

On the Identities of Three Common Shallow-Water Swimming Crabs *Portunus hastatoides* Fabricius, 1798, *P. dayawanensis* Chen, 1986, and *P. pseudohastatoides* Yang and Tang, 2006 (Crustacea: Decapoda: Portunidae): Essentials for Benthic Ecological Monitoring and Biodiversity Studies

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Kingsley J. H. Wong, Kenneth M. Y. Leung, and Benny K. K. Chan (2010) On the identities of three common shallow-water swimming crabs *Portunus hastatoides* Fabricius, 1798, *P. dayawanensis* Chen, 1986, and *P. pseudohastatoides* Yang and Tang, 2006 (Crustacea: Decapoda: Portunidae): essentials for benthic ecological monitoring and biodiversity studies. *Zoological Studies* 49(5): 669-680. The portunid crab *Portunus hastatoides* Fabricius, 1798, is a widely distributed common deposit feeder in sandy and muddy subtidal ecosystems in Indo-Pacific waters and has been frequently used as an indicator species in ecological monitoring studies. The identification of *P. hastatoides* in many previous monitoring studies was somewhat ambiguous and likely confused by the coexistence of other morphologically similar species (i.e., *P. dayawanensis* Chen, 1986, and *P. pseudohastatoides* Yang and Tang, 2006), which were often misidentified as *P. hastatoides*. Correct species identification is crucial to generate accurate results from ecological monitoring and biodiversity surveys. In this paper, we redescribe the diagnostic features of these 3 morphologically similar species, *P. hastatoides* (but see below), *P. dayawanensis*, and *P. pseudohastatoides* in Hong Kong and Taiwanese waters and provide a refined species identification guide for benthic ecologists and environmental protection authorities. In the present study, we also found that *P. hastatoides* in Hong Kong and Taiwan morphologically differed from one of the types of *P. hastatoides* (from the Indian Ocean), suggesting the presence of a cryptic species complex. Before any extensive revisions are made on the group, we continue to refer to the Hong Kong and Taiwanese populations as *P. hastatoides*. Crab specimens were trawled from marine environments within the Taiwan Strait where these 3 *Portunus* species are common. Key features of each of these species were identified; these included the morphology of the carapace frontal teeth and male 1st pleopod. <http://zoolstud.sinica.edu.tw/Journals/49.5/669.pdf>

Key words: *Portunus hastatoides*, Benthic Ecological Monitoring, Biodiversity survey, Swimming crab, Morphology.

The portunid crab *Portunus hastatoides* Fabricius, 1798, is a common benthic deposit feeder in shallow marine waters, commonly occurring in organically polluted subtidal

communities. It is one of the pioneer species to re-colonize disturbed environments after defaunation events (Wu 1982) and has been used as an indicator species for benthic environmental

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monitoring and biodiversity studies in Western Pacific regions (Hong Kong: Shin and Thompson 1982, Wu 1982 1988, Blackmore and Rainbow 2000; Taiwan: Chou et al. 1999, Chou and Fang 2005, Tew et al. 2008; Japan: Ganmanee et al. 2004). *Portunus hastatooides* is widely distributed in Indo-West Pacific waters (Stephenson 1972b), being recorded from Japan (e.g., De Haan 1835, Sakai 1965 1976, etc.), China (Chen 1991, Dai and Yang 1991), Taiwan (e.g., Lin 1949, see Ng et al. 2001), Hong Kong (Shen 1940, Morton and Morton 1983), Burma (Henderson 1893), Malacca (De Man 1895 1907), Singapore (Shen 1937), Ambon, Indonesia (Spiridonov 1999), northern, eastern, and western Australia (Stephenson and Campbell 1959, Campbell and Stephenson 1970, Davie 2002), India (Alcock 1899, Chopra 1935), Iran (Stephenson 1946), the West Indian Ocean (Neumann and Spiridonov 1999), Madagascar (Crosnier 1962), and South Africa (Barnard 1950).

Identifications and records of *P. hastatooides* in previously reported ecological monitoring studies are; however, somewhat confusing. *Portunus hastatooides* was extensively recorded within the Taiwan Strait (Maki and Tsuchiya 1923, Lin 1949, Chang 1963, Yu 1979, Fang 1991, Huang and Yu 1997, Lai et al. 1997, Chou et al. 1999, Hsueh et al. 2006, Hsueh and Hung 2009, see also Ng et al. 2001). On the west coast of Taiwan, Hsueh et al. (2006) and Hsueh and Hung (2009) obtained bulk quantities of *P. hastatooides*, which in fact, were composed of 2 species as revealed by the present study. In Hong Kong, multiple species recorded as "*P. hastatooides*" are believed to be one of the dominant catches in benthic ecological monitoring trawls in muddy waters (see Wu 1982, Cheung 1990). Davie (1992) examined brachyuran samples trawled from Hong Kong and suggested that older records of "*P. hastatooides*" in Hong Kong were incorrect and should be identified as *P. trilobatus* Stephenson, 1972, instead on the basis of the morphology of the frontal region. He noted that no *P. hastatooides* was collected in his survey in Hong Kong and "...can be distinguished by having only three frontal lobes of which the median is less prominent than the laterals; *P. hastatooides* has four frontal lobes..." (Davie 1992: p. 488).

A series of benthic trawling surveys was conducted by the 1st and 2nd authors in Tolo Harbour, Hong Kong in 2007, yielding a considerable amount of *Portunus* specimens. By consulting Chen (1986), we determined that the bulk of this material belonged to *P. dayawanensis*

