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Two new species of sand-bubbler crabs, *Scopimera*, from North China and the Philippines (Crustacea: Decapoda: Dotillidae)

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Abstract

Two undescribed species of *Scopimera* are herein described. *Scopimera sheni* **sp. nov.** from Qingdao, represents the fourth species of the genus to be recognized from North China. *Scopimera philippinensis* **sp. nov.** is the first record of the genus from the Philippines. Morphologically both new species belong to the "normal form" *Scopimera* (*sensu* Kemp 1919). Amongst other characters, each can be distinguished by its diagnostic male first gonopod. Mitochondrial cytochrome oxidase I (COI) gene sequences showed two distinct clades. An East Asia group (Chinese coasts, Japan, Korea and Taiwan) consisting of *S. globosa* De Haan, 1835, *S. ryukyuensis* Wong, Chan et Shih, 2010, *S. sheni* **sp. nov.**, *S. longidactyla* Shen, 1932 and *S. curtelsona* (= *S. cutelsoma*) Shen, 1936; and a Southeast Asia group consisting of the closely related *S. philippinensis* **sp. nov.** and *S. intermedia* Balss, 1934. A dichotomous key is provided for all "normal forms" of *Scopimera* species.

Key words: Brachyura, Dotillidae, *Scopimera*, taxonomy, new species, mitochondrial cytochrome oxidase I gene, COI

Introduction

Sand bubbler crabs of the genus *Scopimera* De Haan, 1833, are common and widespread on soft shores in the Indo-West Pacific region (Kemp 1919; Miyake 1983). Ecologically they play an important role as deposit feeders and bioturbators, and have been shown to affect the productivity of sandy shores (e.g., *S. globosa* De Haan, 1835: Yamaguchi & Takana 1974; *S. crabricauda* Alcock, 1900: Clayton & Al-Kindi 1998). At present there are 14 species in the genus (see Ng *et al.* 2008; Wong *et al.* 2010).

De Haan (1833) established *Scopimera* as a subgenus of *Ocypode* based on the Japanese specimens obtained by von Siebold, although the type species *Ocypode* (*Scopimera*) *globosa* De Haan, 1835 was only officially described two years later (see Yamaguchi & Baba 1993). Seven species have been recorded from the Northwest Pacific and Southeast Asia regions: *S. sigillorum* Rathbun, 1914, *S. bitympana* Shen, 1930, *S. longidactyla* Shen, 1932, *S. intermedia* Balss, 1934, *S. curtelsona* Shen, 1936 (= "*S. curtelsoma*", see Remarks under *S. philippinensis* **sp. nov.**), *S. gordonae* Serène & Moosa, 1981 and *S. ryukyuensis* Wong, Chan et Shih, 2010, (see also Kemp 1919; Serène 1968; Serène & Moosa 1981; Dai & Yang 1991; Ng & Davie 2002; Ng *et al*. 2008; Wong *et al*. 2010). Kemp (1919, p. 311) considered the genus to consist of four morphological groups, with his "normal form" characterized by: 1) the external maxilliped merus no larger than the ischium; and 2) the inner surface of the cheliped and ambulatory meri each possessing a single, entire tympanum. This "normal form" group, includes *S. globosa*, *S. pilula* Kemp, 1919, *S. longidactyla*, *S. intermedia*, *S. curtelsona* and *S. ryukyuensis*, and is largely endemic to the East and Southeast Asian regions, except for *S. pilula* which is found around the Gulf of Bengal and Phuket, Thailand (Kemp 1919; Ng & Davie 2002).

Here we describe two new "normal form" *Scopimera* species, one from Qingdao, Shandong Province, China, and the other from Panay Island (I.), the Philippines (the latter was first found in the collections of the National Museum of Nature and Science, Tokyo (NSMT)). In addition to their distinctive morphological characters, their mitochondrial cytochrome oxidase I (COI) sequences also show clear differences with congeners. A new dichotomous key is also provided to help identify all species in the "normal form" group.

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Material and methods

Sampling sites. Samples were collected in Qingdao, China (June, 2010) and in Iloilo, Panay I., the Philippines (December, 2009). All field-collected specimens were preserved in 95% ethanol upon capture. Holotypes and paratypes were deposited in the National Museum of the Philippines, Manila, the Philippines (NMCR); NSMT; Institute of Oceanography, Chinese Academy of Sciences, Qingdao, China (IOASQ); the Zoological Reference Collection of the Raffles Museum, Singapore (ZRC); National Museum of Natural Science, Taichung, Taiwan (NMNS); the Zoological Collections of the Department of Life Science, National Chung Hsing University, Taichung, Taiwan (NCHUZOOL); and the reference collection of Coastal Ecology Laboratory, Academia Sinica, Taipei, Taiwan (CEL). Comparative material studied, including morphologically similar *S. curtelsona* and *S. globosa*, belong to collections of the ZRC and CEL.

Morphological examinations. The external morphology was examined under a stereomicroscope. Detailed studies of the male first pelopod (G1) were conducted under a compound light microscope and scanning electron microscope (SEM). G1s photographed were air dried, gold coated prior to SEM studies (SEM model: FEI Quanta 2000). The abbreviations CW and CL stand for carapace width and carapace length, respectively.

Molecular analysis. Sequences of the mitochondrial COI gene (658 basepairs (bp)), were obtained following the method described by Wong *et al*. (2010), from three specimens from Panay I., five specimens from Qingdao, and four specimens of *S. curtelsona* from Wenchang, Hainan. Sequences were deposited in the DNA Data Bank of Japan (DDBJ) database, with the accession numbers for *S. philippinensis* **sp. nov.** (CEL-Sco-Phi-001): AB557974, *S. sheni* **sp. nov.** (CEL-Sco-Qingdao-003): AB600940–AB600941, and *S. curtelsona* (CEL-Sco-Hainan-001): AB557970–AB557973. These sequences were compared and analyzed with those from *S. bitympana*, *S. globosa*, *S. intermedia*, *S. longidactyla*, *S. ryukyuensis* and *Dotilla wichmanni* De Man, 1892 previously obtained by Wong *et al*. (2010). The best-fitting model for sequence evolution of the COI dataset was determined by MrModeltest (vers. 2.2, Nylander 2005), selected by the AIC (Akaike information criterion), and was subsequently applied to maximum likelihood (ML) and Bayesian inference (BI) analyses. A maximum parsimony (MP) tree was constructed using the PAUP* program (vers. 4.0b10, Swofford 2003) with 2000 bootstrap reiterations of a simple heuristic search, TBR (tree bisection-reconnection) branch-swapping, and 100 randomly added sequence replications. All characters were equally weighted. The ML analysis was also calculated by PAUP* with 1000 bootstrap replications with the same parameters as in the MP analysis. The BI analysis was performed with MrBayes (vers. 3.1.1, Ronquist & Huelsenbeck 2003) with 4 independent runs. The search was run with 4 chains for 10^7 generations, with trees being sampled every 1000 generations (the first 1000 trees were later discarded as the burn-in). The bp difference and pairwise estimates of Kimura 2-parameter (K2P) distance (Kimura 1980) for inter- and intraspecific genetic diversities were also calculated by PAUP*.

Results

Systematic account

Family Dotillidae Stimpson, 1858

Scopimera De Haan, 1833

Scopimera sheni sp. nov.

