

**REDISCOVERY AND REDESCRIPTION OF THE
RARE HERMIT CRAB, *DIOGENES JUBATUS* (NOBILI, 1903)
(CRUSTACEA: DECAPODA: ANOMURA: DIOGENIDAE),
FROM SINGAPORE**

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ABSTRACT. - A hermit crab recently captured near Singapore has proven to represent a rare species, *Diogenes jubatus* (Nobili, 1903). Originally described in the genus *Troglopagurus* Henderson, this is one of eight species now placed in the genus *Diogenes* Dana, which are characterized by a reduced intercalary rostriform process, and long dense setae on the chelipeds and ambulatory legs. Although *D. jubatus* has been previously compared to other similar species, no illustrations or complete description exist in the literature. Specimens of Nobili's species had not been reported since the original description nearly a century ago. A complete illustrated redescription of *D. jubatus* is presented, including coloration. Some observations on behaviour in an aquarium are included. Diagnostic characters and affinities with other species are discussed, and the taxonomic history of Nobili's species is summarized.

INTRODUCTION

In an account of crustaceans collected by Emile Deschamps from Singapore, Nobili (1903) described a new hermit crab, *Troglopagurus jubatus*, on the basis of five specimens. Nobili compared his species with two others assigned to *Troglopagurus* Henderson, 1893, *T. manaarensis* Henderson, 1893, and *T. jousseaumei* Bouvier, 1897, but did not illustrate his species. No additional specimens of Nobili's species have been reported since the original description. When Forest (1955) synonymized *Troglopagurus* with *Diogenes* Dana, 1851, Nobili's taxon was referred to *Diogenes*. Although Nobili's taxon has been mentioned by various carcinologists (e.g. Alcock, 1905; Forest, 1952; Gordan, 1956; Morgan & Forest, 1991; Rahayu & Forest, 1995), no complete, detailed description, or illustrations exist. The recent capture near Singapore of a specimen which appeared to represent *D. jubatus*, prompted us to compare it with the types of Nobili's species. The comparison confirmed that our specimen indeed represents this taxon, and has provided the opportunity to clarify and adequately document the morphology of this rarely collected hermit crab.

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The type material of *D. jubatus* (Nobili), is contained in the Museo Zoologico Universita di Torino - Museo Regionale di Scienze Naturali, Italy (MZUT). The specimen recently collected from Singapore has been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). We follow McLaughlin (1997) in the use of the term "semichelate" for the condition of the fourth pereopods. The abbreviation SL indicates shield length (to the nearest 0.1 mm), measured from the tip of the rostrum to the midpoint of the posterior margin.

TAXONOMY

Diogenes jubatus (Nobili, 1903)

(Figs. 1-5)

Troglomagurus jubatus Nobili, 1903: 17; 1906: 79, 81 (key); Alcock, 1905: 75 (key), 167; Forest, 1952: 9; Gordan, 1956: 342 (lit.).

Diogenes jubatus - Morgan & Forest, 1991: 670, 676, 678 (key); Rahayu & Forest, 1995: 401.

Material examined. - Lectotype, herein selected: female (SL 4.6 mm) (MZUT Cr 1485, ex 1645), Singapore, coll. E. Deschamps, 1901.

Paralectotypes: 4 males (SL 2.1-4.5 mm) (MZUT Cr 1485, ex 1645), same data as lectotype.

Others - 1 male (SL 5.0 mm) (USNM 275980), channel between Pulau Tekong Island and Changi Point, eastern Singapore, 15-20 m, dredged, coll. R. Teo & T. S. Sin, 27 Jan.1993.

Redescription. - Shield (Fig. 1) about as long as wide. Dorsal surface uneven; usually with 13 low, often weakly calcified tubercles symmetrically arranged (6 on each side, 1 median just anterior to center of shield); with short transverse row of small spines near each anterolateral angle, well marked groove forming an inverted U on anterior half medially, and short transverse rows of plumose setae adjacent to anterior margin of tubercles and near posterolateral angle. Anterolateral margin sloping. Rostrum blunt, broadly subtriangular, not reaching tips of lateral projections. Anterior margins between rostrum and lateral projections weakly concave. Lateral projections with small terminal spine. Posterior carapace with posteromedian plate moderately calcified. Accessory portions of cephalothorax well calcified.

Ocular peduncles (Fig. 1a, c, d) elongate, approximately three-fourths length of shield, reaching to distal margin of penultimate antennular segment, and at most slightly exceeding distal margin of fourth antennal segment; weakly broadened basally, glabrous except for tuft of setae on dorsal surface proximally. Corneae subequal in width to distal width of ocular peduncle. Ocular acicles (Fig. 1) separated basally by one-fifth basal width of 1 acicle; anterior margin with 4 or 5 spines, not extending more than half length of margin. Intercalary rostriform process (Fig. 1b) reduced, consisting of often inconspicuous, oblong lobe with terminal setae.