rather than *P. trilobatus*. Both *P. trilobatus* and *P. dayawanensis* have 3 frontal lobes, but they differ in the morphology of the carapace and chelipeds (Chen 1986). Furthermore, samples of *P. pseudohastatooides* Yang and Tang, 2006, were also collected, and this species had not been reported in any of the previous trawling survey reports from Hong Kong or any other localities aside from the type locality of Guangdong and Guangxi (South China). *Portunus pseudohastatooides* morphologically resembles "*P. hastatooides*" but can be distinguished by the morphology of the frontal region, the shape of the male abdomen, and the 1st pleopod (Yang and Tang 2006). Previous records and identification of "*P. hastatooides*"; therefore, had apparently overlooked and/or misidentified the presence of *P. pseudohastatooides* and *P. dayawanensis*. For "*P. hastatooides*" and *P. pseudohastatooides*, illustrations given in a number of important taxonomic works (e.g., De Haan 1835, Sakai 1965 1976) were unclear in showing the morphology of the frontal margin, while the description on the male 1st pleopod was absent or poor and uninformative. These morphological features are critically essential to separate such morphologically similar species. Some previous illustrations of "*P. hastatooides*" showed characteristics resembling *P. pseudohastatooides* (e.g., Alcock 1899, p. 38: "... (median frontal teeth) usually as prominent as or even more prominent than (laterals)..."; Shen 1937, see frontal region of fig. 5a). Records of *P. hastatooides* from Hong Kong (Wu 1982 1988, Cheung 1990, Blackmore and Rainbow 2000) might be confounded as they probably mixed 1 or more of these morphologically similar species (i.e., *P. hastatooides*, *P. pseudohastatooides*, *P. trilobatus*, and *P. dayawanensis*). In addition, specimens from different localities appear to display a wide range of morphological varieties, notably of the length of the median frontal teeth and the presence/absence of a dark spot on the distal end of dactyli of the swimming legs (see De Man 1895 1907, Lanchester 1900).

For accurate ecological and/or pollution monitoring, it is crucial to correctly identify the target species. In the present study, we redescribe *P. hastatooides*, *P. pseudohastatooides*, and *P. dayawanensis* from Hong Kong and Taiwanese waters with special reference to the morphology of important diagnostic characters including the frontal margins of the carapace and male 1st pleopods (Abele 1971). Based on the results,

a diagnostic key was established for correctly identifying *P. pseudohastatooides*, *P. hastatooides*, *P. trilobatus*, and *P. dayawanensis*.

MATERIALS AND METHODS

Sampling sites

Between 2006 and 2008, samples of *Portunus* were collected from Tolo Channel, Tolo Harbor and western waters around Lantau I. in Hong Kong using a commercial shrimp trawler. Details of the sampling locations and sampling methods are identical to those described in Lui et al. (2007). Some specimens were deposited in the museum of the Swire Institute of Marine Science, Univ. of Hong Kong (SWIMS) and reference collection of the Coastal Ecology Laboratory, Academic Sinica, Taipei, Taiwan (CEL). Additional *Portunus* specimens were examined from the sample collections of National Taiwan Ocean Univ., Keelung, Taiwan (NTOU), and from benthic trawl surveys in the Taiwan Strait (approximately longitude 22°-25°N), deposited in the collection of the National Museum of Natural Science, Taichung, Taiwan (NMNS). The 4 species in question are all currently placed within the subgenus *Xiphonectes* A. Milne-Edwards, 1873 in the genus *Portunus* Weber, 1795 (see Ng et al. 2008). For convenience of reference, subgeneric classification was not used in this study. *Portunus hastatooides* is a widely distributed species. Definite entries under the synonym list are confined to records in major taxonomic treatments in East Asia with descriptions that precisely fit our material plus uncertain records from the Chinese coast and Taiwan Strait, and thus are not intended to be complete. For a complete list of *P. hastatooides* references see Takeda and Miyake (1969) and Yu (1979).

Morphological analysis

The dorsal surface of the carapace, dorsal side of the cheliped merus, and inner and outer surfaces of the chelipeds were photographed under a stereomicroscope with a digital camera installed. The male 1st pleopods (thereafter abbreviated as G1) were critical-point-dried, gold-coated, and examined with a scanning electron microscope (SEM; FEI Quanta 200, USA) following SEM techniques in Wong et al. (2010).

RESULTS

Systematic description

Family PORTUNIDAE Rafinesque, 1815

Genus *Portunus* Weber, 1795

Subgenus *Xiphonectes* A. Milne-Edwards, 1873

Portunus hastatooides

(Figs. 1A-D, 2A, B, 6C, D)

- Portunus hastatooides* Stephenson and Campbell 1959: 101, figs. 2d, 3d, pls. 1(4), 4d, 5d. Crosnier 1962: 68, figs. 109, 122, 123. Dai and Yang 1991: 216, fig. 114(2), pl. 26(3).
 Not *Portunus hastatooides* Yu 1979: 48, fig. 5. (= *P. pseudohastatooides*).
Portunus hastatooides Fabricius 1798: 368. Chen 1991: 356, fig. 356. Fang 1991: 352. Huang and Yu 1997: 68 (in part). Jeng et al. 1997: 117. Lai et al. 1997: 229, fig. 3E. Jeng et al. 1998: 122. Chou and Feng, 2005: 641.
Portunus (Amphitrite) hastatooides Maki and Tsuchiya 1923: 138, pl. 11(5).
Neptunus hastatooides Sato 1936: 1954.
Neptunus (Hellenus) hastatooides Shen 1940: 220. Lin 1949: 19.
Lupa (Hellenus) hastatooides Chang 1963: 4.

Material examined: NE Taiwan: Daxi, Ilan County (Co.) 25 Sept. 1992: 1 ♂ (NTOU); W. Taiwan: Wuci, Taichung Co. 22 Mar. 2003: 5 ♀♀ (NMNS 002129-00040); Bojailiao, Yunlin Co. 5 Feb. 1995: 1 ♂, 2 ♀♀ (NMNS 0002129-00002); Masagou, Tainan Co. 28 June 1995: 6 ♂♂, 7 ♀♀ (NMNS 002129-00005); 3 ♂♂ (NMNS 002129-00037); 14 Sept. 2008: 3 ♂♂ (NMNS 002129-00035); SW Taiwan: Anping Harbor, Tainan Co. 11 Feb. 2004: 8 ♂♂, 5 ♀♀ (NMNS 0004368-00045); Mituo, Kaohsiung Co. 8 Feb. 1995: 40 ♂♂, 44 ♀♀ (NMNS 002129-00015); 10 Oct. 1994: 18 ♂♂, 11 ♀♀ (NMNS 002129-00033); 1 ♂, 6 ♀♀ (NMNS 002129-00055); 8 Feb. 1995: 25 ♂♂, 6 ♀♀ (NMNS 002129-00027); 30 July 1995: 1 ♂, 6 ♀♀ (NMNS 002129-00045); 8 Feb. 1995: 1 ♂ (NMNS 002129-00054); 15 Sept. 1995: 2 ♂♂ (NMNS 002129-00046); 8 Feb. 1995: 30 ♂♂, 34 ♀♀ (NMNS 002129-00016); outer Kaohsiung Harbor 10 Mar. 2004: 50 ♂♂, 20 ♀♀ (NMNS 004368-00049); Chungyun, Kaohsiung Co. 17 Feb. 1995: 39 ♂♂, 79 ♀♀ (NMNS 002129-00006); 11 ♂♂, 1 ♀ (NMNS 002129-00082); 7 Feb. 1995: 1 ♂, 1 ♀ (NMNS 002129-00071); 22 Mar. 1995: 2 ♂♂, 2 ♀♀ (NMNS 002129-00076); 22 Mar. 1995: 1 ♂ (NMNS 002129-00075); 10 Nov. 1994: 15 ♂♂, 6 ♀♀ (NMNS 002129-00038);