(Figs. 1a–e, 2a–b, 3a–b, 4)

Material examined. HOLOTYPE: ♂ (IOASQ-MBM-188711), 36°26'18.565N 120°43'44.186E, "Tai Hu Bay", Qingdao, China, 19 Jun 2010, coll. H.-T. Shih. PARATYPES: 1♂1♀ (IOASQ-MBM-188712), data same as holotype; 1♂2♀♀ (NMNS-6496-001), data same as holotype; 1♂2♀♀ (ZRC 2010.0367), data same as holotype; 2♂♂2♀♀ (NCHUZOOL 13385), data same as holotype; 5♂♂6♀♀ (CEL-Sco-Qingdao-003), data same as holotype.

Comparative material. *Scopimera globosa*: 39 individuals (ZRC 2002.0498), Qingdao, China, 22 Aug 2002, coll. P.K.L. Ng & H.-L. Chen; 10♂♂2♀♀ (CEL-Sco-Japan-001), Wakayama, Japan, 7 Aug 2008, coll. B.K.K. Chan; 9♂♂9♀♀ (CEL-Sco-Qingdao-001), Yellow Island (= Huangdao), Qingdao, China, Jun 2010, coll. B.K.K. Chan.

Diagnosis. Carapace globular, broader than long, surface generally smooth (Figs. 1a, 4); external maxilliped merus slightly smaller than ischium, joint oblique (Fig. 1b); molar along cutting edge of cheliped dactylus absent (Fig. 1c). G1 slender, distal end bent conspicuously into right angle, densely covered by brush of long setae (Fig. 2a–d).

Description. Carapace thick, globular, broader than long, surface generally smooth except for sparsely spaced, rounded tubercles on expanded branchial regions, faintly along lateral margin of front near base of orbits; regions faintly defined (Figs. 1a, 4). External orbital angle triangular, pointed; notch behind external orbital angle comparatively obtuse, followed by posteriorly diverging ridges on both sides, extending approximately 2/3 of carapace length, fringed with soft, plumose setae (Fig. 1a). Sub-orbital ridge lined with about 20 rounded, equal-sized granules, pterygostomian region densely covered with granules of same size. External maxillipeds bulging, merus slightly smaller than ischium, joint oblique; surface generally smooth except for rounded granules along groove running along upper external margin of merus (Fig. 1b).

Chelipeds roughly equal in size, covered with rounded, flattened granules; merus triangular in cross-section, with single longitudinal tympanum each on internal, external surfaces, upper margin sparsely fringed with dark-colored bristles; carpus elongated, rhomboidal; palm as long as fingers; fingers compressed, tapering into pointed tips, soft, dark-colored bristles lined along weak median ridge on outer surface of fingers, internal edges weakly serrated, tooth along inner margin of dactylus very inconspicuous or absent (Fig. 1c).

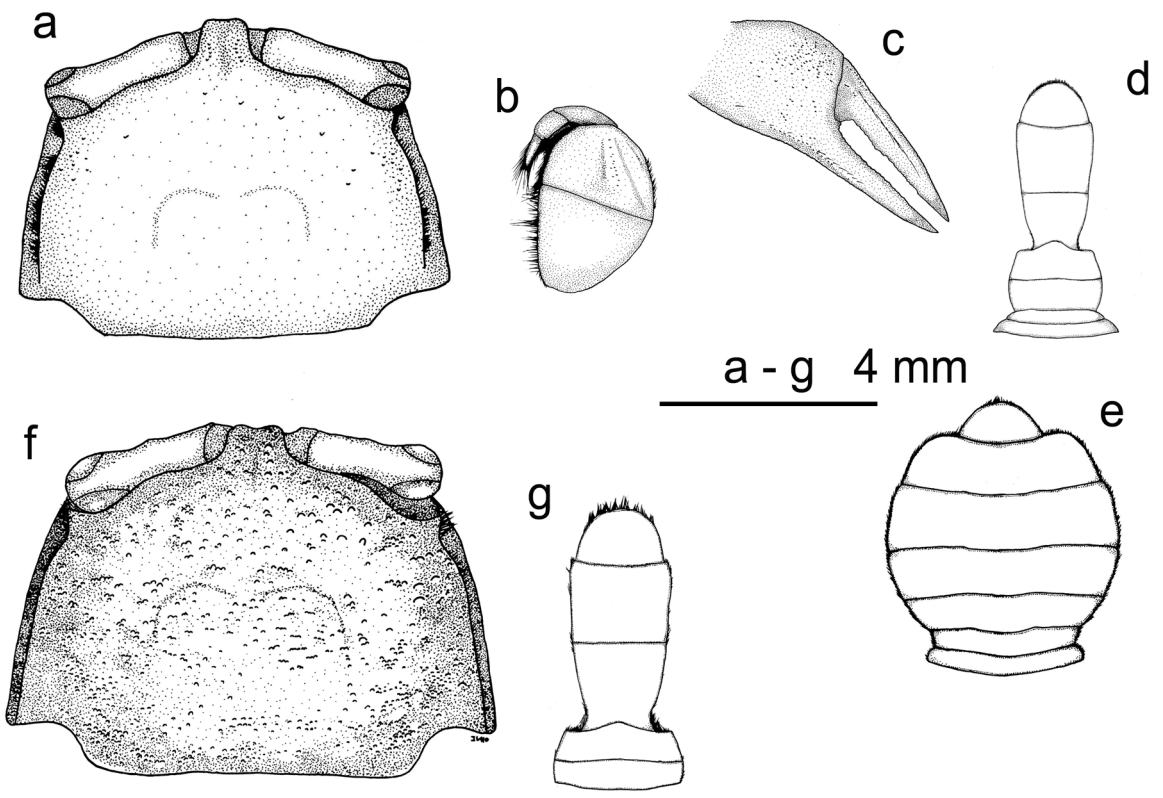

FIGURE 1. *Scopimera sheni* **sp. nov.**: (a) dorsal surface of carapace; (b) left external maxilliped; (c) right chela; (d) male abdomen; (e) female abdomen. *Scopimera globosa* De Haan, 1835: (f) dorsal surface of carapace; (g) male abdomen.

