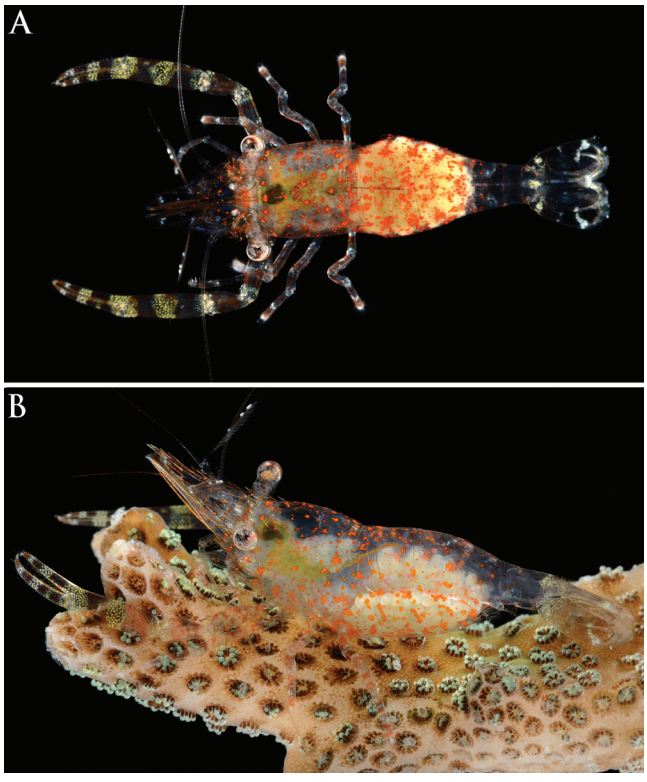

Fig. 86. *Harpilius consobrinus* De Man, 1902: ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD166 (ZRC 2014.0954), dorsal view (A) and shrimp on a fragment of coral host, *Pocillopora damicornis* (L.). Photographs by Arthur Anker

Distribution. Indo-west Pacific, from East Africa to Indonesia, Australia (Great Barrier Reef) and Thailand.

Previous records from Singapore. None.

Ecology. Coral reefs, obligate associate of corals of the genus *Pocillopora*; lower intertidal down to 30 m.

Remarks. *Harpilius consobrinus* is less common than the closely related *H. lutescens* (Dana, 1852), although the latter species has not yet been found in Singapore. The present specimen of *H. consobrinus* was obtained from a colony of *Pocillopora damicornis* (Fig. 86B).

Genus *Ischnopontonia* Bruce, 1966

Ischnopontonia lophos (Barnard, 1962)
(Fig. 87)

Philarius lophos Barnard, 1962: 242.
Ischnopontonia lophos — Bruce, 1966: 595; Johnson, 1979: 32; Bruce, 1979a: 237; Marin & Savinkin, 2007: 180; Chace & Bruce, 1993: 83; Ng & Chou, 1993: 83.

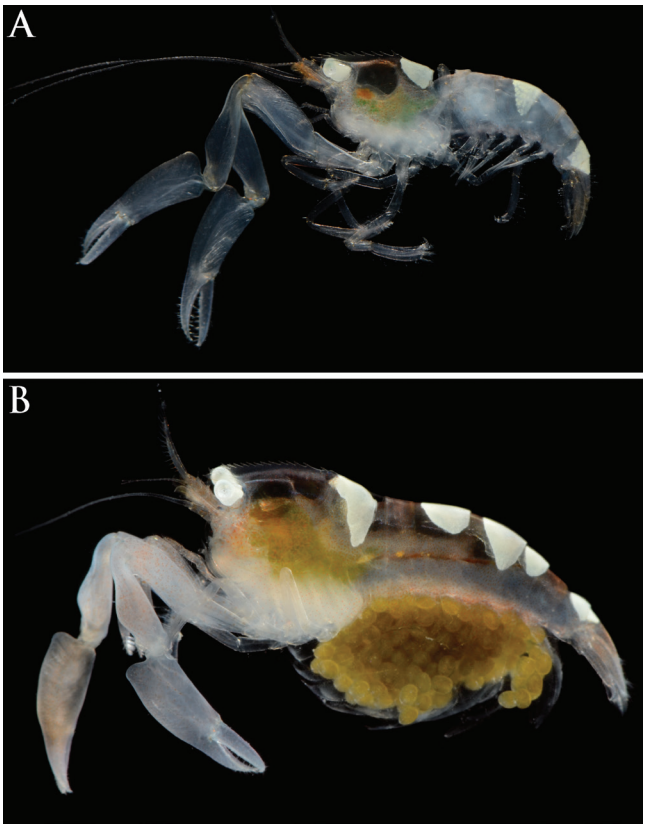

Fig. 87. *Ischnopontonia lophos* (Barnard, 1962): A, male from Pulau Jong, Strait of Singapore, CMBS sta. SD56 (ZRC 2014.0955); B, ovigerous female from the same locality (ZRC 2014.0955) (Photographs by Arthur Anker)

CMBS material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.0955, sta. SD56, S Pulau Jong, 17 m, in coral *Galaxea* sp., leg. S. De Grave et al., 24 May 2013 (SIN-097); 1 ov. female, OUMNH.ZC. 2014-11-356, sta. SD66, W Pulau Hantu, patch reef, 3 m, in coral *Galaxea* sp., leg. S. De Grave et al., 25 May 2013 (SIN-108); 1 male, 2 ov. females, ZRC 2014.0956, sta. SD68, SW Pulau Tekukor, 10 m, in coral *Galaxea* sp., leg. S. De Grave et al., 25 May 2013 (SIN-116); 1 female, OUMNH.ZC. 2014-11-357, sta. SD179, Terumbu Raya, 9.8 m, in coral *Galaxea* sp., leg. S. De Grave et al., 05 June 2013 (SIN-360).

Distribution. Indo-west Pacific, from East Africa to southern Japan and Australia.

Previous records from Singapore. Bruce (1966, 1979), Johnson (1979), Ng & Chou (1993).

Ecology. Coral reefs, obligate associate of corals of the genus *Galaxea* (see Ng & Chou, 1993 and Marin & Savinkin, 2007 for in situ photographs); lower intertidal (rare) to about 15 m.

Remarks. *Ischnopontonia lophos* does not appear to be particularly common in Singaporean waters, which is linked to the rarity of its host coral species.

Genus *Leander* Desmarest, 1849

Leander tenuicornis (Say, 1818)
(Fig. 88)

Palaemon tenuicornis Say, 1818: 249.
Leander tenuicornis — Johnson, 1962: 55; Holthuis, 1952: 155; Johnson, 1979: 29; Chace & Bruce, 1993: 6.

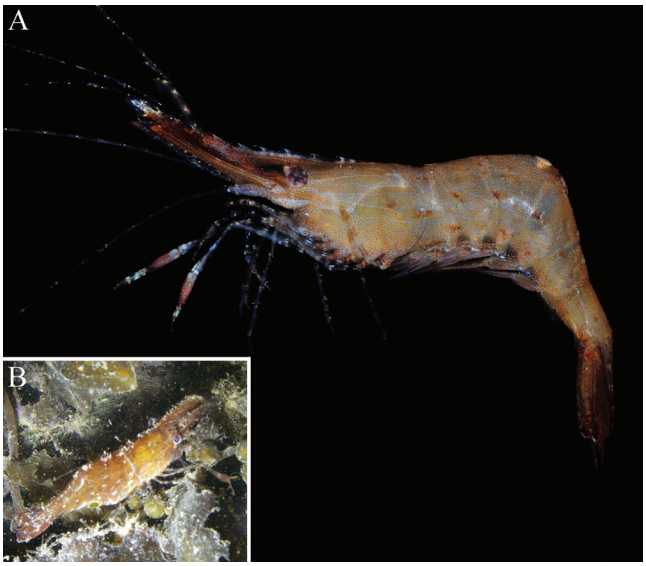

Fig. 88. *Leander tenuicornis* (Say, 1818): A, male from Pulau Sekudu, Straits of Johor, CMBS sta. SW24 (not deposited); B, ovigerous female from Tanah Merah, Strait of Singapore, photographed *in situ* (specimen not collected). Photographs by Arthur Anker [A]; Chay Hoon [B].

CMBS material. Straits of Johor. 1 male, not deposited (location of specimen unknown), sta. SW24, Pulau Sekudu near Pulau Ubin (off Chek Jawa), intertidal sand-seagrass flat, on sea anemone, leg. R. Tan et al., 17 October 2012 (JS-1381) [photographic record only].

Distribution. Mainly circum-tropical and subtropical except for East Pacific (with sporadic records in colder regions); Indo-west Pacific, from the Red Sea and South Africa eastwards to Japan, Philippines, Australia, and Loyalty Islands; Atlantic, from the Mediterranean Sea to Canada (Newfoundland) and Falkland Islands.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Typically associated with floating algal mats and *Sargassum*, as well as attached vegetation, such as algal mats and seagrass beds; intertidal down to about 10 m.

Remarks. Johnson (1962) reported *Leander tenuicornis* as moderately abundant in intertidal and shallow subtidal beds of *Enhalus* and *Sargassum*. The present photographic record is the only specimen encountered during the CMBS survey (Straits of Johor), indicative of a decline in the species' abundance since the 1960s, linked to the general reduction of seagrass beds in Singaporean waters. Although the present whereabouts of the photographed male specimen are unknown, its identity is undisputed due the very characteristic colour pattern (Fig. 88A). In addition, an ovigerous female of *L. tenuicornis* was photographed at Tanah Merah, in the Strait of Singapore, in July 2009 (Fig. 88B).

Genus *Leandrites* Holthuis, 1950

Leandrites celebensis (De Man, 1881)
(Fig. 89)

Leander celebensis De Man, 1881: 141.
Leandrites celebensis — Holthuis, 1950: 36; Johnson, 1979: 30; Chace & Bruce: 1993: 7.

Figure 89. *Leandrites celebensis* (De Man, 1881): male from Lim Chu Kang, West Johor Strait, CMBS sta. SW106 (ZRC 2014.0957) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, ZRC 2014.0957, sta. SW106, Lim Chu Kang mangrove area, intertidal, leg. B.Y. Lee et al., 27 October 2012 (JS-2518); 1 female, OUMNH.ZC. 2014-11-358, sta. MF60, Pulau Tekong, E of mouth of Sungei Unum, intertidal mud flat, leg. H. H. Ng et al., 29 May 2012 (MF60-103); 1 male, 1 ov. female, OUMNH.ZC. 2014-11-359, sta. MF45, Seletar, shore N of Yishun Avenue 1, intertidal mud flat, leg. Y.L. Lee et al., 08 January 2012 (SN 45046-45047).

Distribution. Southern India, Singapore, Indonesia (Java, Sulawesi), and Australia (Northern Territory).

Previous records from Singapore. Johnson (1979).

Ecology. Mudflats and nearby polyhaline waters; lower intertidal and shallow subtidal.

Remarks. Johnson (1962, 1979) recorded the closely related *Leandrites deschampsi* (Nobili, 1903a) from Singapore, stating that it was particularly abundant in mangrove areas and prawn ponds in the Straits of Johor. It is noteworthy that *L. deschampsi* was not encountered during the CMBS survey, perhaps indicative of large scale environmental changes in the area.

Genus *Manipontonia* Bruce, Okuno & Li, 2005

Manipontonia paeneglabra Bruce, 2012
(Fig. 90A)

Manipontonia paeneglabra Bruce, 2012: 1378.

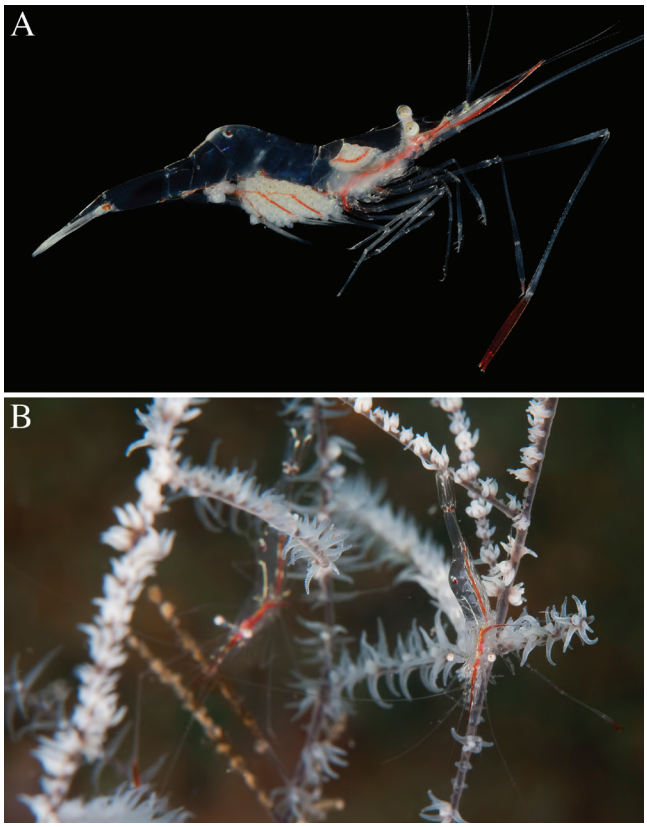

Fig. 90. *Manipontonia paeneglabra* Bruce, 2012: A, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD133 (OUMNH.ZC. 2014-11-361). *Manipontonia* sp., possibly *M. psamathe* (De Man, 1902): B, two individuals from Anilao, Philippines, photographed *in situ* on antipatharian host (specimens not collected) (Photographs by: Arthur Anker [A], Arne Kuilman [B]).

CMBS material. Straits of Johor. 2 ov. females, ZRC 2014.0958, off Tengeh Reservoir, 12.2–13.3 m, leg. C.K. Chim, S.C. Lim, A. Anker et al., 09 April 2014 (3821 DR2); 1 female, ZRC 2014.0959, sta. 92, off PA campsite, muddy, leg. H.H.Ng, 24 January 2013 (5718 TR1-043). Strait of Singapore. 1 male, 1 female, 1 ov. female, OUMNH.ZC. 2014-11-360, sta. 120, beside Pulau Jong, rocky bottom, 43.3–74,6 m, leg. S.C. Lim et al., 15 May 2013; 1 ov. female, ZRC 2014.0960, N of Pulau Jong, 40.8 m, leg. TMSI team, 15 May 2013 (4713 DR1-105); 2 males, 2 ov. females, ZRC 2014.0963, same collection data (4713 DR1-011-014); 1 ov. female, OUMNH.ZC. 2014-11-361, sta. SD133, S Kusu I., 11 m, leg. S. De Grave et al., 31 May 2013 (SIN-259); 1 female, OUMNH.ZC. 2014-11-362, sta. SD133, same collection data (SIN-254c); 4 ov. females, 2 females, OUMNH.ZC. 2014-11-363, sta. SD133, same collection data (SIN-260); 1 ov. female, OUMNH.ZC. 2014-11-364, E of Bedok Jetty, 6.0–7.5 m, leg. TMSI team, 24 January 2013 (5718 TB1-014); 2 females, ZRC 2014.0961, same collection data (5718 TB1-015-016); 4 specimens, OUMNH.ZC. 2014-11-365, sta. TB3, off Raffles Lighthouse, 40.7–40.9 m, sand, large sponges, leg. B. Richer de Forges et al., 21 May 2013 (SS-0304); 1 female, ZRC 2014.0962, SE of Pulau Bukom, 43.3–74.6 m, leg. TMSI team, 15 May 2013 (4713 DR3-005); 1 male, ZRC 2014.0964, sta. TB113, Southern Fairway, S of Sisters Is., 29.3–30.5 m, rocky bottom, leg. S.C. Lim et al., 29 May 2013 (SS-3242).

Distribution. Australian North-West Shelf, South China Sea and Singapore.

Previous records from Singapore. None.

Ecology. Rocky-muddy bottoms below coral reefs, associated with various gorgonians; previously reported depth range: 82–105 m (Bruce, 2002), present records extending its bathymetric range upwards to as shallow as 6 m (but see remarks below).

Remarks. The CMBS material is assigned to *Manipontonia paeneglabra* on account of the absence of a row of setae between the epigastric tooth and the first rostral tooth, as well as the chela of the major second pereopod being very sparsely tuberculate. However, one specimen (OUMNH.ZC. 2014-11-361) has a densely tuberculate chela, considered to be typical for *M. psamathe* (De Man, 1902), but no epigastric row of seta, which is present in *M. psamathe* but not in *M. paeneglabra* according to Bruce (2012). *Manipontonia psamathe* is known from a wide range of cnidarian hosts, including Antipatharia (Fig. 90B), Alcyonacea, Gorgonacea and Hydroidea (Bruce et al., 2005). Both Goh et al. (1999) and Bruce et al. (2005) recorded *M. psamathe* from *Melithaea robusta* (Shann) (Gorgonacea) at Kusu Island, the same locality from which some of the present material was collected. In addition, the colour pattern of specimens morphologically identifiable as *M. paeneglabra* (Fig. 90A) is identical to that of *M. psamathe*, as shown by Bruce et al. (2005). The question whether two species of *Manipontonia* occur in Singapore or whether both taxa are conspecific (in which case *M. paeneglabra* would fall into synonymy *of M. psamathe*) thus remains open.

Genus *Palaemon* Weber, 1795

***Palaemon semmelinkii* (De Man, 1881)**
(Fig. 91)

Leander semmelinkii De Man, 1881: 137; Nobili, 1903a: 8
Palaemon (*Paleander*) *semmelinki* — Holthuis, 1950: 57; Johnson, 1962: 56; Johnson, 1979: 30.
Palaemon semmelinki — Chace & Bruce, 1993: 41.

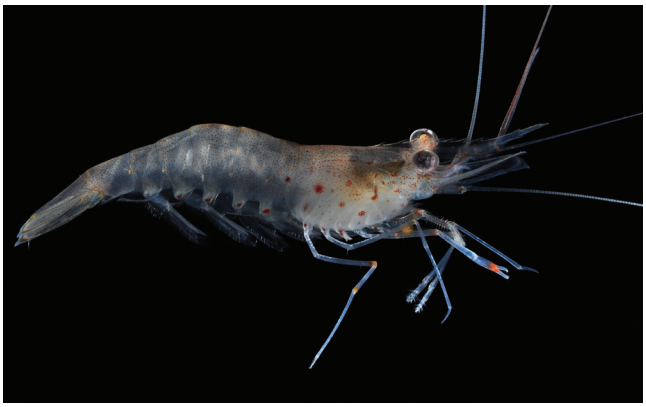

Fig. 91. *Palaemon semmelinkii* (De Man, 1881): female from Lim Chu Kang, West Johor Strait, CMBS sta. SW106 (OUMNH.ZC. 2014-11-366) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 female, OUMNH.ZC. 2014-11-366, sta. SW106, Lim Chu Kang mangrove area, intertidal, hand and tangle nets, leg. B.-Y. Lee et al., 27 October 2012 (JS-2411); 1 male, OUMNH.ZC. 2014-11-367, sta. SW106, same collection data (JS-2506); 1 female, ZRC 2014.0965, sta. SW106, same collection site (JS-2505); 3 females, OUMNH.ZC. 2014-11-368, sta. MF59, Sungei Loyang, river mouth at Pasir Ris Park, intertidal mud flat, seine net, leg. H.H. Ng et al., 25 May 2012 (MF59 136-138); 2 females, ZRC 2014.0966, sta. MF57, Pulau Tekong, NParks mangrove rehabilitation project, Chainage D, mud flat, leg. H.H. Ng et al., 10 May 2012 (SN 57012-57013); 2 females, OUMNH.ZC. 2014-11-369, same collection data (SN 57010-57011); 1 male, ZRC 2014.0967, sta. MF66, Pulau Sarimbun, intertidal mud flat, leg. H.H. Ng et al., 10 July 2012 (SN 66043-044); 26 specimens, OUMNH.ZC.2014-11-370, sta. MF27, Lim Chu Kang, W of Sarimbun Scouts Camp, intertidal mud flat, leg. H.H. Ng et al., 21 July 2011.

Additional material. Straits of Johor. 5 specimens, OUMNH.ZC.2009.20.001, Sarimbun-Poyan mangrove, leg. H.H. Tan et al., 20 January 2004.