Tunggang, Pingtung Co. 13 Aug. 1996: 2 ♀♀ (NMNS 002129-00060); Fangshan, Pingtung Co. 6-7 Apr. 2004 (NMNS 004655-00097).

Comparative material (photographs, see also Fig. 3): Tranquebar, India. Type, 4 specimens (Zoological Museum, Copenhagen, Denmark). Indian Ocean. Type, 2 specimens (Zoological Museum, Kiel, Germany).

Diagnosis: Small species (maximum 3-4 cm in carapace width), carapace dorsoventrally flattened, surface tomentose-covered; 4 frontal teeth, medians distinctly narrower and shorter than laterals; 4 spines on anterior border of cheliped merus. G1 tapering to fine tip, without spines around opening. Dull brownish-yellow in life; without dark spot at tip of dactyli of swimming legs.

Description: Carapace extremely dorsoventrally flattened, dorsal surface covered by short tomentum and small rounded granules; regions moderately well defined, gastric, cardiac, lateral, and median postcardiac regions elevated, separated by deep grooves; mesogastric and metagastric regions separated by less-distinct transverse groove; tubercles coarser on summits; branchial region slightly depressed; faint ridge from branchial region extending to tip of branchial tooth (Fig. 1A); front with 4 teeth excluding inner supraorbital teeth, medians much narrower, shorter than laterals (Fig. 1B); orbital margin with 2 fissures on dorsal side; anterolateral margin with 9 distinct teeth, none rudimentary; 1st 8 small, triangular, of similar size, 9th most prominent, sharp, stout, pointing sideways; anterolateral margin fringed with long plumose setae; angle between posterolateral and posterior margins right or slightly acute, armed with small but distinct tooth; ventral surface of carapace free of setae, with numerous faint transverse rows of beaded tubercles (Fig. 1A). Length of merus of external maxilliped shorter than ischium; anterior distal angle of merus produced into acute angle; external maxilliped fringed with setae, longer, stiffer in inner margins than on outer margin of exopod (Fig. 1D).

Chelipeds subequal, slender, elongated (Fig. 1A); anterior margin of merus armed with 4 sharp spines, 2 on basal 1/3, 1 in middle, 1 on distal 1/3, all pointing outwards; posterior margin with 2 teeth on distal 1/4; both margins fringed with long plumose setae; carpus with 2 distinct spines, 2 beaded ridges; dorsal surface of palm with 2 longitudinal ridges, inner one more prominent, fringed with setae along inner margin, ending with small but distinct spine at base of movable finger; outer surface with 2 parallel longitudinal ridges,

upper one more prominent, extending to base of fingers; lower one extending to tip of immovable finger; fingers shorter than palm, compressed, inner margins serrated, teeth interlocking; large teeth on basal portion of movable finger; tips sharp, curved inwards. All ambulatory legs compressed, fringed on ventral edge on all segments (Fig. 1A); last ambulatory leg fringed with plumose setae, that on anterior border of merus longer, plumose; posterodistal border of merus of last ambulatory leg armed with a series of small teeth, among which 3 or 4 dentiform; posterior margins of carpus, merus, and dactylus unarmed.

Male abdomen an inverted "T" shape, telson longitudinally oval, posterior margin convex; lateral margins of 6th abdominal somite about parallel on posterior 1/3, narrowing (Fig. 1C). G1 slender, pointing anterolaterally, tapering into a fine tip; distal portion with microscopic spines on surface (Figs. 2A, B).

Distribution: Indian Ocean including Madagascar, Chinese coasts, Taiwan Strait, and western, northern, and northeastern Australia.

Remarks: Zimsen (1964) reported on the fate of Fabricius' type material: 5 surviving in the Zoological Museum, Copenhagen, Denmark and 2 in the Zoologische Museum, Kiel, Germany. We examined images of these type material (provided by PKL Ng, National Singapore Univ.). We found that our samples from Hong Kong and Taiwan were consistent with descriptions of Australian, Madagascar, and Chinese specimens (based on the G1 morphology according to Stephenson and Campbell (1959), Crosnier (1962), and Dai and Yang (1991)) but differ, at least from one of the specimens of the type series, in the morphology of the frontal teeth and relative length of the branchial teeth (9th anterolateral teeth). Our specimens also have distinctly shorter branchial spines relative to the carapace width and less-protruding median frontal teeth (Fig. 1B). Alcock (1899: 38), in his descriptions of material in the Indian Museum, also seemed to depict a form which has the "median-teeth-protruding". This suggests the "*P. hastatoides*" consists of a cryptic species complex in the Indo-Pacific region. Before any extensive revision is made of the taxonomy of this group of species, we will continue using the name *P. hastatoides* for Hong Kong and Taiwanese populations. "*Portunus hastatoides*" was recorded as being widely distributed in the Indo-West Pacific region (Stephenson 1972b), and the above distribution records only included literature which revealed morphological features that match our

