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NOTES ON LITTORAL HERMIT CRABS (EXCLUDING COENOBITIDAE) (CRUSTACEA: DECAPODA: ANOMURA) MAINLY FROM SINGAPORE AND PENINSULAR MALAYSIA

Dwi Listyo Rahayu

ABSTRACT.- A number of littoral hermit crabs from the area around Singapore and peninsular Malaysia are deposited in the collection of National University of Singapore and these were examined. From this material, thirty two Diogenidae and Paguridae species, with a wide Indo-West Pacific distribution, were identified. One new species of *Diogenes* is described and one other is redescribed. List of species present in Singapore and Peninsular Malaysia with their geographical distribution is provided.

INTRODUCTION

The reference collections of the National University of Singapore contain a number of unnamed littoral hermit crabs from various islands around Singapore and Malaysia. In comparison with other decapod crustaceans, the hermit crabs from this area has virtually been ignored apart from the studies by Lanchester (1902) and Nobili (1900, 1903).

Forty two pagurid species of the families Diogenidae and Paguridae have been recorded from the region around Singapore and Malaysia. Thirty two of these species were identified from the study area. One species, *Diogenes planimanus* Henderson, 1893 for morphological variation, is redescribed. One specimen from Sri Lanka was identified as *Clibanarius danai* Rahayu & Forest, 1992 and this record considerably extends the westward distribution for this species which was previously known only from Samoa, Vietnam and Indonesia.

Also during this present study, some unnamed specimens from the study area proved difficult to identify from existing known descriptions. This material is described, figured and assigned to a new *Diogenes* species. A list of forty two species of hermit crabs from the study area and the surrounding region, including geographical distribution data, is tabulated.

The references given indicate the original description, those works which give the most complete list of junior synonyms (*ubi* ref & syn.) and the latest publication refering to the

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species. Measurements indicate length of shield (SL), measured in the midline. Second and third pereiopod abbreviated as P2 and P3. The species are presented in alphabetical order.

SYSTEMATICS

FAMILY DIOGENIDAE

Clibanarius cruentatus (H. Milne Edwards, 1848)

Pagurus cruentatus H. Milne Edwards,1848: 62.
Clibanarius cruentatus; Fize & Serène, 1955: 123, fig. 16; Rahayu & Forest 1992: 771.

Material examined. - **Singapore**: 1 male (SL = 6 mm), Labrador Park, 16 Jan.1991.

Distribution. - Mergui archipelago to Madang in New Guinea.

Clibanarius danai Rahayu & Forest, 1992

Clibanarius lineatus; Dana, 1852: 462, 1855: pl. 29, fig. 2; Fize & Serène, 1955: 105, fig. 14 (not *Pagurus lineatus* H. Milne Edwards, 1848: 62).
Clibanarius danai Rahayu & Forest, 1992: 767, figs 4e, 5e, 6e.

Material examined. - **Sri Lanka**: 1 male (SL = 4.5 mm), Bentota Lagoon, coll. M. Kottelat & R. Pethiyagoda, 12 Apr.1990.

Distribution. - This species was previously known from Kalimantan Island (Indonesia), Vietnam, Samoa. Its range is now extended westward to Sri Lanka in Indian Ocean.

Clibanarius infraspinatus Hilgendorf, 1869

Clibanarius infraspinatus Hilgendorf, 1869: 97; Fize & Serène, 1955: 77, fig.10 *ubi* ref. & syn.; Rahayu & Forest, 1992: 749

Material examined. - **Singapore**: 1 male (SL = 6.5 mm), 4 females (SL = 6 - 9 mm), Bedok beach, 26 Jul.1959. - 4 females (SL = 4 - 17.5 mm), 4 male (SL = 5 - 9 mm), East Coast, 1980. - 2 males (SL = 11.5, 16 mm), 9 females (SL = 6.5 - 17.5 mm), Changi Point, muddy beach, 28 Dec.1978 and 19 Nov.1990. - 1 male (SL = 2 mm), Pulau Tekong, dredge. **Peninsular Malaysia**: 4 females (SL = 8 - 13.5 mm), Ayer Lemuroh, 23 Dec.1969. - 1 male (SL = 10.5 mm), 3 females (SL = 5.5, 6.5, 7.5 mm), Telok Bahang, Penang, 16 Dec.1990.

Distribution. - Red Sea, Indian Ocean, Indonesia, North of Australia, Philippines, Singapore, Vietnam and Japan.

Clibanarius longitarsus (De Haan, 1849)

Pagurus longitarsus De Haan, 1849: 211, fig. 3.
Clibanarius longitarsus; Lewinsohn, 1969: 18 *ubi* ref. & syn.; Rahayu & Forest, 1992: 762, figs 4b, 5b, 6b.

Material examined. - **Singapore**: 1 male (SL = 11 mm), Pulau Tiga.

Distribution. - Red Sea, Indian Ocean, Malay Archipelago to Japan.

Clibanarius merguiensis De Man, 1888

Clibanarius aequabilis var. *merguiensis* De Man, 1888: 247.
Clibanarius merguiensis; Forest, 1953a: 446, fig. 7; Fize & Serène, 1955: 145, fig 22 *ubi* ref. & syn.; Rahayu & Forest, 1992: 774, fig. 7.

Material examined. - **Singapore:** 1 male (SL = 3 mm), Labrador Park. - 1 male (SL = 3 mm), Mering.

Distribution. - Mergui Archipelago, Indonesia, Singapore, Vietnam and New Guinea.

Clibanarius ransoni Forest, 1953

Clibanarius ransoni Forest, 1953: 446, figs 2, 6; Fize & Serène, 1955: 150, fig. 23; Ball & Haig,1972: 99, 100; Rahayu & Forest, 1992: 774.

Material examined. - **Indonesia**: 2 females (SL = 3, 3.5 mm), 1 ovigerous female (SL = 3 mm), Sekupang, Batam Island, rocky and mud-flat, coll. H.K.Lua, 30 Sep.1989.

Distribution. - Indonesia, Vietnam and French Polynesia.

Clibanarius serenei Rahayu & Forest, 1992

Clibanarius 1 Fize & Serène, 1955: 90, pl. 3, figs 2, 8, 11, 14.
Clibanarius serenei Rahayu & Forest, 1992: 762, figs 4c, 5c, 6c.

Material examined. - **Singapore**: 7 males (SL = 5.5 - 9.5 mm), 7 females (SL = 6 - 9 mm), Pasir Panjang. - 5 males (SL = 5 - 6 mm), 7 females (SL = 4 - 5 mm), Sungai Buloh, coll. D. L. Rahayu, 7 Dec.1992. **Peninsular Malaysia**: 8 males (SL = 5.5 - 7.5 mm), 5 females (SL = 5 - 9.5 mm), 4 ovigerous females (SL = 5.5 - 6.5 mm), Kuala Keropak, Tanjung Kling, mud-flat, 18 Feb.1965.

Colour in life - Shield and ocular peduncles olive green; antennular peduncles dark green; antennal peduncles dark green with dark brown median longitudinal stripe on lateral face of the fifth segment; left cheliped brown with black tipped green olive spines, tips of fingers white yellowish; P2 and P3 brown, large longitudinal stripe of white yellowish from base of merus to dactyl, under and above this stripe there are a second and a third smaller stripe of the same color.

Remarks.- The specimen from Singapore was collected from muddy bottom on a mangrove area.

Distribution. - Indonesia and Vietnam, and now recorded from Singapore and Peninsular Malaysia.