Distribution. Indo-west Pacific: India, Thailand, Myanmar, Philippines, Singapore, Vietnam and Australia (Northern Territory).

Previous records from Singapore. Nobili (1903a); Johnson (1962, 1979).

Ecology. In brackish water and in mangroves, sometimes in prawn ponds (e.g., in Singapore and Vietnam), also known from fully marine, inshore waters; intertidal and shallow subtidal.

Remarks. *Palaemon semmelinkii* was one of the first caridean shrimps recorded from Singapore, as Nobili (1903a) reported upon a single male specimen of this species from an unspecified location.

Palaemon serrifer (Stimpson, 1860) sensu lato
(Fig. 92)

Leander serrifer Stimpson, 1860: 41.
Palaemon (*Palaemon*) *serrifer* — Holthuis, 1950: 83; Johnson, 1962: 55.
Palaemon serrifer — Johnson, 1979: 31; Ashelby et al., 2012: 296.

Fig. 92. *Palaemon serrifer* (Stimpson, 1860) sensu lato: A, ovigerous female from Labrador Beach, Strait of Singapore (OUMNH.ZC. 2012-09-005); B, ovigerous female from Pulau Ubin, Straits of Johor, CMBS sta. SW25 (not deposited) (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 ov. female, ZRC 2014.0968, sta. SW12, OBS Camp 1, unnamed stream and outlet at beach, intertidal, push net, leg. H.H. Ng, 16 October 2012 (JS-1009); 1 ov. female, ZRC 2014.0970, sta. SW12, same collection data (JS-0828); 2 females, OUMNH.ZC. 2014-11-371, sta. MF9, Pulau Ubin, OBS site, intertidal mud flat, leg. H.H. Ng et al., 13 May 2011 (SN 9019, 9063); 1 ov. female, ZRC 2014.0969, sta. MF48, Sarimbun, shore of Camp High Achievers, along Jalan Bahtera, intertidal mud flat, leg. H.H. Ng, leg.14 February 2012 (SN 48191); 1 ov. female, not deposited (location of specimen unknown), sta. SW25, Pulau Ubin, OBS Camp 1, muddy intertidal, leg. A. Anker, 18 October 2012 (JS-1404). Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-372, sta. IT108, Raffles Lighthouse, intertidal, under rocks and rubble at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3236).

Additional material. Strait of Singapore. 1 ov. female, 1 male, OUMNH.ZC.2012-09-005, Labrador Beach, leg. P. Ng et al., 09 December 2011.

Distribution. Indo-west Pacific: India, Myanmar, Singapore, Indonesia, Australia (Northern Territory), China, Taiwan, Japan, and eastern Russia.

Previous records from Singapore. Johnson (1962; 1967); Ashelby et al. (2012).

Ecology. Low salinity through to fully marine conditions, typically on rocky shores, also found amongst fouling communities and in seagrass beds; intertidal and shallow subtidal.

Remarks. Ashelby et al. (2012) found evidence of pseudo-cryptic speciation in *Palaemon serrifer*, with the populations from Singapore (Labrador Beach), South Korea and Taiwan exhibiting considerable genetic divergence from each other. It remains unclear which of these lineages corresponds to the true *P. serrifer*, originally described from Hong Kong. The material studied herein is morphologically very similar to the Hong Kong material redescribed by Bruce (1990) and will likely turn out to be conspecific after further study.

Palaemon aff. *sewelli* (Kemp, 1925)
(Fig. 93)

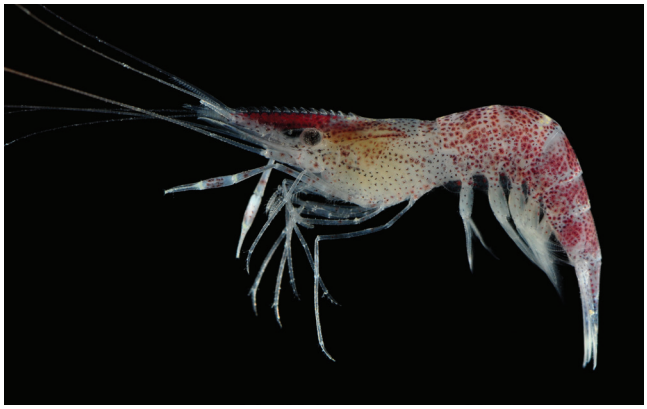

Fig. 93. *Palaemon* aff. *sewelli* (Kemp, 1925): non-ovigerous specimen (possibly male) dredged in the eastern Straits of Johor, between Pulau Ubin and Pulau Tekong CMBS sta. DW89 (not deposited) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 male (?), not deposited (location of specimen unknown), sta. DW89, between Pulau Ubin (Chek Jawa) and Pulau Tekong, 20.5–22.1 m, leg. B. Richer de Forges et al., 25 October 2012 (JS-1984) [photographic record only].

Distribution. *Palaemon sewelli* is known from India, Myanmar, Thailand, Vietnam, China (Guangdong, Guangxi), and now possibly also from Singapore (see below).

Previous records from Singapore. None.

Ecology. Typically in large estuarine areas; depth range 4–9 m.

Remarks. The post mortem colour pattern of the specimen from the eastern Straits of Johor (dredged between Pulau Ubin and Pulau Tekong) here assigned to *Palaemon* aff. *sewelli* (Fig. 93) does not perfectly correspond to either of the two colour forms of the Vietnamese material of *P. sewelli* described and illustrated by Nguyên (2000b). However, it is very similar to the pattern of a single specimen from Guangxi (China) ascribed to this species by Li et al. (2004), whilst Kemp (1925) also recorded specimens which were "dull reddish in colour". Based on the visible morphological features, the photographed specimen bears a general resemblance to *P. sewelli*. However, since the present whereabouts of this specimen are unknown, some important and diagnostic morphological details necessary for a positive identification cannot be checked. Colour patterns are generally quite conservative in species of *Palaemon*, and the two Vietnamese colour forms are known to belong to two species, one of which is currently undescribed (C. Ashelby, pers. comm.). The reddish colour form recorded from Guangxi and now Singapore may represent a third species in the *P. sewelli* complex.

Genus *Palaemonella* Dana, 1852

Palaemonella lata Kemp, 1922
(Fig. 94)

Palaemonella lata Kemp, 1922: 127; Bruce, 2002: 291; Chace & Bruce, 89.

Fig. 94. *Palaemonella lata* Kemp, 1922: female from Kusu Island, Strait of Singapore, CMBS sta. SD177 (ZRC 2014.0985) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 female, ZRC 2014.0985, sta. SD177, SW Kusu I., 16.3 m, leg. H.H. Tan et al., 04 June 2013 (SIN-352).

Distribution. Indo-west Pacific, from East Africa to Japan, Tahiti and Hawaii.

Previous records from Singapore. None

Ecology. Coral reefs, exact depth range unknown, with certainty from intertidal down to 16.3 m; possibly a sponge associate (Bruce, 1970).

Remarks. The single specimen collected adheres closely to the description of the holotype by Kemp (1922), with the colour pattern matching that of an East African specimen, described in Bruce (1970). The present record is the first for Singapore of this relatively rare species.

Palaemonella pottsi (Borradaile, 1915)
(Fig. 95)

Periclimenes (*Falciger*) *pottsi* Borradaile, 1915: 212.
Palaemonella pottsi — Johnson, 1962: 57; Johnson, 1963: 288; Johnson, 1979: 32; Chace & Bruce, 1993: 89.

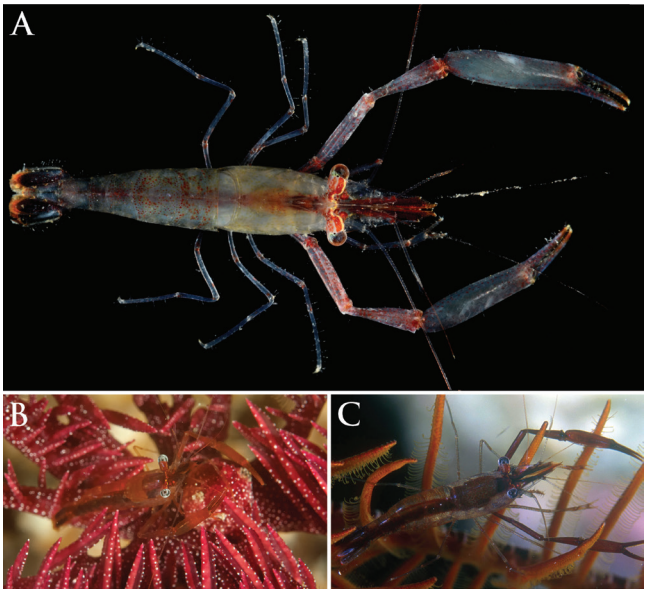

Fig. 95. *Palaemonella pottsi* (Borradaile, 1915): A, male from the eastern Straits of Johor, CMBS sta. TB142 (ZRC 2014.0971); B, individual from Romblon, Philippines, photographed in situ on crinoid host (specimen not collected); C, male from Sipadan, Malaysia, photographed in situ on crinoid host (specimen not collected) (Photographs by: Arthur Anker [A], Arne Kuilman [B], Sergey Parinov (C)).

CMBS material. Straits of Johor. 1 male, 1 female, ZRC 2014.0971, sta. TB142, East Johor Strait, muddy-gravel, dead shells, 28.7–28.8 m, leg. S.C. Lim et al., 31 May 2013 (SIN-287).

Distribution. Indo-west Pacific, from East Africa to Japan, New Caledonia and Marshall Islands.

Previous records from Singapore. Johnson (1962, 1963, 1979).

Ecology. Coral reefs and crinoid grounds, obligate associate of various crinoids (Fig. 95B, C); exact depth range unknown, usually found below 10 m.

Remarks. Johnson (1962) reported a single specimen of *Palaemonella pottsi* collected west of Pulau Pawai. The present record confirms its continued presence in Singapore, but also highlights its rarity, as only a single sample was obtained during the extensive CMBS survey, with numerous crinoids collected and examined for presence of symbiotic decapods. The host of the present specimens of *P. pottsi* collected by a dredge was not recorded.

Palaemonella rotumana (Borradaile, 1898)
(Fig. 96)

Periclimenes rotumanus Borradaile, 1898: 383.
Palaemonella vestigialis Kemp, 1922: 123; Holthuis, 1952: 24.
Palaemonella rotumana — Johnson, 1962: 58; Johnson, 1963: 288; Bruce, 1970: 277; Johnson, 1979: 32; Bruce, 1979a: 217; Chace & Bruce, 1993: 89; Bruce, 2002: 291.
(?) *Periclimenes suvadivensis* (nec Borradaile, 1915) — Johnson, 1962: 59.
(?) *Periclimenes digitalis* (nec Kemp, 1922) — Johnson, 1967: 34.

CMBS material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.0972, sta. SW7, St. John's I., DRTech, pontoon at south lagoon, fouling agents on pontoon, 0–0.5 m, leg. H.H. Tan, J.C. Mendoza, 20 May 2013 (SIN-002); 1 ov. female, OUMNH.ZC. 2014-11-373, sta. SW10, St. John's I., DRTech, pontoon at south lagoon, fouling agents on pontoon, 0–0.5 m, leg. D. Uyeno, J.C Mendoza et al., 21 May 2013 (SIN-033); 1 female, ZRC 2014.0980, sta. SW10, same collection data (SS-0325); 1 male, OUMNH.ZC. 2014-11-374, sta. SD100, St. John's I., DRTech, near jetty, 8–15 m, leg. D. Uyeno & K.Tilbrook, 28 May 2013 (SIN-212); 1 ov. female, OUMNH.ZC. 2014-11-375, sta. SW6, St. John's I., DRTech, south lagoon, under pontoon, leg. S. De Grave & K. Tilbrook, 20 May 2013 (SIN-279a); 1 female OUMNH. ZC. 2014-11-376, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-084a); 1 female, OUMNH.ZC. 2014-11-377, sta. SD45, same collection data (SS-1608); 1 ov. female, ZRC 2014.0973, sta. SD34, N Lazarus I., 14 m, leg. H.H. Tan et al., 22 May 2013 (SIN-047); 2 males, 1 ov. female, 1 female, OUMNH.ZC. 2014-11-378, sta. SD133, S Kusu I., 11 m, leg. S. De Grave et al., 31 May 2013 (SIN-267a); 1 female, ZRC 2014.0984, sta. SD133, S Kusu I., same collection data (SIN-265); 5 specimens, ZRC 2014.0979, sta. SD150, SW Kusu I., 10.7 m, leg. S. De Grave et al., 01 June 2013 (SIN-298); 1 female, OUMNH.ZC. 2014-11-379, N of Pulau Jong, 40.8 m, leg. TMSI team, 15 May 2013 (4713 DR3-088); 1 male, ZRC 2014.0986, same collection data (4713 DR3-004); 1 ov. female, 1 female, ZRC 2014.0974, sta. SD66, W Pulau Hantu, patch reef, 3 m, leg. S. De Grave et al., 25 May 2013 (SIN-109); 1 male, 2 ov. females, ZRC 2014.1073, sta. SB146, W Pulau Hantu, 5–7 m, coral rubble brushing, leg. S. De Grave et al., 01 June 2013 (SIN-296); 1 ov. female, OUMNH.ZC. 2014-11-380, sta. IT82, Beting Bemban Besar, intertidal, leg. K.S. Koh et al., 26 May 2013 (SIN-136a); 1 female, ZRC 2014.0975, sta. IT95, Raffles Lighthouse, intertidal, leg. S. De Grave et al., 28 May 2013 (SIN-185); 1 ov. female, ZRC 2014.0976, sta. IT122, Terumbu Raya, intertidal, leg. C.S. Tan et al., 30 May 2013 (SIN-227); 1 ov. female, ZRC 2014.0977, sta. IT122, same collection data (SIN-250); 1 female, ZRC 2014.0983, sta. IT65, Terumbu Semakau, sandy-rocky beach, 0–0.5 m, leg. J.Y. Ong et al., 24 May 2013 (SIN-107); 1 female, OUMNH.ZC. 2014-11-381, sta. TB113, Southern Fairway, S of Sisters Is., rocky bottom, 29.3–30.5 m, leg. S.C. Lim et al., 29 May 2013 (SIN-247); 1 ov. female, OUMNH.ZC. 2014-11-382, sta. DR112, Southern Fairway S of Sisters Is., 33.6–34.4 m, shells, coral rubble, leg. B. Richer de Forges et al., 30 May 2013 (SS-3244); 1 ov. female, ZRC 2014.0978, sta. IT140, Pulau Tekukor, intertidal, leg. Y.L. Lee et al., 31 May 2013 (SIN-271a); 1 female, ZRC 2014.0981, sta. SB85, SW Pulau Tekukor, 4.5 m, coral rubble brushing, leg. D. Uyeno, H.H. Tan et al., 28 May 2013 (SS-2717); 1 male, ZRC 2014.0982, sta. MF61, Pulau Pawai, southern mangroves, intertidal mud flat, leg. H.H. Ng et al., 10 June 2012 (CMBS 61068).

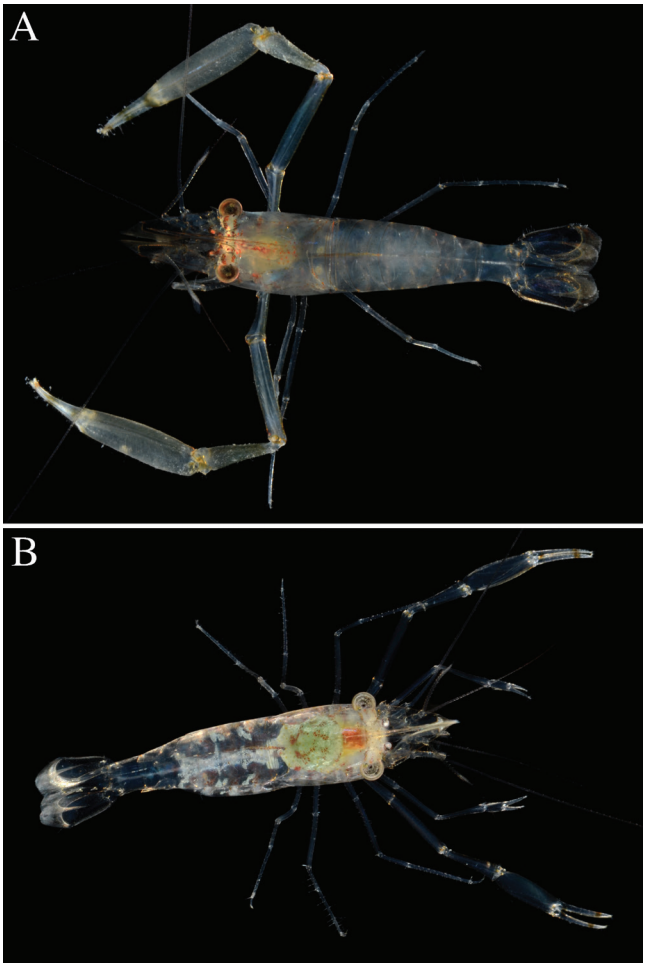

Fig. 96. *Palaemonella rotumana* (Borradaile, 1898): A, female from Terumbu Semakau, Strait of Singapore, CMBS sta. IT65 (ZRC 2014.0983); B, ovigerous female from Lazarus Island, Strait of Singapore, CMBS sta. SD34 (ZRC 2014.0973) (Photographs by: Arthur Anker).

Distribution. Indo-west Pacific, from the Red Sea and southwestern Africa to Japan and central Pacific, Lessepsian migrant in the Mediterranean Sea.

Previous records from Singapore. Johnson (1962, 1963), Bruce (1970, 1979).

Ecology. Variety of habitats, usually on hard (rocky or reef) substrates, often in muddy or silty conditions; intertidal down to 130 m.

Remarks. Johnson (1962) recorded *Cuapetes suvadivensis* (Borradaile, 1915) under the name *Perclimenes suvadivensis*, as sparingly occurring in *Enhalus* beds at Changi and Bedok, and in *Sargassum* beds at Pulau Sudong. In his later publication (Johnson, 1979) the identification was corrected to *Periclimenes digitalis* Kemp, 1922. Since Kemp (1922) himself considered *P. digitalis* as a possible synonym of *Palaemonella rotumana*, it appears quite likely that Johnson's material of *P. suvadivensis* and *P. digitalis* corresponds in fact to *P. rotumana*. *Palaemonella rotumana* is very common in Singapore, particularly in the southern islands of the Strait of Singapore.

Genus *Periclimenaeus* Borradaile, 1915

Periclimenaeus arabicus (Calman, 1939)
(Fig. 97)

Periclimenes (*Periclimenaeus*) *arabicus* Calman, 1939: 210.
Periclimenaeus arabicus — Bruce, 1975: 1563.

Fig. 97. *Periclimenaeus arabicus* (Calman, 1939): ovigerous female from Rasa Sentosa, Strait of Singapore, CMBS sta. 4815 DR1 (specimen not deposited) (Photograph by: Arthur Anker).

CMBS material. None.

Additional material. Strait of Singapore. 1 ov. female, RMNH.CRUS.D.57003, W Terumbu Pempang Tengah, in *Callyspongia* (*Toxochalina*) sp., 9 m, leg. N. de Voogd, 03 April 2006 (SIN20/030406/152).

Distribution. Indo-west Pacific, from East Africa and Oman to Japan and Fiji; intertidal down to 83 m.

Previous records from Singapore. None.

Ecology. Coral reefs, obligate sponge dweller (genera *Gellius*, *Callyspongia* and *Acarnus*).

Remarks. The present material from Terumbu Pempang Tengah is the first record of *Periclimenaeus arabicus* for Singapore. Another specimen, almost certainly of this species was photographed (Fig. 97) during the CMBS workshop, but not deposited.

Periclimenaeus orontes Bruce, 1986

Periclimenaeus orontes Bruce, 1986: 151.

CMBS material. Strait of Singapore. 1 female, OUMNH. ZC. 2014-11-383, off NW Sentosa, 17.7–20.1 m, leg. TMSI team, 11 January 2013 (4815 DR1-053).

Distribution. Australia (Cobourg Peninsula) and Singapore.

Previous records from Singapore. None.

Ecology. The Australian specimen was collected from the sponge *Jaspis stellifera* (Carter); no host was recorded for the Singaporean specimen.