Antennular peduncles slender, with scattered setae; exceeding distal margin of fifth antennal segment by at least half length of ultimate antennular segment. Ultimate segment about 1.3 times as long as penultimate. Basal segment unarmed mesially; lateral face with distal lobe armed with 4-6 small blunt or sharp spines.

Antennal peduncle (Figs. 1a, c, d, 2) very stout. Fifth and fourth segments unarmed,

virtually naked. Third segment with small spine on ventrodistal margin. Second segment with 1-4 spines on dorsolateral distal angle (outermost spine usually largest), and row of small spines on ventrodistal margin. First segment with transverse row of setae and small blunt spines on dorsodistal margin; dorsal face with oblique furrow from distomesial to lateroproximal angles. Antennal acicles not forked, short; distal margin oblique, armed with 6-9 spines. Antennal flagellum long and thick, reaching to tips of dactyls of second pereopods; with very long, simple setae on ventral margin of articles, setae approximately one-third or more as long as entire flagellum; first 2 articles distinctly longer than others.

Mouthparts as figured (Fig. 3). Mandible with 3-segmented palp; distal segment of palp with row of setae on distolateral margin. Maxillule with external lobe of endopod obsolete; internal lobe of endopod with long simple seta distally; proximal endite with row of long, often distally curved thick setae. Maxilla with endopod slightly exceeding distal margin of scaphognathite. First maxilliped with endopod short, not reaching distal margin of exopod; exopod with long plumose setae on lateral margin. Second maxilliped without distinguishing features. Third maxilliped unarmed except for teeth of crista dentata and basis.

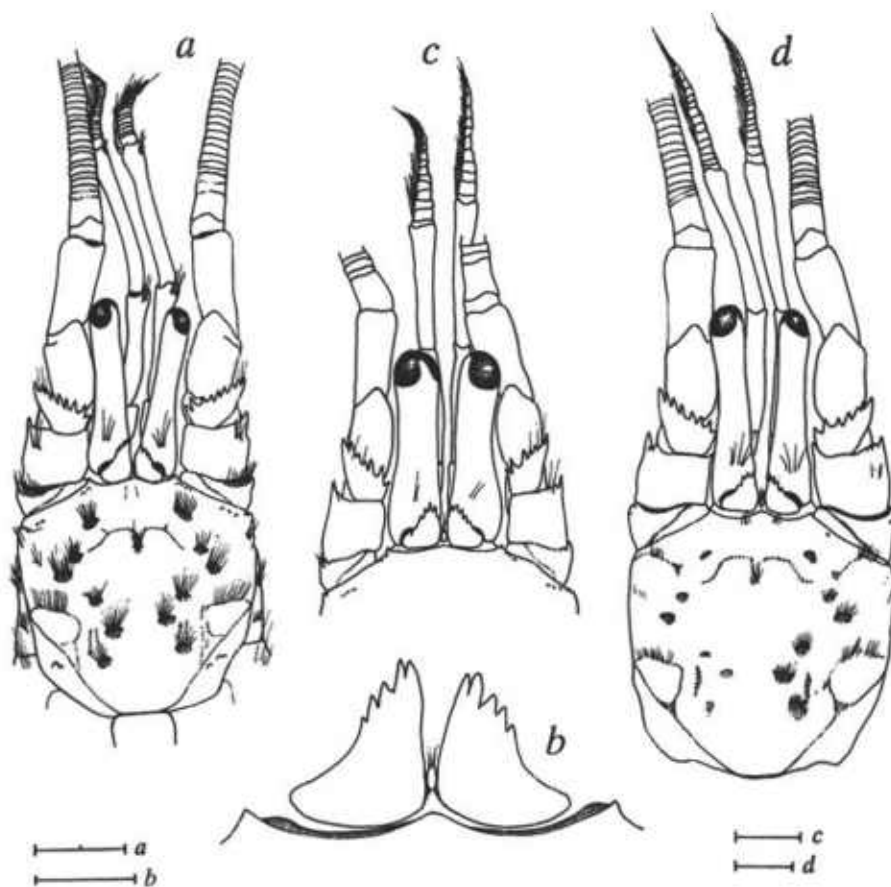


Fig. 1. *Diogenes jubatus*. a, Shield and cephalic appendages; b, Ocular acicles, intercalary rostriform process, and anterior portion of shield of same; c, Anterior portion of shield and cephalic appendages; d, shield and cephalic appendages. Scales equal 2 mm (a), 0.5 mm (b,c), and 1 mm (d). a,b, Male (SL 5.0 mm), channel between Pulau Tekong Island and Changi Point, eastern Singapore, USNM 275980; c, Male (SL 2.1 mm), Singapore, MZUT Cr 1485 (ex 1645); d, Lectotype, female (SL 4.6 mm), Singapore, MZUT Cr 1485 (ex 1645).