Dardanus callichela Cook, 1989

Dardanus callichela Cook, 1989: 115, figs 3, 6 B, 8 A
Pagurus imbricatus; Alcock, 1905: 92, pl. 9, fig. 8; Fize & Serène, 1955: 158, 159, 220, text fig. 35, pl. 6, figs 11-14 (not *Pagurus imbricatus* H. Milne Edwards, 1848: 61).

Material examined. - **Singapore**: 1 female (SL = 15.5 mm), Pulau Semakau, dredge.

Distribution. - Sri Lanka, South China Sea, northwestern Australia and Chesterfield Reef. Now reported from Singapore for the first time.

Dardanus deformis (H. Milne Edwards, 1836)

Pagurus deformis H. Milne Edwards, 1836: 272, pl. 13, figs 4, 4 a; Fize & Serène, 1955: 199, figs 31, 33, E, F, pl. 4, fig. 6 *ubi* ref. & syn.
Dardanus deformis; Gherardi & McLaughlin, 1994: 638.

Material examined. - **Peninsular Malaysia**: 1 ovigerous female (SL = 7.5 mm.), Sipadan, off east coast Sabah, 18 May.1992.

Remarks.- Milne Edwards (1836) made a mistake in mentioning plate 14, figure 2 for the illustration of *Dardanus deformis* while it should be plate 13, figure 4. This error was repeated by Alcock (1905) and Lewinsohn (1969); Morgan (1990) cited correctly plate 13, figure 4 for *D. deformis* Milne Edwards.

Distribution. - Red Sea to Hawaiian Islands and Tuamotu Archipelago.

Dardanus gemmatus H. Milne Edwards, 1848

Pagurus gemmatus H. Milne Edwards, 1848: 60; Forest, 1953b: 557, figs 10, 11.
Neopagurus sp. Kamalaveni, 1950: 85
Dardanus gemmatus; Holthuis, 1953: 48; Haig & Ball, 1988: 164; Poupin, 1994: 22, fig. 18.

Material examined. - **Singapore**: 1 ovigerous female (SL = 17 mm), southern Singapore.

Distribution. - Western Indian Ocean to Hawaiian Island and Tuamotu Archipelago.

Dardanus hessii (Miers, 1884)

Pagurus hessii Miers, 1884: 264, pl. 28, fig. A; Alcock, 1905: 93, pl. 8, fig. 4.
Pagurus hessii; Fize & Serène, 1955: 214, pl. 4, *ubi* ref. & syn.
Dardanus hessii; Haig & Ball, 1988: 165.

Material examined. - **Singapore**: 1 ovigerous female (SL = 5 mm), Bedok beach. **Peninsular Malaysia**: 2 males (SL = 6.5, 7.5 mm) Ayer Lemuroh, 23 Dec.1969. - 2 males (SL = 17 mm), South China Sea, 15 Dec.1982. - 3 males (SL = 4 mm), South of Sembilan Island, Perak, coral and gravel. - 1 female ovigerous (SL = 15.5 mm), Andaman sea, between Penang and Langkawi, 12 Nov.1991. - 1 male (SL = 10.5 mm), Sarawak, East Malaysia.

Distribution. - Red Sea to Torres Strait and Japan.

Dardanus lagopodes (Forskål, 1775)

Cancer lagopodes Forskål, 1775: 93.
Dardanus lagopodes; Lewinsohn, 1969: 32, pl. 2, figs 1, 2 , *ubi* ref.& syn; Gherardi & McLaughlin, 1994: 640.

Material examined. - **Peninsular Malaysia**: 1 male (SL = 19.5 mm), Pasir Buat. - 1 female (SL = 11.5 mm), 1 ovigerous female (SL = 8 mm), Sipadan, 16-18 May.1992. - 1 male (SL = 9.5 mm), 1 ovigerous female (SL = 7.5 mm), Pulau Tioman, Pahang.

Distribution. - Red Sea, Japan to Tuamotu Archipelago.

Dardanus megistos (Herbst, 1804)

Cancer megistos Herbst, 1804: 23, pl. 61, fig. 1.
Pagurus megistos; Fize & Serène, 1955: 160, fig. 24, pl. 4 A, figs 1-3 *ubi* ref. & syn.
Dardanus megistos; Poupin, 1994: 23, fig. 19.

Material examined. - **Singapore**: 1 female (SL = 13.5 mm), 3 ovigerous female (SL = 12 - 14.5 mm), Raffles Lighthouse, Southern Island, 3 May.1953. **Peninsular Malaysia**: 1 male (1974.3.20.116) (SL = 12 mm), 1 female (SL = 7 mm). Pulau Tioman, Pahang. - 1 male (SL = 30 mm), Sipadan, 16 May.1992.

Distribution. - Red Sea and East coast of Africa to Hawaiian Islands and Tuamotu Archipelago.

Dardanus pedunculatus (Herbst, 1804)

Cancer pedunculatus Herbst, 1804: 25, pl. 61, fig. 3.
Dardanus haanii Rathbun, 1902: 34.
Pagurus haanii; Fize & Serène, 1955:158, 159, 207, figs 32, 33, pl. 4 *ubi* ref. & syn.
Dardanus pedunculatus; Poupin, 1994: 24, fig. 20.

Material examined. - **Peninsular Malaysia**: - 2 males (SL = 17.5, 22.5 mm), 1 female (SL = 21 mm), Pulau Tiga, Sabah, 10 Oct.1986. - 2 males (SL = 20 mm), 28 Apr.1987. - 1 male (SL = 20 mm), 5 May.1987.

Distribution. - East coast of Africa to Hawaiian Islands.

Dardanus setifer (H. Milne Edwards, 1836)

Pagurus setifer H. Milne Edwards, 1836: 274; Alcock, 1905: 83, pl. 8, fig. 3; Fize and Serène, 1955: 158, 159, 182, text figs 27, 28, pl. 5, figs 4 - 8 *ubi* ref.& syn.
Dardanus setifer; Haig & Ball, 1988: 167.

Material examined. - **Singapore**: 1 male (SL = 9.5 mm), subtidal waters, off Southern Singapore, coll. SEAFDEC, 21 May.1956.

Distribution. - South Africa, Indonesia, Vietnam, Hongkong and herein recorded from Singapore.

Diogenes avarus Heller, 1865

Diogenes avarus Heller, 1865: 85, pl. 7, fig. 2; Lewinsohn, 1969: 37, fig. 4, *ubi* ref.& syn; Rahayu & Forest, 1995: 398, figs 2b, g, h.

Material examined. - **Singapore**: 3 males (SL = 3 - 4 mm), 2 females (SL = 3 mm), Changi, 25 Feb.1952. - 1 male (SL = 1.5 mm), Changi beach, coll. P.K.L. Ng, 1980. - 3 ovigerous females (SL = 2.5 - 3 mm), Bedok, dredge, 26 Nov.1984. - 1 male (SL = 2 mm), Kallang Basin, dredge, 23 Feb.1989. - 18 males (SL = 2.5 - 3.5 mm), 6 females (SL = 2,5 - 3.5 mm), 2 ovigerous females (SL = 3 mm), Kranji, mangrove, 9 Jul.1990.- 6 males (SL = 2.5 - 3.5 mm), 1 female (SL = 2.5 mm), Sungai Buloh, dredge, 25 - 30 May.1990. - 1 female (SL = 2 mm), 31 May.1991. - 5 males (SL = 4.5 mm), Sungai Buloh, coll. D.L. Rahayu, 7 Dec.1992. - 2 males (SL = 3 mm), Tanjung Penuru. **Peninsular Malaysia**: 2 males (SL = 2.5 mm), Port Dickson. - 2 males (SL = 3.5 - 4 mm), Tanjung Aru, Jesselton, 16 Aug.1952. - 3 males (SL = 1.5 mm), Pulau Pangkor, Perak, sandy beach, 5 - 9 Apr.1969 - 2 males (SL = 3 mm), Northeast of Kampung Mata Ikan. **Indonesia**: 1 male (SL = 3 mm), 1 female (SL = 2.5 mm), 2 ovigerous females (SL = 2.5 - 3 mm), Batam, Riau, muddy flat, coll. H.K. Lua, 30 Sep.1989.