Remarks. *Periclimenaeus orontes* was previously only known only from the holotype, an ovigerous female collected in 1982 on Orontes Reef off Port Essington, Cobourg Peninsula, northern Australia (see Bruce 1986 for an illustrated description of the species). The Singaporean specimen matches the holotype of *P. orontes* in all diagnostic details.

Periclimenaeus tridentatus (Miers, 1884)
(Fig. 98)

Coralliocaris ? *tridentata* Miers, 1884: 294.
Periclimenaeus tridentatus — Holthuis, 1952: 140; Johnson, 1962: 59; Johnson, 1979: 32; Bruce, 1979a: 236; Chace & Bruce, 1993: 93; c: 566.

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0987, sta. TB157, near Southern Fairway, off Kusu I., rocky gravel, 147–160 m, leg. S.C. Lim et al., 03 June 2013 (SIN-314); 1 male, OUMNH.ZC. 2014-11-384, sta. TB157, same collection data (SIN-322); 1 male, OUMNH. ZC. 2014-11-385, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-330); 1 ov. female, OUMNH.ZC. 2014-11-386, sta. SB132, Kusu I., pontoon, 0–5 m, brushing of dead corals, leg. S. De Grave, K. Tilbrook et al., 31 May 2013 (SS-3761); 1 male, ZRC 2014.0988, sta. DR161, near St. John's I., 41.2–44.4 m, gravel, leg. B. Richer de Forges et al., 04 June 2013 (SS-4511); 1 male, ZRC 2014.0989, E of Eastern Holding B, sandy bottom with big rocks, around 65.3 m, leg. S.C. Lim, 17 May 2013 (5414 TB1-037); 1 ov. female, not deposited (location of specimen unknown), near Rasa Sentosa, 21 m, sand, mud, 11 January 2013 (4815 DR1-053).

Distribution. Indo-west Pacific, from Mozambique to southern China, Philippines, Singapore, Australia (Northern Territory, Queensland), Mariana and Society Islands.

Previous records from Singapore. Johnson (1962, 1979), Bruce (1979a).

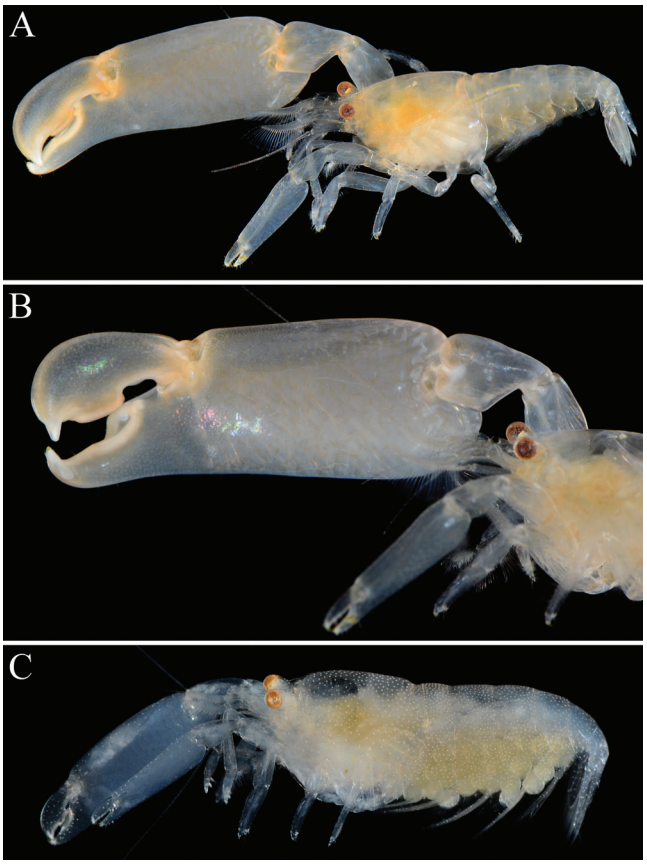

Fig. 98. *Periclimenaeus tridentatus* (Miers, 1884): A, B, male dredged east of Eastern Holding B, Strait of Singapore, CMBS sta. 5414 TB1 (ZRC 2014.0989), lateral view of the shrimp (A) and close-up of the major second pereopod (cheliped) (B); C, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SB132 (OUMNH.ZC. 2014-11-386), in lateral view (Photographs by: Arthur Anker).

Ecology. Coral reefs and associated habitats, apparently associated with both tunicates and sponges (see below); shallow subtidal to 160 m depth.

Remarks. The identity of the material recorded as *Periclimenaeus tridentatus* from Singapore by Johnson (1962, 1979) remains unclear. Johnson (1979) stated that the species was common in sponges; however, *P. tridentatus* is generally considered to be an associate of ascidians, which led Bruce (2002) to conclude that Johnson's material would likely refer to a different species. However, according to Fransen (2006), *P. tridentatus* can be found in both sponges and ascidians. The hosts of the CMBS specimens were not determined (most specimens were found in dredge or coral rubble samples) and the question of the host preferences of the species thus remains open. However, the presence of *P. tridentatus* in Singapore is now confirmed. The present material confirms the existence of a marked sexual dimorphism in the species (Bruce, 2002), with the major chela of largest males being strongly inflated and almost the same size as the body (Fig. 98A, B). Females have a much smaller major chela (Fig. 98C), with the distal margin of the dactylus finely denticulate, a character absent in the males. Most if not all members of the genus *Periclimenaeus* produce a fairly strong snapping sound by rapidly closing the fingers of the major second pereopod, and may be confused in the field, at least at first glance, with the true snapping shrimps of the genus *Synalpheus*.

Genus *Periclimenella* Bruce, 1995

Periclimenella spinifera (De Man, 1902)
(Fig. 99)

Periclimenes pettithouarsii var. *spinifera* De Man, 1902: 824.
Periclimenes spiniferus — Johnson, 1962: 58; Johnson, 1963: 288; Johnson, 1979: 33; Bruce, 1979a: 229.
Periclimenella spinifera — Ďuriš & Bruce, 1995: 656.

Fig. 99. *Periclimenella spinifera* (De Man, 1902): male from Raffles Lighthouse, Strait of Singapore, CMBS sta. IT95 (ZRC 2014.0990) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.0990, sta. IT95, Raffles Lighthouse, intertidal, in coral *Acropora* sp., leg. S. De Grave et al., 28 May 2013 (SIN-183).

Distribution. Indo-west Pacific, from Madagascar to Japan and Fiji.

Previous records from Singapore. Johnson (1962, 1963, 1979), Bruce (1979a).

Ecology. Coral reefs and associated habitats rich in coral rubble, free-living in and under dead corals, in rocky pools etc., sometimes in living corals (including *Millepora*); lower intertidal to at least 20 m.

Remarks. *Periclimenella spinifera* is one of the most common coral reef associated shrimps in the Indo-west Pacific, being apparently absent only from the northwestern Indian Ocean (including the Red Sea) (Chace & Bruce, 1993). The single CMBS specimen was found inside a coral colony of an undetermined species of *Acropora*. *Periclimenella spinifera* is capable of producing a low but audible snapping sound by rapidly closing the fingers of the major second pereopod.

Genus *Periclimenes* Costa, 1844

***Periclimenes brevicarpalis* (Schenkel, 1902)**
(Figs. 100, 101)

Ancylocaris brevicarpalis Schenkel, 1902: 563.
Periclimenes (*Harpilius*) *brevicarpalis* — Holthuis, 1952: 69.
Periclimenes brevicarpalis — Johnson, 1962: 59; Johnson, 1979: 33; Monod, 1976: 24; Chace & Bruce, 1993: 104; Ng, 2009: 106; Ng, 2011: 144; Wang & Yeo, 2011: 28.
"A female prawn" — Chuang, 1961: pl. 15.

Fig. 100. *Periclimenes brevicarpalis* (Schenkel, 1902): A, female from Pulau Sekudu, Straits of Johor, CMBS sta. SW24 (not deposited); B, male-female pair from Sentosa, Strait of Singapore, photographed *in situ* on sea anemone host, *Stichodactyla haddoni* (Saville-Kent) (Photographs by: Arthur Anker [A], Marcus Ng [B]).

CMBS material. Straits of Johor. 1 female, not deposited (location of specimen unknown), sta. SW24, Pulau Sekudu near Pulau Ubin (off Chek Jawa), intertidal sand-seagrass flat, on sea anemone, leg. R. Tan et al., 17 October 2012 (JS-1407). Strait of Singapore. 1 male, ZRC 2014.0991, sta. SD56, S Pulau Jong, 17 m, on sea anemone, leg. S. De Grave et al., 24 May 2013 (SIN-094); 1 female, OUMNH.ZC. 2014-11-387, sta. SD89, S Small Sister's I., 14.7 m, on sea anemone, leg. S. De Grave et al., 27 May 2013 (SIN-165) [infested with a pair of bopyrid isopods]; 2 ov. females, ZRC 2014.0994, sta. IT102, Big Sister's I., intertidal, on sea anemone, leg. KS. Koh, K. Chua et al., 30 May 2013 (SS-3235); 1 male, 1 ov. female, ZRC 2014.0992, sta. IT95, Raffles Lighthouse, intertidal, on sea anemone, leg. S. De Grave et al., 28 May 2013 (SIN-174); 1 female, OUMNH.ZC. 2014-11-388, same collection data (SIN-175); 1 ov. female, ZRC 2014.0993, same collection data (SIN-175); 1 male, OUMNH.ZC. 2014-11-389, sta. SD133, S Kusu I., 11 m, on sea anemone, leg. S. De Grave et al., 31 May 2013 (SIN-257).

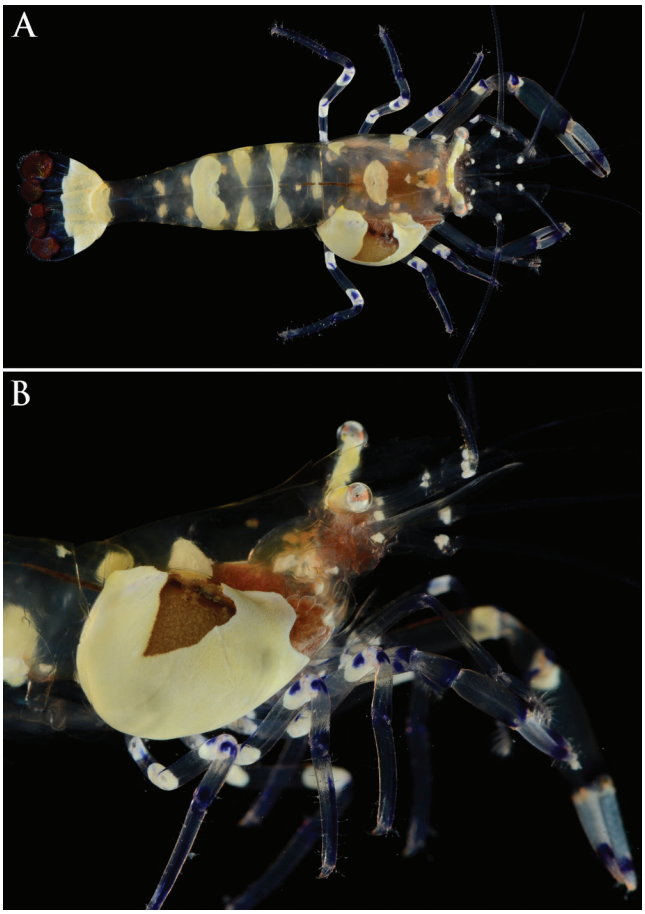

Fig. 101. *Periclimenes brevicarpalis* (Schenkel, 1902): A, B, female from Small Sister's Island, Strait of Singapore, CMBS sta. SD89 (OUMNH.ZC. 2014-11-387), infested with a pair of bopyrid isopods (female and male, latter concealed), possibly *Bopyrina brachytelson* Nierstrasz & Brender in Brandis, dorsal view of the shrimp (A) and close-up of the female isopod (B) (Photographs by: Arthur Anker).

Distribution. Indo-west Pacific, from the Red Sea and East Africa to Japan, Australia and Line Islands.

Previous records from Singapore. Chuang (1961), Johnson (1962, 1963, 1979), Ng (2009, 2011), Wang & Yeo (2011).

Ecology. Various habitats, including coral reefs, rock-sandflats, and seagrass beds, obligate associate of sea anemones; intertidal to at least 20 m.

Remarks. The present material of *Periclimenes brevicarpalis* was collected from the sea anemones *Heterodactyla magnifica* (Quoy & Gaimard) and *Stichodactyla haddoni* (Saville-Kent) (Fig. 100B). In Singapore, *P. brevicarpalis* is also known to associate with *Stichodactyla gigantea* (Forskal), *Heteractis crispa* (Hemprich & Ehrenberg) and *Cryptodendrum adhaesivum* Klunzinger (R. Tan, pers. comm.). The species is rather widespread in the Strait of Singapore (Kusu Island, Pulau Jong, Raffles Lighthouse,

etc.), but can also be observed on *S. haddoni* at Check Jawa (eastern Pulau Ubin) at the eastern entrance of the Straits of Johor (R. Tan, pers. comm.). One shrimp found was infested with a pair of bopyrid isopods (Fig. 101), a very large female and a dwarf male. Interestingly, Bourdon & Stock (1979) reported *Bopyrina brachytelson* Nierstrasz & Brender in Brandis, 1923 attached to a specimen of *P. brevicarpalis* imported from Singapore for aquarium trade.

Periclimenes commensalis Borradaile, 1915
(Fig. 102)

Periclimenes (*Cristiger*) *commensalis* Borradaile, 1915b: 211.
Periclimenes (*Periclimenes*) *commensalis* — Holthuis, 1952: 53.
Periclimenes commensalis — Bruce, 1983: 883.

Fig. 102. *Periclimenes commensalis* Borradaile, 1915: A, ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SD25 (ZRC 2014.0995); B, female (?) from Pulau Hantu, Strait of Singapore, photographed *in situ* on crinoid host (specimen not collected) (Photographs by: Arthur Anker [A], Kelvin Pung [B]).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.0995, sta. SD25, SW St. John's I., 7.6 m, leg. S. De Grave et al., 22 May 2013 (SIN-038); 1 male, 1 female, OUMNH.ZC. 2014-11-390, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-064); 1 female, ZRC 2014.0997, sta. SD89, S Small Sister's I., 14.7 m, leg. S. De Grave et al., 27 May 2013 (SIN-167); 2 ov. females, OUMNH.ZC. 2014-11-391, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-332b); 1 female, ZRC 2014.0996, sta. DR70, near Pulau Sudong & Pulau Semakau, sandy bottom, 20.6–22.6 m, leg. S.C. Lim et al., 25 May 2013 (SIN-111); 1 female, OUMNH.ZC. 2014-11-392, sta. SD68, SW Pulau Tekukor, 10 m, leg. S. De Grave et al., 25 May 2013 (SIN-112); 2 ov. females, ZRC 2014.0998, sta. SD167, SW Pulau Jong, 15.4 m, leg. H.H. Tan et al., 04 June 2013 (SIN-340); 2 females, OUMNH.ZC. 2014-11-393, sta. SD167, same collection data (SIN-342).

Distribution. Indo-west Pacific, from East Africa to Japan and Fiji.

Previous records from Singapore. None.

Ecology. Coral reef and associated habitats rich in rubble and crinoid shelters, obligate associate of crinoids of the families Himerometridae and Zygometridae; lower intertidal to at least 15 m.

Remarks. The host range and specificity of *Periclimenes commensalis* remain to be determined. The present specimens were associated with *Stephanometra tenuipinna* (Hartlaub), *Stephanometra indica* forma *spicata* Carpenter, *Pontiometra andersoni* (Carpenter) and *Himenometra robustapinna* (Carpenter) (C. Messing, pers. comm.). This is the first record of the species for Singapore.

Periclimenes cristimanus Bruce, 1965
(Fig. 103)

Periclimenes cristimanus Bruce, 1965: 487; Johnson, 1979: 33; Chace & Bruce, 1993: 108; Grignard et al., 1994: 107.
(?) *Tulleariocaris zanzibarica* (nec Bruce, 1969) — Tan, 2014: 179.

CMBS material. Strait of Singapore. 1 male, 1 ov. female, OUMNH.ZC. 2014-11-394, sta. SD164, Lazarus I., pontoon, 0–0.5 m, leg. S. De Grave, K. Tilbrook, 03 June 2013 (SIN-317); 1 male, OUMNH.ZC. 2014-11-395, same collection data (SIN-321); 1 male, ZRC 2014.0999, sta. SD177, SW Kusu I., 16.3 m, leg. H.H. Tan et al., 04 June 2013 (SIN-355); 1 female, ZRC 2014.1000, sta. SD145, W Pulau Hantu, 11.7 m, leg. S. De Grave et al., 01 June 2013 (SIN-291); 1

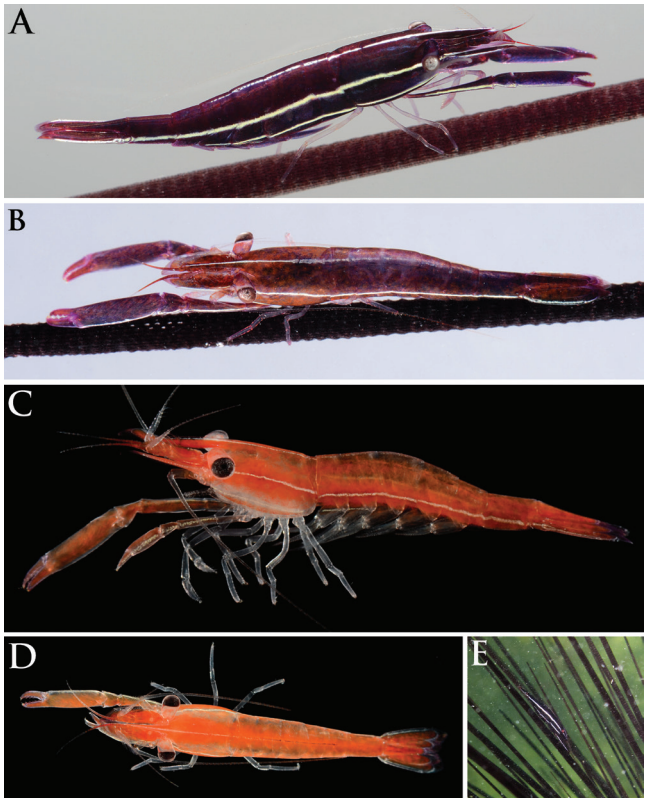

Fig. 103. *Periclimenes cristimanus* Bruce, 1965: A, female from Pulau Hantu, Strait of Singapore, CMBS sta. SD145 (ZRC 2014.1000); B, male from Lazarus Island, Strait of Singapore, CMBS sta. SD164 (OUMNH.ZC. 2014-11-395); both photographed on spines of sea urchin hosts, *Diadema* sp.; C, D, male from Kusu Island, Strait of Singapore, CMBS sta. SD177 (ZRC 2014.0999), in lateral (C) and dorsal (D) views; E, urchin-associated pontoniine shrimp, probably *P. cristimanus*, from Pulau Semakau, Strait of Singapore, photographed in situ on sea urchin host, *Diadema setosum* (Leske) (specimen not collected) (Photographs by: Arthur Anker [A–D], Jeffrey Low [E]).

ov. female, OUMNH.ZC.2014-11-396, sta. SD179, Terumbu Raya, 9.8 m, leg. S. De Grave et al., 05 June 2013 (SIN-363).

Distribution. Indo-west Pacific: Singapore, Malaysia, Philippines, Hong Kong, Australia and Marshall Islands.

Previous records from Singapore. Bruce (1965), Johnson (1979), Grignard et al. (1994).

Ecology. Coral reefs and associated habitats, obligate associate of sea urchins, primarily *Diadema setosum* (Leske), occasionally also *Echinothrix calamaris* (Pallas).

Remarks. Tan (2014) recorded a pontoniine shrimp associated with *Diadema setosum* in Pulau Satumu as *Tuleariocaris zanzibarica* Bruce, 1967, showing only a general underwater photograph on the host and without a voucher specimen. Given its wide range, *T. zanzibarica* may indeed occur in Singapore. However, the colour pattern of *Periclimenes cristimanus* and *T. zanzibarica* are virtually identical, adapted to spines of their hosts (Fig. 103). In addition, all CMBS specimens of *P. cristimanus* were also collected from *Diadema setosum*. Therefore, we provisionally place Tan's (2014) record of *T. zanizibarica* from Singapore under *P. cristimanus*, until actual specimens of the former species become available.

