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Orthotheres baoyu, a new species of pea crab (Crustacea: Brachyura: Pinnotheridae) associated with abalones from Tungsha Island, Taiwan; with notes on the genus

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Abstract. The pinnotherid genus *Orthotheres* Sakai, 1969, is re-diagnosed on the basis of the type species, *O. turboe* Sakai, 1969, and two allied species, *O. haliotidis* Geiger & Martin, 1999, and a new species, *O. baoyu*, from the South China Sea. The genus is characterised by its transversely ovate female carapace with the front visible from dorsal view, a long third maxilliped ischiomerus which is completely fused, the third maxilliped propodus is elongate and extends beyond the articulation with the dactylus, which is inserted subterminally on it, short ambulatory legs, which have a distinctly hooked dactylus, and the dactylus of the second and third legs in which the ventral surface is prominently excavated. The generic affinities of the other species now referred to *Orthotheres* are also discussed at length. The new species is described, figured and compare with congeners.

Key words. Crustacea, Brachyura, Pinnotheridae, *Orthotheres*, taxonomy, revision, new species, South China Sea

INTRODUCTION

Orthotheres Sakai, 1969, is a genus of relatively large pinnotherid crabs normally associated with gastropods (see Schmitt et al., 1973; Geiger & Martin, 1999; for reviews), currently containing eight species globally (Ng et al., 2008). However, its composition has been debated by several authors, and the genus is almost certainly heterogeneous (Campos, 1989; Ahyong & Ng, 2007). Part of the problem has been knowledge of its type species, *O. turboe* Sakai, 1969 (from Japan), which was only briefly described and figured. The primary characters that define members of this genus (in addition to its host) are the subovate carpus of the third maxilliped, and the subcylindrical propodus which is elongate and its dorso-distal margin extends beyond the articulation with the dactylus which is inserted subterminally on it.

The authors recently obtained a species clearly referable to *Orthotheres* from a large abalone in the South China Sea. While it is superficially similar to *O. haliotidis* Geiger & Martin, 1999, from Australia, it differs in a number of carapace, third maxilliped, cheliped and ambulatory leg characters. This new species, here named *O. baoyu* n. sp., is described and figured. Opportunity was taken to re-examine and re-describe the types of *O. turboe* and clarify the diagnostic characters of the genus. The genus is also reviewed.

The terminology used follows Manning (1993) and Ahyong & Ng (2007). The following abbreviations are used: MXP3 = third maxilliped; G1 = male first gonopod; G2 = male second gonopod; P2–P5 = pereiopods 2–5 (ambulatory legs 1–4), respectively. Specimens examined are deposited in the U.S. National Museum of Natural History (USNM), Smithsonian Institution, Washington D.C.; and Queensland Museum (QM), Brisbane; National Taiwan Ocean University (NTOU), Keelung.

TAXONOMY

Family Pinnotheridae De Haan, 1833

Genus *Orthotheres* Sakai, 1969

***Orthotheres* Sakai, 1969: 275.**

Type species. *Orthotheres turboe* Sakai, 1969, by original designation.

Diagnosis. Female carapace transversely ovate, distinctly wider than long, frontal margin slightly extending beyond orbits, just visible from dorsal view; male carapace rounded, slightly wider than long, with distinct front; MXP3 positioned obliquely in buccal cavity, ischium and merus completely fused, elongate, carpus of palp subovate, articulating on subventral margin, propodus elongate, subcylindrical, dorso-distal margin extends beyond articulation with dactylus, dactylus inserted subterminally on propodus; P2–P5 short, bilaterally symmetrical, P5 shortest, dactylus short, distinctly

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hooked, P3 and P4 dactylus with ventral surface prominently excavated; male abdomen with 6 free somites and telson.

Remarks. Ng et al. (2008: 250) recognised eight species in *Orthotheres* Sakai, 1969 (see also Ahyong & Ng, 2007). Five of these species occur in the western Pacific: *O. glaber* (Bürger, 1895) (= *Pinnotheres impressus* Bürger, 1895) [Philippines]; *O. haliotidis* Geiger & Martin, 1999 [Australia]; *O. laevis* (Bürger, 1895) [Philippines]; *O. longipes* (Bürger, 1895)[Philippines]; and *O. turboe* Sakai, 1969 [Japan and Palau]; with four others in the Americas: *O. barbatus* (Desbonne, in Desbonne & Schramm, 1867) [West Indies]; *O. serrei* (Rathbun, 1909) [Puerto Rico]; *O. strombi* (Rathbun, 1905) [Florida]; and *O. unguifalcula* (Glassell, 1936) [Mexico]. Campos (1989), however, had earlier removed *O. laevis* and *O. longipes* from the genus and referred them back to *Pinnotheres*, commenting that "… unlike *Orthotheres*, the female's carapace of these species are not appreciably broader than long, and the dactylus of the walking legs are not uniformly very short and sharply hooked." (Campos, 1989: 1125). He also suggested that *Pinnotheres glaber* (Bürger, 1895) and *Pinnotheres impressus* Bürger, 1895, were close to *O. laevis* and *O. longipes*. Ahyong & Ng (2007) argued that because of the unusual structure of the MXP3 palp, it seemed best to retain *Pinnotheres laevis* and *Pinnotheres longipes*, as well as *Pinnotheres glaber* (which they regarded as a senior synonym of *Pinnotheres impressus*) in *Orthotheres* for the time being. Campos (1989) is certainly correct in his assertion that *Orthotheres* is not monophyletic.

Orthotheres turboe (type species of the genus), *O. haliotidis* and *O. baoyu* n. sp. form a tight group that should be recognised as *Orthotheres* s. str. Members of this genus are characterised by possessing a carapace which is transversely ovate and much wider than long, the females have a distinct front that is not prominently deflexed and is still visible from dorsal view; the MXP3 ischiomerus is subrectangular to subovate with the mesial margin gently concave; the MXP3 has a subcylindrical and elongate propodus with its dorso-distal margin extending beyond the articulation with the dactylus which is inserted subterminally on it; the ambulatory dactylus is strongly curved (almost at right angles) and prominently hook-like (Figs. 3A, B, D–H, J–M; 6A–K; 9); and the dactylus of P3 and P4 is relatively shorter and broader, with the ventral surface prominently concave (Figs. 3E, G; 6J; 9E). The concave ventral surfaces of the P3 and P4 dactyli are more pronounced in female specimens. The dactylus on the other legs is flattened laterally, but there is not prominent concavity on the ventral surface. In *O. haliotidis* and *O. baoyu* n. sp., the MXP3 dactylus insertion on the cylindrical propodus is clearly subterminal (Figs. 2B, C, G; 5B–E; 8D–F). The condition in *O. turboe* is the same (Sakai, 1969: fig. 19a) although his figure is not very precise. The problem is that in these species, the carpus of the palp is not inserted at the margin of the ischiomerus but actually submarginally on the inner surface (Sakai, 1969: fig. 19a). As such, it is not easy to draw the palp accurately with the surfaces flat.