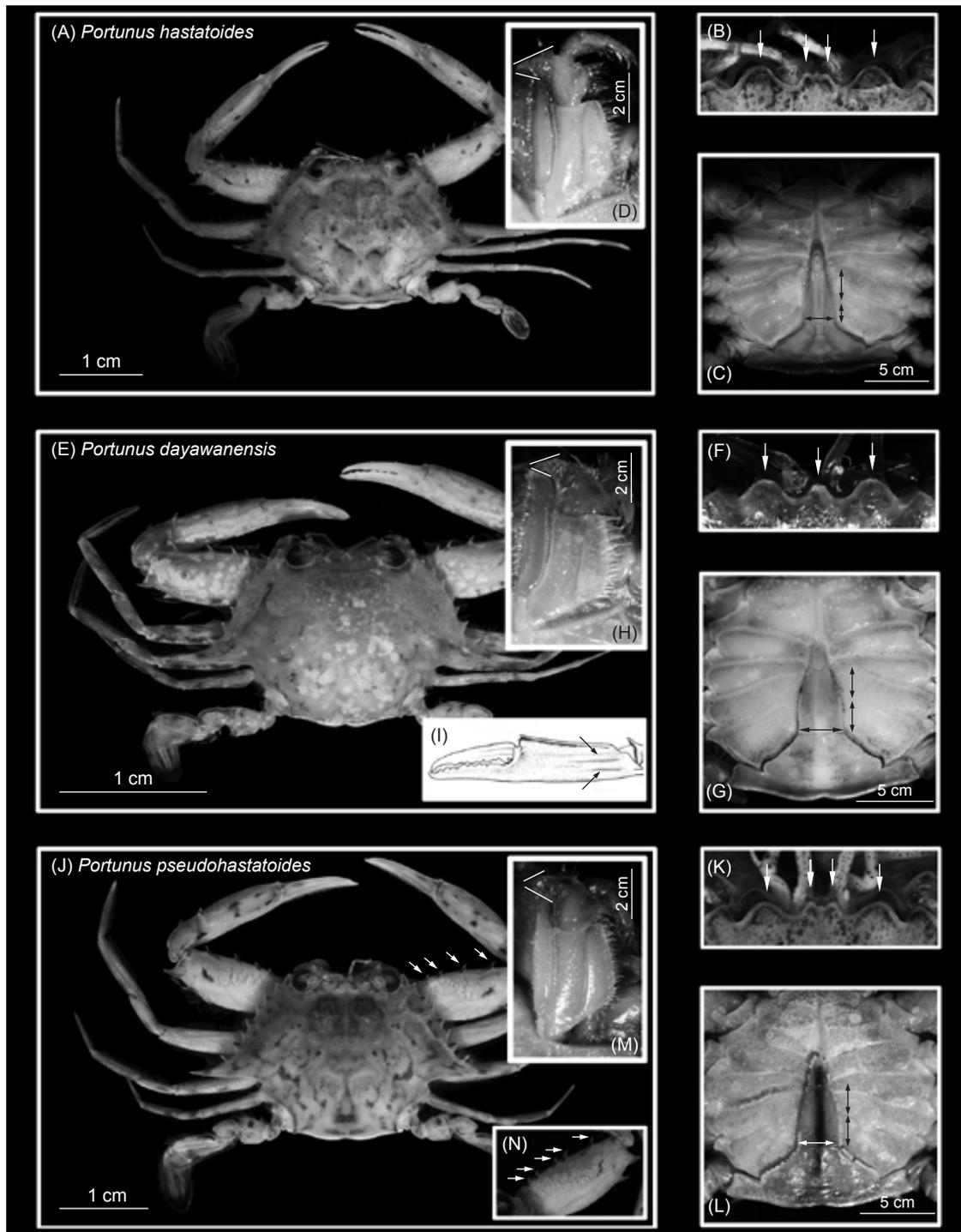


Fig. 1. *Portunus hastatooides* (from Taiwanese waters). (A) Entire animal; (B) frontal region, arrows indicate the frontal lobes; (C) male abdomen, arrows indicate the relative width of the 6th somite and ratio of the parallel lateral margins; (D) external maxilliped, with the produced anterior distal angle marked by white lines. *Portunus dayawanensis* (from Hong Kong). (E) Entire animal; (F) frontal region, arrows indicate the frontal lobes; (G) male abdomen, arrows indicate the relative width of the 6th somite and the ratio of the parallel lateral margins; (H) external maxilliped, with the produced anterior distal angle marked by white lines; (I) inner surface of right cheliped, with arrows indicating faint ridges. *Portunus pseudohastatooides* (from Taiwanese waters). (J) Entire animal, with arrows showing the number of spines on the anterior margin of the cheliped merus in “normal” individuals; (K) frontal region, with arrows indicating the frontal lobes; (L) male abdomen, with arrows indicating the relative width of the 6th somite and the ratio of the parallel lateral margins; (M) external maxilliped, with the produced anterior distal angle marked by white lines; (N) unusual cheliped merus with 5 spines on the anterior margin.

specimens from the Taiwan Strait.

***Portunus dayawanensis* Chen, 1986**

(Figs. 1E-I, 2C, D)

Portunus dayawanensis Chen 1986: 84, fig. 1.

Portunus (Xiphonectes) dayawanensis Ng et al. 2008: 152.

Material examined: Tolo Channel, Hong Kong Aug. 2007: 16 ♂♂, 15 ♀♀; Dec. 2007: 141 ♂♂, 29 ♀♀ (CELRC).

Diagnosis: Small species (maximum 3-4 cm in carapace width), dorsoventrally flattened, carapace surface bare, without ridges on gastric region; 3 rounded frontal lobes, 4 spines on anterior border of cheliped merus, inner surface of palm with faint ridges but no rows of setae. Dull brownish-yellow when alive, and no dark circular spot on dactyli of swimming legs.

Description: Carapace dorsoventrally flattened, dorsal surface covered with small granules, slightly tomentose or naked; regions moderately well defined, mesogastric, cardiac,

protobranchial, mesobranchial, and lateral and median postcardiac regions elevated, each separated by grooves; metagastric region slightly depressed; slightly larger granules irregularly distributed on gastric regions and behind orbits; faint ridge of granules aligned along epibranchial region towards epibranchial tooth (Fig. 1E); front armed with 3 rounded lobes excluding inner supraorbital teeth, median slightly less-pronounced than laterals (Fig. 1F); orbit with 2 fissures on posterior margin; anterolateral margin armed with 9 distinct teeth, anterior 4 slightly smaller than preceding 4; epibranchial teeth straight, longest, directed sideways, more prominent than preceding 8; anterolateral border fringed with plumose setae; posterolateral and posterior borders acute, armed with small but conspicuous spine (Fig. 1E). Length of merus of external maxilliped shorter than ischium; anterior distal angle of merus produced forming a triangle; external maxilliped fringed with setae, longer and stiffer in inner margins than that outer margin of exopod (Fig. 1H).