Periclimenes incertus Borradaile, 1915
(Fig. 104)

Periclimenes (*Cristiger*) *incertus* Borradaile, 1915: 210.
Periclimenes (*Periclimenes*) *impar* Kemp, 1922: 147.
Periclimenes incertus — Bruce, 1980: 10; Chace & Bruce, 1993: 114.

Fig. 104. *Periclimenes incertus* Borradaile, 1915: ovigerous female from Lazarus Island, Strait of Singapore, CMBS sta. SD34 (ZRC 2014.1001) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1001, sta. SD34, N Lazarus I., 14 m, on sponges, leg. H.H. Tan et al., 22 May 2013 (SIN-048); 2 ov. females, OUMNH.ZC. 2014-11-397, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, on sponges. leg. S. De Grave et al., 23 May 2013 (SIN-058); 1 male, 2 females, ZRC 2014.1002, sta. SD68, SW Pulau Tekukor, 10 m, on sponges, leg. S. De Grave et al., 25 May 2013 (SIN-118); 1 ov. female, OUMNH.ZC. 2014-11-398, sta. SD133, S Kusu I., 11 m, on sponges, leg. S. De Grave et al., 31 May 2013 (SIN-255); 1 ov. female, ZRC 2014.1003, sta. SD133, same collection data (SIN-263); 1 female, OUMNH.ZC. 2014-11-399, same collection data (SIN-264).

Distribution. Indo-west Pacific, from East Africa to New Caledonia.

Previous records from Singapore. None.

Ecology. Coral reefs and associated habitats, obligate associate of sponges; low intertidal to 53 m.

Remarks. The present material represents the first record of *Periclimenes incertus*, a rather inconspicuous species (Fig. 104), from Singapore. None of the sponges, on which this species was found in Singapore, were determined.

Periclimenes kempi Bruce, 1969

Periclimenes kempi Bruce, 1969a: 260; Bruce, 1979a: 224; Bruce, 1981a: 80.

CMBS material. Strait of Singapore. 3 ov. females, 3 females, 1 male, OUMNH.ZC. 2014-11-400, sta. IT95, Raffles Lighthouse, intertidal, on soft coral, leg. S. De Grave et al., 28 May 2013 (SIN-178); 1 ov. female, ZRC 2014.1004, same collection data (SIN-179).

Distribution. Indo-west Pacific, from the Red Sea and East Africa to Singapore, Australia and Fiji.

Previous records from Singapore. Bruce (1979a).

Ecology. Coral reefs and associated habitats with abundance of soft corals, obligate but non-specific associate of various soft corals, e.g. *Dendronephthya*, *Nephthea*, *Stereonephthya*, *Sinularia*, amongst others; lower intertidal to 15 m.

Remarks. The present specimens of *Periclimenes kempi* were collected from an undetermined soft coral, probably a species of either *Lobophytum* or *Sinularia* (S. De Grave, pers. obs.).

Periclimenes cf. *obscurus* Kemp, 1922

Periclimenes (*Periclimenes*) *obscurus* Kemp, 1922: 144.
Periclimenes obscurus — Bruce, 2007: 126.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1005, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-077); 1 ov. female, OUMNH.ZC. 2014-11-401, sta. SD45, same collection data (SIN-086); 1 female, ZRC 2014.1006, same collection data (SIN-089); 1 ov. female, 1 female, OUMNH.ZC. 2014-11-402, sta. SD56, S Pulau Jong, 17 m, leg. S. De Grave et al., 24 May 2013 (SIN-092); 1 ov. female, ZRC 2014.1007, sta. IT95, Raffles Lighthouse, intertidal, leg. S. De Grave et al., 28 May 2013 (SIN-178); 1

ov. female, OUMNH.ZC. 2014-11-403, sta. SD133, S Kusu I., 11 m, leg. S. De Grave et al., 31 May 2013 (SIN-262); 2 ov. females, 2 females, ZRC 2014.1008, sta. SD150, SW Kusu I., 10.7 m, leg. S. De Grave et al., 01 June 2013 (SIN-300); 1 male, 2 females, OUMNH.ZC. 2014-11-404, same collection data (SIN-311); 2 males, 2 ov. females, OUMNH.ZC. 2014-11-405, sta. SD179, Terumbu Raya, 9.8 m, leg. S. De Grave et al., 05 June 2013 (SIN-365).

Distribution. Indo-west Pacific, from the Persian Gulf (Kuwait) to Australia.

Previous records from Singapore. None.

Ecology. Poorly known, apparently associated with a variety of sponges, hydroids and gorgonians; depth range in Singapore: 10–16 m.

Remarks. The CMBS material is assigned to *Periclimenes* cf. *obscurus* based on two diagnostic features: (1) carpus of the second pereopod shorter than the palm and (2) antennal tooth always in a marginal position. The majority of specimens have subequal second pereopods, but a few specimens exhibit unequal ones. The Singaporean specimens were collected from undetermined gorgonians, soft corals and hydroids. A more detailed study of this material in conjunction with a wider study of the *P. obscurus* group may reveal more than one species of this complex being present in Singapore.

Genus *Philarius* Holthuis, 1952

Philarius gerlachei (Nobili, 1905)

Harpilius Gerlachei Nobili, 1905a: 160.
Philarius gerlachei — Holthuis, 1952: 152 (part.); Chace & Bruce, 1993: 127; Marin & Anker, 2011: 2.

CMBS material. Strait of Singapore. 1 female, ZRC 2014.1011, sta. IT108, Raffles Lighthouse, intertidal, "under rocks and rubble" at low tide, leg. Y.L. Lee, J.C. Mendoza et al., 30 May 2013 (SS-3234).

Distribution. Indo-west Pacific, from the Red Sea to Australia; material from French Polynesia reported as *P. gerlachei* may refer to the closely related *P. polynesicus* Marin & Anker, 2011.

Previous records from Singapore. None.

Ecology. Coral reefs, obligate associate of corals of the genus *Acropora*; lower intertidal to around 15 m.

Remarks. *Philarius gerlachei*, like other members of the genus *Philarius*, is an obligate associate of living corals (*Acropora* spp.). Therefore, it is very likely that the single specimen from Raffles Lighthouse was collected from a colony of *Acropora* and not "under rocks and rubble" as stated in the collection data for station IT108 at Raffles Lighthouse.

Genus *Phycomenes* Bruce, 2008

Phycomenes sulcatus (Ďuriš, Horká & Marin, 2008)
(Fig. 105)

Periclimenes aesopius — Johnson, 1962: 58; Johnson, 1968: xxi; Johnson, 1979: 33.
Periclimenes indicus — Bruce, 1979a: 221.
Periclimenes sulcatus Ďuriš et al., 2008: 36.
Phycomenes sulcatus — Bruce, 2010: 368; Wang & Yeo, 2011: 41.

CMBS material. Straits of Johor. 1 ov. female, not deposited (location of specimen unknown), sta. SW13, Pulau Ubin, Chek Jawa, mud flat near boardwalk, low tide, leg. A. Anker, P.K.L. Ng et al., 17 October 2012 (JS-0725). Strait of Singapore. 2 ov. females, OUMNH.ZC. 2014-11-406, sta. SW155, St. John's I., DRTech, north lagoon, intertidal, leg. S. De Grave et al., 03 June 2013 (SIN-325); 1 male, 2 ov. females, 1 female, ZRC 2014.1012, St. John's I., DRTech, north lagoon, 0–0.5 m, sandy with seagrass, leg. R. Tan, P. Yan, 04 June 2013 (SW170); 1 ov. female, ZRC 2014.1009, Seringat-Kias, artificial lagoon, on sandy beach and seagrass, leg. Y.L. Lee et al., 24 May 2013 (SS-1609).

Additional material. Strait of Singapore. 5 specimens, OUMNH.ZC.2011-02-004, Pulau Semakau, muddy beach, intertidal seagrass bed, leg. S. De Grave et al., 27 August 2010.

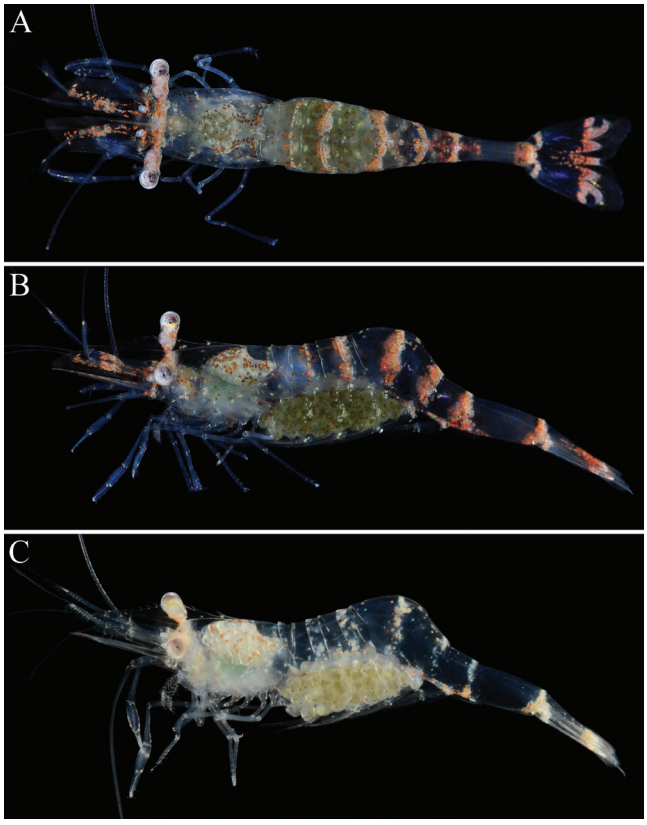

Fig. 105. *Phycomenes sulcatus* (Ďuriš, Horká & Marin, 2008): A. B,, ovigerous female from Pulau Ubin, Straits of Johor, CMBS sta. SW13 (not deposited), in dorsal (A) and ventral (B) views; C, ovigerous female from St. John's Island, Strait of Singapore, CMBS sta. SW155 (OUMNH.ZC. 2014-11-406) (Photographs by: Arthur Anker).

Distribution. Presently known only from Vietnam and Singapore.

Previous records from Singapore. Johnson (1962, as *Periclimenes aesopius*), Johnson (1977, as ? *Periclimenes indicus*), Wang & Yeo (2011, colour photograph).

Ecology. Primarily in muddy sea grass beds, but also on a variety of other substrates; intertidal down to 4 m.

Remarks. The photographic record of *Phycomenes sulcatus* in Wang & Yeo (2011) was based on the additional material listed above. Johnson (1962) recorded this species as *Periclimenes aesopius* and noted it to be abundant in littoral weed beds around Singapore. On the basis of a single sample from Siglap, donated by D.S. Johnson to the Natural History Museum in London, Bruce (1979a) re-identified this material as *Periclimenes indicus*. In all likelihood, A.J. Bruce discussed this issue with D.S. Johnson, as Johnson (1979) gives "=? *P indicus*" under the second listing of *P. aesopius*. Some of the abundant material referred to *P. aesopius* by Johnson (1962) was recently found in the unaccessioned part of the ZRC collection, of which three samples were restudied herein. Although several species are present in these samples, the majority of specimens are clearly identifiable as *P. sulcatus*, as evidenced by the characteristic folds on the abdominal tergites.

Genus *Pontonides* Borradaile, 1917

Pontonides loloata Bruce, 2005
(Fig. 106)

Pontonides loloata Bruce, 2005: 367.

Fig. 106. *Pontonides loloata* Bruce, 2005: A, B, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD133 (ZRC 2014.1013), in dorsal (A) and lateral (B) views (Photographs by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1013, sta. SD133, S Kusu I., 11 m, leg. S. De Grave et al., 31 May 2013 (SIN-258).

Distribution. Indo-west Pacific: Papua New Guinea, Singapore, Japan, several unconfirmed photographic records from the Philippines, Indonesia and Malaysia.

Previous records from Singapore. None.

Ecology. Deeper portions of coral reefs, obligate associate of black corals, *Cirripathes* spp.; known depth range: 5–25 m, probably deeper.

Remarks. The single CMBS specimen, an ovigerous female, is assigned to *Pontonides loloata* on account of the single transverse pale-yellow band on the carapace (Fig. 106), which presumably separates it from the closely related *P. ankeri* Marin, 2007, the latter with two bands (Marin, 2007). However, morphologically intermediate forms are known (S. De Grave, pers. obs.) and most likely both taxa are conspecific.

Genus *Pontoniopsis* Borradaile, 1915

Pontoniopsis comanthi Borradaile, 1915
(Fig. 107)

Pontoniopsis comanthi Borradaile, 1915: 213; Holthuis, 1952: 153; Bruce, 1981b: 396.

Fig. 107. *Pontoniopsis comanthi* Borradaile, 1915: ovigerous female from Pulau Jong, Strait of Singapore, CMBS sta. SD167 (ZRC 2014.1014) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1014, sta. SD167, SW Pulau Jong, ~15.4 m, in undetermined crinoid, leg. H.H. Tan et al., 04 June 2013 (SS-4520).

Distribution. Indo-west Pacific, from the Red Sea to Fiji and Gilbert Islands.

Previous records from Singapore. None.

Ecology. Coral reefs and associated habitats, obligate associate of various crinoids; usually found between 5 and 15 m.

Remarks. Although widely distributed in the Indo-west-Pacific, *Pontoniopsis comanthi* is herein recorded from Singapore for the first time. The crinoid host of the single specimen collected on a reef off Pulau Jong was not identified; the species is known to be associated with species of *Comanthus*, *Comatula*, *Heterometra*, *Lamprometra* and *Tropiometra*, according to Bruce (1982b).

Genus *Urocaridella* Borradaile, 1915

Urocaridella antonbruunii (Bruce, 1967)
(Fig. 108)

Periclimenes antonbruunii Bruce, 1967: 45.
Urocaridella antonbruunii — Chace & Bruce, 1993: 42.

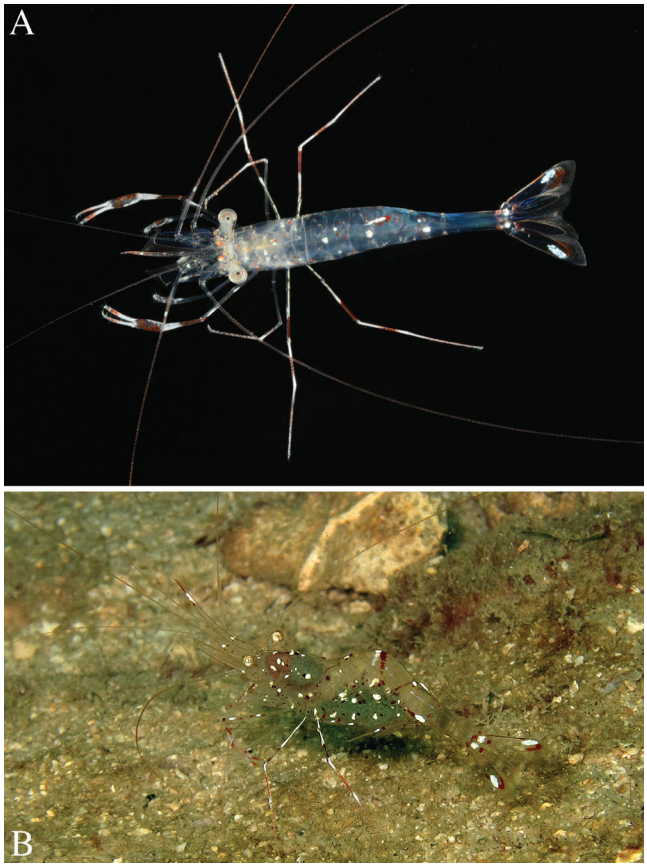

Fig. 108. *Urocaridella antonbruuni* (Bruce, 1967): A, male from Kusu Island, Strait of Singapore, CMBS sta. SD177 (ZRC 2014.1015); B, ovigerous female from Sisters Islands, photographed in situ (specimen not collected) (Photographs by: Arthur Anker [A], Jeffrey Low [B]).

CMBS material. Strait of Singapore. 1 male, ZRC 2014.1015, sta. SD177, SW Kusu I., 16.3 m, leg. H.H. Tan et al., 04 June 2013 (SIN-353).

Distribution. Indo-west Pacific: Comores, Singapore, Japan, Australia, New Caledonia, Loyalty Islands and Palau; however, some of these records may refer to other species (see below).

Previous records from Singapore. None.

Ecology. Shallow reef systems, fish cleaner; depth range: around 5–30 m.

Remarks. *Leandrites cyrtorhynchus* Fujino & Miyake, 1969 is currently considered a synonym of *Urocaridella antonbruuni*, but will be resurrected in the near future (J. Okuno, pers. comm.). The current record may thus require a re-assessment. *Urocaridella antonbruuni* can be easily recognised in the field by its striking and species-specific colour pattern (Fig. 108).

Urocaridella urocaridella (Holthuis, 1950)
(Fig. 109)

Leander urocaridella Holthuis, 1950: 6, 28; Johnson, 1962: 55; Johnson, 1979: 29.
Urocaridella urocaridella — Chace & Bruce, 1993: 42.

Fig. 109. *Urocaridella urocaridella* (Holthuis, 1950): male dredged off Tengeh Reservoir, Straits of Johor, CMBS sta. 3821 DR2 (ZRC 2014.1016) (Photograph by: Arthur Anker).

CMBS material. Straits of Johor. 1 male, ZRC 2014.1016, off Tengeh Reservoir, 12.2–13.3 m, leg. C.K. Chim, S.C. Lim, A. Anker et al., 09 April 2014 (3821 DR2-AA69); 1 female, OUMNH.ZC. 2014-11-407, sta. CMBS-D07, between mouth of Sungei Mamam to Kelong FC72E, 4 m, leg. H.H. Tan et al., 06 March 2012 (D07-097); 2 females, OUMNH.ZC. 2014-11-408, sta. TB141, East Johor Strait, sunken wood, charcoal, rocks, mud, 28.3–28.4 m, leg. S.C. Lim et al., 31 May 2013 (SIN-275). Strait of Singapore. 1 male, ZRC 2014.1017, sta. TB96, Near Eastern Bunkering A, clay bottom, 22.4–25.1 m, leg. S.C. Lim et al., 28 May 2013 (SIN-214); 1 female, ZRC 2014.1018, sta. DR183, near Raffles Lighthouse, 39.7–42.1 m, rocks, gravel, sand, shells, leg. B. Richer de Forges et al., 06 June 2013 (SS-4821); 1 male, OUMNH.ZC. 2014-11-409, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-011); 1 male, 1 female, ZRC 2014.1019, same collection data (5414 TB1-048-049); 1 female, OUMNH. ZC. 2014-11-410, sta. TB69, near Pulau Sudong and Pulau Semakau, sandy bottom, 17.9–18.9 m, leg. S.C. Lim et al., 25 May 2013 (SIN-124); 2 ov. females, ZRC 2014.1020, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-123-124); 1 female, OUMNH.ZC. 2014-11-411, sta. TB28, Eastern Boarding

Ground A, gravel-rocky bottom, 94.3–97.6 m, leg. S.C. Lim et al., 22 May 2013 (SIN-041).

Distribution. Indo-west Pacific, from the Maldives to Singapore and New Caledonia.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Poorly known, "sub-planktonic" according to Johnson (1962), found on various types of bottoms; depth range (based on literature records): lower intertidal to 130 m.

Remarks. The present material demonstrates *Urocaridella urocaridella* to be abundant in Singapore, both in the Straits of Johor and in the Strait of Singapore, at depths ranging from 4 m (mouth of Sungei Mamam on Pulau Ubin) to 125 m (east of Kusu Island), and on a variety of substrates. The species seems to have a different ecology compared to the other species in the genus, and also presents a strikingly different colour pattern (Fig. 109, compare with Figs. 108, 110).