A second group contains the American species: *O. barbatus*, *O. serrei*, *O. strombi* and *O. unguifalcula*, all of which have female carapaces that are also distinctly wider than long and the front strongly deflexed such that it is not visible from dorsal view (cf. Rathbun, 1918: pl. 19 figs. 1–4, 9, 11, pl. 20 figs. 1, 2; Campos, 1989: fig. 2). The mesial margin of the MXP3 ischiomerus of these species is also deeply concave, and the MXP3 propodus is clearly short and subovate or subconical rather than elongate, with the dactylus inserted terminally (cf. Rathbun, 1905: unnumbered second figure; Rathbun, 1909: 69, unnumbered figure; Rathbun, 1918: figs. 41, 44a, 45; Campos, 1989: figs. 1b, 3a). The MXP3 palp of *O. unguifalcula* figured by Glassell (1936: pl. 21 fig. 2) is inaccurate and it actually has three rather than two articles (see Campos, 1989: fig. 3a). The MXP3 ischiomerus of *O. barbatus* figured by Rathbun (1918: fig. 44a) is rather short but appears to be damaged. The ambulatory dactyli of all four species are also gently curved and not strongly hooked (cf. Rathbun, 1918: pl. 19 figs. 1–4, 8–11, pl. 20 figs. 1, 2; Campos, 1989: fig. 2).

There is a third group for the remaining West Pacific species. As re-described and figured by Ahyong & Ng (2007: fig. 24), *O. glaber* (= *O. impressus*) differs markedly from other *Orthotheres* in having a rounded carapace, the female frontal margin is visible from dorsal view, and the ambulatory legs (notably the dactyli) are asymmetrical, and while curved, are not prominently hooked. The carapace shape and P2–P5 characters are more typical of species of *Arcotheres* Manning, 1993, but the form of the palp is clearly different. *Orthotheres laevis* and *O. longipes* also share the same set of characters as *O. glaber*; and all three species probably belong to their own group (cf. Bürger, 1895: pl. 9 figs. 23–25, 31; pl. 10 figs. 21–24; Ahyong & Ng, 2007: fig. 3E, F). The MXP3 dactylus is inserted subterminally in *O. glaber* (Ahyong & Ng, 2007: fig. 24C, F); but appear to be more terminal in position for *O. laevis* and *O. longipes* (cf. Bürger, 1895: pl. 10 figs. 22, 24).

While *Orthotheres* s. str. can be defined relatively easily; the other two groups of species previously referred to this genus will need to referred to new genera in the future. Specimens of these species are now being examined, and new genera will need to be established for them once this study is complete.

***Orthotheres turboe* Sakai, 1969**
(Figs. 1–3)

Orthotheres turboe Sakai, 1969: 275, pl. 2 figs. 1, 2; text fig. 19a; Sakai, 1976: 574, text figs. 314a–c; Miyake, 1983: 242 (list); Miyake, 1998: 242 (list); Ng et al., 2008: 250 (list).

Material examined. Holotype: ovigerous female (12.7 × 9.1mm) (USNM 125889), in stomach of *Turbo argyrotomus* Linnaeus, 1758 (Turbinidae), Yoron Island, Amami Islands, Ryukyu Islands, Japan, coll. K. Sakai & H. Yamada, late 1960s. Paratype: 1 male (4.8 × 4.5 mm) (USNM 126231), same data as holotype.

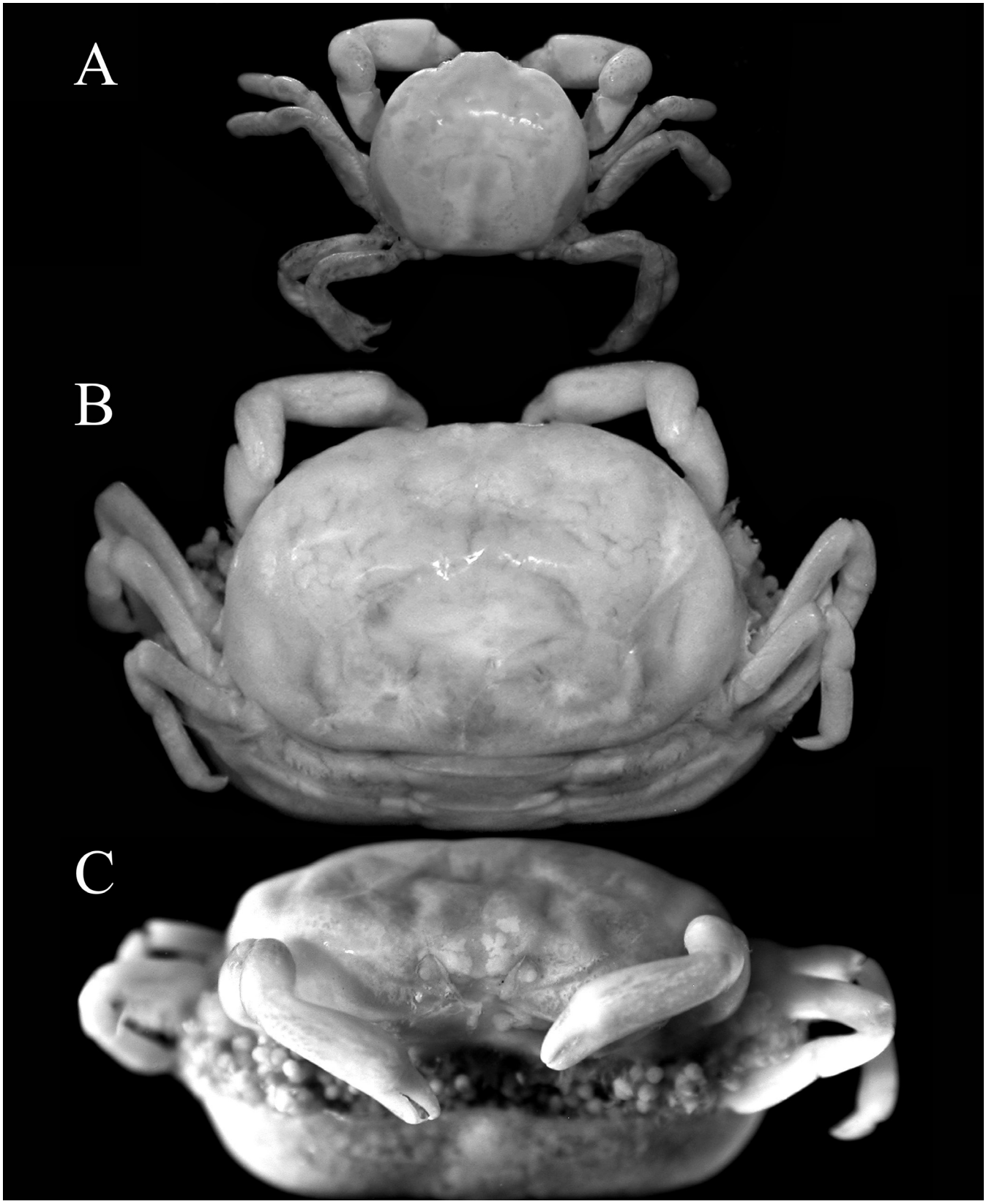

Fig. 1. *Orthotheres turboe* Sakai, 1969. A, paratype male (4.8 × 4.5 mm) (USNM 126231), Ryukyus, Japan; B, C, holotype ovigerous female (12.7 × 9.1 mm) (USNM 125889), Ryukyus, Japan. A, B, overall habitus; C, frontal view of cephalothorax.