Distribution. - Indian Ocean, from Red Sea and east coast of Africa to Mergui Archipelago, Indonesia, Singapore, Peninsular Malaysia, New Guinea and Northern Australia

Diogenes custos (Fabricius, 1798)

Diogenes custos Fabricius, 1798: 412; Alcock, 1905: 64, pl. 4, fig. 1; Tirmizi & Siddiqui, 1982: 32, figs 14-17; Rahayu & Forest, 1995: 387.

Material examined. - **Singapore**: 1 male (SL = 6 mm), Siglap, beach seine, 1951. - 1 male (SL = 10 mm), Singapore Regional Fisheries Station, otter trawl, 24 Nov.1955, - 1 male (SL = 4.5 mm), southern Singapore, dredge, 26 Jan.1956. - 4 males (SL = 3 - 6 mm), 2 females (SL = 4, 5 mm), 3 ovigerous females (SL = 5 - 6 mm), Bedok, 27 Mar.1982. - 2 males (SL = 3.5,7 mm), Singapore, 26 Jan.1984. - 1 female (SL = 6.5 mm), 1 ovigerous female (SL = 7.5 mm), Changi Point. - 3 males (SL = 4.5 - 7.5 mm), 1 female (SL = 3.5 mm), 2 ovigerous females (SL = 6.5, 8.5 mm), South Singapore, sandy bottom. **Peninsular Malaysia**: 1 male, (SL = 9.5 mm), Pontian, Johore, coll. C.M. Yang, 31 Mar.1991.

Distribution. - Indian Ocean, Indonesia and Australia and herein recorded from Singapore and Peninsular Malaysia.

Diogenes fasciatus Rahayu & Forest, 1995

Diogenes fasciatus Rahayu & Forest, 1995: 388, figs 1 a - h.

Material examined. - **Singapore**: 1 male (SL = 2 mm)(1990.4082-4084), Pulau Tekong, 27 Mar.1987. - 1 female (SL = 3 mm), Changi beach, 27 Aug.1987. - 1 male (SL = 3.5 mm), East Singapore, coll. PKL.Ng, 1990. - 5 males (SL = 1.5 - 3 mm), East Coast beach, coll. S.H. Chan, 16 Jun.1991.

Remarks - *Diogenes fasciatus* belongs to first sub-group of the second group of *Diogenes* i.e. a group which have antennal and antennular peduncles longer than ocular peduncles (Rahayu & Forest, 1995). Longitudinal red line on pereopods persists after being preserved in alcohol for several months and this character separates the species from other *Diogenes* of the same group.

Distribution. - This species was previously known only from Indonesia (Java and southern Sulawesi), the range is now extended north-westward to Singapore.

***Diogenes laevicarpus*, new species**
(Fig. 1.)

Holotype: Male (SL = 2 mm), **Peninsular Malaysia**, West Johor Strait, 12 May.1987.

Paratype: Male (SL = 2 mm), Singapore, Pulau Tekong, 27 Mar.1987.

Etymology: The specific name from the Latin *laevis* = smooth, polished; refers to the carpus of the third pereiopod which is spineless.

Description - Shield approximately as long as broad, anterior margin between rostrum and lateral projections concave; rostrum short and broad, exceeded by lateral projections. Lateral projections triangular, each with terminal spine. Dorsal surface of shield with scattered spinules and setae.

Ocular peduncles stout, 2/3 length of shield, reaching distal end of penultimate segment of antennular peduncles, barely exceeding half of fifth segment of antennal peduncles. Corneal width about 1/3 length of peduncles. Ocular acicles large, separated basally, anterior margin with row of spines. Intercalary rostral process simple, slightly shorter than ocular scales.

Antennular peduncles slender, ultimate and penultimate segments unarmed, basal segment with spine on distoventral margin.

Antennal peduncles reaching distal half of terminal segment of antennular peduncles. First segment short, unarmed; second segment with very strong dorsolateral and smaller dorsomesial spines; third, fourth and fifth segments unarmed. Antennal acicle reaching base of fifth penduncular segment, terminating in strong spine; mesial margin with a row of 5 or 6 spines.

Left cheliped much larger than right. Dactyl as long as palm, with row of tubercles along dorsal margin; cutting edge with strong calcareous teeth terminating in calcareous claw, crossing tip of fixed finger; lateral surface with tubercles above ventral margin, rest of lateral surface smooth; mesial surface with row of tubercles. Fixed finger broad, cutting teeth large, ventral margin with row of blunt tubercles, lateral surface finely tuberculate. Palm broader than long; dorsal margin with row of strong spines; ventral margin with rows of strong, rounded tubercles, continuing to base of propodus then parallel with carpal articulation, finally curving distally along midline of propodus, tubercles reduced distally; rest of lateral surface smooth except for row of minute spines between median rows of tubercles and dorsal margin of the palm. Carpus with row of strong spines along dorsal and ventral margins, lateral surface with scattered tubercles. Merus with row of spines on dorsal and ventral margin; lateral surface with scattered tubercles.

Dactyl of right cheliped twice length of palm; dorsal margin with scattered small tubercles, lateral surface with row of spinules, larger proximally; cutting edge with small teeth, terminating in calcareous claw, crossing fixed finger at tip. Palm half length of carpus, dorsal margin with row of strong spines, lateral surface with scattered tubercles; row of pointed tubercles on the middle of palm, ventral margin unarmed. Carpus with dorsal margin spinose, lateral face with row of spines. Dorsal margin of merus with 2 or 3 spines distally, ventral margin with small spines, mesial surface with row of spines, lateral surface smooth.