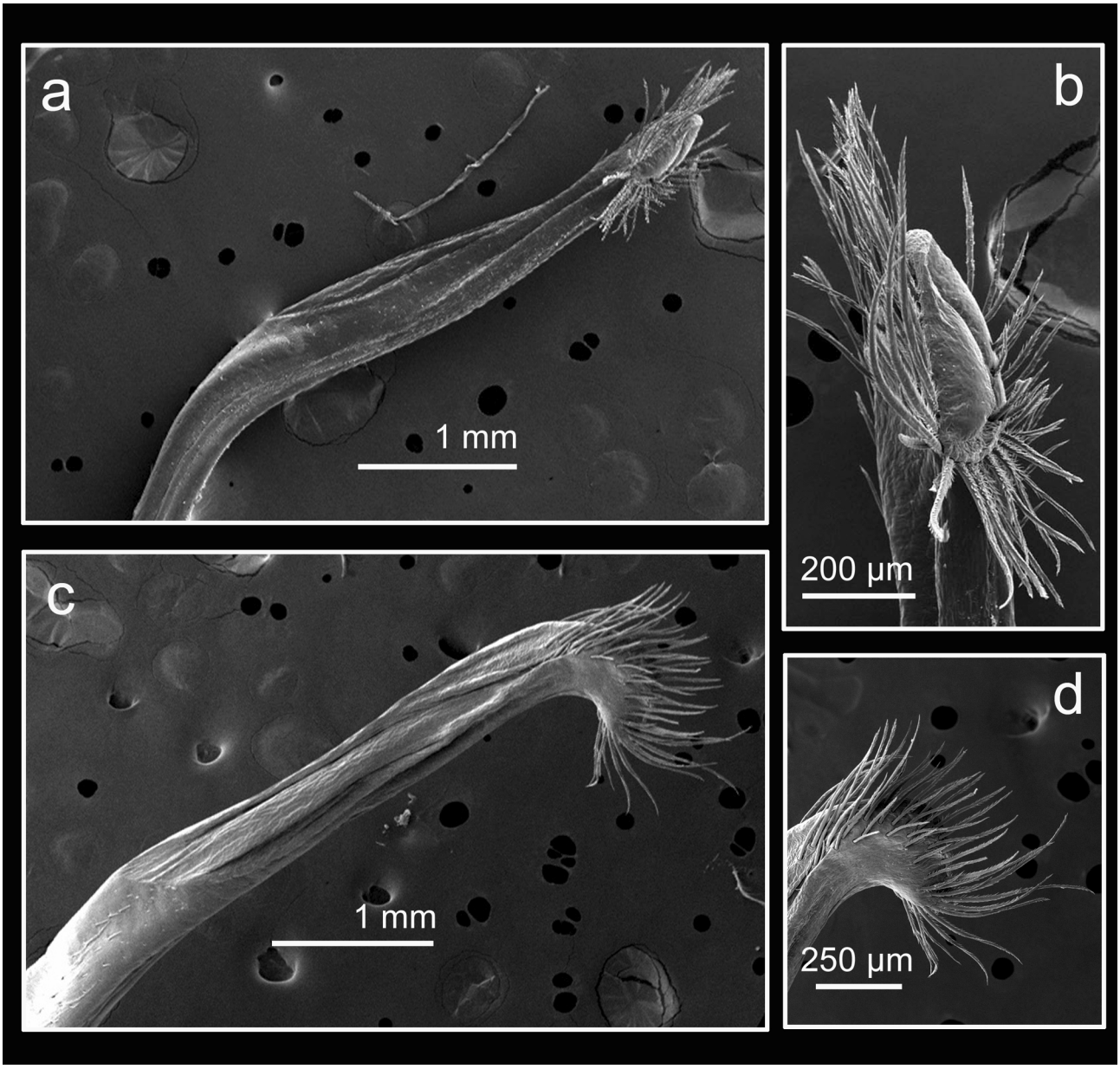

FIGURE 2. G1 of *Scopimera sheni* **sp. nov.**: (a, b) inner-lateral view; (c, d) ventral view.

Ambulatory legs slender; first, second longest, subequal in length, fourth shortest; meri extremely compressed, single tympanum occupying most of the segment; propodi, respective dactyli similar in length; dactyli taper to sharp tips, first to third curved inwards, fourth outwards (Fig. 4). Dark bristles along both margins of ambulatory meri, carpi, propodi, dactyli, denser along margins of meri, carpi, propodi of first to third (Fig. 4).

Male abdomen slender, elongated; telson semi-circular, slightly broader than long; sixth somite longer than broad, distal margin slightly broader; fifth somite longer than broad, base constricted, proximal margin concavely rounded; fourth somite much broader than long (Fig. 1d). Female abdomen broad, circular; telson as small semi-circle, somites 6–3 broad, fifth broadest (Fig. 1e). Male G1 slender, recurved upwards (Fig. 2a), tapering to fine tip, distal portion conspicuously bent inwards and slightly upwards almost at right angle, upper and outer margin lined with brush of light-colored setae, longer along distal portion and around opening (Fig. 2a–d).

Size. CW 7.6 mm, CL 6.0 mm for the holotype male (Fig. 4).

Coloration. In general yellowish gray when alive, carapace mottled with cream blots; thoracic somites whitish; cheliped carpi somewhat yellow, chelae whitish; ambulatory legs faintly decorated with brownish bands (Fig. 3a–b). Dark patch on external maxilliped meri also visible after at least 2 months of alcohol preservation.

Habitat. Burrows in the middle intertidal zone of open sandy flats.

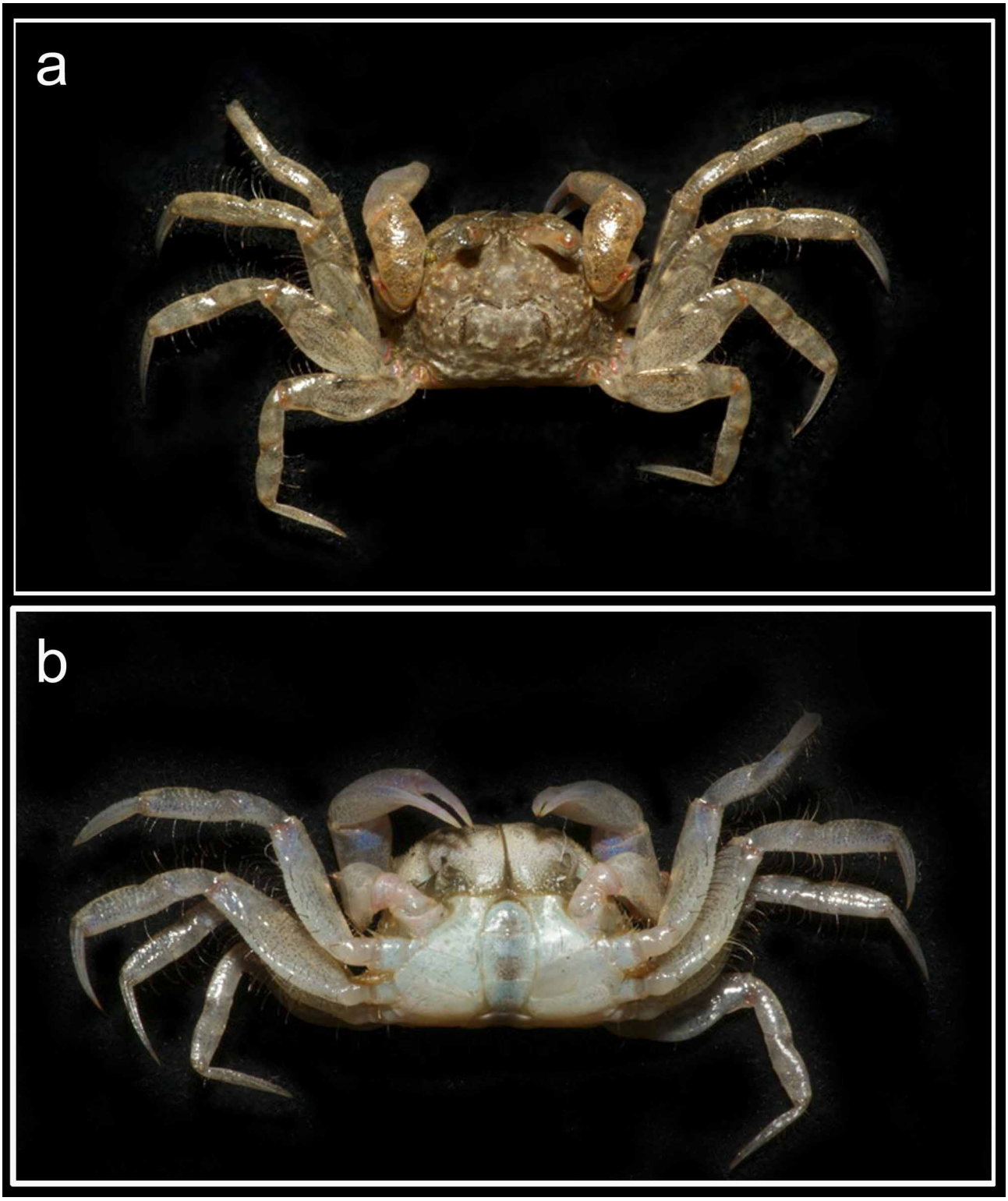

FIGURE 3. Live coloration of *Scopimera sheni* **sp. nov.**: (a) dorsal view; (b) ventral view.