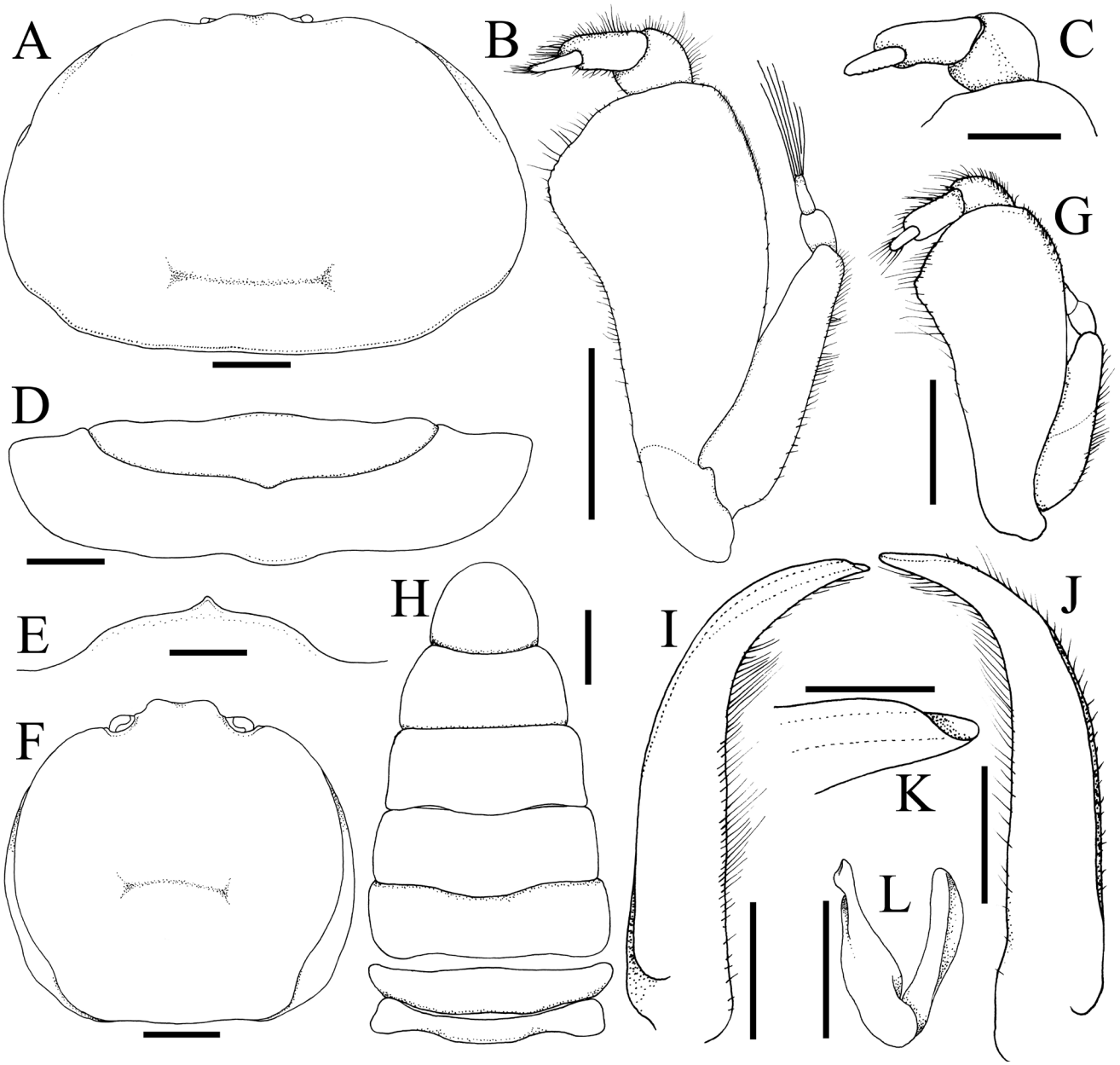

Fig. 2. *Orthotheres turboe* Sakai, 1969. A–E, holotype ovigerous female (12.7 × 9.1mm) (USNM 125889), Ryukyus, Japan; F–L, paratype male (4.8 × 4.5 mm) (USNM 126231), Ryukyus, Japan. A, F, dorsal view of carapace; B, left MXP3; C, G, lateral view of MXP3 dactylus and propodus (lateral view, setae not drawn) [dotted line at base of ischiomerus shows breakage line]; D, female abdominal somite 6 and telson; E, female thoracic sternites 1 and 2; H, male abdomen; I, left G1 (ventral view); J, left G1 (dorsal view); K, distal part of left G1 (ventral view); L, left G2. Scale bars = 2.0 mm [A, D]; 1.0 mm [B, E, F]; 0.5 mm [C, G–J, L]; 0.1 mm [K].

Diagnosis. *Female*: Carapace transversely ovate, wider than long, width to length ratio 1.39; dorsal surface smooth, glabrous, distinctly convex; front projecting slightly anteriorly beyond orbits, entire, margin distinctly sinuous with prominent median concavity (Figs. 1B; 2A). Eyes small, just visible in dorsal view; mobile, completely filling orbit (Fig. 2A). MXP3 outer surface with scattered short setae; dactylus elongate, inserted distinctly before base of propodus; propodus about 2 times length of dactylus, cylindrical, as long as subovate carpus; carpus inserted on inner surface of ischiomerus, just below distal margin; ischiomerus long, articles completely fused, anteromesial angle of merus angular to weakly angularfrom lateral view; exopod relatively stout, ca. 1/2 length of ischiomerus, flagellum 2–segmented (Fig. 2B, C). Anterior thoracic sternum wide sternites 1, 2 completely fused (Fig. 2E). Chela long; mesioventral margin distinctly setose; outer surfaces of palm, fingers (except for distal and marginal parts) almost smooth; ventral parts of inner surface with numerous setae which do not obscure surface; fingers ca. half length of palm; dactylus occlusal margin with large subproximal tooth, with 3 or 4 denticles behind it; pollex occlusal margin with 1 subproximal tooth, with 2 or 3 denticles behind it (Fig. 3C). Ambulatory legs short, left and right sides symmetrical; P2–P4 merus relatively long; P5 propodus elongate; no natatory setae present; relative lengths of meri P2<P3=P4>P5; dactylus short with prominently hooked tip, ventral margin lined with short setae; P3 and P4 dactylus relatively shorter, broader, dorsal margin