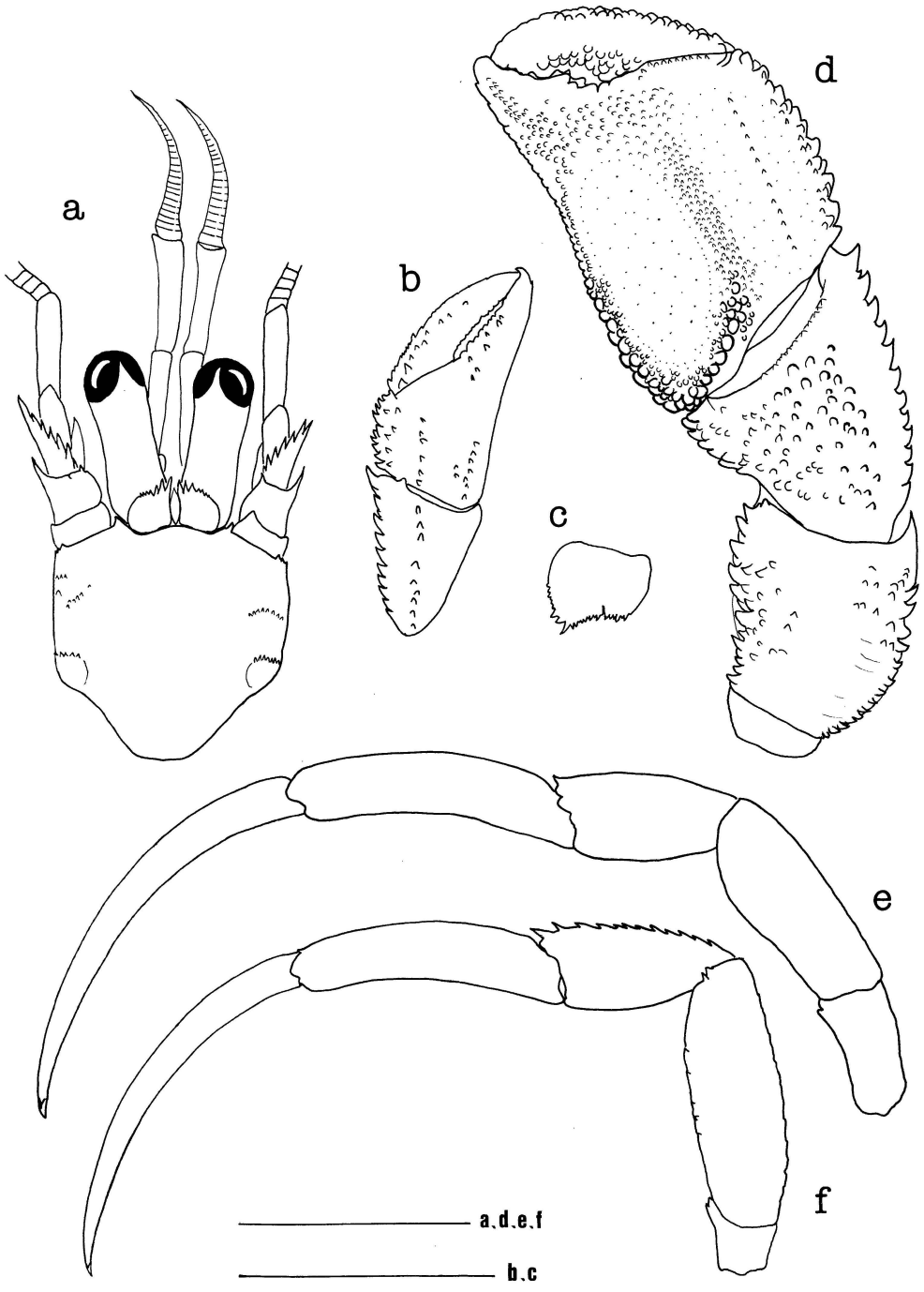

Fig. 1. *Diogenes laevicarpus*, new species. Male, holotype (SL = 2 mm). a, shield and cephalic appendages; b, right cheliped; c, telson; d, left cheliped; e, third left pereiopod; f, second left pereiopod. Scales 2 mm.

Ambulatory legs slender; dorsal margins with long setae, dactyls also with long setae on distoventral margin. Carpus of P2 with spines along dorsal margin. P3 longer than P2; dactyl curved, carpus with only dorsodistal spine.

Telson asymmetrical, left lobe larger than right, with spines on anterior margin.

Remarks - This new species ressembles *Diogenes costatus* Henderson, 1893 and *D. lophochir* Morgan, 1989 in possessing a pronounced curved crest on the lateral surface of the palm of the left cheliped. However, *D. lophochir* Morgan differs from *D. laevicarpus* new species in having the same length of the antennal and antennular peduncles, both exceeding the ocular peduncles by the entire length of their ultimate segments; P2 and P3 with spines along entire dorsal margin of propodus and carpus.

Diogenes costatus Henderson and *D. laevicarpus* new species are similar in having the ocular peduncles reaching half the length of ultimate segment of antennal peduncles; *D. costatus* Henderson has the propodus and the carpus of P2 and P3 spinulous along the dorsal margin while in *D. laevicarpus* new species the spines present only on the dorsal margin of the carpus of P2.

The ambulatory legs of this new species are long and slender, and ressemble to those of *D. dorotheae* Morgan & Forest and *D. fasciatus* Rahayu & Forest. The latter two species have different spination and tuberculation on the left cheliped (see Morgan & Forest, 1991; Rahayu & Forest, 1995) and a row of spines along dorsal margins of the carpus of P2 and P3, whereas *D. laecivarpus* new species has dorsodistal spine on the carpus of P3.

Diogenes lophochir Morgan,1989
(Fig. 2.)

Diogenes lophochir Morgan, 1989: 398, fig. 2.

Material examined. **- Singapore**: - 1 male (SL = 3 mm), Bedok, coll. D.S. Johnson, 3 Nov.1951. Changi beach: - 1 male (SL = 5 mm), 25 Feb.1952. - 1 male (SL = 5 mm), 14 Feb.1957. - 1 male (SL = 5mm), seagrass bed, 27 Sep.1957. - 1 female (SL = 3.5 mm) (1992.10758), 27 Sep. 1959. - 1 female (SL = 2.5 mm), 27 Aug.1987. - 1 male (SL = 5.5 mm), coll. P.K.L. Ng, 17 Dec.1989. - 1 male (SL = 3.5 mm), 2 females (SL = 4.5 mm) (1990.4092), Pulau Tekong, dredge, coll. Reef Ecology Study Team, NUS, 26 Mar.1987. - 4 males (SL = 1.5-3.5 mm), East-coast.

Remarks - *Diogenes lophochir* Morgan was described from two males and one left cheliped. The material from Singapore agrees well with the description of the species by Morgan (1989). Like all other *Diogenes*, this species shows great variation of the left cheliped. One male has an elongate left cheliped (Fig. 2a); the dorsal margin has an irregular row of blunt spines and a row of smaller spines below it, the propodus has the ventral margin curved and with tubercles forming a crest extending from the proximoventral angle, parallel with carpal articulation, then curving distally along midline of propodus; the tubercles are not as strong and pronounced as in Morgan's original material. Also there is an obscure second row of tubercles between the medial crest and the dorsal margin. Another male has the dorsoventral height of the left cheliped large (Fig. 2c),the ventral margin of the propodus is slightly curved, with strong spines, and a row of small spines between the medial crest and dorsal margin. The four females examined, have a stout left cheliped (Fig. 2b), with palm much broader than long, ventral margin almost straight, and with strong row of spines.