Distribution. So far known only from the type locality (but see "Remarks" below).

Etymology. The new species is named after the late Dr. Jia-Rui Shen (Chia-Jui Shen), for his remarkable pioneering studies of the brachyuran fauna of China. His life-long contribution to crustacean taxonomy was undertaken during the most politically turbulent era of modern Chinese history (Dai 1997). The specific epithet is used as a noun in the genitive case.

Remarks. *Scopimera sheni* **sp. nov.** most closely resembles *S. globosa*, which is also present in North China. The two can be different carapace ornamentation, with the surface of *S. sheni* **sp. nov.** being smooth (more apparent in preserved specimens; Fig. 4) whereas that of *S. globosa* being covered with tubercles (Fig. 1a, f). The G1 is also clearly different from that of *S. globosa*: that of *S. globosa* tapers to a fine tip, the distal end is not bent, and the setae forming the brush on the inner surface are of similar length (see Shen 1932: text-fig. 157b; Sakai 1939: text-fig 106b; Dai & Yang 1991: fig. 253(2); Wong *et al.* 2010: fig. 3a–c). In *S. sheni* **sp. nov.** , the G1 is bent inward almost at a right-angle, and bears a dense brush of setae on the outer surface (Fig. 2a–d).

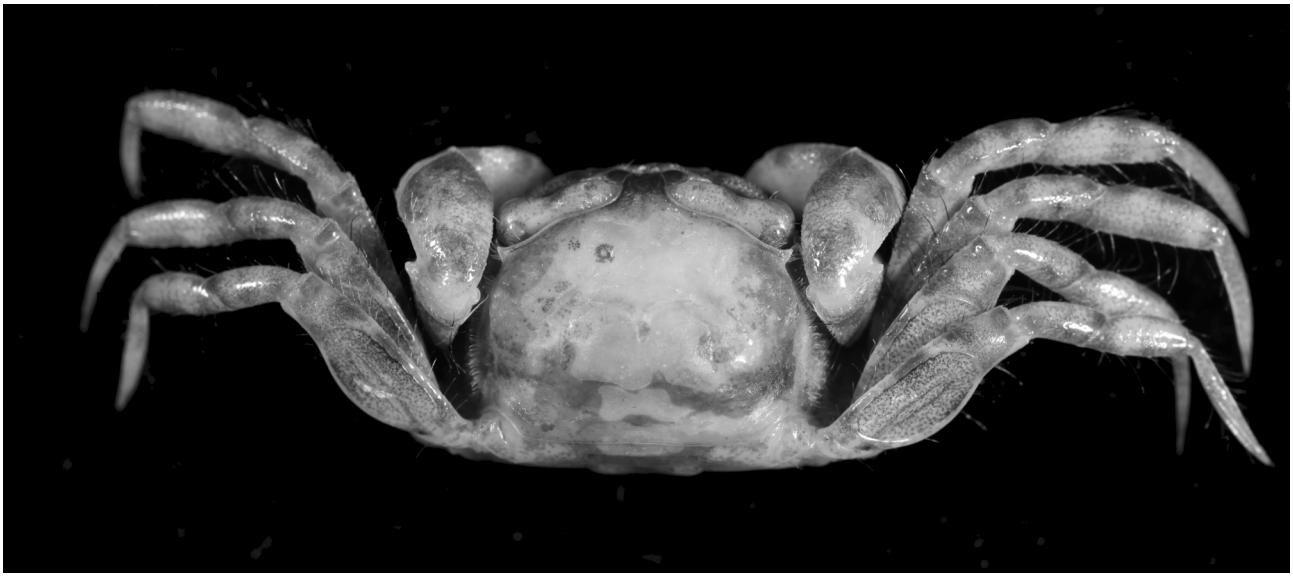

FIGURE 4. *Scopimera sheni* **sp. nov.** male holotype: CW 7.6 mm, CL 6.0 mm (IOASQ-MBM-188711).

The brachyuran fauna of North China was extensively studied and reviewed by Shen (1932), who reported 3 species: *S. globosa*, *S. bitympana* and *S. longidactyla*. A record of "*S. tuberculata*" was also added to Shen's (1937) checklist of North China Brachyura, apparently following his recognition of nine male specimens from Peichihli (= Bohai) Bay, and a large number of specimens from South China as "*S. tuberculata*" (see Shen 1935). Shen's South China "*S. tuberculata*" have subsequently been correctly identified as *S. intermedia* Balss, 1934 (see Wong *et al.* 2010); *S. tuberculata* Stimpson, 1858 was also therein regarded as a subjective junior synonym of *S. globosa*. Shen's (1935, 1937) "*S. tuberculata*" material from North China has so far not been found, and therefore its identity is still uncertain

Material examined from Qingdao, also contains specimens of *S. globosa*, *S. bitympana* and *S. longidactyla*; however, none of these three species are endemic to North China: *S. globosa* is found from Japan to Korea and North China; *S. longidactyla* from North China, and the coasts of Korea and Taiwan; and *S. bitympana* from Korea, along the Chinese coast from Shandong to Hainan, and also from Taiwan (Shen 1932; Sakai 1939, 1976; Kamita 1941; Kim 1973; Dai & Yang 1991). Despite examining large *Scopimera* collections from Japanese waters in NMST and the National History Museum and Institute, Chiba (CBM), Japan, the present *S. sheni* **sp. nov.** has not been found, suggesting that it is absent from Japanese shores. Further studies are needed to better define the distribution of *S. sheni* **sp. nov.** along the coasts of North China and adjacent regions.

***Scopimera philippinensis* sp. nov.**

(Figs. 5a–d, 6a–b, 7a–b, 8)

Material examined. HOLOTYPE: ♂ (NMCR-28030), Iloilo, Panay I., the Philippines, 20 Nov 2009, coll. K.J.H. Wong & D.K.H. Lo. PARATYPES: 2♂♂1♀ (NSMT-Cr 16011), Villa beach, Iloilo, Panay I., Philippines, 20 Feb 2004, coll. M. Komatsu & M. Takeda; 7♂♂4♀♀ (CEL-Sco-Phi-001), data same as holotype; 2♂♂ (NMNS-6495-001), data same as holotype; 2♂♂ (NMCR-28031), data same as holotype; 2♂♂1♀ (ZRC-2010.0017), data same as holotype.

Comparative material. *Scopimera curtelsona*: 12♂♂18♀♀ (CEL-Sco-Hainan-001), Wenchang, Hainan Island, China, 2 Dec 2008, coll. K.J.H. Wong *et al*.

Diagnosis. Carapace globular, broader than long, surface generally smooth except on branchial regions (Fig. 5a). External maxilliped merus smaller than ischium, joint oblique (Fig. 5b); triangular tooth present on inner margin of cheliped dactylus (Fig. 5c). G1 slender, tip rounded, surrounded with brush of setae, among which one very long seta extends prominently (Fig. 6a, b).