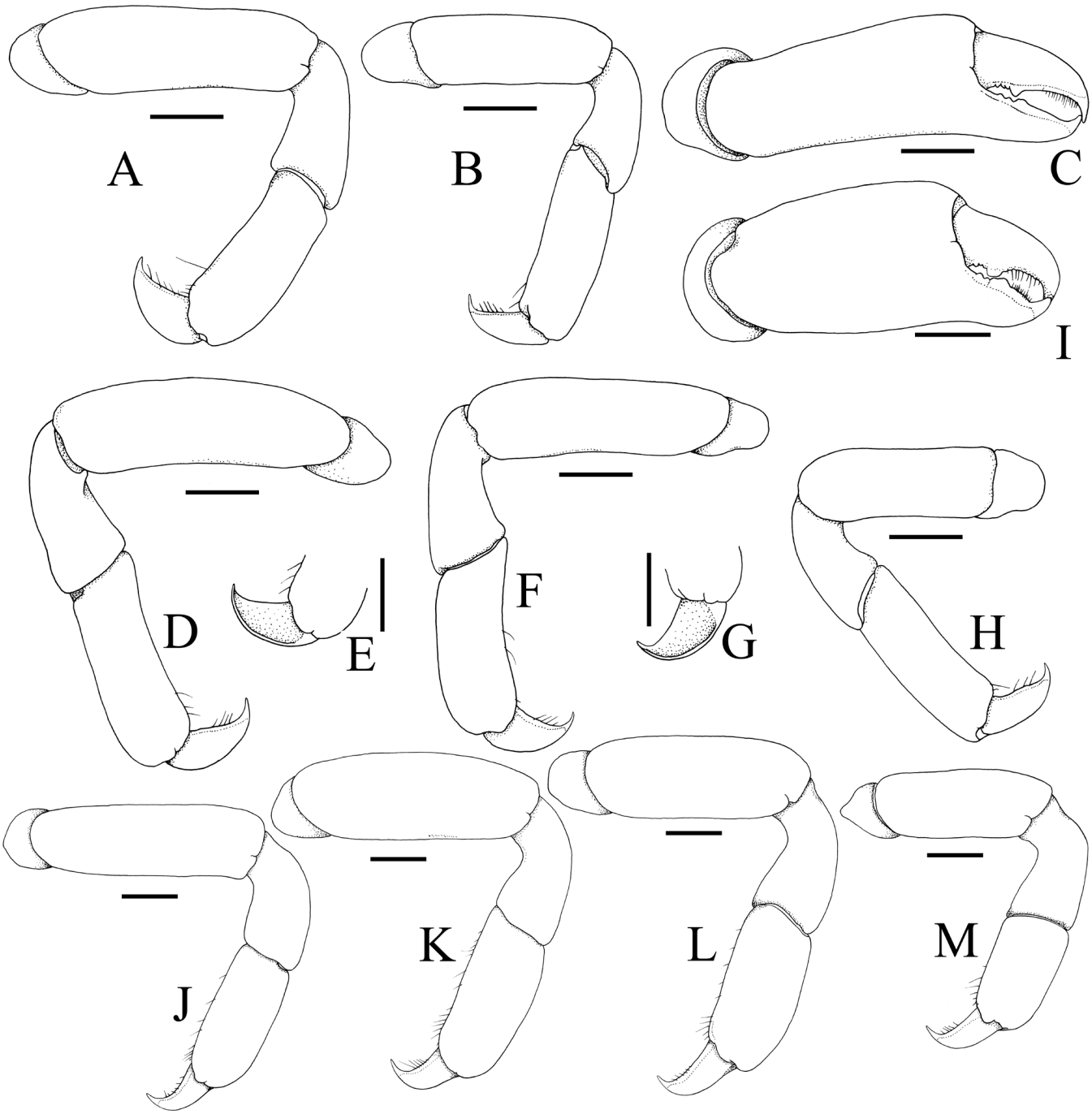

Fig. 3. *Orthotheres turboe* Sakai, 1969. A–H, holotype ovigerous female (12.7 × 9.1mm) (USNM 125889), Ryukyus, Japan; I–M, paratype male (4.8 × 4.5 mm) (USNM 126231), Ryukyus, Japan. A, right P4; B, right P5; C, outer view of right female chela; D, left P3; E, ventral view showing concave surface of left P3 dactylus; F, left P4; G, ventral view showing concave surface of left P4 dactylus; H, left P5; I, outer view of right male chela; J–M, right P2–P5, respectively. Scale bars = 1.0 mm [A–H]; 0.5 mm [I–M].

carinate, ventral surface forming gently but prominently concave surface (Fig. 3A, B, D–H). Abdomen wide, extending to buccal region, covering bases of ambulatory legs; telson deeply recessed into distal margin of somite 6 with gently sinuous distal margin (Fig. 2D).

Male: Carapace circular, slightly wider than long, width to length ratio 1.07; dorsal surface smooth, gently convex; front distinctly projecting anteriorly, margin prominently sinuous (Figs. 1A, 2F). Eyes distinctly visible in dorsal view (Figs. 1A; 2F). MXP3 as in female (Fig. 2G). Anterior thoracic sternum relatively wide sternites 1, 2 fused, with shallow concave suture (towards buccal cavity) separating from sternite 3; sternites 3, 4 fused, with very shallow groove separating them; sternoabdominal cavity reaching to just before suture between sternites 3/4. Chela relatively stout, shorter than in female; occlusal margin of fingers with distinct subproximal tooth and 3 or 4 denticles behind it (Fig. 2I). Ambulatory legs short, left and right sides symmetrical; P5 propodus short; no natatory setae present; relative lengths of meri P2=P3=P4>P5; dactylus short with prominently hooked tip, ventral margin lined with short setae; P3 and P4 dactylus

with ventral surface gently concave (Fig. 3J–M). Abdomen relatively wider; telson semicircular (Fig. 2H). G1 relatively stout, distal third gently curved outwards, tip with distinct dorsal opening (Fig. 2I–K). G2 short, with subspatuliform tip; exopod stout, almost as long as endopod (Fig. 2L).

Remarks. Sakai (1969: 277) stated that a female (presumably the holotype) was 13.0 by 8.5 mm while a male specimen was 5.1 by 5.0 mm. The present holotype female measures 12.7 × 9.1 mm and the paratype male is 4.8 × 4.5 mm. The holotype female and paratype specimens examined agree with those he figured (Sakai, 1969: pl. 2 figs. 1, 2). The MXP3 of the species, as figured by Sakai (1969) is misleading. It was clearly drawn in situ from the inner surface, with the structure still attached to the specimen and probably also at an angle, making it appear longer; and the propodus and dactylus very short (Sakai, 1969: fig. 19a). The MXP3 is actually less elongate, and the propodus and dactylus much longer (Fig. 2B).

For comparisons with *O. haliotidis* and *O. baoyu* n. sp., see remarks for the latter species.

Orthotheres haliotidis Geiger & Martin, 1999
(Figs. 4–6)

Pinnixa faba – Haswell, 1882: 113; Grant & McCulloch, 1906: 6, 23; Schmitt et al., 1973: 108 (list); Davie, 2002: 431 (list). [not *Pinnixa faba* (Dana, 1851)].

Orthotheres haliotidis Geiger & Martin, 1999: 273, figs. 1–7; Ng et al., 2008: 250 (list); Ahyong & Brown, 2003: 10.

Material examined. 2 ovigerous females (12.7 × 8.8 mm, 12.3 × 7.9 mm) (AM P3155), in *Haliotis asinina*, Masthead Island, 23°32'S 151°44'E, Queensland, Australia, coll. A.R. McCulloch & E. Le G. Troughton, no date; 1 ovigerous female (14.0 × 9.9 mm) (AM P64672), North West Island, Capricorn Group, 23°18'S 151°42'E, Queensland, Australia, coll. M. Ward, December 1929; 1 ovigerous female (10.0 × 7.0 mm) (AM P72222), Heron Island, 23°26'S 151°55'E, Queensland, Australia, coll. J. Bishop, no date; 1 male (7.4 × 6.7 mm), 1 ovigerous female (11.4 × 7.9 mm) (AM P72223), in branchial cavity of *Haliotis asinina*, Heron Island, 23°26'S 151°55'E, Queensland, Australia, coll. M.L. Kok, 8 April 1963; 1 male (6.3 × 6.1 mm), 1 ovigerous female (13.7 × 9.3 mm) (QM), almost certainly from Queensland, no other data.