***Urocaridella* sp.**
(Fig. 110)

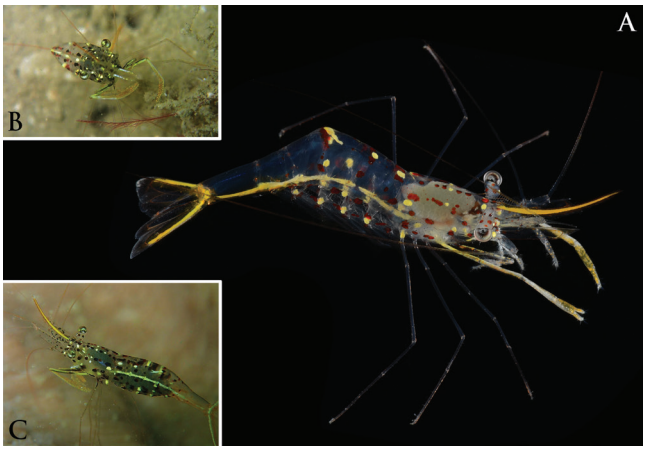

Fig. 110. *Urocaridella* sp.: A, female from Kusu Island, Strait of Singapore, CMBS sta. SD166 (ZRC 2014.1021); B, C, ovigerous female from Pulau Hantu, Strait of Singapore, photographed in situ in frontal (B) and lateral (C) views (specimen not collected) (Photographs by: Arthur Anker [A], Toh Chay Hoon [B, C]).

CMBS material. Strait of Singapore. 1 female, ZRC 2014.1021, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-329).

Distribution. Singapore (present material), Indonesia, Japan (based on photographic records, e.g., Minemizu, 2000, 2013; Kuiter & Debelius, 2009), Papua New Guinea (A. Anker, pers. obs.), probably more widespread in the Indo-west Pacific.

Previous records from Singapore. None.

Ecology. Shallow reef systems, possibly fish cleaner; depth range: around 5–30 m.

Remarks. This undescribed species, easily distinguishable from *U. antonbruuni* by its diagnostic colour pattern (Fig. 110), is well known to underwater photographers and has been illustrated several times in underwater guides, for example, as *Urocaridella* sp. 1 in Kuiter & Debelius (2009) or as *Urocaridella* sp. C. in Minemizu (2013). It is currently being studied by J. Okuno (pers. comm.).

Genus *Vir* Holthuis, 1952

***Vir philippinensis* Bruce & Svoboda, 1984**
(Fig. 111)

Vir philippinensis Bruce & Svoboda, 1984: 87; Chace & Bruce, 1993: 132.

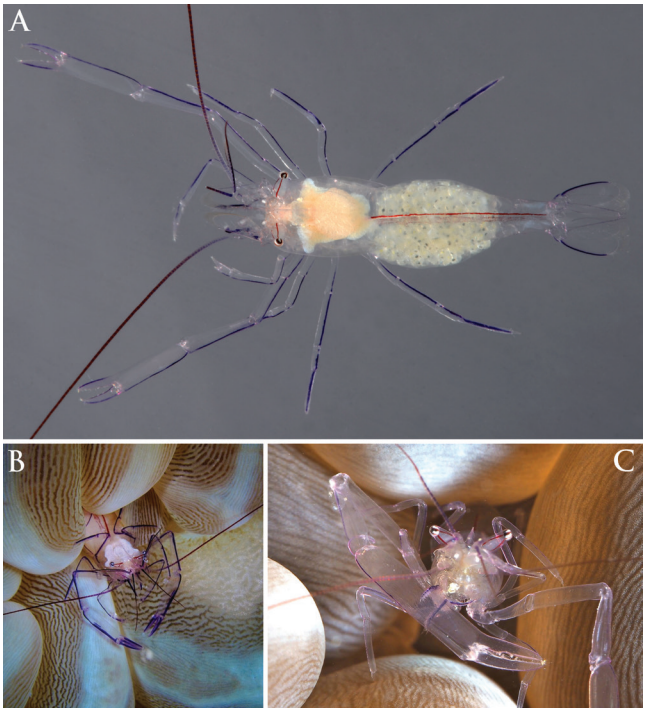

Fig. 111. *Vir philippinensis* Bruce & Svoboda, 1984: A, ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. SD151 (ZRC 2014.1022); B, ovigerous female from Mabul, Malaysia, photographed in situ on bubble coral host (specimens not collected); C, male (?) from Pulau Bintan, Indonesia, photographed in situ on bubble coral host, close-up of frontal region and second pereopods (chelipeds) (Photographs by: Arthur Anker [A], Gianni Cicalese [B], Katherine Lu [C]).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1022, sta. SD151, SW Kusu I., 19.6 m, on bubble coral, leg. S. De Grave et al., 03 June 2013 (SIN-303).

Distribution. Indo-west Pacific, from the Red Sea to Japan and Australia.

Previous records from Singapore. None.

Ecology. Coral reefs, associated with various corals, most often with *Plerogyra sinuosa* (Dana), but also with *Fungia* spp. and *Euphyllia* spp. (Fig. 111B, C).

Remarks. *Vir philippinensis* is herewith recorded from Singapore for the first time. The present specimen (Fig. 111A) was collected from the bubble coral *Euphyllia ancora* Veron & Pichon (S. De Grave, pers. obs.).

Family Pandalidae Haworth, 1825

Genus *Chlorotocella* Balss, 1914

Chlorotocella gracilis Balss, 1914
(Fig. 112)

Chlorotocella gracilis Balss, 1914: 33; Johnson, 1962: 47; Hayashi & Miyake, 1968: 12; Johnson, 1979: 47; Chace, 1985: 11.

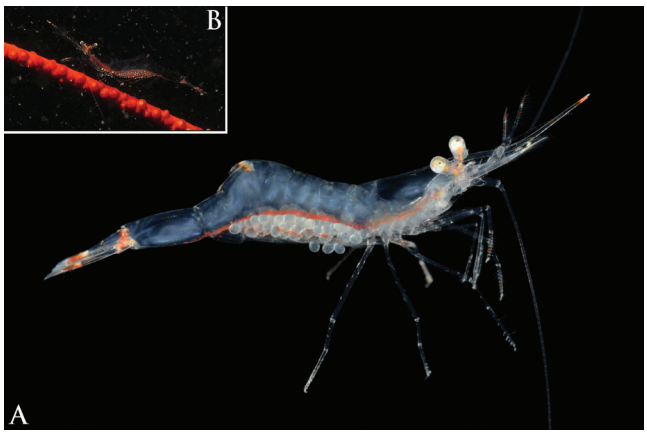

Fig. 112. *Chlorotocella gracilis* Balss, 1914: A, ovigerous female from the channel between Lazarus and St. John's islands, Strait of Singapore, CMBS sta. SD45 (ZRC 2014.1024); B, ovigerous female from Pulau Hantu, Strait of Singapore, photographed in situ on a gorgonian (specimen not collected) (Photographs by: Arthur Anker [A], Jeffrey Low [B]).

CMBS material. Strait of Singapore. 1 male, 1 ov. female, ZRC 2014.1023 sta. SD25, SW St. John's I., 7.6 m, leg. S. De Grave et al., 22 May 2013 (SIN-037); 1 female, OUMNH.ZC. 2014-11-412, sta. SW26, St. John's I., DRTech, pontoon at south lagoon, fouling agents on pontoon, 0–0.5 m, leg. R. Tan, 22 May 2013 (SIN-051); 1 female, ZRC 2014.1026, sta. SD123, St. John's I., lagoon next to public jetty, 5–13 m, leg. C.W. Lin, D. Uyeno, 30 May 2013 (SIN-218); 1 ov. female, ZRC 2014.1024, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-059); 1 ov. female, OUMNH.ZC. 2014-11-413, sta. SD45, same collection data (SIN-080); 1 male, ZRC 2014.1025, same collection data (SIN-088); 1 ov. female, OUMNH.ZC. 2014-11-414, sta. SD89, S Small Sisters' I., 14.7 m, leg. S. De Grave et al., 27 May 2013 (SIN-166); 1 ov. female, OUMNH.ZC. 2014-11-415, sta. SD143, E Pulau Hantu, 12 m, leg. H.H. Tan et al., 31 May 2013 (SIN-281); 1 female, ZRC 2014.1027, same collection data (SIN-282); 1 male, 2 females, OUMNH.ZC. 2014-11-416, sta. SD145, W Pulau Hantu, 11.7 m, leg. S. De Grave et al., 01 June 2013 (SIN-289a); 1 ov. female, OUMNH.ZC. 2014-11-417, same collection data (SIN-290); 1 ov. female, ZRC 2014.1028, same collection data (SIN-292); 1 female, OUMNH.ZC. 2014-11-418, same collection data (SIN-293); 1 female, ZRC 2014.1029, sta. SD151, SW Kusu I., 19.6 m, leg. S. De Grave et al., 03 June 2013 (SIN-309a); 2 females, OUMNH.ZC. 2014-11-421, same collection data (SIN-312); 1 female, ZRC 2014.1030, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-333); 1 female, OUMNH.ZC. 2014-11-422, E of Bedok Jetty, 6.0–7.5 m, leg. TMSI team, 24 January 2013 (5718 TB1-037); 1 female, ZRC 2014.1031, same collection data (5718 TB1-064).

Distribution. Indo-west Pacific, from the Andaman and Nicobar Islands eastwards to Japan and Australia.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Variety of substrates, usually silty reefs, coral rubble overgrown by algae and hydroids, also on jetties, pontoons, buoys etc., presumably a facultative associate of gorgonians and hydroids, but also recorded from a jellyfish, *Mastigias papua* (Lesson) in Japan (Hayashi & Miyake, 1968).

Remarks. *Chlorotocella gracilis* is very common in the Strait of Singapore, as shown by the abundant CMBS material. Most specimens were collected from undetermined gorgonians (as shown in Fig. 112B) and hydroids.

Genus *Procletes* Spence Bate, 1888

Procletes levicarina (Spence Bate, 1888)
(Fig. 113)

Dorodotes levicarina Spence Bate 1888: 680.
Heterocarpoides levicarina — Johnson, 1962: 46; Johnson, 1979: 47; Chace, 1985: 16.
Procletes levicarina — Kim et al., 2011: 399.

CMBS material. Strait of Singapore. 1 female, ZRC 2014.1032, sta. TB185, near Pulau Senang, 24.3–24.5 m, smelly mud, laterite rocks, gravel, leg. B. Richer de Forges et al., 06 June 2013 (SS-4525); 1 female, ZRC 2014.1033, sta. 87, outside Marina South Pier, mud-sand, 9.9–11.3 m, leg. P.S.H. Wong et al., 14 January 2013 (5316 DR1-012); 1 ov. female, OUMNH.ZC. 2014-11-423, sta. TB96, near Eastern Bunkering A, 25.1–22.4 m, clay, leg. S.C. Lim et al., 28 May 2013 (SIN-189); 1 female, OUMNH.ZC. 2014-11-424, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-077).

Fig. 113. *Procletes levicarina* (Spence Bate, 1988): ovigerous female dredged near Eastern Bunkering A, Strait of Singapore, CMBS sta. TB96 (OUMNH.ZC. 2014-11-423) (Photograph by: Arthur Anker).

Distribution. Indo-west Pacific, from the Red Sea to Singapore, Indonesia, Philippines, and South China Sea.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Nekto-benthic and planktonic; from surface waters down to 400 m.

Remarks. Johnson (1962) noted that *Procletes levicarina* (reported under the generic name *Heterocarpoides*) was only known from a small pocket of deeper water in the Strait of Singapore. However, the present records demonstrate that the species is more widespread in Singaporean waters. To our knowledge, the colouration of *P. levicarina* is shown here (Fig. 113) for the first time.

Family Pasiphaeidae Dana, 1852

Genus *Leptochela* Stimpson, 1860

Leptochela crosnieri Hayashi, 1995

Leptochela (*Leptochela*) *crosnieri* Hayashi, 1995: 89.

CMBS material. Strait of Singapore. 1 female, ZRC 2014.1034, sta. DR222, W of Pulau Berkas and Pulau Pawai, sand, shells and sponges, 18.7 m, leg. S. C. Lim et al., 21 October 2013 (SEA-1575); 1 ov. female, OUMNH. ZC. 2014-11-425, Eastern Boarding Ground A (E of Kusu I.), 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-006); 1 female, OUMNH.ZC. 2014-11-426, same collection data (5313 TB3-113); 1 female, ZRC 2014.1035, sta. TB30, Marina Barrage, outside Marina Bay, muddy gravel bottom, 17.1–19.1 m, leg. S.C. Lim et al., 22 May 2013 (SIN-050).

Distribution. Previously known only from New Caledonia.

Previous records from Singapore. None.

Ecology. Largely unknown; bathymetric range in New Caledonia: 13–43 m, now extended down to 80 m in Singapore.

Remarks. This is only the second record for *Leptochela crosnieri*, although unpublished records (S. De Grave, pers. obs.) prove that the species is more widespread in the Indo-west Pacific.

Leptochela gracilis Stimpson, 1860

Leptochela gracilis Stimpson, 1860a: 42.
Leptochela (*Leptochela*) *gracilis* — Chace, 1976: 11.

CMBS material. Straits of Johor. 1 male, ZRC 2014.1036, sta. TB141, East Johor Strait, wood, charcoal, rocks, mud, 28.3–28.4 m, leg. S.C. Lim et al., 31 May 2013 (SIN-276); 1 male, OUMNH.ZC. 2014-11-427, sta. DW29, off E Pulau Ubin (Chek Jawa), 13.4–24.7 m, sand, mud, leg. B. Richer de Forges, 18 October 2012 (DW29); 1 ov. female, ZRC 2014.1037, sta. DR6, off Pandan River mouth, 4.5–55 m, leg. TMSI team, 31 May 2012 (4517 DR6-004). Strait of Singapore. 1 female, OUMNH.ZC. 2014-11-428, sta. DW128, E of Changi Naval Base, 18.3–21.8 m, muddy bottom, leg. B. Richer de Forges et al., 30 October 2012 (JS-2879); 1 female, ZRC 2014.1038, sta. SW26, St. John's I., DRTech, pontoon at south lagoon, fouling agents on pontoon, 0–0.5 m, leg. R. Tan, 22 May 2013 (SIN-051a); 1 female, OUMNH.ZC. 2014-11-429, sta. DR70, near Pulau Sudong and Pulau Semakau, sandy bottom, 20.6–22.6 m, leg. S.C. Lim et al., 25 May 2013 (SIN-122); 1 ov. female, ZRC 2014.1039, sta. TB96, near Eastern Bunkering A, clay bottom, 22.4–25.1 m, leg. S.C. Lim et al., 28 May 2013 (SIN-192); 1 ov. female, OUMNH.ZC. 2014-11-430, sta. TB97, near Eastern Bunkering A, sticky clay, 22.4–22.7 m, leg. S.C. Lim et al., 28 May 2013 (SIN-203); 1 female, ZRC 2014.1040, sta. DR57, S of Bedok, 46.2 m, leg. S.C. Lim et al., 24 May 2013.

Distribution. Indo-west Pacific: Korea, China, Japan and Singapore.

Previous records from Singapore. None.

Ecology. On variety of bottoms; typical depth range: 30–194 m, one CMBS record from much shallower water (pontoon) is rather unusual.

Remarks. Boone (1935) described *Leptochela pellucida* Boone, 1935 on the basis of a single female from the entrance to the Durian Straits south of Singapore. Although considered a synonym of *L. gracilis* by Chace (1976), the latter author questioned the locality as being considerably beyond the previously reported distribution range of the species. The present records validate the occurrence of *L. gracilis* in the Sunda Shelf area.

Leptochela pugnax De Man, 1916

Leptochela pugnax De Man, 1916: 148.
Leptochela (*Leptochela*) *pugnax* — Chace, 1976: 31.

CMBS material. Straits of Johor. 1 female, ZRC 2014.1041, sta. DW55, near mouth of Pasir River, 11.6–13.0 m, laterite gravel, shells, leg. B. Richer de Forges et al., 23 October 2012 (JS-1657). Strait of Singapore. 1 ov. female, OUMNH.ZC. 2014-11-431, sta. DR262, W of Jurong I., muddy bottom, 16.5 m, leg. S.C. Lim et al., 19 December 2013 (SEA-3128); 1 male, OUMNH.ZC. 2014-11-432, sta. TB185, near Pulau Senang, 24.3–24.5 m, smelly mud, laterite rocks, gravel, leg. B. Richer de Forges et al., 06 June 2013; 1 male, ZRC 2014.1042, sta. D15, Pulau Sekudu - Malang Papan beacon, leg. K.S. Tan et al., 07.03.2012 (D15681–15698).

Distribution. Indo-west Pacific, from the Maldives to Singapore, Indonesia and Japan.

Previous records from Singapore. None.

Ecology. Largely unknown, apparently on both sandy and muddy bottoms; depth range: 8–140 m, but also attracted to surface lights.

Remarks. The CMBS material represents the first record of *Leptochela pugnax* for Singapore.

***Leptochela sydniensis* Dakin & Colefax, 1940**
(Fig. 114)

Leptochela sydniensis Dakin & Colefax, 1940: 153; Chace, 1976: 40.

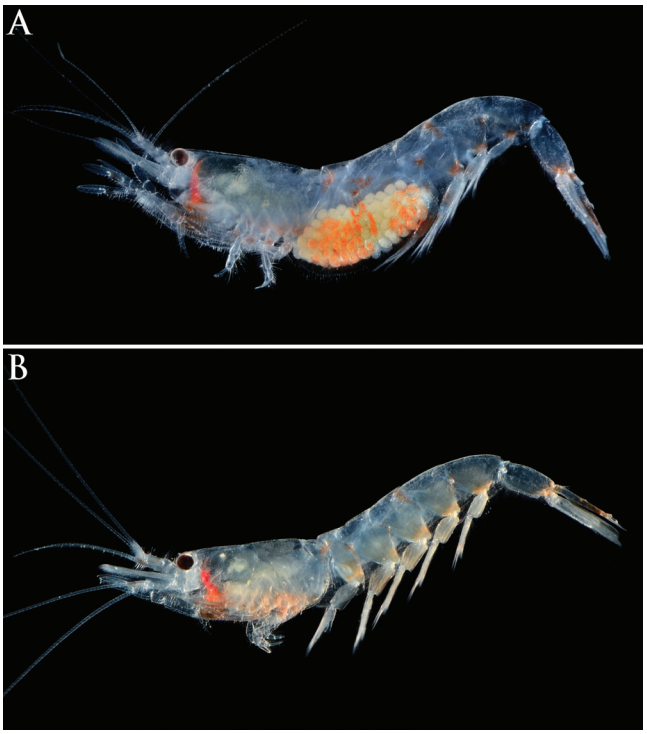

Fig. 114. *Leptochela sydniensis* Dakin & Colefax, 1940: A, ovigerous female, dredged near Sarimbun Reservoir, Straits of Johor, CMBS sta. DR368 (ZRC 2014.1044); B, male dredged near Pulau Senang, Strait of Singapore, CMBS sta. TB185 (ZRC 2014.1049) (Photographs by: Arthur Anker).