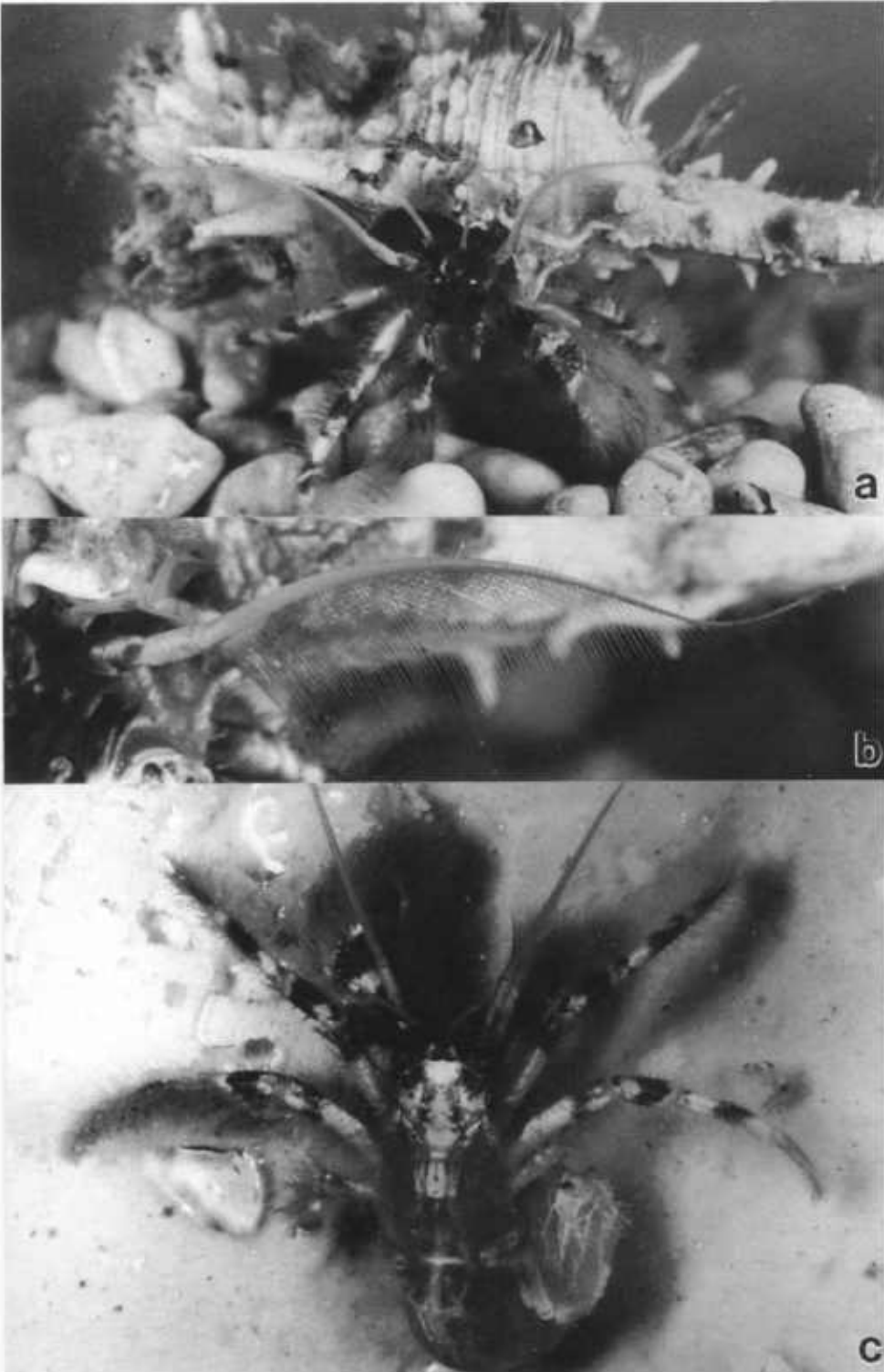


Fig. 2. *Diogenes jubatus*, photographed live in aquarium. a, frontal view; b, left antenna; c, specimen with shell housing removed. Male (SL 5.0 mm), channel between Pulau Tekong Island and Changi Point, eastern Singapore, USNM 275980.