Chelipeds slightly unequal, right larger than

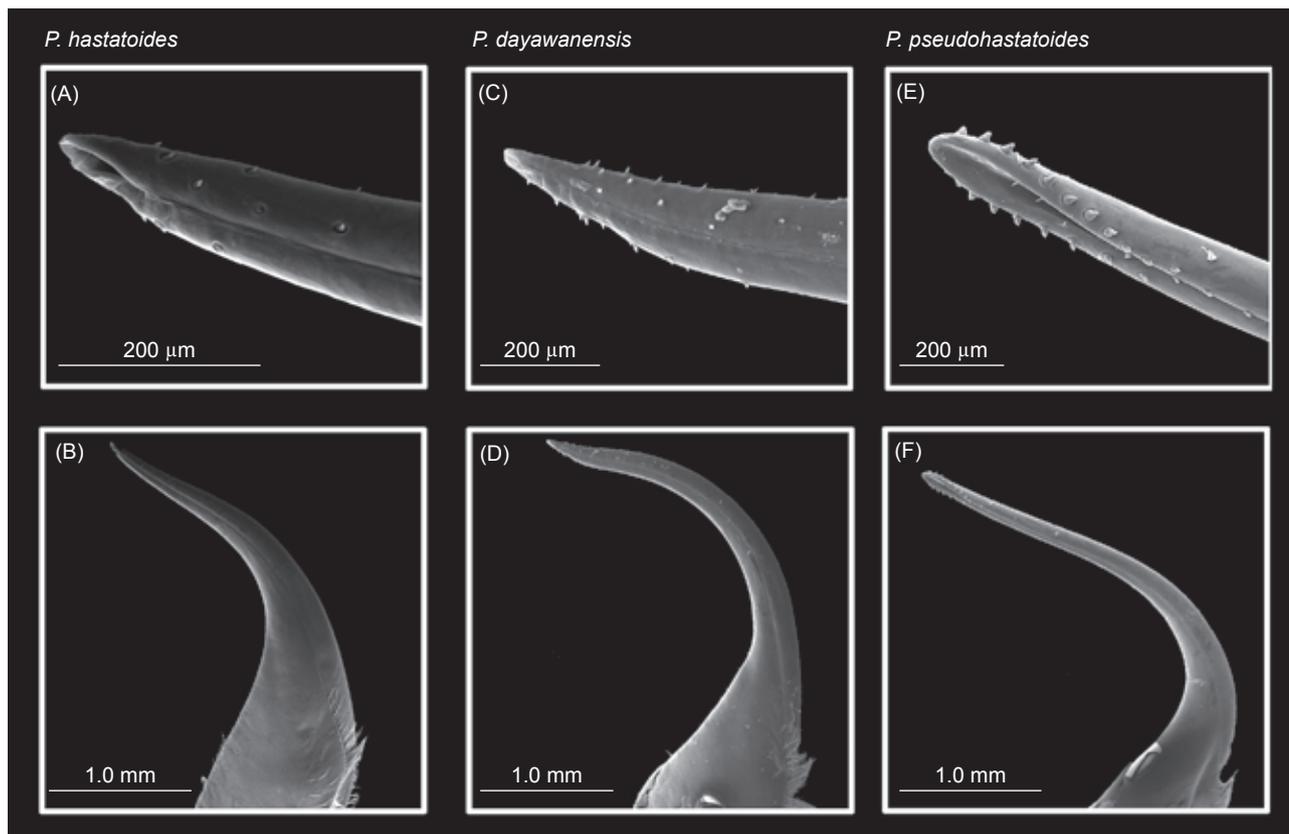


Fig. 2. *Portunus hastatooides* (from Taiwanese waters). Ventral view of tip of G1 (A); ventral view of G1 (B). *Portunus dayawanensis* (from Hong Kong waters). Ventral view of tip of G1 (C); ventral view of G1 (D). *Portunus pseudohastatooides* (from Taiwanese waters). Ventral view of tip of G1 (E); ventral view of G1 (F).

left (Fig. 1E); anterior margin of merus armed with 4 sharp teeth, 3 on inner 1/2 and remainder near distal end; posterior margin with 2 teeth, 1 on distal 1/4 and the other at distal end; anterior and posterior margins fringed with short, plumose setae; carpus armed with 2 teeth, 1 on outer surface and the other in inner angle and 3 indistinct ridges composed of rows of tubercles; palm slightly longer than fingers; outer, dorsal margin of palm defined by 2 elevated ridges composed of tubercles, extending from base of fingers to carpus, inner ridge lined with inconspicuous row

of short setae, armed with small teeth on distal end; inner surface of palm with 2 faint ridges; tips of fingers curved inwards, pointed (Fig. 1I). All ambulatory legs compressed, fringed with setae on ventral edge on all segments (Fig. 1E); last with longer setae, that on anterior border of merus longer, plumose; posterodistal border of merus of last ambulatory leg armed with a series of small teeth, among which 3 or 4 dentiform; posterior margins of carpus, merus, and dactylus unarmed; propodus, dactylus flattened, fringed with plumose setae.