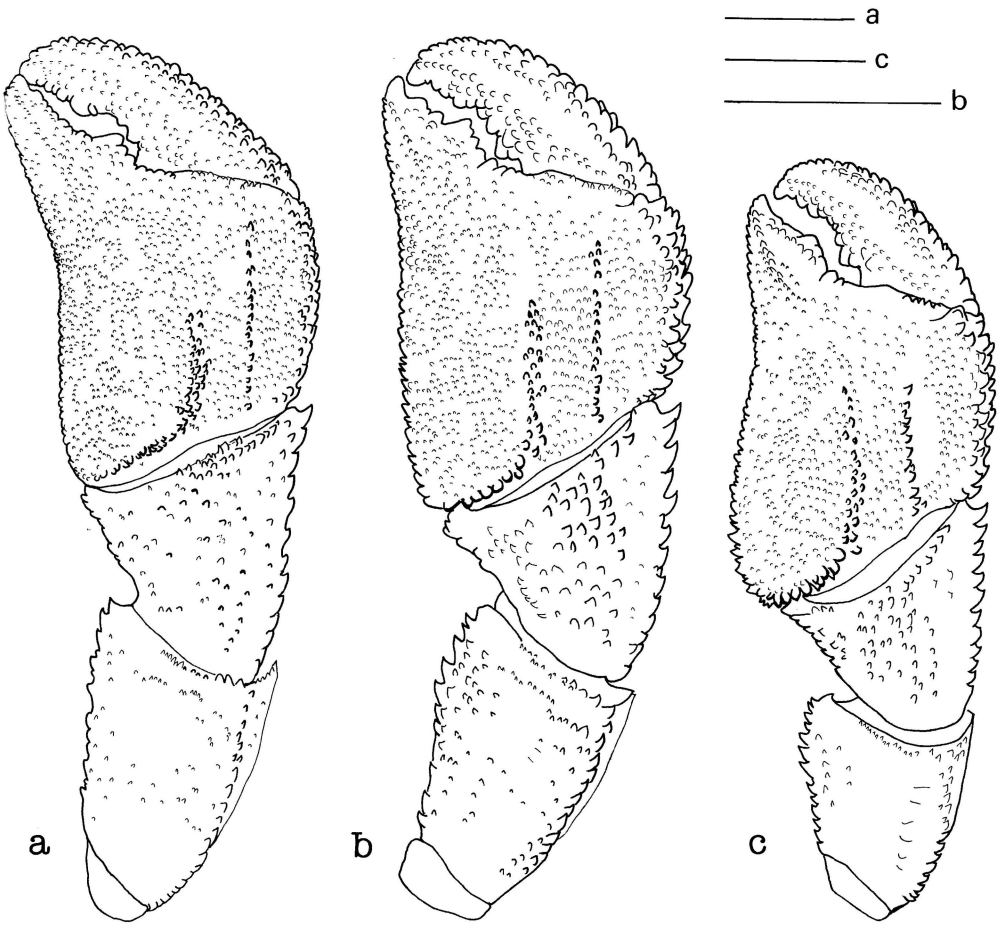

Fig. 2. *Diogenes lophochir* Morgan, left cheliped, a , Male (SL = 4.5 mm); b, Female (SL = 4.5mm); c, Male (SL = 3.5 mm). Scales 3 mm.

Morgan (1989) noted that the presence of a pronounced curved crest on the lateral face of the left chela, while lacking a crest or row of tubercles between medial crest and dorsal margin of the palm, distinguished this species from *Diogenes rectimanus* Miers, *D. investigatoris* Alcock and *D. bicristimanus* Alcock. Some of the specimens from Singapore possess a row of tubercles or spines between the medial crest and the dorsal margin of the palm. Even so, the differences between *D. lophochir* Morgan and the three latter *Diogenes* are still noticeable. *D. rectimanus* Miers is very spinous, the ventral margin of propodus of the left cheliped is straight and armed with strong spines; *D. investigatoris* Alcock has the ambulatory legs smooth, a few inconspicuous spinules at the far end of dorsal margin of carpus; *D. bicristimanus* Alcock has a broad longitudinal ridge on the lateral face of the propodus of the left cheliped, continuing to the tip of the fixed finger.

Diogenes jubatus (Nobili, 1903)

Troglopagurus jubatus Nobili, 1903: 17; Alcock, 1905: 75 (key), 167; Forest, 1952:9.
Diogenes jubatus; Morgan & Forest, 1991: 670, 676, 678 (key); Rahayu & Forest, 1995: 401.

Material examined. - **Singapore**: - 1 male (SL = 5 mm), Singapore. **Peninsular Malaysia** (Northwest): 4 male (SL = 4 - 4.5 mm), 1 ovigerous female, (SL = 4 mm), Port Swettenham, Dec.1934.

Remarks - This species can be included in the group II, sub group 2; a group of *Diogenes* species characterized by dense plumose setae, especially on the ambulatory legs, and a very small sometimes vestigial intercalary rostral process (Rahayu & Forest, 1995).

Several authors have mentioned *Diogenes jubatus* Nobili (Alcock, 1905, Forest, 1952, Gordan, 1955, Morgan & Forest, 1991, Rahayu & Forest, 1995). This species never been recorded since the first description by Nobili in 1903, until recent observation by Lemaitre & Ng (1996) who provide redescription and illustration of the species.

Distribution. - Singapore.

Diogenes pallescens Whitelegge, 1897

Diogenes pallescens Whitelegge, 1897: 141, pl, figs 2, 2 a-c; Ball & Haig, 1972: 89, fig. 2; Rahayu & Forest, 1995: 413.

Material examined. - **Singapore**: 1 ovigerous female (SL = 2 mm), Raffles Lighthouse, rocks pools, 27 Jan.1964.

Distribution. - Indonesia, Singapore and Funafuti (Ellice Islands).

Diogenes planimanus Henderson, 1893

(Fig. 3.)

Diogenes planimanus Henderson, 1893: 416, pl. 39, figs 5, 6.; Tirmizi & Siddiqui, 1982: 43, figs 21, 22.

Diogenes custos var. *planimanus* Alcock, 1905: 66, pl. 6, fig. 3.

Material examined. - **Peninsular Malaysia**: 7 males (SL = 3 - 4.5 mm), 3 females (SL = 3 - 4 mm), Pasir Bogak, Pulau Pangkor, Perak, coll. D.S. Johnson, 5 - 9 Apr.1965.

Redescription - Shield broader than long; anterior margin between rostrum and lateral projection concave; rostrum short and broad, lateral projection large, broadly triangular, largely exceeding rostrum, terminating in acute spine, hidden under pointed tubercles. Anterolateral margin with numerous spines, stronger distally; anterolateral portion of dorsal surface with row of minutes spines. Rostrum, anterior margin and lateral projection with pointed tubercles.

Ocular peduncles stout, 2/3 length of shield, reaching to half length of terminal segment of antennal peduncles. Width of corneas about 1/4 length of peduncles. Ocular acicles large, triangular; anterior margin with several spines. Intercalary rostral process spinouse, longer than ocular scales.

Antennal peduncles as long as, or slightly longer than, antennular peduncles. First segment short, unarmed, second segment with strong spine at laterodistal margin, mesiodistal margin with 2 or 3 minutes spines. Third segment with 1 spine distally, fourth and fifth segments unarmed. Antennal acicles large, weakly bifurcate, anterior margin with strong spines, outer margin reaching 3/4 length of fourth peduncular segment, inner margin about 1/4 length of the fourth peduncular segment.

Antennular peduncles exceeding ocular peduncles by half length of terminal segment. Ultimate and penultimate segments unarmed, basal segment with row of minute spines on anterolateral margin.

Left cheliped much larger than right, dactyl longer than palm; cutting edge with calcareous teeth, terminating in calcareous claw, crossing tip of fixed finger. Lateral surface granulated, dorsal margin with row of rounded spines, below which is row of tubercles. Mesial face with row of tubercles. Fixed finger with calcareous teeth on cutting edge, terminating in calcareous claw; ventral margin with row of blunt or pointed tubercles extending onto base of propodus and continuing along proximal margin of propodus, parallel with carpal articulation, then continuing to the middle of lateral face of palm; second row situated between this median row of tubercles and the dorsal margin of palm. Dorsal margin of palm with row of pointed tubercles. Rest of lateral surface with scattered tubercles. Carpus with 2 rows of spines on dorsal margin, lateral surface with row of spines, 1 strong spine in the middle; distolateral margin with row of tubercles. Dorsal margin of merus with row of spines, larger distally, mesial margin with row of minute spines, lateral face with scattered tubercles.

Right cheliped slender, dactyl longer than palm, cutting edge with small calcareous teeth, terminating in small calcareous claw. Dorsal margin with row of small spines, lateral face with longitudinal row of spines. Fixed finger broader than dactyl, lateral face with scattered small tubercles. Palm with row of minute spines on dorsal margin. Carpus shorter than merus, dorsal margin with row of small spines, lateral face with longitudinal row of spines, rest of lateral face with scattered tubercles. Merus with row of spines along dorsal and ventral margins.