Chelipeds markedly dissimilar, left longer, much stronger. Left cheliped (Figs. 2c, 4a) with outer face of chela covered with long, dense plumose setae concealing surface beneath; cutting edge of fingers with several unequally-sized calcareous teeth, terminating in blunt calcareous claw. Dactyl about as long as upper margin of palm; upper margin with irregular row of spines; outer face with spines medially. Fixed finger weakly deflected ventrally; with spines on outer face. Palm with irregular row of spines on upper and lower margins; outer face armed with spines except on median area; inner face smooth except for tufts of setae on mid-upper and mid-lower surfaces. Carpus with tufts of setae mostly placed in front of spines or tubercles; upper margin well delimited, with row of spines including stronger distal spine; outer distal margin with row of spines decreasing in sharpness and size towards lower margin; outer face with longitudinal row of small spines on upper half; inner face smooth except for tufts of setae on upper and lower halves. Merus with row of spines on well delimited, setose dorsal margin; ventrolateral margin with irregular rows of spines; lateral and ventral faces with scattered small tubercles, ventral face with long dense plumose setae

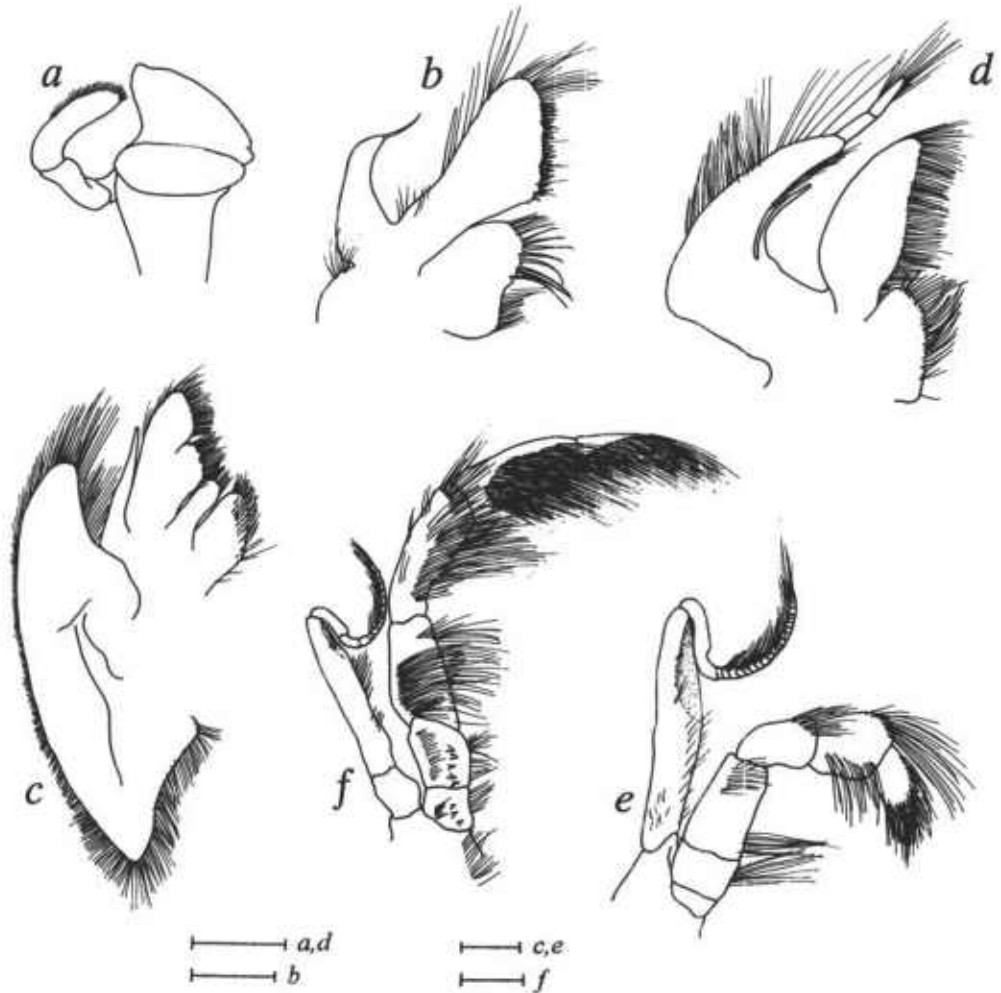


Fig. 3. *Diogenes jubatus*. Left mouthparts, internal view: a, mandible; b, maxillule; c, maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped. Scales equal 0.5 mm (a-e), and 1 mm (f). Male (SL 5.0 mm), channel between Pulau Tekong Island and Changi Point, eastern Singapore, USNM 275980.