Description. Carapace inflated, width at least 1.5 times as length, longitudinally arched, latitudinally cylindrical, most raised across branchial regions; surface divided by shallow grooves; longitudinal groove along front, extending 1/4 of carapace length marked; curved, rounded "M-shaped" groove surrounding anterior, lateral of cardiac region slightly shallower; surface smooth except for several sparsely distributed, rounded flat tubercles at summits of raised branchial regions (Fig. 5a). Eyes situated on elongated stalks, orbits oblique when viewed above (Fig. 5a). External orbital angle as acute triangle, not extending beyond lateral margins; ridge along lateral margins faintly defined if present (Fig. 5a). Lateral margins diverge posteriorly, distance between both external orbital angles less than that across bases of the last ambulatory legs (Figs. 5a, 8). External maxillipeds convex, merus slightly smaller than ischium, joint between which straight, oblique (Fig. 5b). Ventral surface almost entirely glabrous except dense tufts of soft setae between bases of first, second ambulatory legs; thin light-colored setae sparsely scattered around bases of appendages.

Entire cheliped covered in fine granules, total length slightly more than carapace length; merus with single longitudinal ovate tympana on proximal half of inner surface; carpus subequal to merus in length, ovate; palm as long as fingers, shorter than carpus; fingers slender, distal ends taper into sharp tips, inner margin of dactylus armed with triangular tooth, that of both fingers weakly serrated with beaded tubercles (Fig. 5c). Ambulatory legs slender, elongated, second leg longest, slightly longer than first, fourth leg shortest; each merus compressed, tympana entire, occupying most of the segment, carpus slightly shorter than propodus, dactylus tapers to sharp tip. Thin, light-colored setae very sparsely distributed along both margins of merus, posterior margins of all legs.

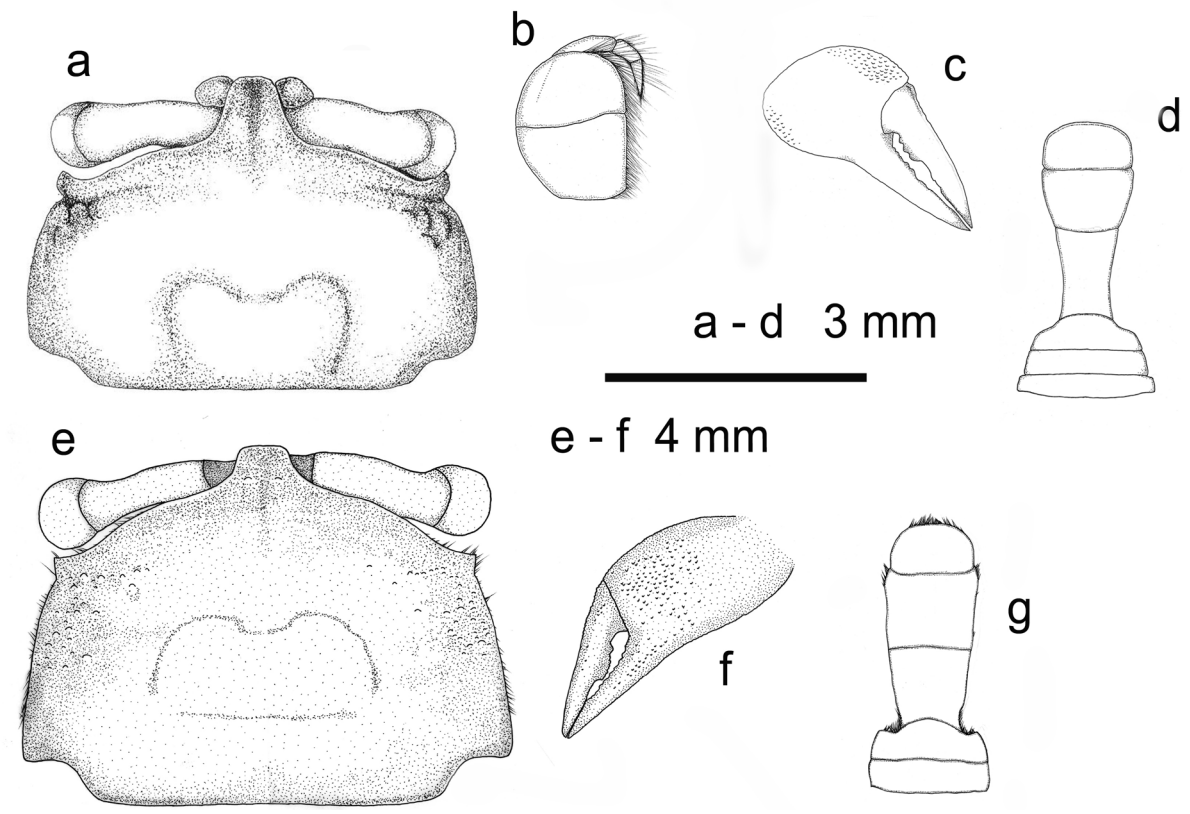

FIGURE 5. *Scopimera philippinensis* **sp. nov.**: (a) dorsal surface of carapace; (b) right external maxilliped; (c) right chela; (d) male abdomen. *Scopimera curtelsona* (= *S. curtelsoma*) Shen, 1936: (e) dorsal surface of carapace; (f) left chela; (g) male abdomen.