CMBS material. Straits of Johor. 1 ov. female, OUMNH.ZC. 2014-11-433, sta. DR325, outside Changi CP7 shore, near staging area to Pulau Tekong, sandy bottom with numerous broken shells, 11.3 m, leg. K.S. Tan et al., 19 March 2014 (SEA-5032); 1 male, ZRC 2014.1043, sta. DR338, beside Tekong East and Pengarang, 9.6–11.5 m, clay-mud bottom, leg. A. Anker et al., 25 March 2014 (0523 DR1-AA04); 1 female, OUMNH.ZC. 2014-11-435, sta. CMBS-D06, between Pulau Ubin and Pulau Tekong, sand-mud bottom, 16 m, leg. TMSI team, 06 March 2012 (D06-663); 1 ov. female, OUMNH.ZC. 2014-11-436, sta. DR274, in front of Sembawang jetty, fine mud, 9.8 m, leg. S.C. Lim et al., 17 January 2014 (SEA-3960); 1 ov. female, OUMNH.ZC. 2014-11-437, sta. DR370, between Tanjong Tuan and Tanjong Murai, 8.9–9.9 m, coarse sand, leg. S.C. Lim et al., 09 April 2014 (4025 DR2-AA87); 2 ov. females, ZRC 2014.1044, sta. DR368, next to Sarimbun Reservoir, 8.8–9.2 m, mud, coarse sand, leg. A. Anker et al., 09 April 2014 (4126 DR2-AA83-84). Strait of Singapore. 1 male, ZRC 2014.1047, sta. DW128, E of Changi Naval Base, 18.3–21.8 m, muddy bottom, leg. B. Richer de Forges et al., 30 October 2012; 1 male, 2 females, ZRC 2014.1045, sta. TB28, Eastern Boarding Ground A (E of Kusu I.), gravel-rocky bottom, 94.3–97.6 m, leg. S.C. Lim et al., 22 May 2013 (SIN-035); 1 male, 3 ov. females, ZRC 2014.1046, E of Eastern Holding B, 61.7–66.8 m, leg. TMSI team, 13 May 2013 (5414 TB1-162-166); 1 female, OUMNH.ZC. 2014-11-438, sta. SW26, St. John's I., DRTech, pontoon at south lagoon, fouling agents on pontoon, 0–0.5 m, leg. R. Tan, 22 May 2013 (SIN-051b); 1 ov. female, ZRC 2014.1048, sta. DW04, near Pulau Sekudu, 13.9 –14.1 m, leg. B. Richer de Forges et al., 16 October 2012; 1 ov. female, OUMNH.ZC. 2014-11-439, sta. DW04, same collection data (JS-0281); 1 ov. female, ZRC 2014.1050, sta. DW04, same collection data (JS-0277); 1 male, ZRC 2014.1049, sta. TB185, near Pulau Senang, 24.3–24.5 m, smelly mud, laterite rocks, gravel, leg. B. Richer de Forges et al., 06 June 2013 (SS-4526); 1 male, OUMNH.ZC. 2014-11-442, sta. DR184, near Raffles Lighthouse, 31.6–35.4 m, rocks, gravel, sand, shells, leg. B. Richer de Forges et al., 06 June 2013; 1 male, ZRC 2014.1051, sta. DR202, Eastern Fairway, sandy bottom, 54.7 m, leg. S.C. Lim et al., 10 September 2013 (SEA-0367).

Distribution. Indo-west Pacific, from the Arabian Sea to Australia and Japan.

Previous records from Singapore. None (but see under "Remarks" below).

Ecology. On a variety of bottoms (mud, sand, shells, gravel), also in intertidal algal beds or amongst fouling growth on pontoons; from near-surface waters down to 300 m.

Remarks. The present material demonstrates *Leptochela sydniensis* to be the most common species of *Leptochela* in Singaporean waters. As such, it may correspond to the species that Johnson (1962, 1979) reported as *Leptochela robusta* Stimpson, 1860, although this hypothesis requires confirmation.

Family Processidae Ortmann, 1896

Genus *Nikoides* Paulson, 1875

***Nikoides danae* Paulson, 1875**
(Fig. 115)

Nikoides danae Paulson, 1875: 98; Hayashi, 1975: 53; De Grave & Anker, 2013: 238.

CMBS material. Straits of Johor. 1 female, ZRC 2013.0398, sta. SW41, Pulau Sekudu near Pulau Ubin (off Chek Jawa), mud-sand with seagrass, suction pump, in burrow, leg. A. Anker et al., 20 October 2012 (JS-1448). Strait of Singapore. 1 male, ZRC 2014.1052, sta. SW50, St. John's I., beach near public jetty, rubble beach, 0.1 m, leg. S.T. Ahyong, 23 May 2013 (SIN-068); 1 female, OUMNH.ZC. 2014-11-443, sta. IT80, Terumbu Bemban, rocky reef, intertidal, leg. C.S. Tan et al., 26 May 2013 (SIN-127); 1 ov. female, OUMNH.

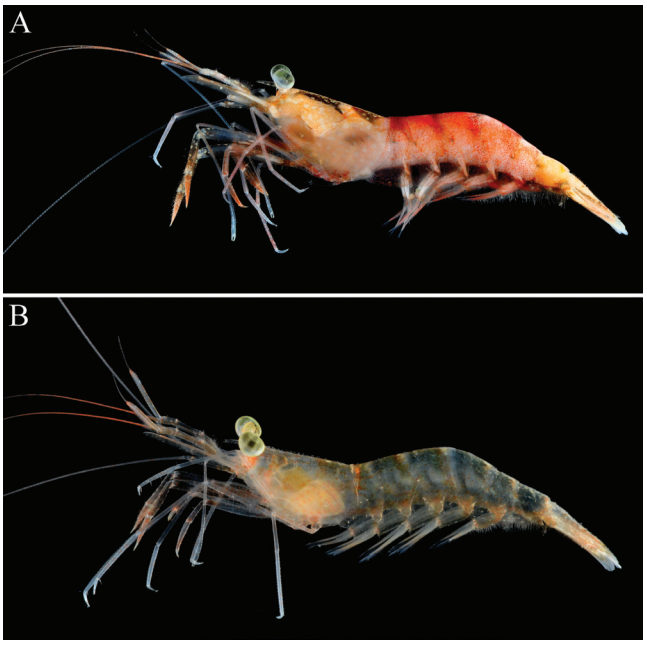

Fig. 115. *Nikoides danae* Paulson, 1875: A, female from Pulau Sekudu, Straits of Johor, CMBS sta. SW41 (ZRC 2013.0398), infested with a microsporidean parasite; B, male from St. John's Island, Strait of Singapore, CMBS sta.SW50 (ZRC 2014.1052). (Photographs by: Arthur Anker).

ZC. 2014-11-444, same collection data (SIN-148); 1 female, OUMNH.ZC. 2014-11-445, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-160a); 1 ov. female, ZRC 2014.1053, sta. IT86, same collection data (SIN-147).

Distribution. Indo-west Pacific, from the Red Sea to Japan, Guam and Australia.

Previous records from Singapore. De Grave & Anker (2013).

Ecology. Seagrass beds, reefs and associated environments, rocky intertidal pools; intertidal and shallow subtidal.

Remarks. *Nikoides danae* was recently recorded from Singapore by De Grave & Anker (2013) based on a single female from Pulau Sekudu, in the Straits of Johor (CMBS material). The present records demonstrate that the species is also common in the Strait of Singapore.

Nikoides gurneyi Hayashi, 1975
(Fig. 116A)

Nikoides gurneyi Hayashi, 1975: 58; De Grave & Anker, 2013: 231.

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1054, sta. IT65, Terumbu Semakau, sandy-rocky beach, 0–0.5 m, leg. J.Y. Ong et al., 24 May 2013 (SIN-105); 1 ov. female, OUMNH.ZC. 2014-11-446, same collection data (SIN-106); 1 female, ZRC 2014.1055, sta. IT82, Beting Bemban Besar, intertidal, leg. K.S. Koh et al., 26 May 2013 (SIN-135); 1 ov. female, OUMNH.ZC. 2014-11-447, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-155); 1 female, ZRC 2014.1056, same collection

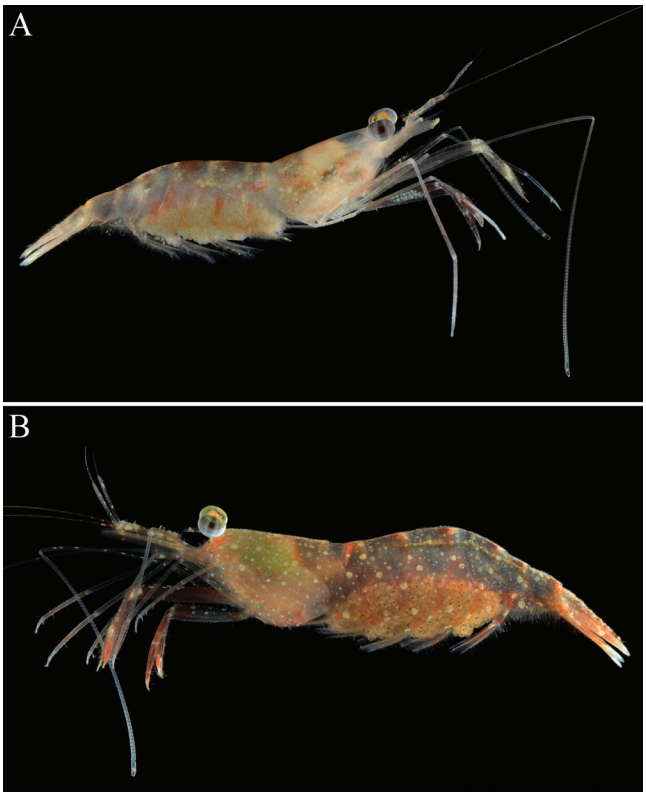

Fig. 116. *Nikoides gurneyi* Hayashi, 1975: A, ovigerous female from Terumbu Semakau, Strait of Singapore, CMBS sta. IT65 (ZRC 2014.1054). *Nikoides sibogae* De Man, 1918: B–: ovigerous female dredged east of Eastern Holding B, Strait of Singapore, CMBS sta. TB116 (OUMNH.ZC. 2014-11-453) (Photographs by: Arthur Anker).

data (SIN-156a); 1 female, OUMNH.ZC. 2014-11-448, same collection (SIN-159); 3 males, OUMNH.ZC. 2014-11-449, sta. SD150, SW Kusu I., 10.7 m, leg. S. De Grave et al., 01 June 2013 (SIN-299); 1 female, ZRC 2014.1057, sta. SB55, SW of Kusu I., 4 m, brushing of dead corals, leg. H.H. Tan, S. De Grave, D. Uyeno et al., 25 May 2013 (SS-1634).

Distribution. Indo-west Pacific, from the Red Sea and East Africa to Indonesia, Singapore, Malaysia and Taiwan.

Previous records from Singapore. De Grave & Anker (2013).

Ecology. Seagrass beds, reef-associated habitats, intertidal pools; intertidal to below 10 m.

Remarks. *Nikoides gurneyi* was recently recorded from Singapore by De Grave & Anker (2013) based on material from Pulau Ubin (Chek Jawa) in the East Johor Strait, collected in 2001. The present records demonstrate that the species also occurs in the Strait of Singapore.

Nikoides sibogae De Man, 1918
(Fig. 116B)

Nikoides Sibogae De Man, 1918: 160.
Nikoides sibogae — Johnson, 1962: 54; Johnson, 1979: 46; Hayashi, 1975: 65.

CMBS material. Straits of Johor. 1 ov female, ZRC 2014.1058, sta. DW79, channel between Pengerang and E. Pulau Tekong (off Tanjung Pengelih), 11.7–12.6 m, mud, sunken wood, debris, leg. B. Richer de Forges, 24 October 2012; 1 ov. female, ZRC 2014.1061, sta. TB141, East Johor Strait, sunken wood, charcoal, rocks, mud, 28.3–28.4 m, leg. S.C. Lim et al., 31 May 2013 (SIN-277). Strait of Singapore. 1 ov. female, 1 female, ZRC 2014.1059, sta. TB96, near Eastern Bunkering A, clay bottom, 22.4–25.1 m, leg. S.C. Lim et al., 28 May 2013 (SIN-190); 1 male, OUMNH.ZC. 2014-11-450, sta. TB96, same collection data (SIN-193); 1 ov. female, OUMNH.ZC. 2014-11-451, sta. TB96, same collection data (SIN-210); 1 ov. female, ZRC 2014.1060, sta. TB97, near Eastern Bunkering A, sticky clay, 22.4–22.7 m, leg. S.C. Lim et al., 28 May 2013 (SIN-200); 2 females, OUMNH.ZC. 2014-11-452, same collection data (SIN-202); 1 ov. female, 1 female, ZRC 2014.1062, sta. TB126, Eastern Boarding Ground A (E of Kusu I.), silt, rocks, shells, 67.9–79.3 m, leg. TMSI team, 17 May 2013 (5313 TB3-111-112); 1. ov. female, OUMNH.ZC. 2014-11-453, sta. TB116, E of Eastern Holding B, sandy bottom, 61.7–66.8 m, leg. K.S. Tan, 13 May 2013 (5414 TB1-001); 1 ov. female, OUMNH.ZC. 2014-11-454, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SIN-328).

Distribution. Indo-west Pacific, from the Persian Gulf and East Africa to Indonesia, Japan and the Mariana Islands, recently reported as a Lessepsian migrant in the Mediterranean Sea (Levitt et al., 2014).

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Various soft or mixed sediments; lower intertidal to below 100 m.

Remarks. *Nikoides sibogae* appears to be relatively common in Singaporean waters, both in the Straits of Johor and in the Strait of Singapore. Most specimens were collected by dredges or benthic trawls over soft sediments.

Genus *Processa* Leach, 1815 [in Leach, 1815–1875]

Processa zostericola Hayashi, 1975
(Fig. 117)

Processa zostericola Hayashi, 1975a: 137; De Grave & Anker, 2013: 229.

CMBS material. Strait of Singapore. 1 male, 2 ov. females, OUMNH.ZC. 2014-11-455, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-153); 1 ov. female, OUMNH.ZC. 2014-11-456, same collection data (SIN-156b); 1 male, ZRC 2014.1063, same collection data (SIN-158) [infested with a pair of bopyrid isopods]; 1 ov. female, ZRC 2014.1064, sta. DR239, outside Pulau Bukom staff chalet, mud, sand, gravel, 27.6 m, leg. S.C. Lim et al., 11 December 2013 (SEA-2060).

Distribution. Indo-west Pacific: known with certainty from Japan, Korea, Indonesia, Singapore and New Caledonia.

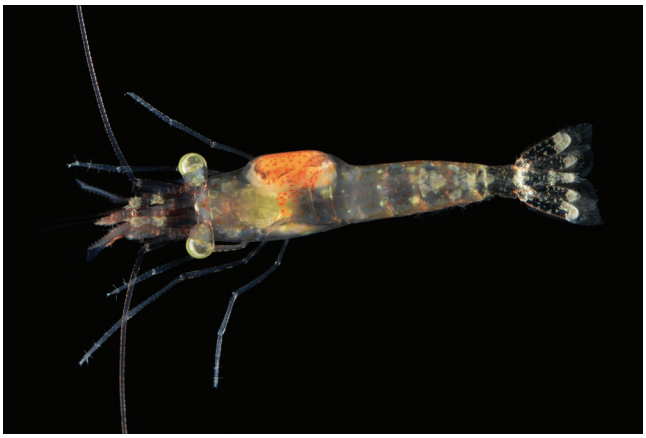

Fig. 117. *Processa zostericola* Hayashi, 1975: male from Cyrene Reef, Strait of Singapore, CMBS sta. IT86 (ZRC 2014.1063), infested with a pair of bopyrid isopods (Photograph by: Arthur Anker).

Previous records from Singapore. De Grave & Anker (2013).

Ecology. Seagrass beds; intertidal and shallow subtidal.

Remarks. *Processa zostericola* appears to be relatively common in the Strait of Singapore. As already discussed by De Grave & Anker (2013), Johnson's (1962) record of the closely related *P. australiensis* Baker, 1907 from Changi Beach remains unconfirmed.

Family Rhynchocinetidae Ortmann, 1890

Genus *Cinetorhynchus* Holthuis, 1995

Cinetorhynchus hendersoni (Kemp, 1925)
(Fig. 118)

Rhynchocinetes hendersoni Kemp, 1925: 265.
Cinetorhynchus hendersoni — Okuno, 1997: 46.

CMBS material. Strait of Singapore. 1 male, OUMNH.ZC. 2014-11-457, sta. SD177, SW Kusu I., 16.3 m, leg. H.H. Tan et al., 04 June 2013 (SIN-348); 1 ov. female, ZRC 2014.1065, same collection data (SIN-349).

Distribution. Indo-Pacific, from the Red Sea to Hawaii and Panama.

Previous records from Singapore. Okuno (1997).

Ecology. Typically on coral reefs, also on rocky shores and near bases of pontoons, walls etc., nocturnal; intertidal to at least 20 m.

Remarks. *Cinetorhynchus hendersoni* was first recorded from Singaporean waters by Okuno (1997) on the basis of a single male specimen from an unspecified location. The present record from Kusu Island in the Strait of Singapore confirms the presence of the species in this area.

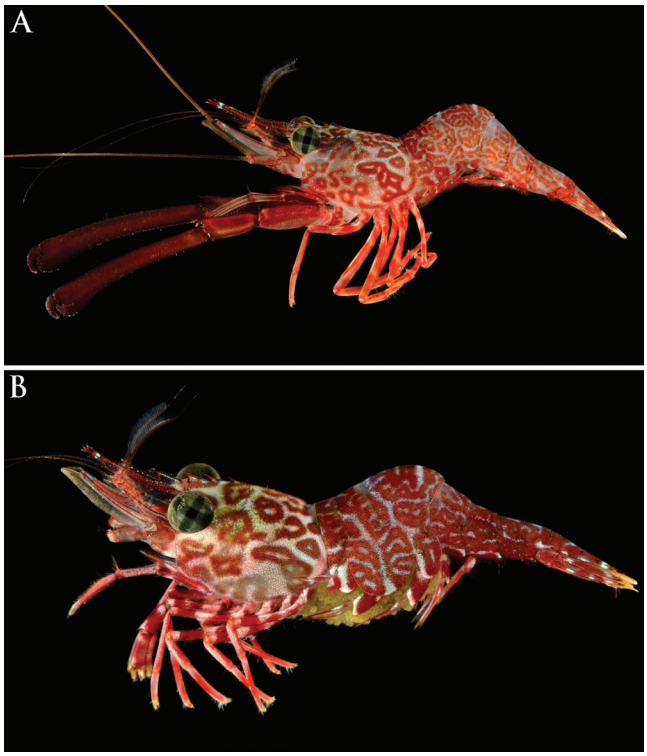

Fig. 118. *Cinetorhynchus hendersoni* (Kemp, 1925): A, male from Kusu Island, Strait of Singapore, CMBS sta. SD177 (OUMNH.ZC. 2014-11-457); B, ovigerous female from the same locality (ZRC 2014.1065). (Photographs by: Arthur Anker).

Family Thalassocarididae Spence Bate, 1888

Genus *Chlorotocoides* Kemp, 1925

***Chlorotocoides spinicauda* (De Man, 1902)**
(Fig. 119)

Chlorotocus spinicauda De Man, 1902: 856.
Chlorotocoides spinicauda — Chace, 1985: 4; Johnson, 1962: 46; Johnson, 1979.

CMBS material. Strait of Singapore. 1 female, ZRC 2014.1072, sta. TB05, beside Pulau Sebarok, rocky, 63.8–64.1 m, leg. S.C. Lim et al., 20 May 2013. (SS-0301); 1 female OUMNH.ZC. 2014-11-458, same collection data (SS-0302).

Fig. 119. *Chlorotocoides spinicauda* (De Man, 1902): female dredged near Pulau Sebarok, Strait of Singapore, CMBS sta. TB05 (ZRC 2014.1072) (Photograph by: Arthur Anker).

Distribution. Indo-west Pacific: Maldives, Andaman Islands, Indonesia, Singapore, Philippines and South China Sea.

Previous records from Singapore. Johnson (1962, 1979).

Ecology. Presumably semi-pelagic or nekto-benthic; depth range: 15–141 m.

Remarks. The placement of the monospecific genus *Chlorotocoides* in the family Thalassocarididae requires confirmation. In *C. spinicauda*, the carpus of the second pereopod is subdivided into two articles, contrasting to the undivided carpus in all members of the genus *Thalassocaris* Stimpson, 1860. The posterior margin of the third abdominal somite is unarmed in *C. spinicauda*, whilst bearing a sharp, posteriorly projecting spine in species of *Thalassocaris*. On the other hand, as Chace (1985) pointed out, the endopod of the first pleopod of the male and the appendix masculina are "remarkably like those in *Thalassocaris*", which may be the "strongest evidence for combining the two genera in a single, distinct family". In addition, the colour pattern of *C. spinicauda* (Fig. 119) is similar to that of *Thalassocaris crinita* (Dana, 1852) (see Marin & Chan, 2011: fig. 3).

Family Thoridae Kingsley, 1879

Genus *Thor* Kingsley, 1878

***Thor marguitae* Bruce, 1978**

Thor marguitae Bruce, 1978: 159; Komai et al., 2015: 406..

CMBS material. Strait of Singapore. 1 ov. female, OUMNH. ZC. 2014-11-459, sta. SD166, SW Kusu I., 19.1 m, leg. H.H. Tan et al., 03 June 2013 (SS-6811).