Right cheliped (Figs. 2c, 4b) reaching approximately to distal margin of palm of left cheliped. Chela with outer face of fingers and upper half of outer face of palm with dense plumose setae concealing surface beneath; outer and inner faces unarmed. Fingers terminating in calcareous tips; cutting edges with small calcareous teeth. Dactyl slightly longer than upper margin of palm; upper margin with row of small spines. Carpus with long setae and 1 distal spine on dorsal margin; lateral face with spine on dorsal half of distal margin, and row of small spines or tubercles on lower half of distal margin. Merus with long setae on dorsal margin; lateral face with scattered small tubercles; ventrodistal margin with row of spines; ventral face with long plumose setae.

Second pereopods (Fig. 2c, 4c) similar. Dactyl approximately 1.2-1.4 times as long as propodus, terminating in sharp corneous claw. Propodus and dactyl with long, dense setae on dorsal and ventral faces, and median longitudinal row of tufts of setae on lateral faces. Carpus with small dorsodistal spine, and dorsal row of setae. Merus and carpus with few tufts of setae on lateral faces; ventral margin of merus setose.

Third pereopods (Fig. 2c, 4d) similar left from right except for setation pattern. Left with dense mat of long plumose setae on outer faces of propodus and dactyl; right lacking dense mat of setae on propodus and dactyl. Otherwise similar to first ambulatory legs.

Coxae of chelipeds and second to fifth pereopods with 1-3 low, wide tubercles on ventral face, each tubercle with row of setae. Anterior lobe of sternite of third pereopods (Fig. 4e) subrectangular, subdivided anteriorly into 2 lobes each with 2-4 small spines and tuft of setae.

Fourth pereopod semichelate. Dactyl terminating in short corneous claw. Propodus with well developed rasp consisting of 5 to 10 rows of scales. Propodus and carpus with small dorsodistal spine.

Fifth pereopod chelate. Propodal rasp extending for less than half length of propodus.

Uropods strongly asymmetrical. Left and right protopods each with row of blunt spines posteriorly; right protopod (Fig. 4f) produced posteriorly forming rasp of corneous scales.

Telson (Fig. 4g) with posterior lobes strongly asymmetrical, left largest. Terminal margins of lobes armed throughout with spines (stronger on left).

Females with unpaired, biramous left second to fifth pleopods (Fig. 5a-d); endopod and exopod divided into 2 or more articles. Males with unpaired, uniramous left second to fifth pleopods (Fig. 5e); distal segment divided into 2-4 articles.

Colour in life. - Shield white except for black areas medially and posterior to anterolateral margin; with some iridescence. Ocular peduncles mostly black except for white area basally and narrow white band adjacent to corneae. Ocular acicles black with white distal margin. Basal and penultimate segments of antennular peduncle, and first to third segments of antennal peduncle, black; remaining segments and antennular and antennal flagella, whitish; long setae of antennal flagellum light brown (retained for long time after preservation). Endopod of third maxilliped white, with merus, carpus, propodus, and dactyl each with black band medially. Exopod of third maxilliped and remaining mouthparts with light purple tint. Chelipeds white, each with wide black band distally on merus and carpus, and palm with

black inner face; dactyl with black area on inner face. Ambulatory legs white, each with black band on merus, carpus, propodus, and dactyl.

Distribution. - Known only from Singapore thus far; subtidal to 20 m.