Second pereopod with dactyl curved and slender, longer than propodus. Dorsal margin with row of tubercles, extending from proximal end to mid-length, broad sulcus along lateral face, remaining surface smooth. Propodus with 3 rows of blunt or pointed tubercles on dorsal margin, lateral face with tubercles. The tubercles on the propodus sometimes reduced. Carpus with 2 rows of spines on dorsal margin, 1 longitudinal row of spines on lateral face and distolateral face also with row of spines. Dorsal margin of merus with minute spines, ventral margin with small spines distally.

Third pereopod with dactyl and merus as in second pereopod. Propodus with 2 rows of blunt or pointed tubercles on dorsal margin, lateral face with tubercles, sometimes reduced. Carpus with row of spines along dorsal margin, distolateral face with minute spines.

Telson asymmetrical, left side larger than right. Lateral margin of left lobe with strong spines; on the mesial margin of this lobe and on the right lobe much smaller spines.

Remarks - The specimens studied here agree well with the original description of this species by Henderson (1893). The series of individuals of both sexes and different sizes in the Singapore material, allows a more precise definition of the species.

The palm of the left cheliped has a ridge of tubercles which runs parallel to the carpal articulation (Henderson, 1893). In our material this ridge continues to the midlength of the palm in the form of two or three longitudinal rows of tubercles, and there is a second row between this median row and the dorsal margin. The left cheliped also is variable in form, and can be elongated with the ventral margin of the propodus straight (Fig.3 g, i), or with a stout propodus with wide palm (Fig. 3 h). In some specimens there is row of tubercles

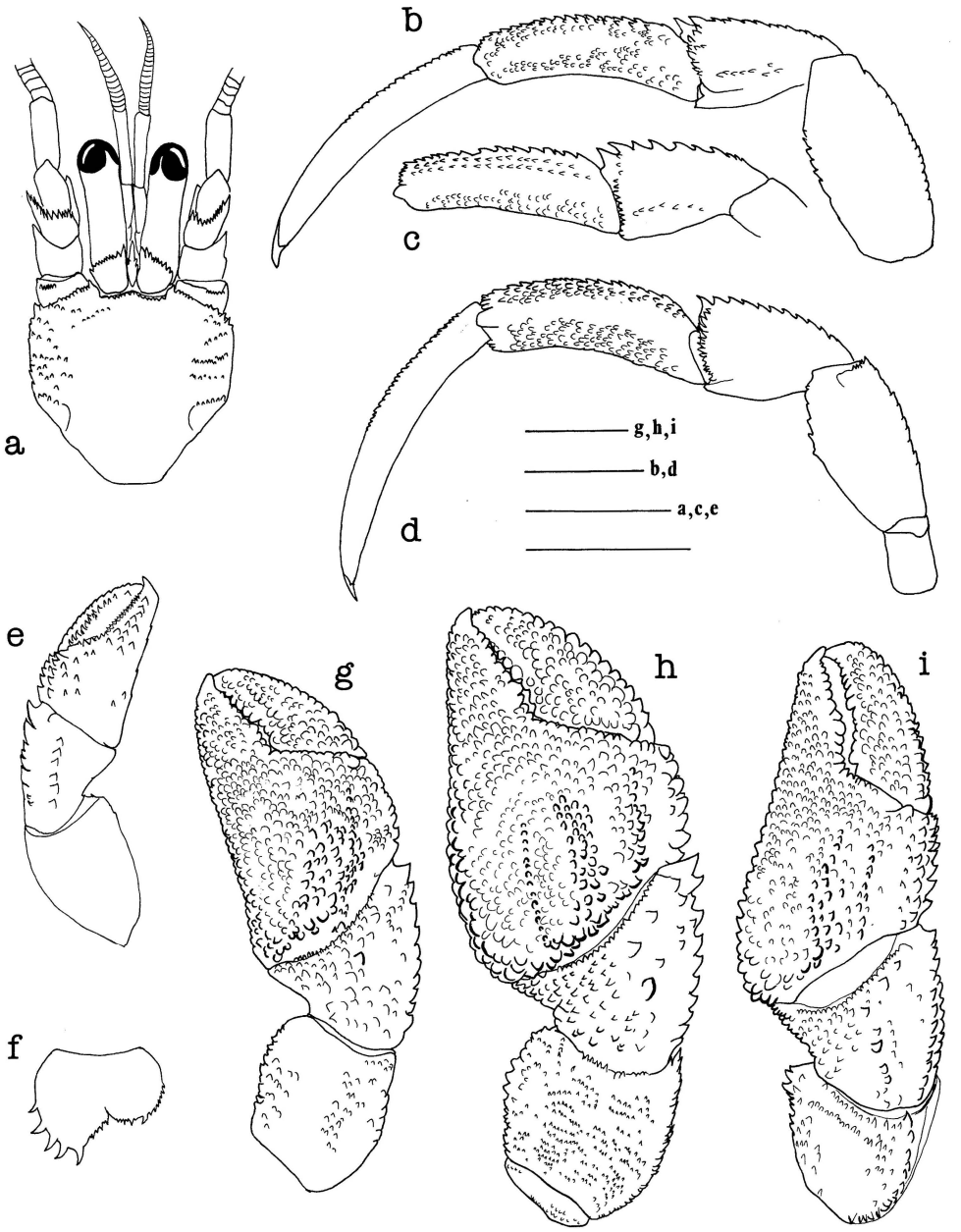

Fig. 3. *Diogenes planimanus* Henderson. Male (SL = 4 mm). a, shield and cephalic appendages; b, c, second left pereiopod; d, third left pereiopod; e, right cheliped; f, telson; g, i, h (Female), left cheliped. Scales 2 mm.

between the median row of tubercles and the ventral margin of palm (Fig. 3 h).

Henderson (1893) mentioned glabrous tuberculiform elevations on the dorsal margin of the propodus of P2. In some of our material these elevations are in the form of three rows of pointed tubercles (Fig. 3 c). The carpus of P2 has a medial longitudinal row of spines on the lateral face, and strong spines along the dorsal margin.

Distribution. - Arabian Sea and Singapore.

Diogenes platyops Rahayu & Forest, 1995

Diogenes platyops Rahayu & Forest, 1995: 399, figs 4 a-h.

Material examined. - **Singapore**: 1 ovigerous female (SL = 4 mm), Bedok Sea, 27 Apr.1982. - 1 male (SL = 3 mm)(1990.4090), Pulau Tekong, 27 Mar.1987. - 1 female (SL = 3 mm) (ZRC. 1991.9494), northern Pulau Semakau, 14 Mar.1989. - 3 males (SL = 2 - 4 mm), Pulau Hantu, Southern Islands, sledge.

Colour in alcohol: - Shield cream, with reddish-orange patches, especially on anterolateral margin and lateral surface; ocular peduncles cream, with red patches proximally, ocular scales orange basally and cream distally; cheliped cream, palm and carpus with reddish-orange patches on dorsal margin, lateral and mesial surfaces. P2 and P3 with a red band proximally and on mid length of propodus, carpus with a longitudinal red stripe.

Distribution. - Indonesia (Java sea) and Singapore.

Diogenes aff. *rectimanus* Miers, 1884

?*Diogenes rectimanus* Miers, 1884: 26, pl. 27, fig. c; Henderson, 1893: 419; Lanchester, 1902: 366; Alcock, 1905: 71, pl. 6, fig. 8, pl. 7, fig. 2; Morgan, 1987: 175; Haig & Ball, 1988: 167.