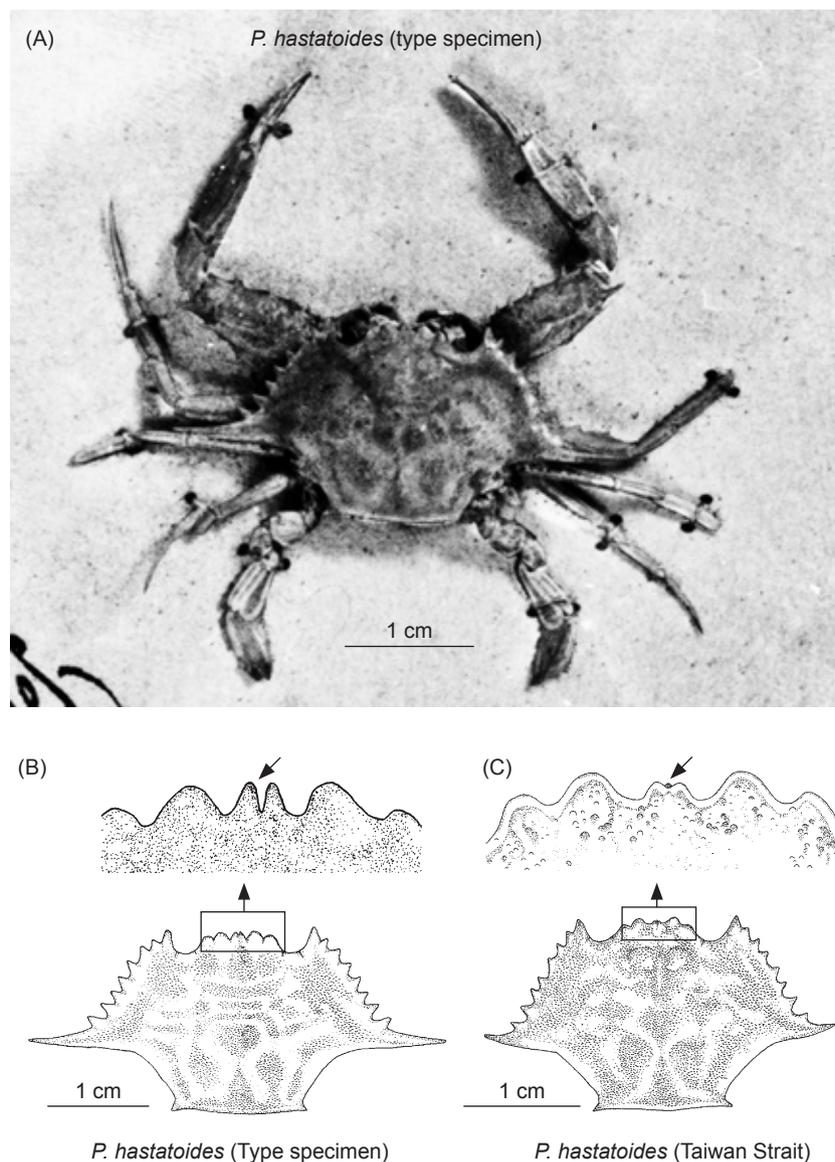


Fig. 3. (A) One of the types of *Portunus hastatooides* Fabricius, 1798 lodged in the Zoological Museum, Copenhagen, Denmark (photo courtesy Peter K.L. Ng). (B) Carapace of one of the type materials of *P. hastatooides* (Zoological Museum, Copenhagen, Denmark); insert shows a magnified view of the frontal teeth. (C) Carapace of *P. hastatooides* (Taiwan Strait); insert shows a magnified view of the frontal teeth. Arrows indicate morphological variations in the shape and size of the frontal teeth.

Male abdomen an inverted "T" shape, telson ovate, narrow, longer than broad, lateral margins convex, "egg-like"; 6th abdominal somite longer than broad, lateral margins convex, posterior margin twice length of anterior margin; 3rd-5th somites fused (Fig. 1G). G1 long, slender, strongly curved outwards, tapering with very small spines on distal end (Figs. 2C, D).

Distribution: Present records only cover Sanmen I., Daya Bay (= Dayawan), Guangdong, China (type locality), and Tolo Harbour, Hong Kong.

Remarks: Specimens examined in the present study were collected in Hong Kong, which is very close to the type locality, Daya Bay, China. The present specimens identified as *P. dayawanensis* agree well with the morphological description in Chen (1986), notably the absence of ridges on the gastric regions of the carapace, the posterodistal border of the carpus of the swimming leg lacking spines, and the inner surface of the cheliped palm lacking rows of setae, although specimens preserved in alcohol which appear naked may have a very fine layer of omentum, especially when observed under light microscopy. *Portunus dayawanensis* is a new record for Hong Kong, and it was absent from trawl samples conducted in Taiwan waters (collections in the NMNS).

***Portunus pseudohastatoides* Yang and Tang
2006**

(Figs. 1E-N, 2E-F)

Portunus pseudohastatoides Yang and Tang 2006: 691, figs. 1, 2.

Portunus (Xiphonectes) pseudohastatoides Ng et al. 2008: 152.

Portunus hastatoides Yu 1979: 48, fig. 5.

Portunus hastatoides Huang and Yu 1997: 68 (in part).

not *Portunus hastatoides* Stephenson and Campbell 1959: 101, figs. 2d, 3d, pls. 1(4), 4d, 5d. Crosnier 1962: 68, figs. 109, 122, 123. Dai and Yang 1991: 216, fig. 114(2), pl. 26(3).

Material examined: Hong Kong: Lantau I. Dec. 2007: 1 ♂ (CELRC). NE Taiwan: Daxi, Ilan Co. 8 Jan. 1991: 1 ♂ (NTOU); 5 June 1991: 1 ♂, 2 ♀♀ (NTOU); 8 Nov. 1991: 2 ♂♂, 3 ♀♀ (NTOU); 24 Oct. 1992: 1 ♂ (NTOU); NW Taiwan: Hsinchu Co. 8 July 1995: 24 ♂♂, 21 ♀♀ (NMNS 002129-00032); 19 Sept. 1994: 1 ♂, 1 ♀ (NMNS 002129-00080); 2 Nov. 1994: 1 ♂ (NMNS 002129-00079); 18 Jan. 1995: 1 ♀ (NMNS 002129-00031); Wuci, Taichung Co. 3 Oct. 1994: 34 ♂♂, 19 ♀♀ (NMNS 002129-00017); 14 May 1995: 8 ♂♂, 5 ♀♀ (NMNS 002129-00069); 3 Oct.