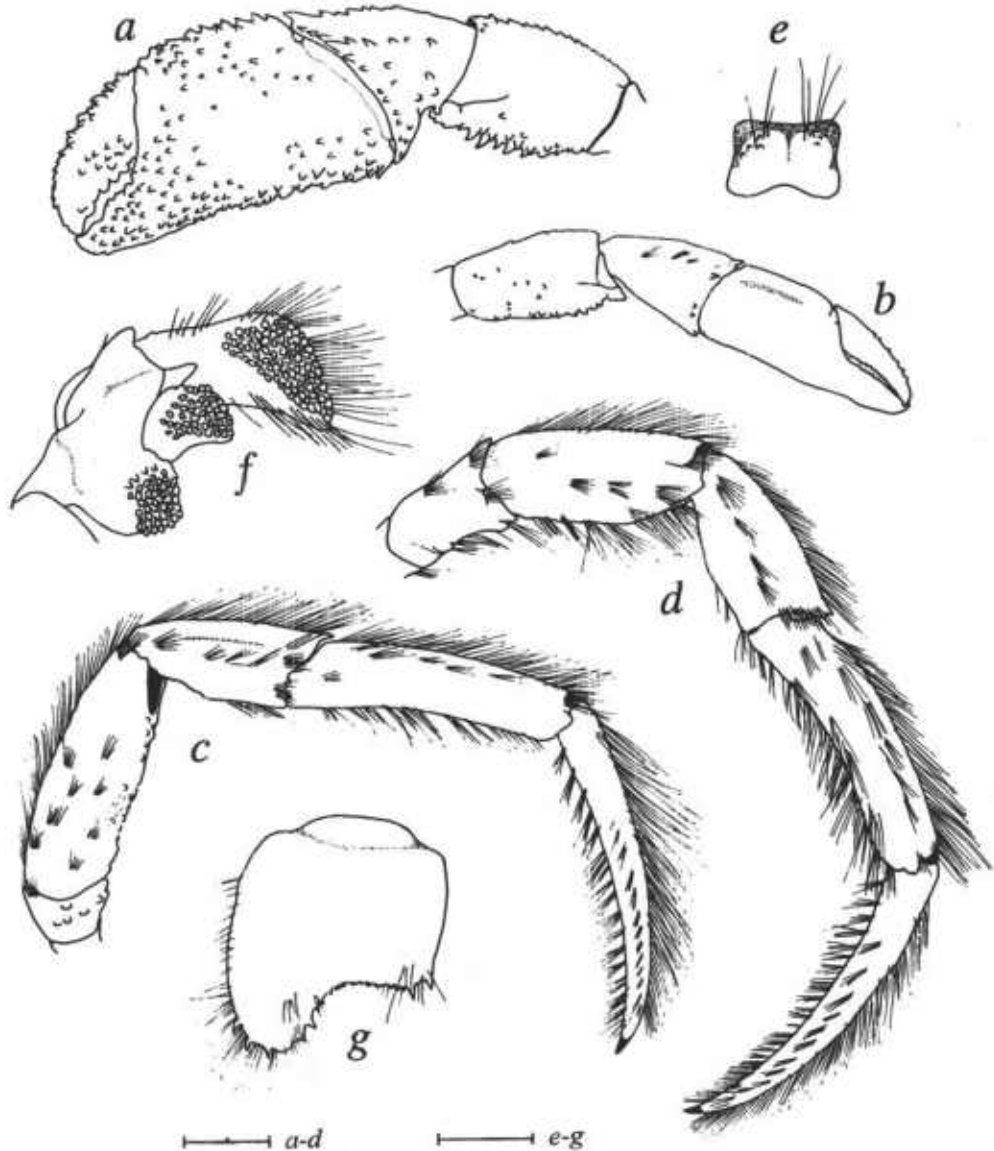


Fig. 4. *Diogenes jubatus*. a, Left cheliped (setae omitted), outer view; b, Right cheliped (outer view), setae omitted; c, Second right pereopod, lateral view; d, Third right pereopod, lateral view; e, Anterior lobe of sternite of third pereopods, ventral view; f, Right uropod, dorsal view; g, telson, dorsal view. Scales equal 2 mm (a-d), and 1 mm (e-g). a,b, Paralectotype, male (SL 4.2 mm), Singapore, MZUT Cr 1485 (ex 1645); c,d,f,g, Male (SL 5.0 mm), channel between Pulau Tekong Island and Changi Point, eastern Singapore, USNM 275980; e, Lectotype, female (4.6 mm), Singapore, MZUT Cr 1485 (ex 1645).

Habitat and behaviour. - The specimen recently collected in the channel between Pulau Tekong Island and Changi Point, eastern Singapore, was dredged over a substrate consisting of a mixture of gravel, sand and mud, in waters with strong currents. The specimen was found living in a *Murex* gastropod shell. In an aquarium in the laboratory, this hermit crab was quite active, displaying considerable more agility than other *Diogenes* species from the area. In the aquarium, the hermit crab was observed to have distinct preference for areas with strong currents, such as those near air outlets or the efferent end of the air pump. The hermit crab maintained its long antennae arched slightly above body level, widely apart (Fig. 2a), and facing into the current, flicking them through its mouthparts when fish flakes were introduced into the aquarium. This behaviour, and the "cast-net" structure of the long and strong antennae, suggests that the species uses the antennae for capturing food. Several other species of *Diogenes* also exhibit "cast-net" antennae, and a similar behaviour has been observed by Boltz (1961) for *D. brevirostris* Stimpson, 1858.

Affinities. - This species most closely resembles *D. platyops* Rahayu & Forest, 1995, from Indonesia. *Diogenes jubatus* differs from *D. platyops* in several characters. The antennal peduncles are distinctly stouter in *D. jubatus* than in *D. platyops*. The fixed finger of the left cheliped is weakly deflected in *D. jubatus*, whereas it is not in *D. platyops*. The dactyls of the second and third pereopods of *D. jubatus* are 1.2-1.4 as long the propodi; the dactyls of *D. platyops* are 0.9-1.0 as long as the propodi. The setation on the propodus and dactyl of the left third pereopod of *D. jubatus* consist of a dense mat of plumose setae that entirely cover the lateral faces of the segments; setation of *D. platyops* is arranged as dense fringes on the dorsolateral and ventrolateral margins that partially cover the lateral faces of the segments.