Diagnosis. *Female*: Carapace transversely ovate, wider than long, width to length ratio 1.41–1.55; dorsal surface smooth, glabrous, distinctly convex; front projecting slightly anteriorly beyond orbits, entire, margin gently sinuous with shallow median concavity (Fig. 4B; 5A). Eyes small, just visible in dorsal view; mobile, completely filling orbit (Fig. 5A). MXP3 outer surface with numerous short setae; dactylus elongate, inserted distinctly before base of propodus; propodus about 2 times length of dactylus, cylindrical, as long as subovate carpus; carpus inserted on inner surface of ischiomerus, just below distal margin; ischiomerus long, articles completely fused, anteromesial angle of merus distinctly angular from lateral view; exopod relatively stout, ca. 2/3 length of ischiomerus, flagellum 2–segmented (Fig. 5B, D). Anterior thoracic sternum wide sternites 1, 2 completely fused. Chela long; mesioventral margin distinctly setose; outer surfaces of palm, fingers (except for distal and marginal parts) almost smooth; ventral parts of inner surface with numerous setae which do not obscure surface; fingers ca. half length of palm; dactylus occlusal margin with large triangular subproximal tooth, with 4 or 5 denticles behind it; pollex occlusal margin with 1 subproximal tooth, with 3 or 4 denticles behind it (Fig. 6M). Ambulatory legs short, left and right sides symmetrical; P2–P4 merus relatively long; P5 propodus elongate; no natatory setae present; relative lengths of meri P2<P3=P4>P5; dactylus short with prominently hooked tip, ventral margin lined with short setae; P3 and P4 dactylus relatively shorter, broader, dorsal margin carinate, ventral surface gently but prominently concave surface (Fig. 6E–K). Abdomen wide, extending to buccal region, covering bases of ambulatory legs; telson deeply recessed into distal margin of somite 6 with gently sinuous distal margin (Fig. 5G, H).

Male: Carapace circular, slightly wider than long, width to length ratio 1.10; dorsal surface smooth, gently convex; front distinctly projecting anteriorly, margin gently sinuous (Fig. 4A). Eyes distinctly visible in dorsal view (Fig. 4A). MXP3 as in female. Anterior thoracic sternum relatively wide sternites 1, 2 fused, with shallow concave suture (towards buccal cavity) separating from sternite 3; sternites 3, 4 fused, with very shallow groove separating them; sternopleonal cavity reaching to just before suture between sternites 3/4. Chela relatively stout, shorter than in female; occlusal margin of fingers with subproximal tooth (larger in dactylus) and 4 or 5 denticles behind it (Fig. 6L). Ambulatory legs short, left and right sides symmetrical; P5 propodus long; no natatory setae present; relative lengths of meri P2=P3=P4>P5; dactylus short with prominently hooked tip, ventral margin lined with short setae; P3 and P4 dactylus with ventral surface gently concave (Fig. 6A–D). Abdomen relatively narrower; telson semicircular (Fig. 5F). G1 relatively stout, distal third gently distinctly bent outwards, tip without distinct large opening (Fig. 5I–L). G2 short, with rounded tip; exopod stout, shorter than endopod (Fig. 3M).

Remarks. The present specimens agree well with the description and figures of Geiger & Martin (1999) whose specimens were from Queensland and Western Australia (see also Ahyong & Brown, 2003). The MXP3 ischiomerus depicted by Geiger & Martin (1999) appears to be dimorphic although the authors did not discuss it. The inner distolateral margin of the ischiomerus of the male paratype was shown as almost straight and sloping, with the edge angular (Geiger & Martin, 1999: figs. 3A, 4A, B) whereas that of the female holotype was figured as evenly convex with the edge rounded (Geiger & Martin, 1999: fig. 4C). The condition of the male paratype agrees well with those observed for the present series of specimens for both sexes, and there is no dimorphism observed. It is possible the female holotype figured by Geiger & Martin (1999: fig. 4C) is anomalous in this character or the structure was figured at an angle. Geiger & Martin (1999: fig. 3) shows a gently curved G1 with a relatively short distal part although Geiger & Martin

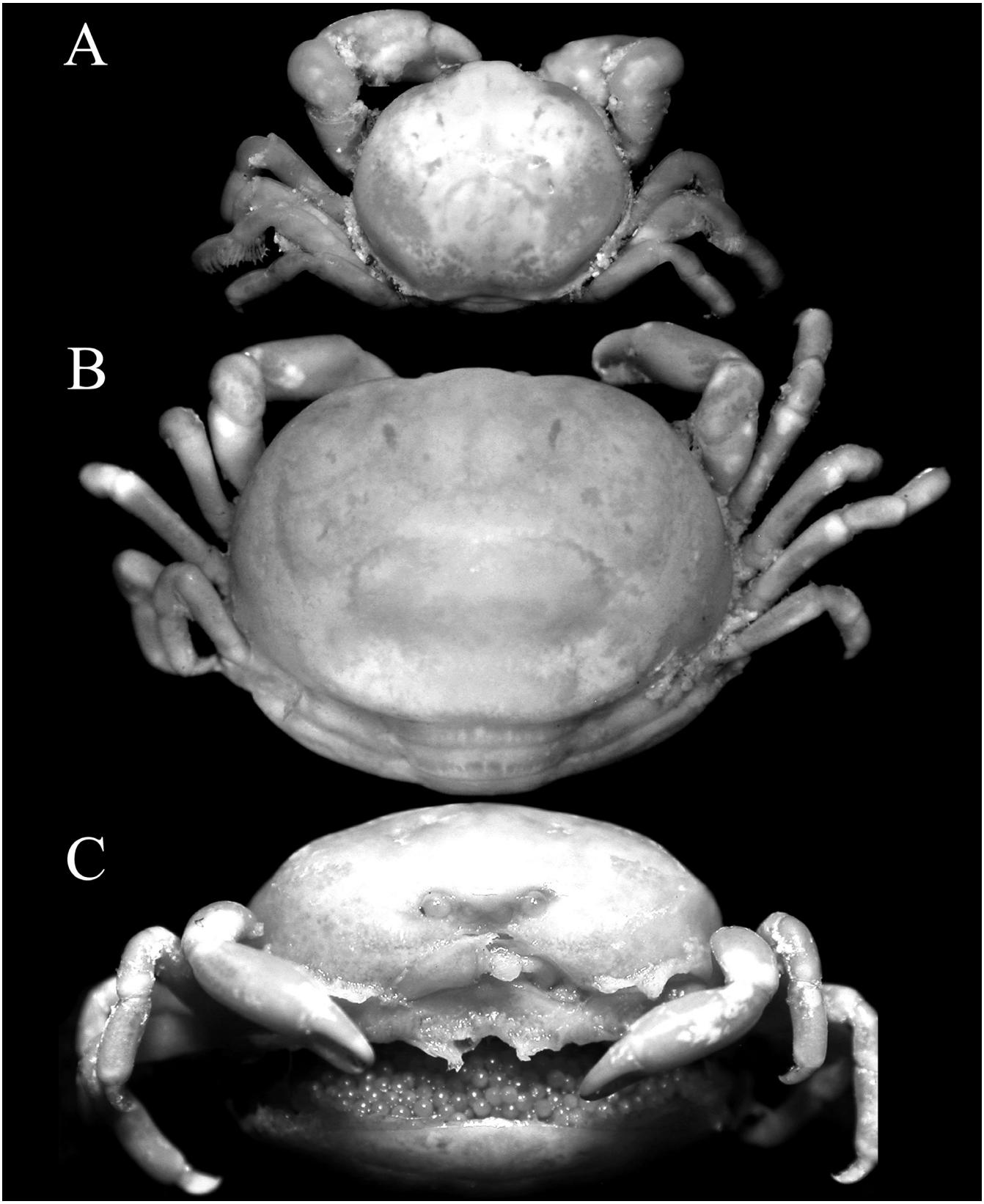

Fig. 4. *Orthotheres haliotidis* Geiger & Martin, 1999. A, male (7.4 × 6.7 mm) (AM P72223); B, C, ovigerous female (12.7 × 8.8 mm) (AM P3155). A, B, overall habitus; C, frontal view of cephalothorax.