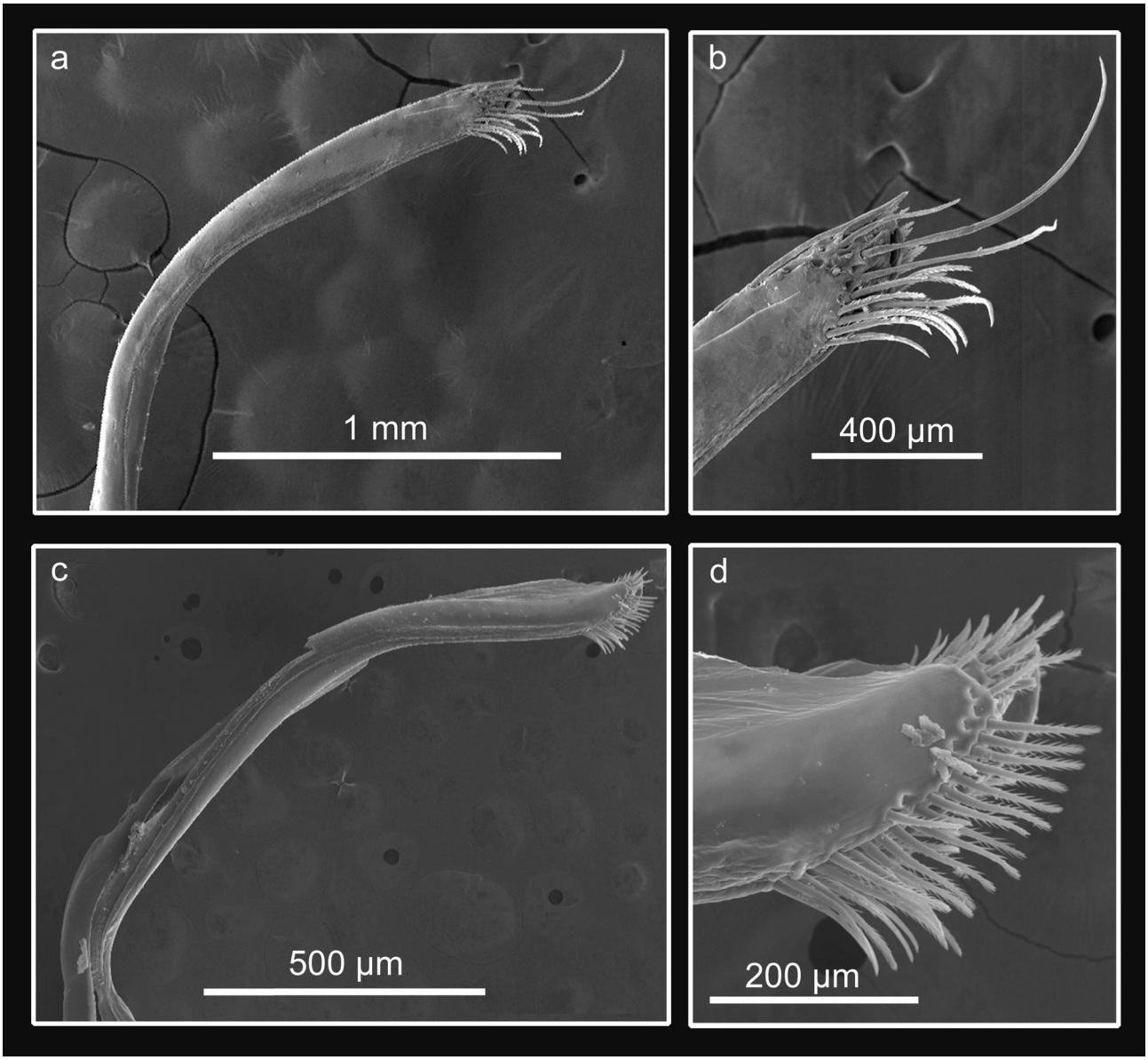

FIGURE 6. G1 of *Scopimera philippinensis* **sp. nov.** (a, b); G1 of *Scopimera curtelsona* Shen, 1936 (c, d).

Male abdomen elongated, telson distally rounded, broader than long, lateral margins subparallel on proximal half; sixth somite broader than long, distal margin longer than proximal; fifth somite longer than broad, slightly trapezoidal, proximal margin concave, approximately 2/3 as long as distal; fourth somite broad, lateral margins diverge posteriorly (Fig. 5d). G1 slender, curving dorsally, tapering to rounded tip; brush of setae near distal inner curve, among which extends a single conspicuous extremely long seta (Fig. 6a, b). Female abdomen roughly circular, telson semicircular; sixth somite distinctly broader than telson, both distal angles rounded; fifth, sixth somites with same width, broader than long, lateral borders subparallel.

Size. CW 4.3 mm, CL 3.0 mm for the holotype male (Fig. 8).

Coloration. Carapace grayish brown, faintly reddish when alive (Fig. 7a). Appendages banded with dark patches (Figs. 7a, b, 8). External maxillipeds creamish-yellow, scattered with dark and whitish dots, dark dots more concentrated on merus, creating irregular patterns (Fig. 7b). Ventral surface creamish-yellow, also sprinkled with microscopic dark and whitish dots.

Etymology. The specific epithet *philippinensis* is named after the type locality, the Philippines, denoting the discovery of this genus in the Philippines (see Remarks).

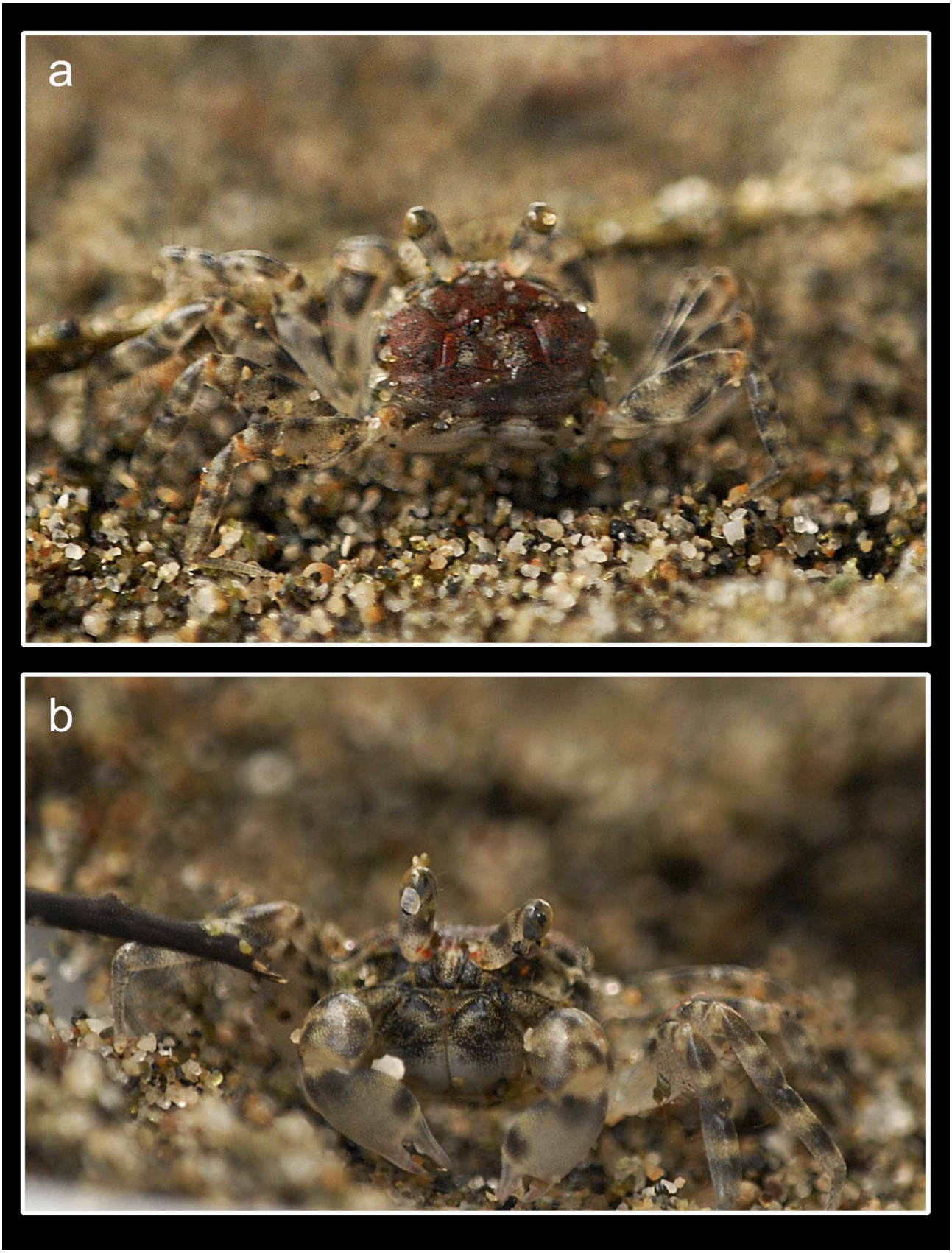

FIGURE 7. *In-situ* photograph of *Scopimera philippinensis* **sp. nov.**: (a) dorsal view; (b) frontal view. (Photo credit: D.K.H. Lo).

Habitat. The species inhabits the mid-intertidal zone of open, exposed sandy shores. Burrows are typical of *Scopimera*—a vertical, tube-like burrow, appearing as a circular hole on the surface, with radiating lines of small globular sand balls at the opening. The type locality, Iloilo, Panay I., is a semi-exposed sandy shore facing south, and had agricultural land-use directly adjacent to landward of the beach. The local distribution of the species appears to be restricted to the mouths of small streams, and often associated with polluted water. Locally *S. philippinensis* **sp. nov.** was not common, and generally neglected by local people due to their small size. The ghost crab *Ocypode ceratophthalmus* (Pallas, 1772), occurs sympatrically with *S. philippinensis* **sp. nov.**, was abundant.