1994: 29 ♂♂, 18 ♀♀ (NMNS 002129-00018); 3 Oct. 1994: 10 ♂♂, 7 ♀♀ (NMNS 002129-00041); 22 Mar. 1995: 5 ♂♂, 1 ♀ (NMNS 002129-00040); 3 Oct. 1994: 1 ♂ (NMNS 001983-00007); Taichung Harbor, Taichung City 23 Nov. 1994: 29 ♂♂, 29 ♀♀ (NMNS 002129-00020); outer Taichung Harbor, Taichung City 5 Apr. 2004: 1 ♂, 2 ♀♀ (NMNS 004655-00098); 5 ♂♂, 4 ♀♀ (NMNS 004368-00042); 24 Apr. 2004: 1 ♂, 2 ♀ (NMNS 004655-00092). W Taiwan: Bojailiao, Yunlin Co. 21 Apr. 1995: 42 ♂♂, 59 ♀♀ (NMNS 002129-00004); 29 Aug. 1994: 11 ♂♂, 4 ♀♀ (NMNS 002129-00043); 40 ♂♂, 54 ♀♀ (NMNS 0002129-00002); 17 Feb. 2004: 8 ♂♂, 13 ♀♀ (NMNS 004655-00076); 24 May 1995: 7 ♂♂, 17 ♀♀ (NMNS 002129-00044); 17 Sept. 1995: 2 ♀♀ (NMNS 002433-00056); 14 Sept. 1994: 1 ♂, 1 ♀ (NMNS 002433-00055); 17 Mar. 1995: 9 ♂♂, 24 ♀♀ (NMNS 002129-00019); 14 Sept. 1994: 52 ♂♂, 19 ♀♀ (NMNS 002129-00003); 5 Feb. 1995: 38 ♂♂, 45 ♀♀ (NMNS 002129-00001); Masagou, Tainan Co. 28 June 1995: 65 ♂♂, 53 ♀♀ (NMNS 002129-00005); 24 Dec. 1994: 5 ♂♂, 18 ♀♀ (NMNS 002129-00034); 23 Mar. 1995: 18 ♂♂, 43 ♀♀ (NMNS 002129-00007); 14 Oct. 1993: 24 ♂♂, 19 ♀♀ (NMNS 002129-00009); 26 Aug. 1994: 16 ♂♂, 28 ♀♀ (NMNS 002129-00024); 14 Oct. 1993: 8 ♂♂, 9 ♀♀ (NMNS 002129-00029); 1 Aug. 1995: 4 ♂♂, 6 ♀♀ (NMNS 002129-00037); 14 Oct. 1994: 2 ♂♂, 8 ♀♀ (NMNS 002129-00028); 2 ♂♂, 6 ♀♀ (NMNS 002129-00035); 19 Nov. 1994: 1 ♂ (NMNS 002129-00062); 10 Jan. 1995: 1 ♂, 1 ♀ (NMNS 002433-00054); 14 Oct. 1994: 24 ♂♂, 30 ♀♀ (NMNS 002129-00012); 14 Oct. 1994: 37 ♂♂, 16 ♀♀ (NMNS 002129-00011); 14 Oct. 1994: 24 ♂♂, 22 ♀♀ (NMNS 002129-00010). SW Taiwan: Mituo, Kaohsiung Co. 10 Nov. 1994: 1 ♂, 4 ♀♀ (NMNS 002129-00055); 1 ♂, 2 ♀♀ (NMNS 002129-00016); Chungyun, Kaohsiung Co. 1 ♀ (NMNS 002129-00038); Taiwan Strait: Makung, Penghu 5 Sept. 1974: 1 ♀ (NTOU).

Diagnosis: Small species, dorsoventrally flattened, very slightly tomentose or naked carapace; front 4-lobed, medians narrower yet more protruding than broader laterals; posterior angle armed with spine; 4 spines on anterior border of cheliped merus. Oval-shaped, spoon-like opening on tip of G1, surrounded by at least 10 stout spines.

Description: Carapace extremely dorsoventrally flattened, dorsal surface naked or very finely tomentose; regions well defined; mesogastric, cardiac, median, and lateral post cardiac regions

elevated, separated by deep grooves; short transverse alignment of granules found on slightly raised metagastric region; postcardiac regions separated by shallow groove; mesobranchial and epibranchial regions slightly raised, more or less fused; ridge on epibranchial region extending to distal end of epibranchial spine; faint groove separating anterolateral region from epibranchial region; granule patches sparsely covering summits of raised regions (Fig. 1J). Front armed with 4 teeth excluding inner supraorbital teeth, medians acute, narrower yet extending beyond rounded, broader laterals (Fig. 1K); inner-orbital teeth triangular, lower than lateral frontal teeth; orbit with 2 small fissures on posterior margin; anterolateral border with 9 distinct teeth, 2nd-4th smaller, successive ones increasing in size; epibranchial teeth straight, longest, directed sideways; posterolateral margin arched, angle with posterior border right or acute, armed with conspicuous spine; anterolateral border fringed with plumose setae (Fig. 1J). Length of ischium of external maxilliped about 3 times of that of merus; anterodistal angle of merus strongly produced, directed laterally; margins fringed with setae, longer and stiffer in inner margins than outer margin of exopod (Fig. 1M).

Chelipeds elongated, subequal (Fig. 1J); anterior and posterior borders of merus fringed with plumose setae; 4 or unusually 5 acute teeth (Fig. 1N) on anterior border, 2 small on basal 1/4 portion, 1 or 2 in middle, and 1 on near distal end; 2 stouter teeth on distal portion of posterior border; carpus with 2 spines, 1 on outer surface and 1 in inner angle, and 3 granular ridges; dorsal surface of palm aligned with 2 longitudinal ridges, interior one fringed with row of long plumose setae extending to base of movable finger, ending with small sharp spine, other ridge on same surface less apparent; outer surface of palm with longitudinal ridges, 2nd most defined, extending from basal spine to base of fingers; 3rd to tip of immovable finger; inner surface with 1 faint longitudinal ridge; fingers slightly shorter than palm, compressed, with small interlocking serrated teeth, tips pointed, directed inwards. All ambulatory legs compressed, fringed with setae on ventral edge on all segments (Fig. 1J); posterodistal edge of merus of last ambulatory leg fringed with row of small teeth, with 2 or 3 on distal angle more produced, dentiform; propodus, dactylus flattened, fringed with plumose setae, unarmed.

Male abdomen an inverted "T" shape, telson longer than broad, basal border convex, triangular,

with angles rounded; 6th somite longer than broad, lateral borders convex, posterior border roughly 1.5 times as long as anterior; lateral margins about parallel on posterior 1/2 and narrowing to front; 3rd-5th abdominal somites fused, but transverse grooves still visible (Fig. 1L). G1 slender, curving strongly outwards, tapering towards tip. End with oval, spoon-shaped opening, fringed with 10-12 evenly-spaced stout pointed teeth (Figs. 2E, F).

Distribution: Guangxi, Guangdong (South China: type locality), Hong Kong, west coast (Taiwan Strait) and northeastern Taiwan.