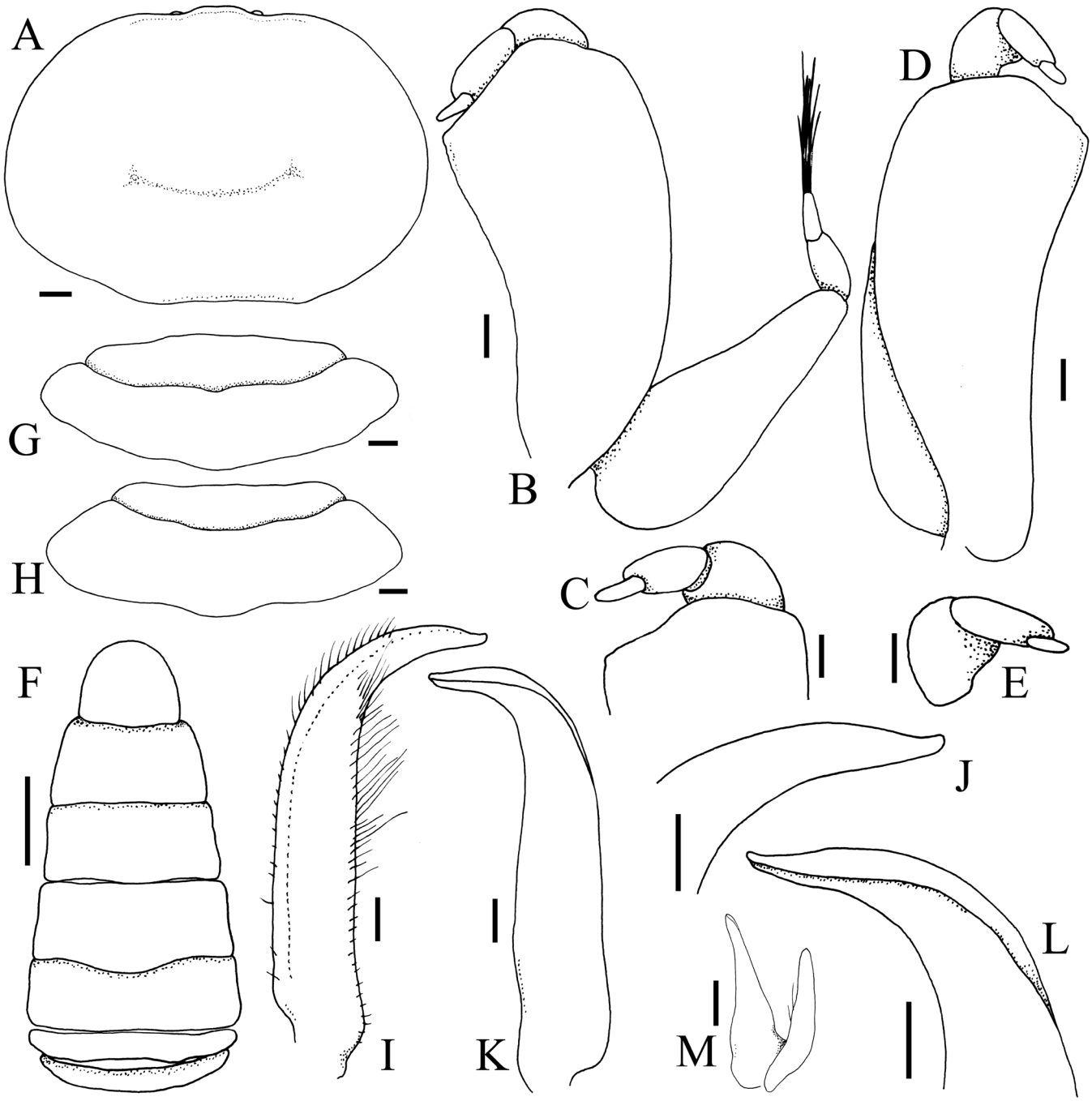

Fig. 5. *Orthotheres haliotidis* Geiger & Martin, 1999. A–C, G, ovigerous female (12.7 × 8.8 mm) (AM P3155); D, E, H, ovigerous female (12.3 × 7.9 mm) (AM P3155); F, I–M, male (7.4 × 6.7 mm) (AM P72223). A, dorsal view of carapace; B, left MXP3 (setae not drawn); C, left MXP3 palp (lateral view, setae not drawn); D, left MXP3 (setae not drawn); E, left MXP3 palp (lateral view, setae not drawn); F, male abdomen; G, H, female abdominal somite 6 and telson; I, left G1 (ventral view); J, distal part of left G1 (ventral view, setae not drawn); K, left G1 (dorsal view, setae not drawn); L, distal part of left G1 (dorsal view, setae not drawn); M, left G2 (ventral view). Scale bars = 1.0 mm [A, F, G, H], 0.2 mm [B–E, I–M].

(1999: fig. 7) indicates a G1 more like the present one (Fig. 5I, K), with the distal part more elongated and curved at right angles. The median part of the G1 looks as if it has a low indentation (cf. Geiger & Martin 1999: fig. 7B) but this appears to be an artifact of the SEM process.

For comparisons with *O. turboe* and *O. baoyu* n. sp., see remarks for the latter species.

***Orthotheres baoyu* n. sp.**
(Figs. 7–9)

Material examined. Holotype: ovigerous female (12.7 × 9.4 mm) (NTOU CP 20020627a), from 8.5 cm long abalone (*Haliotis asinina* Linnaeus, 1758; Haliotidae), Tungsha islands, Taiwan, coll. M.-H. Chen, 27 June 2002. Paratype: 1 poorly preserved female (8.6 × 7.1 mm) (NTOUCP 20020627b), same data as holotype.