Distribution. Previously only known from Australia (Great Barrier Reef) and southern Japan (Okinawa).

Previous records from Singapore. None.

Ecology. Coral reefs, possibly associated with corals, *Porites andrewsi* Vaughan (Bruce, 1978) and *Fungia repanda* Dana (Komai et al., 2015); shallow subtidal (reef flat) to 16–20 m.

Remarks. The single CMBS specimen, collected on a silty reef off Kusu Island, closely adheres to the description of the type series of *Thor marguitae* in Bruce (1978), being characterised by a trifid, down-turned rostral tip, an angular pterygostomial angle, the presence of a proximo-lateral protuberance on the stylocerite, and the formula of the meral spines on the ambulatory pereopods (P3-5) being 3:2:1. The colour pattern of the Singaporean female, unfortunately documented only by an unpublishable low-resolution photograph, also matches that of the type specimens (Bruce, 1978) as well as with the colour photograph in Komai et al. (2015).

***Thor paschalis* (Heller, 1862)**
(Fig. 120)

Hippolyte paschalis Heller, 1862b: 276.
Thor paschalis — Kemp, 1914: 94; Kemp, 1916b: 388; Johnson, 1962: 47; Johnson, 1979: 46; Chace, 1997: 92.

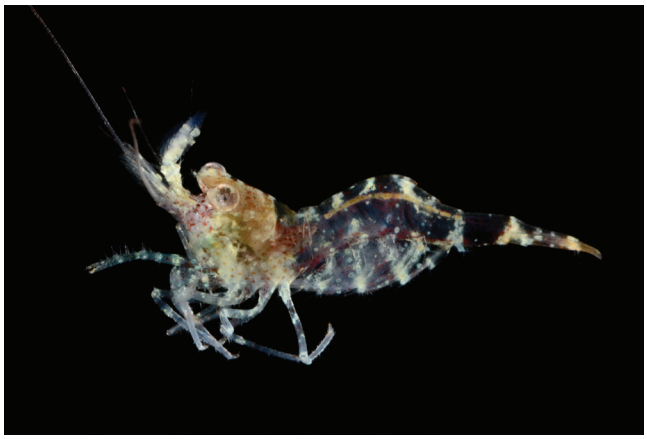

Fig. 120. *Thor paschalis* (Heller, 1862): ovigerous female from Kusu Island, Strait of Singapore, CMBS sta. CH (OUMNH.ZC. 2014-11-466) (Photograph by: Arthur Anker).

CMBS material. Strait of Singapore. 1 ov. female, ZRC 2014.1066, sta. SD34, N Lazarus I., 14 m, leg. H.H. Tan et al., 22 May 2013 (SIN-049); 1 male, 2 ov. females, ZRC 2014.1067, sta. SD45, channel between Lazarus I. and St. John's I., 16.2 m, leg. S. De Grave et al., 23 May 2013 (SIN-084b); 1 ov. female, OUMNH.ZC. 2014-11-460, sta. SD45, same collection data (SIN-087); 1 ov. female, OUMNH.ZC. 2014-11-461, sta. SW117, St. John's I., DRTech, north lagoon, intertidal, leg. P.K.L.Ng et al., 30 May 2013 (SIN-216); 2 females, OUMNH.ZC. 2014-11-462, sta. SB41, W Pulau Semakau, coral rubble and rocks, coral rubble brushing, 5 m, leg. S. De Grave et al., 23 May 2013 (SIN-065); 1 ov. female, ZRC 2014.1068, sta. IT86, Cyrene Reef, intertidal, leg. Y.L. Lee et al., 27 May 2013 (SIN-157b); 1 ov. female, OUMNH.ZC. 2014-11-463, sta. IT95, Raffles Lighthouse, intertidal, leg. S. De Grave et al., 28 May 2013 (SIN-177b); 1 ov female, OUMNH.ZC. 2014-11-464, sta. IT95, same collection data (SIN-178); 1 male, 1 ov. female, ZRC 2014.1069, sta. IT93, Pulau Jong, intertidal, leg. Y.L. Lee et al., 28 May 2013 (SIN-209); 1 ov. female, OUMNH.ZC. 2014-11-465, sta. TB157, near Southern Fairway off Kusu I., rocky gravel, 147–160 m, leg. S.C. Lim et al., 03 June 2013 (SIN-323); 1 ov. female, ZRC 2014.1070, sta. SB152, SW Kusu I., coral rubble brushing, 11 m, leg. S. De Grave et al., 03 June 2013 (SIN-324); 2 ov. females, 1 female, OUMNH.ZC. 2014-11-466, Kusu I., in dead coral head, leg. S. De Grave, 22 May 2013 (SIN-072); 1 female, ZRC 2014.1071, sta. IT124, Terumbu Pempang Laut, intertidal, leg. Y.L. Lee et al., 30 May 2013 (SS-3986).

Distribution. Indo-west Pacific, from the Red Sea to Japan, Indonesia and the Mariana Islands.

Previous records from Singapore. Kemp (1916a), Johnson (1962, 1979).

Ecology. Typically in seagrass beds, algal clumps, coral rubble and dead coral heads overgrown by algae etc.; intertidal and shallow subtidal, exceptionally to 160 m (but see under "Remarks" below).

Remarks. In the Singaporean material of *Thor paschalis*, several specimens are noteworthy, in that the pterygostomial angle is developed into a small tooth; however, in all other morphological features, as well as in the colour pattern (Fig. 120), they fit the diagnosis of *T. paschalis*. The vast majority of CMBS specimens were collected in the intertidal and shallow subtidal, but one sample (OUMNH.ZC. 2014-11-465) came allegedly from a rather unusual depth for the species, 147–160 m. This depth record considerably extends the species' bathymetric range, although a mix-up of stations cannot be excluded.

DISCUSSION

A total number of 219 nominal caridean taxa in 63 genera and 14 families have now been recorded from Singapore, numerically dominated by the Alpheidae, with 109 taxa (Table 1). However, this number includes a relatively high proportion of taxa which were either not found during the CMBS surveys or potentially based on misidentified material in Johnson (1962, 1979). To give but two examples of such taxa, Johnson (1979) reported *Alpheus paralpheopsides* Coutière, 1905 as being rare on reef slopes in the Strait of Singapore. Johnson's material is still present in the ZRC collection, and whilst being too poorly preserved for a positive identification, it is not considered to represent *A. paralpheopsides* (A. Anker, pers. obs.). Johnson's (1962) record of *Periclimenes parvus* Borradaile, 1898 from coral head at Raffles Lighthouse was based on a single specimen in the Bedford-Lanchester collection in the Natural History Museum in London. This specimen is no longer extant and in the absence of further records, Bruce & Okuno (2006) considered Johnson's record as doubtful. Further examples of such nominal taxa are highlighted in Table 1. On the other hand, Table 1 also includes problematic species complexes, especially in the family Alpheidae (see below).

During the CMBS survey work (Straits of Johor and Singapore combined), 128 taxa (including well-defined species, tentatively identified species (cf., aff.), and species complexes = species sensu lato) belonging to 53 genera and 12 families of Caridea were collected, which represents 58.5% of the total number of nominal taxa listed in Table 1. A further 17 taxa are listed, based on relatively recent collections from various museums (mainly ZRC), although some (e.g., *Thuylamea camelus*) stretch back to the early 1990s. Numerous taxa herein reported represent species complexes, notably in the alpheid genera *Alpheus* and *Synalpheus*. For instance, material listed under *Alpheus edwardsii* sensu lato, *A. euphrosyne* sensu lato (A. Anker, in prep.) *A. lobidens* sensu lato, *A. facetus* sensu lato, and *A. splendidus* sensu lato, may comprise at least a further dozen or so species, once fully resolved. Some habitats have not been sufficiently well sampled during the CMBS, to produce some taxa "expected" to occur in Singaporean

waters (e.g., based on their presence in western Indonesia); this is particularly true of deeper reef slopes or mudflat areas with a diverse infauna. Taking all this into account, we postulate that the present day caridean shrimp fauna of Singapore comprises at least 150 species.

Whilst historically, other caridean shrimp taxa may indeed have been present in Singapore (as listed in Johnson, 1962, 1979), due to the extensive habitat modification and degradation since the 1960s these taxa are likely no longer present. For example, *Cuapetes johnsoni* was reported by Johnson (1962, as *Periclimenes calmani*) to be abundant in the mangrove channels in the Jurong area, as well as in the seagrass beds at Tanjong Gul. These areas have undergone extensive land reclamation since then, with no mangrove or seagrass beds left, and the species appears to potentially have gone locally extinct. Similarly, not a single specimen of the infaunal alpheid shrimp *Salmoneus singaporensis* was collected during CMBS, indicating its extreme rarity or possible extinction in Singapore.

At the level of genera and families, 10 genera and two families reported from Singapore by Johnson (1962, 1979) or other workers (e.g., Bruce, 1998) were not re-collected during CMBS. Most of these genera belong to the family Palaemonidae and are symbionts of corals or other sessile or slowly moving invertebrates (e.g., *Anapontonia*, *Harpiliopsis*, *Jocaste*, *Lipkemenes*). The two families not collected during the CMBS are the Hymenoceridae and Anchistioididae, each with one species recorded from Singapore (Table 1). It is possible that a more intense search for these "missing" taxa in the least disturbed coral reef areas of Singapore will eventually result in their re-collection. Perplexingly, the absence of specimens of the lysmatid genus *Exhippolysmata* (with two subspecies reported by Johnson as abundant, see Table 1) in the extensive coverage by dredging during the survey, remains unexplained.

The present work also records 47 species for the first time for Singapore, including at least two undescribed species (*Climeniperaeus* sp., *Urocaridella* sp.). These two species are currently being studied by our colleagues (C.H.J.M. Fransen and J. Okuno, respectively), based on material collected elsewhere. The most notable new records are *Salmoneus seticheles* (previously known only from northern Australia), *Thuylamea camelus* (genus and species previously known only from Vietnam), *Periclimenaeus orontes* (previously known only from northern Australia), *Lysmata lipkei* (previously known only from Japan), *Leptochela crosnieri* (previously known only from New Caledonia), and *Thor marguitae* (previously known only from eastern Australia). Other noteworthy records are *Alpheus ehlersii*, *A. macellarius*, *A.* cf. *williamsi*, *Automate anacanthopus*, *Prionalpheus sulu*, *Salmoneus alpheophilus*, *Synalpheus thai* (all Alpheidae), *Ancylomenes magnificus*, *Palaemon* aff. *sewelli*, *Periclimenaeus arabicus*, *Pontonides loloata* (all Palaemonidae), *Latreutes anoplonyx* (Hippolytidae), *Ogyrides orientalis* (Ogyrididae) and *Philocheras pilosus* (Crangonidae).

Taxonomic actions were taken for three snapping shrimps: *Alpheus dispar* Randall, 1840, previously a junior synonym of *A. brevirostris* (Olivier, 1811) and now revalidated as a full species; *Alpheus imitatrix* De Man, 1909b, previously a subspecies of *A. pareuchirus* Coutière, 1905 and now treated as a distinct species; and *Alpheus monoceros* Heller, 1862, previously in synonymy of *Athanas dimorphus* and now formally considered to be a nomen dubium. The poor taxonomic knowledge of many Indo-west Pacific Alpheidae currently makes a straight and unambiguous identification of many Singaporean taxa nearly impossible. Some of the above identifications, such as *Alpheus* cf. *leptocheles*, *A.* cf. *pareuchirus*, *A.* cf. *williamsi*, are clearly tentative and will certainly change after comparative material is available. This is also true for all the other alpheid taxa reported under the umbrella of sensu lato.

Of the 128 taxa collected during the CMBS survey, 35 were present in both the Straits of Johor and the Strait of Singapore, whilst 16 were only present in the Straits of Johor, in sharp contrast to the 78 taxa collected only in the Strait of Singapore. The species occurring in both straits are primarily shrimps confined to deeper water or intertidal, seagrass or mangrove habitats. The predominance of species in the Strait of Singapore is clearly linked to the larger range of habitat types, including a few remaining patches of coral reefs around some of the islands, especially Kusu Island and Raffles Lighthouse, the two localities with the highest diversity of shrimp species.

Many shrimps, especially in the families Alpheidae and Palaemonidae, are known to be symbiotically associated with other marine organisms, such as sponges, corals, molluscs, echinoderms, or other crustaceans. In Singapore, the proportion of symbiotic shrimps (including obligate and facultative symbionts) to free-living shrimps (including species with life style largely unknown) is about 30%, which is probably much lower compared to that in the Philippines or eastern Indonesia, which have a much larger spectrum of host animals. Parasitic infestation by rhizocephalan barnacles (Thompsoniidae, Figs. 4D, 28B) and bopyrid isopods (both branchial Bopyrinae and abdominal Hemiarthrinae, Figs. 30A, 52, 101, 117) was relatively high in some common species. For instance, the infestation by *Thompsonia* sp. (Thompsoniidae) was noted in four individuals of *Alpheus chiragricus* and three individuals of *Alpheus serenei*. Hemiarthrine isopods were common in some species of snapping shrimps (*Alpheus*, *Synalpheus*), with one individual of *Synalpheus iocasta* recorded with a double infestation, i.e., by a pair of bopyrine and a pair of hemiarthrine isopods. One palaemonid shrimp, *Brucecaris tenuis*, was found infested by a rather uncommon dajid isopod (Fig. 76B, C). A microsporidean infestation was seen at least in one processid shrimp (Fig. 115A). Finally, one individual of each *Alpheus strenuus* and *Synalpheus stimpsonii*, two common alpheid shrimps, had "ecto-commensal" copepods, presumably of the family Anthessiidae, on their carapaces (Figs. 30D, 50B).

Table 1. Annotated list of caridean species (including tentatively identified species and species complexes) recorded up till now from marine and brackish waters of Singapore (excluding euryhaline species of Atyidae and Palaemonidae). Species recorded during the present study are highlighted in bold.

Taxon	Previous records from Singapore	Remarks
ALPHEIDAE		
Alpheus acutofemoratus Dana, 1852	Johnson (1979)	Singaporean record needs confirmation
Alpheus alcyone De Man, 1902	Banner & Banner (1966), *lapsus calami* according to Johnson (1979)	apparently not present in Singapore
***Alpheus alpheopsides* Coutière, 1905 (s. lat.)**	Johnson (1962, 1979)	Johnson's available material re-identified as *A. tenuipes*
Alpheus angustodigitus De Man, 1911	Johnson (1962, 1979)	see under *A. brevirostris*
Alpheus audouini Coutière, 1905	Johnson (1962)	see under *A. edwardsii* and *A. lobidens*
Alpheus sp. cf. *audouini* Coutière, 1905	Johnson (1962)	see under *A. euphrosyne*
***Alpheus bannerorum* Bruce, 1987**	Johnson (1979, as *A*. cf. *maindroni*)	
Alpheus bengalensis Coutière, 1905	Johnson (1962, 1979, as *A. paracrinitus*)	Johnson's material non-identifiable (in poor condition), not *A. bengalensis*
Alpheus bisincisus De Haan, 1849 (s. lat.)	Johnson (1962, erroneous record, 1979), Banner & Banner (1966a)	presence in Singapore based on unconfirmed record of Banner & Banner (1966); no Singaporean material of *A. bisincisus* found in ZRC; Johnson's (1962) material of *A. bisincisus* later referred to *A. audouini* (see Johnson, 1979)
***Alpheus brevirostris* (Olivier, 1811)**	Johnson (1962, 1979, as *A. angustodigitus*)	taxon needs further study, synonymy of *A. angustodigitus* needs confirmation
Alpheus bucephalus Coutière, 1905	Banner & Banner (1966), Johnson (1979)	record requires confirmation
***Alpheus chiragricus* H. Milne Edwards, 1837**	Johnson (1962, 1979)	
Alpheus crassimanus Heller, 1865	Johnson (1962)	see under *A. lobidens*
***Alpheus digitalis* De Haan, 1844 (s. lat.)**	Johnson (1962, 1979, as *A. distinguendus*)	taxon needs further study, possibly undescribed species closely related to *A. digitalis* and/or *A. longiforceps*
***Alpheus dispar* Randall, 1840**	Johnson (1979, ?part., as *A. angustidigitus*)	taxon needs further study and confirmation of status
Alpheus distinguendus De Man, 1909	Johnson (1962, 1979)	see under *A.* cf. *digitalis*
***Alpheus djeddensis* Coutière, 1897 (s. lat.)**	Johnson (1979)	species complex currently under study (Anker, in prep.)
***Alpheus edamensis* De Man, 1888**	Banner & Banner (1966), Johnson (1979)	
***Alpheus edwardsii* (Audouin, 1826) (s. lat.)**	Walker (1887), Johnson (1962, 1979, as *A. edwardsii* and *A. audouini*)	species complex currently under study (Anker, in prep.)
***Alpheus ehlersii* De Man, 1909**	None	
Alpheus euchirus Dana, 1852	Johnson (1962, 1979)	problematic taxon possibly not present in Singapore; all Johnson's (1962, 1979) material later reidentified as *A. serenei* (see Banner & Banner 1982)
***Alpheus eulimene* De Man, 1909**	None	needs further study
Alpheus euphrosyne De Man 1897 (s. lat.)	Johnson (1962, as *A.* sp. cf. *audouini*, 1979)	species complex currently under study (Anker, in prep.); *A. euphrosyne* (*s. str.*) very rare in Singapore, Johnson's (1979) material mostly not *A. euphrosyne*

Taxon	Previous records from Singapore	Remarks
***Alpheus facetus* De Man, 1908 (s. lat.)**	None	species complex currently under study (Anker, in prep.)
Alpheus gracilis Heller, 1861	Johnson (1979)	possibly species complex; Singaporean record requires confirmation (incomplete material)
Alpheus hippothoe De Man, 1888	Johnson (1962, 1979)	doubtful record, may not refer to *A. hippothoe* (see also remarks under *A. serenei*)
***Alpheus imitatrix* De Man, 1909**	None	formerly known as *A. pareuchirus imitatrix*
Alpheus lanceloti Coutière, 1905	Johnson (1962, as *A.* cf. *lanceloti*, 1979)	uncertain record, may not be *A. lanceloti*; morphologically similar species: *A. philoctetes* De Man, 1909
***Alpheus* cf. *leptocheles* Banner & Banner, 1975**	None	taxon needs further study
Alpheus leptochirus Coutière, 1905	Johnson (1962, as *A.* cf. *leptochirus*, 1979)	uncertain record, may not refer to *A. leptochirus*
***Alpheus leviusculus* Dana, 1852 (s. lat.)**	None	taxon needs further study, possibly species complex
***Alpheus lobidens* De Haan, 1849 (s. lat.)**	Johnson (1962, as *A. audouini*, 1979, as *A. crassimanus*)	species complex currently under study (Anker, in prep.)
***Alpheus lottini* Guérin-Méneville, 1829 (s. lat.)**	Johnson (1962, 1963, as *A. ventrosus*, 1979)	species complex currently under study (Anker, in prep.)
Alpheus lutini Coutière, 1905	Johnson (1962)	see under *A. obesomanus*
***Alpheus macellarius* Chace, 1988**	None	some of Johnson's material of *A. rapax* re-identified as *A. macellarius*
Alpheus maindroni Coutière, 1898	Johnson (1962, as *A.* cf. *maindroni*, 1979)	erroneous record, Johnson's material re-identified as *A. bannerorum*
***Alpheus malabaricus* (Fabricius, 1775) (s. lat.)**	Banner & Banner (1966), Johnson (1979)	species complex
Alpheus microrhynchus De Man 1897 (s. lat.)	Johnson (1962, 1979)	species complex currently under study (Anker, in prep.); records of Johnson (1962, 1979) based on misidentified material; *A. microrhynchus* (*s. str.*) most likely absent from Singapore
***Alpheus obesomanus* Dana, 1852**	Johnson (1962, as *A. lutini*, 1979), Banner & Banner (1966)	possibly species complex
***Alpheus pacificus* Dana, 1852 (s. lat.)**	None	species complex currently under study (Anker, in prep.)
Alpheus paracrinitus Miers, 1881 (s. lat.)	Johnson (1962, as *A. bengalensis*, 1979)	species complex currently under study (Anker, in prep.); Johnson's extant material non-identifiable, neither *A. bengalensis* nor *A. paracrinitus*
***Alpheus paralcyone* Coutière, 1905 (s. lat.)**	Johnson (1962, 1963, 1979), Banner & Banner (1966a)	possibly species complex
Alpheus paralpheopsides Coutière, 1905	Johnson (1979)	Johnson's material non-identifiable (in poor condition), not *A. paralpheopsides*
***Alpheus pareuchirus* Coutière, 1905**	Johnson (1962, 1979)	material needs further taxonomic study; extant Johnson's material either non-identifiable (not *A. pareuchirus*) or *A. lobidens* species complex
***Alpheus parvirostris* Dana, 1852**	Johnson (1962, 1979)	