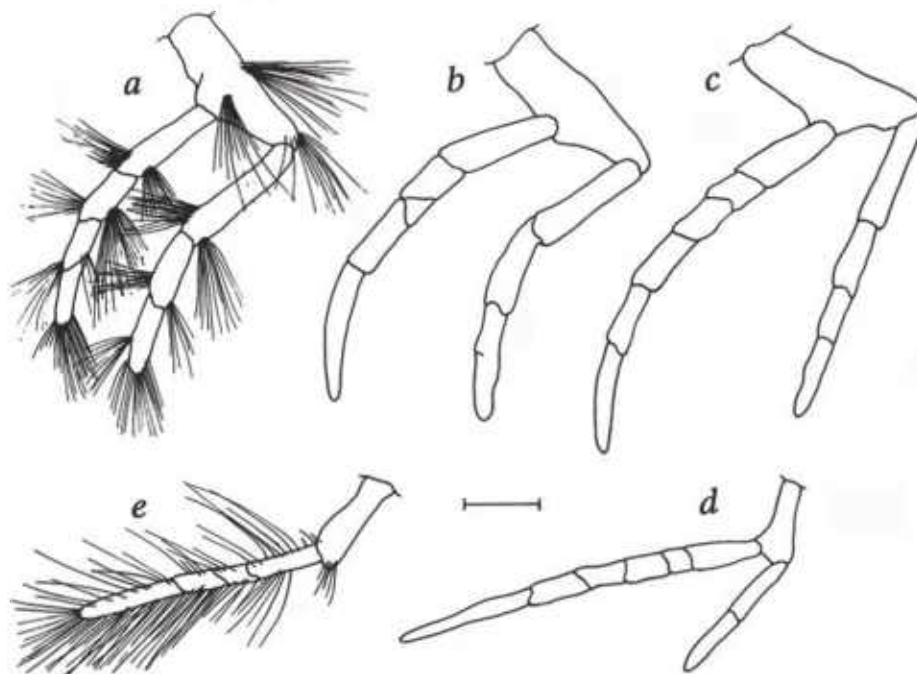


Fig. 5. *Diogenes jubatus*. a-d, Female left pleopods, lateral view (setae omitted in b-d): a, Second; b, third; c, Fourth; d, Fifth. e, Male left second pleopod, lateral view. Scale equals 1 mm. a-d, Lectotype, female (4.6 mm), Singapore, MZUT Cr 1485 (ex 1645); e, Male (SL 5.0 mm), channel between Pulau Tekong Island and Changi Point, eastern Singapore, USNM 275980.

Remarks. - Similarities of *Diogenes jubatus* with *D. manaarensis* (Henderson, 1893), and *D. jousseaumei* (Bouvier, 1897), have been pointed out by Nobili (1903, all as *Troglopagurus*), and Morgan & Forest (1991). Although no specimens of either *D. manaarensis* or *D. jousseaumei* have been examined during this study, it is apparent from the literature cited herein that the potential for confusion of *D. jubatus* with these taxa as well as with *D. platyops*, does exist. Since Nobili (1903) did not select a holotype for his taxon, a lectotype is herein selected for *D. jubatus* from the syntypic series.

Comparison of specimens of *D. jubatus* with Henderson's (1893: 421, pl. 39, figs. 9-11) description and figures of *D. manaarensis*, shows more similarities with that species than with *D. jousseaumei*. Carcinologists have separated *D. jubatus* from *D. manaarensis* based on the ocular peduncles and acicles, antennal acicles, cheliped setation, and length of dactyl of ambulatory legs (Nobili, 1906; Morgan & Forest, 1991). They have considered that in *D. manaarensis* the ocular peduncles reach to the midline of the ultimate antennular segment; the ocular acicles have spines along the entire distolateral margin; the antennal acicles are "truncate"; the chelipeds have moderate setation; and the dactyls of the ambulatory legs are no longer than the propodi. In contrast, in *D. jubatus*, the ocular peduncles reach only to the proximal margin of the ultimate antennular segment; the antennal acicles are "not truncate"; the ocular acicles have spines only distally; the chelipeds are densely setose; and the dactyls of the ambulatory legs are longer than the propodi. While these differences are useful in separating the two taxa, there is some difficulty in using as diagnostic characters "truncate" vs. "not truncate" condition of the antennal acicle, and the armature of the ocular acicles. In both species the antennal acicles could be considered "truncate", if we interpret this condition to be shortened, cut-off, with the distal margin squared. In *D. jubatus*, the distal margin is armed with spines as in *D. manaarensis*, but in the former, the margin is slightly oblique, not squared; however, in *D. manaarensis*, at least the right antennal acicle depicted by Henderson (1893: pl. 39, fig. 9) can be considered oblique.