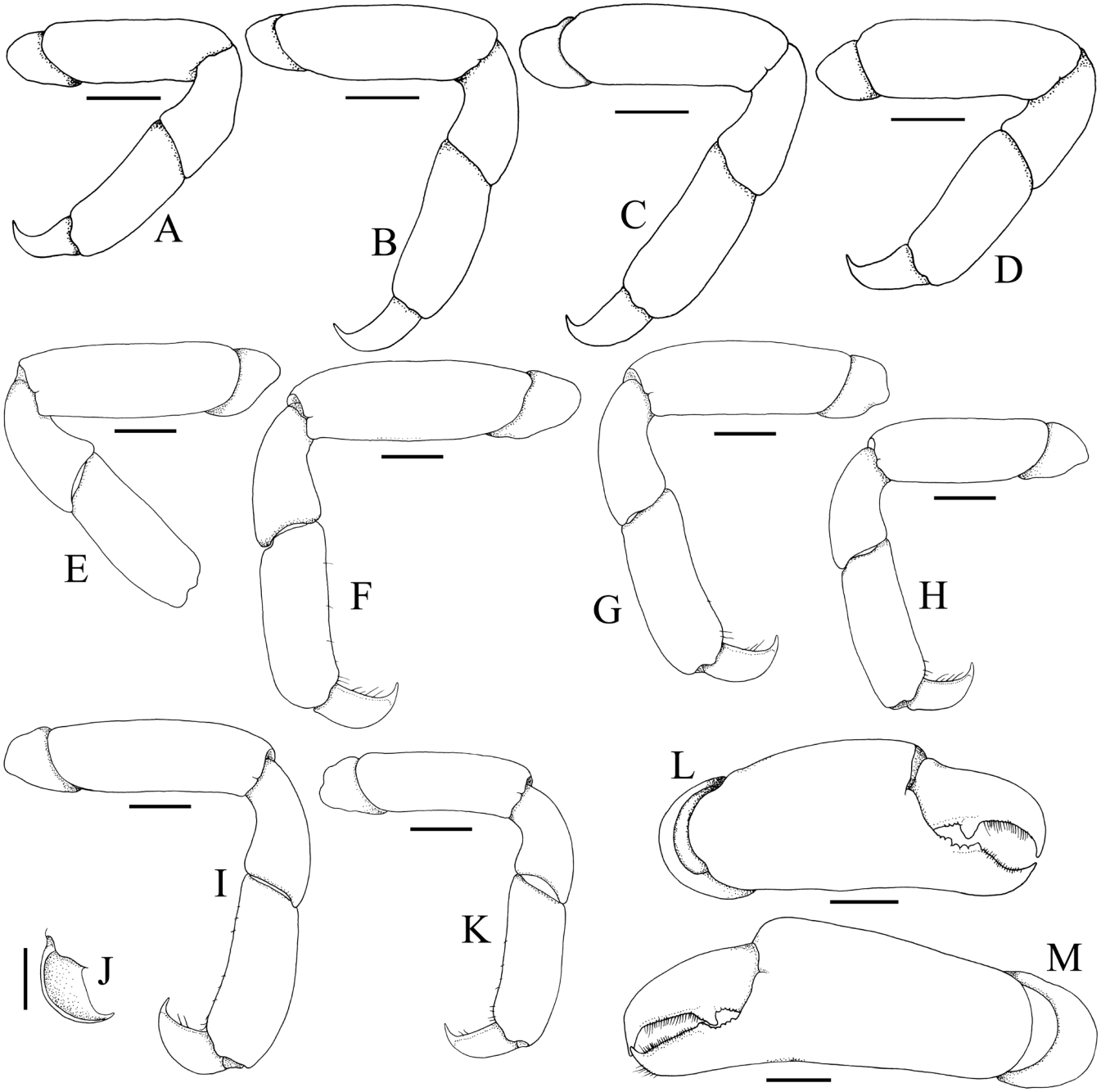

Fig. 6. *Orthotheres haliotidis* Geiger & Martin, 1999. A–D, ovigerous female (12.7 × 8.8 mm) (AM P3155), Queensland; L, male (6.3 × 6.1 mm) (QM), Queensland; E–K, M, ovigerous female (13.7 × 9.3 mm) (QM), Queensland. A–D, right P2–P5, respectively; E–H, left P2–P5, respectively; I, right P4; J, ventral view showing concave surface of right P4 dactylus; K, right P5; L, outer view of right male chela; M, outer view of left female chela. Scale bars = 1.0 mm.

Diagnosis. *Female*: Carapace transversely ovate, wider than long, width to length ratio 1.35; dorsal surface smooth, glabrous, gently convex; front projecting slightly anteriorly beyond orbits, entire, margin gently sinuous with shallow median concavity (Figs. 7A, B; 8A). Eyes small, just visible in dorsal view; mobile, completely filling orbit (Figs. 7B; 8A). MXP3 outer surface with numerous short plumose setae; dactylus elongate, inserted distinctly before base of propodus; propodus about 2 times length of dactylus, cylindrical, as long as subovate carpus; carpus inserted on inner surface of ischiomerus, below distal margin; ischiomerus very long, articles completely fused, anteromesial angle of merus rounded from lateral view, subangular from submesial view; exopod relatively stout, ca. 1/2 length of ischiomerus, flagellum 2–segmented (Fig. 8D–F). Anterior thoracic sternum wide sternites 1, 2 completely fused. Chela relatively long; mesioventral margin distinctly setose; outer surfaces of palm, fingers (except for distal and marginal parts) almost smooth; ventral parts of inner surface with numerous setae which do not obscure surface; fingers ca. half length of palm; dactylus occlusal margin with large subproximal tooth, with no denticles behind it; pollex occlusal margin with 1 subproximal tooth, with no denticles behind it (Fig. 8C). Ambulatory legs short, left and right sides symmetrical; P2–P4 merus relatively long; P5 propodus elongate; no natatory setae present; relative lengths of meri