Remarks: The typical G1 with spine-surrounded opening (*P. pseudohastatooides*) was illustrated in Yu (1979) based on Taiwanese specimens from Keelung, Ilan, and Penghu under *P. hastatooides*, but apparently overlooked the 2 extremely similar species (*P. hastatooides* and *P. pseudohastatooides*). Some material in the National Museum of Natural Science, Taichung, Taiwan, labeled "*Portunus hastatooides*" were also found to be *P. pseudohastatooides*. *Portunus pseudohastatooides* represents a new record for Taiwan. Sites where these specimens were obtained are generally located in northwestern waters of Taiwan in the Taiwan Strait. Specimens from the southwest were found to be composed primarily of *P. hastatooides*. Determining the precise distributions of the 2 species and the possible role of freshwater input as a physical barrier requires further studies. A minority of specimens have 5 spines on the anterior border of the right cheliped merus instead of the usual 4, but all other characters of that specimen match those of *P. pseudohastatooides*, suggesting that they are intraspecific variations.

DISCUSSION

On the identities of *P. hastatooides*, *P. pseudohastatooides*, *P. trilobatus*, and *P. dayawanensis*

With the addition of the records of *P. pseudohastatooides* and *P. dayawanensis*, there are now 4 morphologically similar *Portunus* species of the *P. hastatooides* species group present in the common trawl samples. Such species can be identified through the following diagnostic characters listed in the key below and the summary in table 1.

Key for identifying the 4 recorded species of *Portunus* from Taiwan and Hong Kong

Small portunid crab, maximum 3-4 cm in carapace width, dorsoventrally flattened. All 9 anterolateral teeth distinct, last longest, directed sideways. Angle between posterior border and posterolateral margin angle right or acute, armed with spine. Distal anterior angle of merus of external maxilliped produced. Anterior border of cheliped merus armed with 4 teeth.

- 1a. Front 3-lobed, median slightly smaller than laterals..... (2)
- 1b. Front 4-lobed, medians distinctly smaller than laterals.. (3)
- 2a. Carapace covered with long fine setae, with ridges on gastric and branchial regions; posterodistal margin of carpus of last ambulatory leg with spines.....
..... *P. trilobatus* (not found)
- 2b. Carapace almost naked, without ridges on gastric and branchial regions; posterodistal margin of carpus of last ambulatory leg smooth *P. dayawanensis*
- 3a. Tip of G1 slender, tapering off to a fine tip; median frontal teeth less extended than laterals..... *P. hastatooides*
- 3b. Tip of G1 slender with oval-shaped opening on distal end. Opening surrounded by 10-12 spines; median frontal teeth produced beyond laterals *P. pseudohastatooides*

Variation in the presence of a dark spot on the distal end of the dactyli of the swimming legs in *P. hastatooides* sensu lato

Remarks on whether a dark spot is present on the dactyli of swimming legs of specimens were included in a number of past publications, yet opinions contrast with each other. De Man (1907) recorded Japanese specimens without this feature, and among two of Lanchester’s (1900) 6 specimens from Singapore and Malacca, the spots were absent. However, the character stays for prolonged periods even in alcohol preservation (Chopra 1935), and the presence of the spot was recorded or illustrated based on specimens

from Burma (Henderson 1893), Singapore (Shen 1937), and Japan (Sakai 1965 1976). Among our specimens from the Taiwan Strait and Hong Kong, no *P. hastatooides* or *P. dayawanensis* shows this feature, while in *P. pseudohastatooides*, the dark spot is not consistent. Specimens of *P. pseudohastatooides* with only 1 swimming leg dactylus bearing a dark spot exist. Despite this character possibly not being reliable for recognizing *P. pseudohastatooides* individuals, those recorded specimens bearing this character may possibly be *P. pseudohastatooides*, but not vice versa.

Records of *P. trilobatus* Stephenson, 1972 and *P. dayawanensis* Chen, 1986 from Hong Kong

In surveys done in northeastern waters of Hong Kong in 1977 and 2007, “*P. trilobatus*” sensu Davie (1992) was not regarded as a rare species. According to Davie (1992), “*P. trilobatus*” occupied 54.8% of the total catch (1594 of the total 2778 individuals) in abundance in Tolo Channel and surrounding waters in 1977. However, trawling surveys conducted in Dec. 2007 for the present study, found that all individuals of 170 “*P. trilobatus*” were actually *P. dayawanensis*, of the 882 decapod and stomatopod crustacean specimens obtained within Tolo Channel (Wong unpubl. data). Based on the delineation of *P. trilobatus* and *P. dayawanensis* in Chen (1986), no *P. trilobatus* was identified from the samples in the present study.

Davie (1992) in recognizing *P. trilobatus* from northeastern waters of Hong Kong stated that differences between this species and *P. hastatooides* were in “having only three frontal lobes of which the median is less prominent than the laterals” with no remarks on *P. dayawanensis*. There are many species in the Indo-West Pacific

Table 1. Diagnostic morphological characters in identifying *Portunus hastatooides*, *P. dayawanensis*, and *P. pseudohastatooides*

	<i>P. hastatooides</i>	<i>P. dayawanensis</i>	<i>P. pseudohastatooides</i>
Frontal region	4 teeth, medians narrower and less protruding than laterals	3 teeth, medians smaller	4 teeth, medians narrower, but equally or more protruding than laterals
G1	Slender, tapering into a tip without conspicuous spines	Slender, tapering into a sharp tip with small spines	Slender, curving strongly outwardly with oval, spoon-shaped opening, which is surrounded by stout spines
6th somite of male abdomen	Comparatively narrower, parallel on the posterior 1/3	Comparatively broader, parallel on the posterior 1/2	Comparatively narrower, parallel on the posterior 1/2

which also have 3 frontal teeth, although many greatly different in other characters. However, the 31 species now recognized in the subgenus *Xiphonectes* pose taxonomic problems, as many of them are not well known, including the type species (see Ng et al. 2008). In the context of the East Asian fauna, and the recent recognition of 2 species close to *P. hastatooides* by Chen (1986) and Yang and Tang (2006), the previous confusion about their identities (including by Davie 1992) is understandable. This is also true of all records of "*P. hastatooides*" from China, Taiwan, and Hong Kong by earlier workers (e.g., Sakai 1976, Dai and Yang 1991, Ng et al. 2001).

Portunus trilobatus was described from Lampong Bay, Sumatra, Indonesia (Stephenson 1972a) and subsequently reported from Malaysia, the Philippines (Stephenson 1972b), and Indonesia (Stephenson 1972a). Records of this species are scarce apart from Stephenson's papers. On the basis of the present study, the record by Davie (1992) of this species from Hong Kong and East Asia has to be excluded for the time being.

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