Diogenes jubatus exhibits marked differences in setation between the right and left third pereopods (Fig. 2c). As previously mentioned, on the left leg a dense mat of long plumose setae is present on the lateral faces of propodus and dactyl; the right leg lacks this mat, and has only long simple setae on the dorsal and ventral margins. A similar condition has been reported for *D. jousseaumei* and *D. stenops* Morgan & Forest, 1991 (see Nobili, 1903, as *Troglopagurus*; Morgan & Forest, 1991). Additionally, at least two other species, *D. setocristatus* Morgan & Forest, 1991, and *D. platyops*, also exhibit denser setation on the left than on the right third pereopods. However, in the latter two species the dense setae on the left leg are arranged in fringes on the dorsolateral and ventral margins of propodus and dactyl (see Morgan & Forest, 1991; Rahayu & Forest, 1995).

History of generic and group placement. - The close similarity between *Troglopagurus* and *Diogenes*, was first observed by Bouvier (1897), who remarked that the two differed only in that *Troglopagurus* lacked the mobile rostrum present in *Diogenes*, and that as a consequence the ocular acicles were closer together in *Troglopagurus*. Forest (1952), in his description of *Diogenes mercatoris*, observed similarities between his species and *T. jousseaumei*, and concluded that at least *T. jousseaumei* and *T. persicus* should be transferred to *Diogenes*. Because Forest did not have first hand information on the type species of the genus, *T. manaarensis*, or *T. jubatus*, he retained *Troglopagurus* for these two species until such time as specimens could be studied. Subsequently, Forest (1955: 75) mentioned that he had examined the type of *T. manaarensis*, and synonymized *Troglopagurus* with *Diogenes*. He based his decision on the observation that all four species assigned to *Troglopagurus*

have an interocular process that had not been mentioned or apparently was overlooked by previous carcinologists, and which represented a reduced condition of the mobile rostrum in *Diogenes* species. Although Lewinsohn (1969) disagreed with Forest and retained *Troglopagurus* for a specimen he reported as *T. jousseauiei* Bouvier 1897, he (Lewinsohn) had only one specimen, and apparently did not have direct knowledge of other species in the *Troglopagurus* group. Recent studies, however, indicate that the interocular process in species of the *Troglopagurus* group, and the mobile rostrum of *Diogenes* species, are homologous structures (Morgan, 1987; Morgan & Forest, 1991; Rahayu & Forest, 1995). In assigning Nobili's *T. jubatus* to *Diogenes*, however, these carcinologists did not have specimens of Nobili's species on hand, and assumed that an interocular process was present. Our study of Nobili's types of *T. jubatus* as well as the specimen reported herein from Singapore, confirms that an interocular process indeed exists in this species. The process in *D. jubatus* is reduced to a small oblong lobe with a tuft of setae (Fig. 1b), and therefore, it rightfully belongs in *Diogenes*.

As previously mentioned, *Diogenes jubatus* is one of four species originally described in the genus *Troglopagurus* Henderson, 1893, sometimes referred to as the *Troglopagurus* group (e.g. Morgan & Forest, 1991). The other species assigned to this group, all from the Indian Ocean region, include the type of the genus, *T. manaarensis* Henderson, 1893, *T. jousseauiei* Bouvier, 1897, and *T. persicus* Nobili, 1905. These, and four species of *Diogenes*, were defined by Morgan & Forest (1991) as the '*Diogenes jousseauiei* complex', based on the presence of a markedly reduced intercalary rostriform process. Rahayu & Forest (1995), in their division of *Diogenes* species, included *D. jubatus* in Group II, subgroup 2. This subgroup, equivalent to Morgan & Forest's (1991) '*Diogenes jousseauiei* complex' [except that Rahayu & Forest (1995) excluded *D. persicus*, and added one more new species], was defined for species characterized by a reduced interocular process, and long, dense setae on the chelipeds and ambulatory legs. In addition to *T. jubatus*, Rahayu & Forest included in the subgroup, *D. manaarensis*, *D. jousseauiei*, *D. mercatoris* Forest, 1952, *D. crosnieri* Dechanci, 1964, *D. setocristatus* Morgan & Forest, 1991, *D. stenops* Morgan & Forest, 1991, and *D. platyops*.

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