Material examined. - **Singapore**: 3 males (SL = 3 - 4.5 mm), 1 female (SL = 3.5 mm), Bedok, 27 Apr.1982. - 1 male (SL = 2 mm)(1990.4095), Pulau Tekong, 27 Mar.1987. - 1 male (SL = 2 mm), East Coast. - 1 ovigerous female (SL = 2 mm), western Johor Straits.

Diagnosis - Shield approximately as long as broad. Ocular peduncles slender, shorter than antennular and antennal pedunces. Intercalary rostral process simple spinule, shorter than ocular scales. Antennal peduncles as long as or slightly shorter than antennular peduncles. Antennal scales slender, not reaching distal end of fourth segment. Left cheliped much larger than right. Dactyl longer than palm; dorsal margin with row of strong spines, lateral surface near dorsal margin with longitudinal row of spines, extending from the base of dactyl to the middle or 2/3 of its length, remainder of dorsal surface with a few, scattered, pointed tubercles. Fixed finger broader than dactyl, ventral margin with strong curved spines, which continue to base of propodus; second row of strong curved spines on ventrolateral surface, starting at middle of fixed finger and continuing to base of propodus, parallel to carpal articulation and continuing to mid-length of palm. Carpus with row of spines along dorsal margin, ventral margin with strong spine distally, lateral surface with scattered strong spines. Merus with row of spines along ventral margin, stronger medially; lateral face with few pointed tubercles. Ambulatory legs slender, weakly setose, dactyl longer than propodus. Carpus of P2 with row of spines along dorsal magin, while P3 has 1 - 2 strong spines on dorsodistal margin.

Telson asymmetrical.

Remarks - The specimens from Singapore agree well with Miers's original description of *Diogenes rectimanus* in bearing strong and curved spines on both the left cheliped and the dorsal margin of carpus of P2; however, there is no row of spines along dorsal margin of carpus of P3, no setae on cheliped and pereiopods, and basal segment of antennular peduncles bears minute spines on mesial border.

The specimens from Singapore are similar to *Diogenes rectimanus sensu* Henderson from Madras deposited in the Muséum National d'Histoire Naturelle, Paris, in having row of spines only on dorsal margin of carpus of P2.

These specimens have the same characters as Morgan's specimens from Northern Territory, Australia, i.e. the left cheliped laterally compressed and the ventral margin bears a strong ridges of spines. Morgan (1987) stated that his specimens from Northern Territory agree closely with Alcock's description and illustration of *Diogenes rectimanus*.

Clark et al. are making a revision of Lanchester's material in which the holotype of *D. rectimanus* Miers will be redescribed (personal communication); therefore the specimens from Singapore are provisionally assigned to *Diogenes* aff. *rectimanus*.

Diogenes stenops Morgan & Forest, 1991

Diogenes jousseaumei; Morgan, 1987: 179 (not *Troglopagurus jousseaumei* Bouvier, 1897).
Diogenes stenops Morgan & Forest, 1991: 671, figs 9, 10.

Material examined. - **Singapore**: 1 male (SL = 1.5 mm), 2 females (SL = 2 - 3 mm), 1 female ovigerous (SL = 2.5 mm), East Coast.

Distribution. - Northern Australia and herein recorded from Singapore.

Diogenes tumidus Rahayu & Forest, 1995

Diogenes tumidus Rahayu & Forest, 1995: 402, figs 5 a - h.

Material examined. - **Singapore**: 3 males (SL = 2 - 3 mm), Changi, 14 Feb.1957. - 2 males (SL = 2.5 mm), 2 females (SL = 2, 2.5 mm), 1 ovigerous female (SL = 2.5 mm), Raffles Lighthouse, rock pools, 27 Jan.1964. - 1 male (SL = 3.5 mm), 1 female (SL = 4 mm), Pulau Sudong, shore collection, 29 Mar.1965. - 28 males (SL = 1.5 - 4 mm), 5 females (SL = 2 - 3 mm), 6 ovigerous females (SL = 2.5 - 3 mm), Labrador Park, 16 Jan.1991. **Indonesia**: 8 males (SL = 2-3 mm), 5 females (SL = 2 - 3.5 mm), 1 ovigerous female (SL = 3.5 mm), Batam, rock pools, coll. H.K. Lua, 30 Sep.1989.

Remarks - In general the material from Singapore agrees well with Rahayu and Forest's (1995) description of this species. Some variation was noted in the material from Pulau Sudong: ocular peduncles slender, as long as shield, and corneal width about 1/6 length of peduncles; lateral projection with 3 - 4 spines, considerably exceeding rostrum; ocular scales large and with 6 - 7 distal spines.

Distribution. - Indonesia and Singapore.

Paguristes longirostris Dana, 1852

Paguristes longirostris Dana, 1852: 436. Alcock, 1905: 36, pl. 1, fig. 5. Nobili, 1903: 21.

Material examined - **Singapore**: 1 male (SL = 7 mm), West of Pulau Pawai, gravel, 5 fms, coll. D.S. Johnson, Dec.1952. - 1 male (SL = 6.5 mm), 1 ovigerous female (SL = 6 mm), Pulau Hantu, coll. Reef Ecology Study Team, 9 Jun.1992. - 1 male (SL = 4 mm), Pulau Semakau, dredge, 20 meter, coll. P.K.L. Ng, 27 Oct.1992. - 2 males (SL = 4, 6.5 mm), 2 females (SL = 3, 5 mm), southern Singapore, sandy bottom. - 3 males, (SL = 3 - 4 mm), 2 females (SL = 3.5, 4 mm), Singapore . - 2 males (SL = 7.5, 9 mm), 1 female (SL = 4 mm), 1 ovigerous female, (SL = 6.5 mm), East Coast Singapore, 1980.

Remarks - This species is recognizable by the scale-like, imbricated tubercles on the chelipeds.

Distribution. - Bay of Bengal and Singapore.

FAMILY PAGURIDAE

Nematopagurus muricatus Henderson, 1896

Nematopagurus muricatus Henderson, 1896: 524, fig. 3. Alcock, 1905: 111, pl. 12, fig. 5. Lewinsohn, 1969: 74.

Material examined - **Peninsular Malaysia**: 1 male (SL = 3 mm), Ayer Lemuroh, 23 Dec.1969. - 1 male (SL = 3.5 mm), Pulau Tioman, 15 meter, coll. P.K.L. Ng, Jun.1984.

Remarks - The material from Singapore agrees well with the syntype of *Nematopagurus muricatus* Henderson (an ovigerous female, lacking left cheliped and in very poor condition). The right cheliped of the syntype has stronger spines and sparse setae, while in the present male the spines are small and the setae dense.

Distribution. - Red Sea, Indian Ocean, and now recorded from Peninsular Malaysia.

Pagurus kulkarnii Sankolli, 1962

Pagurus kulkarnii Sankolli, 1962: 136, figs 1, 2. Morgan, 1987: 182.

Material examined. - **Singapore**: 1 male (SL = 4.5 mm), Sentosa Beach. - 1 male, northern Semakau, sledge.14 Mar.1989. - 2 males (SL = 2, 3.5 mm) (1990. 4082. 4084), Pulau Tekong, 27 Mar.1987, dredge. - 1 male (SL = 3.5 mm), Ponggol Point, Enhalus zone, 21 Apr.1965.

Distribution. - Indian Ocean, Indonesia, northern Australia and Singapore.

Pagurus pergranulatus (Henderson, 1896)

Eupagurus pergranulatus Henderson, 1896: 520; Alcock, 1905: 125, pl. 11, fig. 1.
Pagurus pergranulatus; Haig & Ball, 1988: 190.