Distribution. At present, only known from Iloilo, Panay I., the Philippines.

Remarks. *Scopimera philippinensis* **sp. nov.** closely resembles other "normal form" congeners, especially *S. curtelsona*, by possessing a conspicuous molar on the cutting margin of the cheliped dactylus (Fig. 5c, f) (even in small size individuals), and relatively smooth, broad carapaces (Fig. 5a, e). However it clearly differs from *S. curtelsona* by the morphology of the male abdomen and G1. For *S. philippinensis* **sp. nov.**, the sixth abdominal somite of males is distinctly broader than long, the proximal margin is much shorter, and the fifth much longer than broad, such that the entire abdomen appears "concave" along the lateral margin (Fig. 5d); while for that of *S. curtelsona*, both breadth and length of sixth and fifth abdominal somites do not markedly differs, and the lateral margins of the 2 somites combined are only slightly converging towards the proximal end (Fig. 5g). G1 morphologies of *S. philippinensis* **sp. nov.** and *S. curtelsona* are also diagnostic: the G1 of *S. philippinensis.* **sp. nov.** possesses a brush of setae near distal inner curve, among which extends a single extremely long seta (Fig. 6a, b), while that of *S. curtelsona* is fringed by short setae, that are denser and slightly longer on the inner surface (Fig. 6c, d).

Despite being commonly recorded from elsewhere across the entire region, no *Scopimera* species have been previously reported from the Philippines (Estampador 1937, 1959; Ward 1941; Serène 1968). This is especially peculiar because this area is otherwise considered to have the highest marine species biodiversity in the world (see Ng et al. (2009)). There have also been many collections made throughout the Philippines, and numerous studies have reported on the crab fauna in great detail (e.g., Garth & Kim (1983) on xanthids; Tan (1996) and Komatsu *et al*. (2004, 2005) on leucosiids; and Mendoza & Ng (2007) and Mendoza & Naruse (2009) on *Macrophthalmus*). Other much less conspicuous intertidal members of the Dotillidae have also been recorded, such as species of *Dotilla*, *Ilyoplax* and *Tmethypocoelis* (see Estampador 1959, and most recently Davie & Naruse (2010). Thus, the absence of previous records of *Scopimera* is either just an anomaly, or perhaps *S. philippinensis* **sp. nov.** is the only species present and does indeed have a very narrow range. This is a noteworthy issue that needs more research.

FIGURE 8. *Scopimera philippinensis* **sp. nov.** male holotype: CW 4.3mm, CL 3.0 mm (NMCR-28030).

After reexamining the description of *Scopimera curtelsona* by Shen (1936), we realized that this species had been commonly misspelled as *S. curtelsoma* by recent authors (e.g. Dai & Yang 1991). Shen (1936) clearly used the spelling "*curtelsona*" consistently throughout the text. The International Code of Zoological Nomenclature (1999) Article 32.3 states "The correct original spelling of a name is to be preserved unaltered, except where it is mandatory to change the suffix or the gender ending under Article 34". We thus follow this original spelling here.

DNA Analyses and Discussion

The phylogenetic tree of COI (Fig. 9), with BI, ML and MP support values, showed both *S. sheni* **sp. nov.** and *S. philippinensis* **sp. nov.** each form distinct species-level clades when compared with the other known species in East and Southeast Asia. While Fig. 9 shows *S. sheni* **sp. nov.** to be genetically closest to *S. globosa* and *S. ryukyuensis*, the relationship is only weakly supported and the true relationship cannot be considered clear. A major clade is composed of the East Asia (China, Japan and Taiwan) species, *S. globosa*, *S. ryukyuensis*, *S. sheni* **sp. nov.**, *S. longidactyla* and *S. curtelsona*. Phylogenetically *S. philippinensis* **sp. nov.** is most closely related to *S. intermedia* from Taiwan, Hong Kong and Singapore, and both species form a separate Southeast Asia clade.

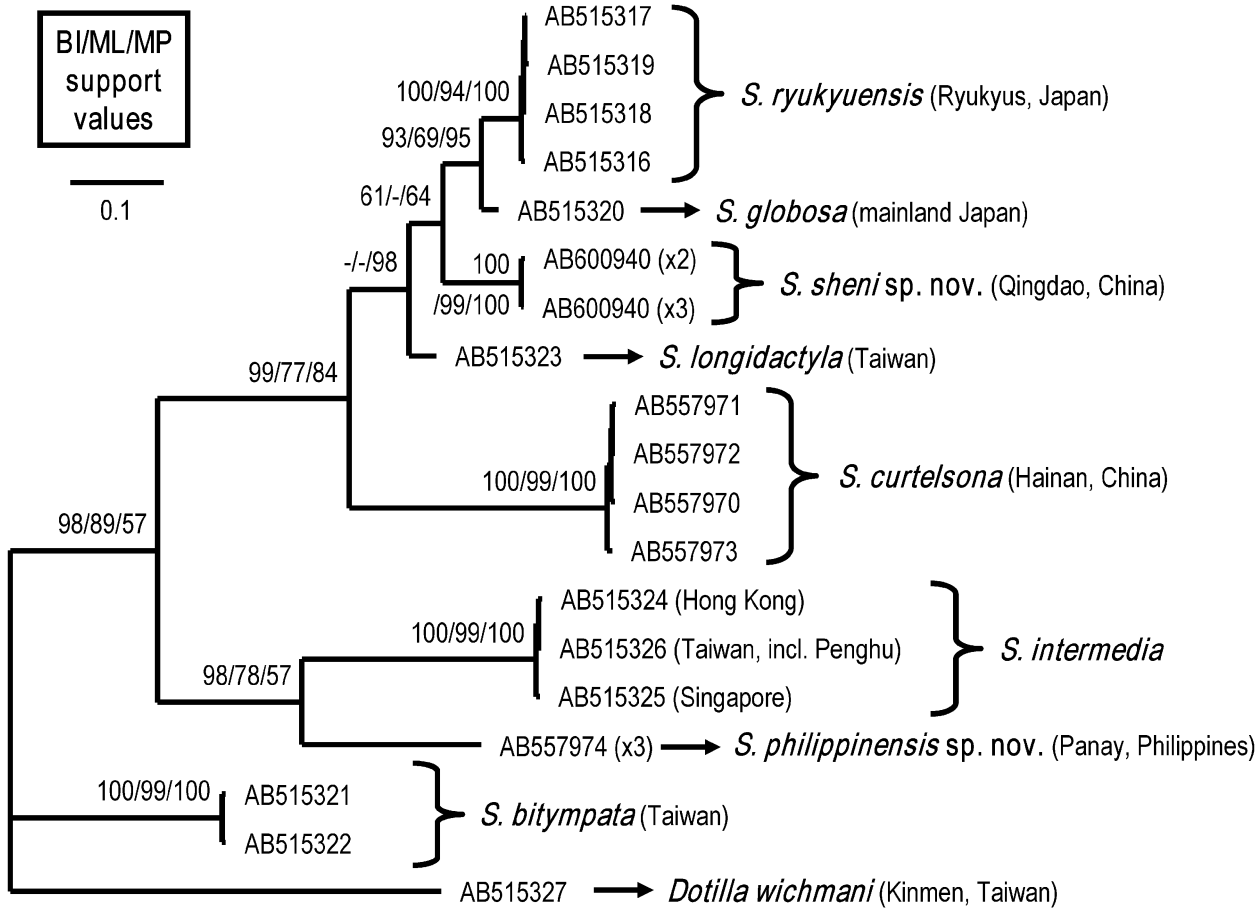

FIGURE 9. A Bayesian inference (BI) tree of the *Scopimera* species from East and Southeast Asia, based on the COI gene. Support values for BI, maximum likelihood (ML) and maximum parsimony (MP) are represented at the nodes. The haplotypes are shown as the accession numbers, with the localities and species behind.