Taxon	Previous records from Singapore	Remarks
Alpheus pomatoceros Banner & Banner, 1966	Banner & Banner (1966a), Johnson (1979)	see under *A. splendidus*
***Alpheus pubescens* De Man 1908**	None	
***Alpheus rapacida* De Man, 1908 (s. lat.)**	Johnson (1962, 1979)	possibly species complex
***Alpheus rapax* Fabricius, 1798 (s. lat.)**	Johnson (1962, 1979), Banner & Banner (1984)	possibly species complex
***Alpheus serenei* Tiwari, 1963**	Johnson (1962, 1979, both as *A. euchiurus*), Banner & Banner (1982)	
Alpheus sibogae De Man, 1908	Johnson (1979)	record requires confirmation
***Alpheus splendidus* Coutière, 1897 (s. lat.)**	Johnson (1962, 1963, 1979)	species complex currently under study (Anker, in prep.)
***Alpheus spongiarum* Coutière, 1897 (s. lat.)**	Johnson (1962, 1963, 1979)	Singaporean material needs further study
Alpheus stanleyi Coutière, 1908 (s. lat.)	Johnson (1962, 1979)	record requires confirmation
***Alpheus strenuus* Dana, 1852 (s. lat.)**	Johnson (1979)	species complex
Alpheus supachai Banner & Banner, 1966	Johnson (1979)	
***Alpheus tenuipes* De Man, 1910**	Johnson (1962, 1979, as *Alpheus alpheopsides)*	
Alpheus variabilis De Man, 1909	Johnson (1979, as *A. bisincisus variabilis*)	Johnson's material likely not *A. variabilis*
Alpheus ventrosus H. Milne-Edwards, 1837	Johnson (1962, 1963)	see under *A. lottini*
***Alpheus* cf. *williamsi* Bruce, 1994**	None	Singaporean material needs further study
***Athanas dimorphus* Ortmann, 1894**	Johnson (1962, 1979, both as *A. monoceros*)	
***Athanas japonicus* Kubo, 1936 (s. lat.)**	Anker (2003a, partly as *A.* cf. *japonicus*)	possibly species complex, needs further study
***Athanas jedanensis* De Man 1910**	Johnson (1962, 1979)	
Athanas monoceros (Heller, 1862)	Johnson (1962, 1979)	*nomen dubium*; Johnson's (1962, 1979) material most likely *A. dimorphus*
***Athanas parvus* De Man, 1910**	Johnson (1962, 1979, as *A. parvus* and *A. sibogae*)	
***Athanas polymorphus* Kemp, 1915**	Anker (2003a)	Singaporean material needs further study (see Anker 2003a)
Athanas sibogae De Man, 1910	Johnson (1979)	junior synonym of *A. parvus* (see Banner & Banner, 1960, 1973; Chace, 1988)
***Automate anacanthopus* De Man, 1910**	None	
***Potamalpheops johnsoni* Anker, 2003**	Anker (2003a)	
***Potamalpheops tigger* Yeo & Ng, 1997**	Yeo & Ng (1997), Anker (2003a)	
***Prionalpheus sulu* Banner & Banner, 1971**	None	
***Racilius compressus* Paulson, 1875**	Banner & Banner (1966a), Johnson (1979)	
***Salmoneus alpheophilus* Anker & Marin, 2006**	None	
***Salmoneus hilarulus* (De Man, 1910)**	Johnson (1962, 1979)	
***Salmoneus* cf. *pusillus* Anker & Marin, 2006**	None	incomplete specimen, tentative identification

Taxon	Previous records from Singapore	Remarks
***Salmoneus serratidigitus* (Coutière, 1897) (s. lat.)**	None	possibly species complex
***Salmoneus seticheles* Anker, 2003**	None	
***Salmoneus singaporensis* Anker, 2003**	Johnson (1962, 1979, both as *S. hilarulus*)	see Anker (2003a) and remarks in text
***Salmoneus* sp.**	None	incomplete specimen
Synalpheus acanthitelsonis Coutière, 1905	Johnson (1962, 1979)	see under *S. hastilicrassus*
Synalpheus amboinae (Zehntner, 1894)	Johnson (1962, 1963, 1979)	see under *S. stimpsoni*
***Synalpheus bispinosus* De Man, 1910**	Johnson (1979)	
***Synalpheus bituberculatus* De Man, 1910**	Johnson (1962, 1979)	
Synalpheus consobrinus De Man, 1909	Johnson (1979)	see under *S. stimpsoni*
Synalpheus comatularum (Haswell, 1882)	Walker (1887), discussed in Johnson (1962)	probably not present in Singapore
***Synalpheus coutierei* Banner, 1953**	Johnson (1962, 1979, both as *S. exilipes*)	material needs further taxonomic study
***Synalpheus demani* Borradaile, 1900**	Johnson (1962, 1979, both as *S. triunguiculatus*)	
Synalpheus exilipes Coutière, 1905	Johnson (1962, 1979)	see under *S. coutierei*
***Synalpheus fossor* (Paulson, 1875) (s. lat.)**	Johnson (1962, 1979, both as *S. stormi*)	species complex
Synalpheus gravieri Coutière, 1905	Johnson (1962, 1963, 1979)	see under *S. neomeris*
Synalpheus cf. *gravieri* Coutrière 1905	Goh et al. (1999)	see under *S. iphinoe*
***Synalpheus hastilicrassus* Coutière, 1905 (s. lat.)**	Johnson (1962, 1979, both as *S. acanthitelsonis*)	species complex; most species match description of *S. acanthitelsonis*
Synalpheus hilarulus De Man, 1910	Johnson (1962, 1979)	record requires confirmation
***Synalpheus iocasta* De Man, 1909**	Johnson (1979)	
***Synalpheus iphinoe* De Man, 1909**	Johnson (1962, 1963, 1979), Goh et al. (1999, as *S.* cf. *gravieri*)	taxon needs further study
***Synalpheus jedanensis* De Man, 1909**	Johnson (1962, 1979)	taxon needs further study
***Synalpheus neomeris* (De Man, 1897) (s. lat.)**	Johnson (1962, 1963, 1979, as *S. neomeris* and *S. gravieri*)	possibly species complex
***Synalpheus neptunus* (Dana, 1852) (s. lat.)**	Walker (1887); repeated in Johnson (1962, 1979)	species complex, all previous records from Singapore doubtful
Synalpheus pescadorensis Coutière, 1905	Johnson (1962, 1979)	see under *S. quadriarticulatus*
***Synalpheus quadriarticulatus* Banner & Banner, 1975**	Johnson (1962, 1979, both as *S. pescadorensis*)	
***Synalpheus quadrispinosus* De Man, 1910**	Johnson (1962, 1963, 1979)	
***Synalpheus stimpsonii* (De Man, 1888) (s. lat.)**	Johnson (1962, 1963, as *S. stimpsoni* and *S. amboinae*) (1979, as *S. stimpsoni*, *S. consobrinus S. amboinae*)	species complex under study (Anker et al., in prep.)
Synalpheus stormi De Man, 1910	Johnson (1962, 1979)	see under *S. fossor*
***Synalpheus streptodactylus* Coutière, 1905 (s. lat.)**	Johnson (1979)	taxon needs further study, possibly species complex
***Synalpheus thai* Banner & Banner, 1966**	Johnson (1962, as *S.* sp. *laevimanus* group, 1979)	
***Synalpheus theano* De Man, 1910**	Johnson (1962, 1979) (doubtful records)	first confirmed record from Singapore
Synalpheus triunguiculatus (Paulson, 1875)	Johnson (1962, 1979)	see under *S. demani*

Taxon	Previous records from Singapore	Remarks
***Synalpheus tumidomanus* (Paulson, 1875) (s. lat.)**	Johnson (1962, 1979)	species complex; some specimens correspond to *S. theophane* (currently synonym of *S. tumidomanus*)
Synalpheus sp. (*laevimanus* group)	Johnson (1962)	see under *S. thai*
***Thuylamea camelus* Nguyên, 2001**	None	
ANCHISTIOIDIDAE		
Anchistioides willeyi (Borradaile, 1900)	Johnson (1979)	Requires confirmation
CRANGONIDAE		
***Aegaeon orientalis* Henderson, 1893**	Johnson (1962, 1979)	
***Philocheras angustirostris* (De Man, 1918)**	Johnson (1962, 1979)	
***Philocheras parvirostris* (Kemp, 1916)**	None	
***Philocheras pilosus* (Kemp, 1916)**	None	
***Pontocaris arafurae* (Bruce, 1988)**	None	
HIPPOLYTIDAE		
***Gelastocaris paronae* (Nobili, 2905)**	Johnson (1962, 1979)	
***Hippolyte ventricosa* H Milne Edwards, 1837**	Johnson (1962, 1968,1979)	
***Latreutes anoplonyx* Kemp, 1914**	None	
Latreutes mucronatus (Stimpson, 1860)	Johnson (1962, 1979)	Requires confirmation
***Latreutes porcinus* Kemp, 1916**	Johnson (1962, 1979)	
***Latreutes pymoeus* Nobili, 1904**	Johnson (1962, 1979)	
***Saron marmoratus* (Olivier, 1811)**	Johnson, 1962, 1979	
Saron neglectus De Man, 1902	Johnson (1962, 1979)	Requires confirmation
***Tozeuma lanceolatum* Stimpson, 1860**	Stephensen (1925), Johnson (1962, 1979), Ng (2009, 2011)	
HYMENOCERIDAE		
Phyllognathia simplex (Balss, 1913)	Johnson (1979)	Requires confirmation
LYSMATIDAE		
Exhippolysmata ensirostris ensirostris (Kemp, 1914)	Johnson (1962, 1979)	Requires confirmation
Exhippolysmata ensirostris punctata (Kemp, 1914)	Johnson (1962, 1979)	Requires confirmation
***Lysmata kuekenthali* (De Man, 1902)**	None	
***Lysmata lipkei* Okuno & Fiedler, 2010**	None	
***Lysmata vittata* (Stimpson, 1860)**	Johnson (1962, 1979)	
***Lysmatella prima* Borradaile, 1915**	Johnson (1962, 1963, 1979)	
***Mimocaris heterocarpioides* Nobili, 1903**	Johnson (1962, 1979)	
OGYRIDIDAE		
***Ogyrides orientalis* (Stimpson, 1860)**	None	

Taxon	Previous records from Singapore	Remarks
PALAEMONIDAE		
Anapontonia denticauda Bruce, 1967	Johnson (197), Bruce (1979)	Requires confirmation
***Anchistus custoides* Bruce, 1977**	None	
***Anchistus custos* (Forskal, 1775)**	Johnson (1962, 1963, 1979), Johnson & Liang (1966)	
Anchistus miersi (De Man, 1888)	Johnson (1962, 1963, 1979)	Recently found at Raffles Lighthouse
***Ancylomenes holthuisi* (Bruce, 1969)**	Johnson (1979, as *P. aesopius*), Bruce (2003), Ng (2011), Toh (2013)	
***Ancylomenes magnificus* (Bruce, 1979)**	None	Photographic record only
***Brucecaris tenuis* (Bruce, 1969)**	None	
***Climeniperaeus* sp.**	None	Undescribed species
Conchodytes monodactylus Holthuis, 1952	Johnson (1962, 1963, 1979)	Only report is a single pre-1960 specimen
***Conchodytes placunae* (Johnson, 1967)**	Johnson (1967, 1979)	
***Coralliocaris graminea* (Dana, 1852)**	Johnson (1962, 1979)	
Cuapetes akiensis (Kubo, 1936)	Bruce (1987)	Only report is two specimens from an unknown location
***Cuapetes amymone* (De Man, 1902)**	Johnson (1962, 1963, 1979), Bruce (1979)	
Cuapetes calmani (Tattersall, 1921)	Johnson (1962, 1979)	Some material reported under this name by Johnson was re-identified as *Cuapetes johnsoni* by Bruce (1987). The true *C. calmani* is thought to be absent from Singapore.
***Cuapetes elegans* (Paulson, 1875)**	Johnson (1962, 1979)	
***Cuapetes grandis* (Stimpson, 1860)**	Johnson (1962, 1979)	
Cuapetes johnsoni (Bruce, 1987)	Bruce (1987)	Despite being considered very common in the 1960s, was not found during the CMBS survey.
***Cuapetes platycheles* (Holthuis, 1952)**	None	
***Cuapetes seychellensis* (Borradaile, 1915)**	Johnson (1962, 1968, 1979), Bruce (1979)	
Cuapetes suvadivensis (Borradaile, 1915)	Johnson (1962)	Not present in Singapore, see Johnson (1979)
***Dasycaris zanzibarica* Bruce, 1973**	Ng (2009, 2011)	
***Hamodactylus boschmai* Holthuis, 1952**	Johnson (1979), Goh et al. (1999)	
***Hamodactylus noumeae* Bruce, 1970**	Goh et al. (1999)	
Harpiliopsis beaupresii (Audouin, 1826)	Johnson (1962, 1963, 1979)	Requires confirmation, but likely present
***Harpilius consobrinus* De Man, 1902**	None	
Harpilius lutescens Dana, 1852	Johnson (1962, 1963, 1979)	Requires confirmation, but likely present
***Ischnopontonia lophos* (Barnard, 1962)**	Bruce (1966, 1979), Johnson (1979), Ng & Chou (1993)	
Jocaste lucina (Nobili, 1901)	Bruce (1998)	Unsubstantiated record only
***Leander tenuicornis* (Say, 1818)**	Johnson (1979)	Photographic record
***Leandrites celebensis* (De Man, 1881)**	Johnson (1979)	
Leandrites deschampsi (Nobili, 1903)	Nobili (1903), Johnson (1962, 1979)	

Taxon	Previous records from Singapore	Remarks
Leandrites stenopus Holthuis, 1950	Johnson (1979)	Requires confirmation
Lipkemenes lanipes (Kemp, 1922)	Johnson (1962, as *Periclimenes brooki*), Johnson (1979, as *Periclimenes brocki),* Bruce (1992, as *Periclimenes lanipes*)	Requires confirmation as to its continuing presence. Despite numerous basket stars dredged up during the St John's Workshop, this species was not found.
***Manipontonia paeneglabra* Bruce, 2012**	None	
Manipontonia psamathe (De Man, 1902)	Johnson (1962), Bruce (1979), Goh et al. (1999), Bruce et al. (2005)	Unclear if two species of *Manipontonia* occur in Singapore, or indeed whether both names are synonymous
Palaemon carinicauda Holthuis, 1950	Balss (1914, as *Leander styliferus* var. *carinatus*)	Considered a doubtful record by Holthuis (1950) and Johnson (1962)
***Palaemon semmelinkii* (De Man, 1881)**	Nobili (1903), Johnson (1962, 1979)	
***Palaemon serrifer* (Stimpson, 1860)**	Johnson (1962, 1967), Ashelby et al. (2012)	
***Palaemon* aff. *sewelli* (Kemp, 1925)**	None	Photographic record only
***Palaemonella lata* Kemp, 1922**	None	
***Palaemonella pottsi* (Borradaile, 1915)**	Johnson (1962, 1963, 1979)	
***Palaemonella rotumana* (Borradaile, 1898)**	Johnson (1962, 1963), Bruce (1970, 1979)	
***Periclimenaeus arabicus* (Calman, 1939)**	None	
***Periclimenaeus orontes* Bruce, 1986**	None	
***Periclimenaeus tridentatus* (Miers, 1884)**	Johnson (1962, 1979), Bruce (1979)	
***Periclimenella spinifera* (De Man, 1902)**	Johnson (1962, 1963, 1979), Bruce (1979)	
***Periclimenes brevicarpalis* (Schenkel, 1902)**	Chuang (1961), Johnson (1962, 1962b, 1979), Ng (2009, 2011), Wang & Yeo (2011)	
***Periclimenes commensalis* Borradaile, 1915**	None	
***Periclimenes cristimanus* Bruce, 1965**	Bruce (1965), Johnson (1979), Grignard et al. (1994)	
Periclimenes digitalis Kemp, 1922	Johnson (1979)	Likely a synonym of *Palaemonella rotumana*, see text
Periclimenes diversipes Kemp, 1922	Bruce (1979)	Requires confirmation
***Periclimenes incertus* Borradaile, 1915**	None	
Periclimenes investigatoris Kemp, 1922	Johnson (1979)	Requires confirmation
***Periclimenes kempi* Bruce, 1969**	Bruce (1979)	
***Periclimenes obscurus* Kemp, 1922**	None	
Periclimenes parvus Borradaile, 1898	Johnson (1962, 1979)	Reported on the basis of a single specimen, which is no longer extant. Considered a doubtful record by Bruce & Okuno (2006)
***Philarius gerlachei* (Nobili, 1905)**	None	
Philarius imperialis Kubo, 1940	Johnson (1962, 1979)	Requires confirmation
Phycomenes indicus (Kemp, 1915)	Bruce (1977, 1979)	Not present in Singapore, material re-identified as *P. sulcatus*
***Phycomenes sulcatus* (Ďuriš, Horká & Marin, 2008)**	Johnson (1962, as *Periclimenes aesopius*), Johnson (1979, as ?*Periclimenes indicus*), Wang & Yeo (2011)	

Taxon	Previous records from Singapore	Remarks
Platycaris latirostris Holthuis, 1952	Johnson (1979)	Requires confirmation
***Pontonides loloata* Bruce, 2005**	None	
***Pontoniopsis comanthi* Borradaile, 1915**	None	
***Urocaridella antonbruunii* (Bruce, 1967)**	None	
***Urocaridella urocaridella* (Holthuis, 1950)**	Johnson (1962, 1979)	
***Urocaridella* sp.**	None	Currently undescribed
***Vir philippinensis* Bruce & Svoboda, 1984**	None	
PANDALIDAE		
Chlorocurtis jactans (Nobili, 1904)	Johnson (1979)	Requires confirmation
***Chlorotocella gracilis* Balss, 1914**	Johnson (1962, 1979)	
***Procletes levicarina* (Spence Bate, 1888)**	Johnson (1962, 1979)	
PASIPHAEIDAE		
***Leptochela crosnieri* Hayashi, 1995**	None	
***Leptochela gracilis* Stimpson, 1860**	None	
***Leptochela pugnax* De Man, 1916**	None	
Leptochela robusta Stimpson, 1860	Johnson (1962, 1979)	Unclear if Johnson's records refer to one of the other species recorded during CMBS or if *L. robusta* also occurs in Singapore
***Leptochela syniensis* Dakin & Colefax, 1940**	None	
PROCESSIDAE		
***Nikoides danae* Paulson, 1875**	De Grave & Anker (2013)	
***Nikoides gurneyi* Hayashi, 1975**	De Grave & Anker (2013)	
***Nikoides sibogae* De Man, 1918**	Johnson (1962, 1979)	
Processa australiensis Baker, 1907	Johnson (1962)	Johnson (1979) assigns this material to *P. macrognatha*
Processa macrognatha (Stimpson, 1860)	Johnson (1979)	Poorly known species, likely a mis-identification of *P. zostericola* or possibly *P. australiensis*
Processa processa (Spence Bate, 1888)	Nobili (1903), De Man (1920), Johnson (1962, 1979)	Species of uncertain taxonomic status.
***Processa zostericola* Hayashi, 1975**	De Grave & Anker (2013)	
RHYNCHOCINETIDAE		
***Cientorhynchus hendersoni* (Kemp, 1925)**	Okuno (1997)	
THALASSOCARIDIDAE		
***Chlorotocoides spinicauda* (De Man, 1902)**	Johnson (1962, 1979)	
THORIDAE		
***Thor marguitae* Bruce, 1978**	None	
***Thor paschalis* (Heller, 1862)**	Kemp (1916), Johnson (1962, 1979)	

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