Material examined. - **Peninsular Malaysia**: 1 male (SL = 4 mm), Sembilan Island, Perak, shell-gravel, 45 - 81 meter, coll. D.S. Johnson, 29 Oct.1953.

Remarks - This specimen differs from the description of *Pagurus pergranulatus* (Henderson) in the proportions of the ocular, antennal and antennular peduncles: the ocular peduncles are shorter than either the antennal or antennular peduncles.

Distribution. - Sri Lanka, Andaman Islands, Maluku (Indonesia), Queensland (Australia) and herein recorded from Peninsular Malaysia.

Spiropagurus spiriger (De Haan, 1849)

Pagurus spiriger De Haan, 1849: 206, pl. XIII. fig. 2.
Spiropagurus spiriger; Alcock, 1905: 118, pl. 13, fig. 1; Miyake, 1978: 137, text fig. 54 *ubi* ref & syn.

Material examined. **Singapore**: 1 male (SL = 4 mm), 1 female (SL = 7 mm), 2 ovigerous females (SL = 4 mm) southern Singapore. - **Peninsular Malaysia**: 1 ovigerous female (SL = 4.5 mm), Ayer Lemuroh, 23 Dec.1969.

Distribution . - Indian Ocean, Singapore, Peninsular Malaysia and Japan

DISCUSSION

Most of the hermit crabs in Singapore and Peninsular Malaysia are common species and widely distributed in the Indo-West Pacific (Table 1). Six species namely *Clibanarius serenei* Rahayu & Forest,1992, *Diogenes fasciatus* Rahayu & Forest, 1995, *D. jubatus* Nobili,1903, *D. laevicarpus,* new species , *D. platyops* Rahayu & Forest, 1995, *D. tumidus* Rahayu & Forest, 1995, *Pagurus moluccensis* Haig & Ball, 1988, seem at present to be exclusively Indo-Malaysian. Thirteen species inhabit the entire Indo-West-Pacific, of which nine species (*Clibanarius infraspinatus* (Hilgendorf, 1869), *C. longitarsus* (De Haan, 1849), *C. striolatus* Dana, 1852, *Dardanus deformis* (H. Milne Edwards, 1836), *D. hessii* (Miers, 1884), *D. lagopodes* (Forskål, 1775), *D. megistos* (Herbst, 1804), *Nematopagurus muricatus* Henderson,1896 and *Spiropagurus spiriger* (De Haan,1849) extend northward to Japan, and four others: *Calcinus laevimanus* (Randall, 1839), *Clibanarius corallinus* (H. Milne Edwards, 1848), *Dardanus gemmatus* (H. Milne Edwards, 1848), *D. pedunculatus* (Herbst, 1804) extend westward to the Red Sea and the East Coast of Africa , eastward to Tuamotu and Hawai. The remaining species inhabit the Indian Ocean with a range extending to eastern part of Indonesia and New Guinea. Within this group three species, *Aniculus ursus* (Olivier, 1811) reaches as far as the Marshall Islands, *Dardanus callichela* Cook, 1989 from Chesterfield Island and *Pagurus kulkarnii* Sankolli, 1962 occurs in Northern Territory, Australia.

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Table 1. Geographic distribution of Singapore and Malaysian hermit crabs (* species recorded in earlier literature and present in material studied; # species recorded in earlier literature but not present in material studied).

Species	Distribution
Diogenidae	
#*Aniculus ursus* (Olivier, 1811)	East Coast of Africa, Indian Ocean, Indonesia, Singapore, Fidji, Carolines, Mariannas and Marshall Islands.
#*Calcinus laevimanus* (Randall, 1839)	Red Sea and Indian Ocean to Hawaii and Tuamotu.
#*Clibanarius corallinus* (H. Milne Edwards, 1848)	East Indian Ocean to French Polynesia.
C. cruentatus (H. Milne Edwards, 1848)	Mergui Archipelago to Madang, new Guinea.
C. danai Rahayu & Forest, 1992	Sri Lanka, Indonesia, Vietnam and Samoa.
#*C. eurysternus* (Hilgendorf, 1878)	East Indian Ocean, Indonesia, Singapore, Marshall and Gilbert Islands.
**C. infraspinatus* (Hilgendorf, 1869)	Red Sea, Indian Ocean, Indonesia, Singapore, Vietnam, Japan and north of Australia.
**C. longitarsus* (De Haan, 1849)	Red Sea to Japan.
**C. merguiensis* De Man, 1888	Mergui Archipelago, Indonesia, Singapore, Vietnam and New Guinea.
#*C. padavensis* De Man, 1888	Mergui Archipelago, Malaysia and New Guinea.
C. ransoni Forest, 1953	Indonesia, Singapore, Vietnam and French Polynesia.
C. serenei Rahayu & Forest, 1992	Indonesia, Singapore and Vietnam.
#C. striolatus Dana, 1852	Red Sea and Japan to Tahiti.
Dardanus deformis (H. Milne Edwards, 1836)	Red Sea and Japan to Hawaii and Tuamotu.
D. gemmatus (H. Milne Edwards, 1848)	Western Indian Ocean to Hawaii and Tuamotu.
**D. hessii* (Miers, 1884)	Red Sea to Torres Strait and Japan.
Dardanus calllichela Cook, 1989	Sri Lanka to Chesterfield reef.
D. lagopodes (Forskål, 1775)	Red Sea, Japan to Tuamotu.
**D. megistos* (Herbst, 1804)	Red Sea, Japan to Hawaii and Tuamotu.
D. pedunculatus (Herbst, 1804)	East coast of Africa to Hawaii
D. setifer (H. Milne Edwards, 1836)	South Africa, Indonesia, Singapore, Vietnam and Hongkong.
**Diogenes avarus* Heller, 1865	Red Sea, Indian Ocean, Indonesia, Singapore, New Guinea and Northern Australia.
D. custos (Fabricius, 1798)	Indian Ocean to Australia.
#*D. desipiens* Lanchester, 1902	Penang, Malaysia.
D. fasciatus Rahayu & Forest, 1995	Singapore, Indonesia.
#*D. jubatus* (Nobili, 1903)	Singapore.
D. laevicarpus new species	Singapore.
D. lophochir Morgan, 1989	Singapore and Southwestern Australia.
#*D. mixtus* Lanchester, 1902	Penang, Malaysia.
Diogenes pallescens Whitellege, 1897	Singapore, Indonesia, New Guinea and Funafuti.
D. platyops Rahayu & Forest, 1995	Singapore and Indonesia.

**D. planimanus* Henderson, 1893	Indian Ocean, Arabian Sea and Singapore.
D. rectimanus Miers, 1884	East Coast of India, Singapore and Torres Strait.
D. aff. *rectimanus*	Singapore.
#*D. senex* Heller, 1865	Red Sea and Indian Ocean.
D. stenops Morgan & Forest, 1991	Singapore and Northern Australia.
D. tumidus Rahayu & Forest, 1995	Singapore and Indonesia.
**Paguristes longirostris* (Dana, 1852)	Indian Ocean and Singapore.
Paguridae	
Nematopagurus muricatus Henderson, 1896	Red Sea, Sri Lanka, Maldives and Singapore.
Pagurus kulkarnii Sankoli, 1962	Arabian Sea, Singapore, Indonesia, Northwestern Australia.
P. pergranulatus (Henderson, 1896)	Sri Lanka, Andaman, Singapore, Moluccas, Northern Australia.
**Spiropagurus spiriger* De Haan, 1849	Red Sea to Japan.

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