Pairwise nucleotide divergences (K2P distance) and mean number of differences of COI within the two new *Scopimera* species and the rarer *S. curtelsona* are presented in Table 1. The five specimens of *S. sheni* **sp. nov.** include two haplotypes with one bp difference; the three specimens of *S. philippinensis* **sp. nov.** share the identical haplotype; and the four specimens of *S. curtelsona* have slightly different haplotypes with average 0.38% (0.15–0.61%) of K2P. For the interspecific divergence of K2P, *S. sheni* **sp. nov.** differs from *S. globosa* and *S. ryukyuensis* by ≥ 9.04% and ≥ 9.39%, respectively; *S. philippinensis* **sp. nov.** differs from *S. intermedia* by ≥ 16.27%; and *S. curtelsona* differs from *S. longidactyla* by ≥ 12.86%. In similar studies of intertidal crabs, the

TABLE 1. Matrix of percentage pairwise nucleotide divergences with K2P distance (lower left) and mean number of differences (upper right) based on 658 bp of COI (and value range) within and between species of genus *Scopimera* and outgroup.

	Within species		Between species								
	Nucleotide divergence	Mean nucleotide difference	*S. ryukyuensis*	*S. globosa*	*S. sheni*	*S. longidactyla*	*S. curtelsona*	*S. intermedia*	*S. philippinensis*	*S. bitympana*	*Dotilla wichmanni*
S. ryukyuensis	0.23 (0.15–0.30)	1.5 (0–2)	—	28.75 (28–29)	58.75 (57–60)	54.25 (53–55)	90.5 (89–92)	113 (111–115)	98.5 (98–99)	106.75 (106–108)	118.25 (117–119)
S. globosa	0 (0)	0 (0)	4.55 (4.43–4.59)	—	55.5 (55–56)	49 (49)	88.5 (88–90)	114 (113–115)	98 (98)	108 (107–109)	124 (124)
S. sheni	0.15 (0.15)	1 (0–1)	9.70 (9.39–9.93)	9.13 (9.04–9.22)	—	50.5 (50–51)	89.75 (88–91)	121.33 (121–122)	119 (119)	111.5 (111–112)	130 (130)
S. longidactyla	0 (0)	0 (0)	8.90 (8.68–9.04)	8.00 (8.00)	8.20 (8.12–8.29)	—	78.5 (77–80)	112.33 (112–113)	98 (98)	111 (111)	114 (114)
S. curtelsona	0.38 (0.15–0.61)	2.5 (1–4)	15.44 (15.14–15.74)	15.06 (14.77–15.36)	15.28 (14.93–15.52)	13.15 (12.86–13.43)	—	106 (104–109)	100.75 (100–102)	116.5 (115–118)	125 (124–126)
S. intermedia	0.31 (0.15–0.46)	2 (0–3)	19.76 (19.34–20.18)	19.99 (19.78–20.20)	21.56 (21.49–21.71)	19.66 (19.59–19.80)	18.30 (17.90–18.92)	—	96 (95–97)	119 (118–120)	125 (124–126)
S. philippinensis	0 (0)	0 (0)	16.78 (16.68–16.88)	16.69 (16.69)	20.90 (20.90)	16.72 (16.72)	17.24 (17.09–17.48)	16.47 (16.27–16.67)	—	104 (104)	119 (119)
S. bitympana	0.46 (0.46)	3 (3)	18.40 (18.25–18.66)	18.67 (18.47–18.87)	19.39 (19.28–19.49)	19.27 (19.27)	20.30 (19.99–20.61)	20.93 (20.72–21.14)	17.83 (17.83)	—	115 (115)
Dotilla wichmanni	0 (0)	0 (0)	20.63 (20.37–20.78)	21.82 (21.82)	23.17 (23.17)	19.73 (19.73)	22.03 (21.82–22.24)	22.03 (21.82–22.24)	20.78 (20.78)	20.05 (20.05)	—

smallest interspecific K2P divergences are often much lower then found here, e.g., *Scopimera* (e.g. *S. ryukyuensis* vs *S. globosa*: 4.43%, Wong *et al*. 2010), *Uca* (*U. iranica* vs *U. albimana*: 11.91%, Shih *et al*. 2009; *U. jocelynae* vs *U. neocultrimana*: 4.94%, Shih *et al*. 2010), *Mictyris* (*M. guinotae* vs *M. brevidactylus*: 3.62%, Davie *et al*. 2010) and *Helice/Chasmagnathus* (*Helice tridens* vs "*Helice latimera* clade": 4.74%, recalculated from Shih & Suzuki 2008). Given such large interspecific divergences between the present new species and their congeners, it is clear that *S. sheni* **sp. nov.**, *S. philippinensis* **sp. nov.** and *S. curtelsona* are all valid species-level taxa.

Diagnostic key for *Scopimera* "normal form" species (*sensu* Kemp 1919)
(no material of *S. pilula* was examined)

1. Male chelipeds extremely elongated, approaching 3 times carapace length, inner margin of cheliped dactylus armed with rectangular molar. G1 very slender, strongly curved dorsally . . . . . *S. pilula*
- Male chelipeds not as long 2
2. Total length of 1st ambulatory leg shorter than 2nd, similar to the 3rd; no conspicuous brush of setae of tip of G1 3
- Total length of 1st ambulatory leg similar to 2nd; G1 distal tip with conspicuous brush of setae 6
3. Setae around distal tip of G1 conspicuously differing in length 4
- G1 directed very slightly outwards, setae around tip not conspicuously differing in length but may be slightly longer and denser on inner surface 5
4. Cheliped carpus elongated; G1 conspicuously bent inwards, outwards near distal end, several long, straight setae extending from very tip . . . . . *S. intermedia*
- G1 not conspicuously bent, crown of short spines surrounding opening, one or two very long and slightly bent setae extending from very tip . . . . . *S. philippinensis* **sp. nov.**
5. Cardiac region of carapace smooth, molar along inner margin of dactylus rectangular, very conspicuous . . . . . *S. curtelsona*
- Cardiac region of carapace covered with rounded tubercles, molar along inner margin of dactylus flat-triangular, step-like, less conspicuous; thoracic sternites often appear crimson in color in live specimens. . . . . *S. longidactyla*
6. Tip of G1 very conspicuously bent inwards at right angle . . . . . *S. sheni* **sp. nov.**
- Tip of G1 distal straight. 7
7. Branchial regions raised, transverse ridge behind external orbital angle diverging posteriorly; external maxilliped merus with random dark patterns; found in Japan, Korea and North China . . . . . *S. globosa*
- Branchial regions extremely raised, transverse ridge behind external orbital angle sub-parallel; tubercles on carapace separate and distinct; dark patterns on external maxilliped merus appearing ring-like; only known from the Ryukyus, Japan . . . . . *S. ryukyuensis*

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