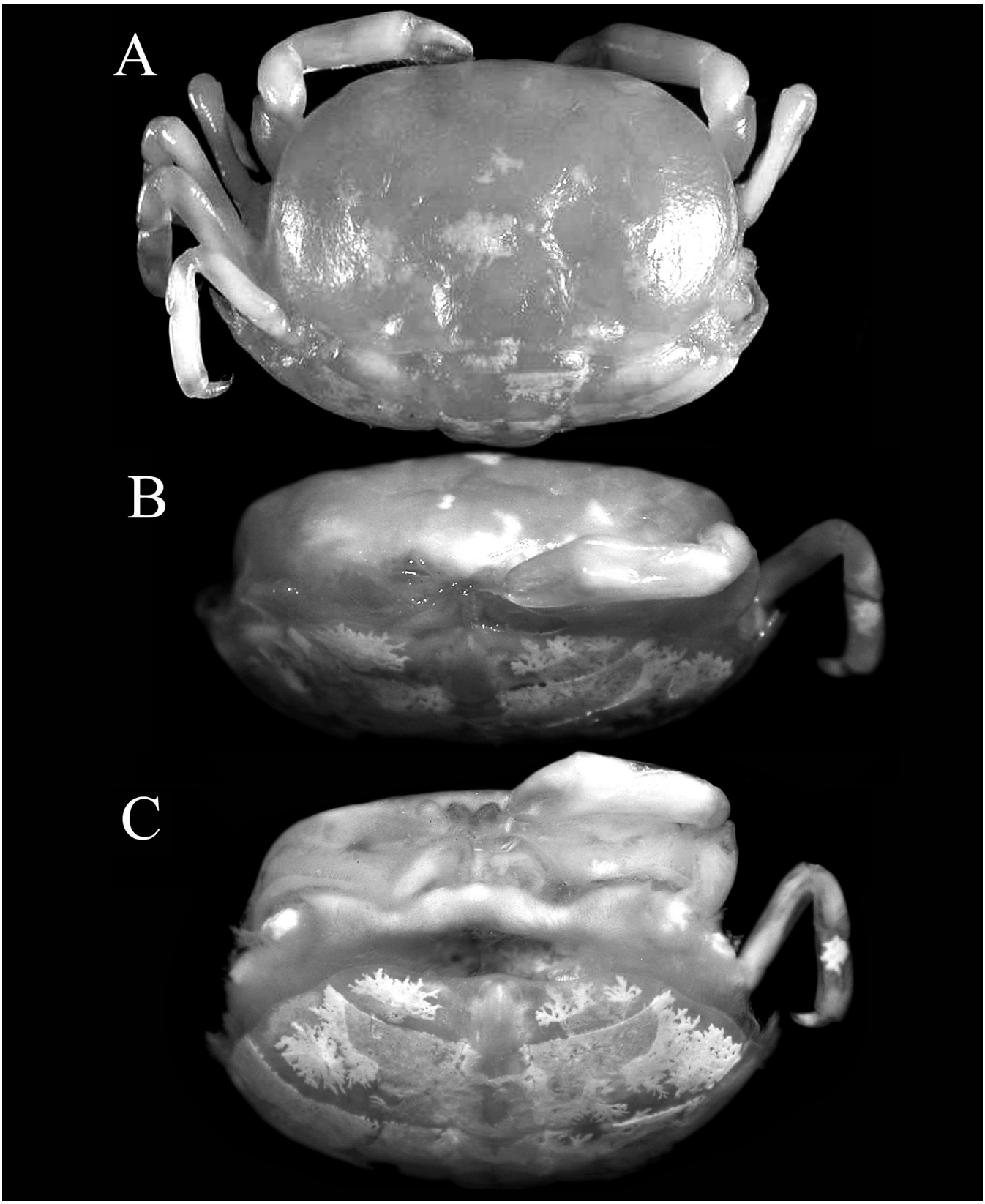

Fig. 7. *Orthotheres baoyu* n. sp., holotype ovigerous female (12.7 × 9.4 mm) (NTOU CP 20020627). A, overall habitus; B, frontal view of cephalothorax; C, ventral view of cephalothorax.

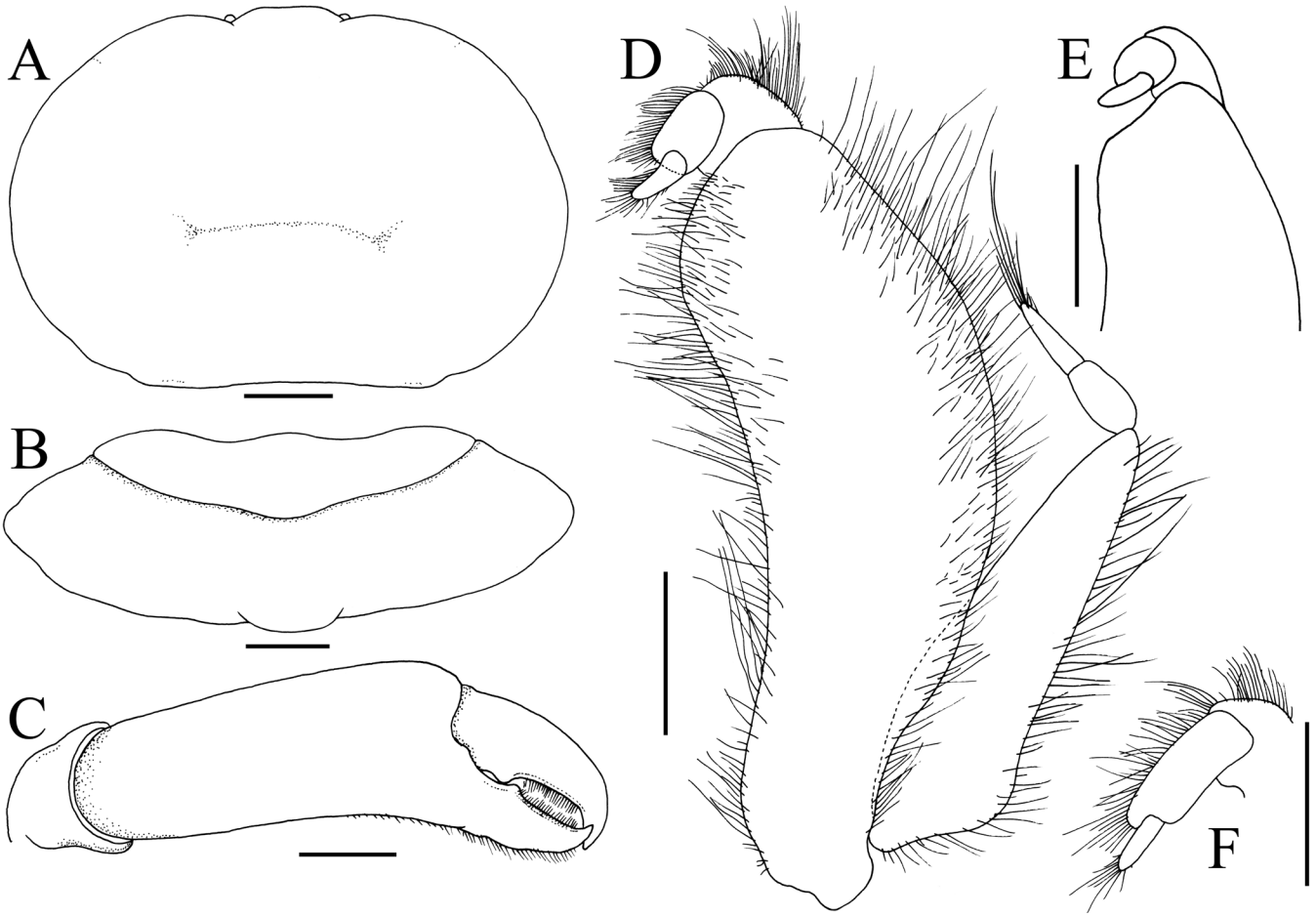

Fig. 8. *Orthotheres baoyu* n. sp., holotype ovigerous female (12.7 × 9.4 mm) (NTOU CP 20020627). A, dorsal view of carapace; B, female abdominal somite 6 and telson; C, outer view of right chela; D, left MXP3; E, left MXP3 (mesial view, setae not drawn); F, lateral view of MXP3 dactylus and propodus. Scale bars = 2.0 mm [A, B]; 1.0 mm [C, E]; 0.5 mm [D, F].

P2<P3=P4>P5; dactylus short with prominently hooked tip, ventral margin lined with short setae; P3 and P4 dactylus relatively shorter, broader, dorsal margin carinate, ventral surface forming gently but prominently concave surface (Fig. 9). Abdomen wide, extending to buccal region, covering bases of ambulatory legs; telson deeply recessed into distal margin of somite 6 with distinctly sinuous distal margin (Fig. 8B). *Male*: not known.

Etymology. The species name is derived from the Chinese name for abalone, "bao-yu". The name is used as a noun in apposition.

Remarks. The three species differ in various characters. For well-preserved female specimens, the dorsal carapace surface of *O. haliotidis* (Fig. 4C) and *O. turboe* (Fig. 1C) is distinctly more convex compared to that of *O. baoyu* n. sp. (Fig. 7B). Although the carapace width to length ratios do not reflect it, the carapace of *O. turboe* appears to be the widest because posterolateral parts are more prominently expanded laterally (Figs. 1B; 2A); in *O. haliotidis* and *O. baoyu*, the posterolateral areas are only gently convex (Figs. 4B; 5A; 7A; 8A). The frontal margin of *O. turboe* is diagnostic in that it is distinctly sinuous, with the median part prominently concave (Figs. 1B; 2A). In *O. haliotidis* and *O. baoyu*, the frontal margin is only slightly sinuous with the median part gently concave (Figs. 4B; 5A; 8A). The MXP3 are distinct for *O. baoyu*; it has the most prominently elongated ischiomerus, with the anteromesial part rounded when it is lying flat (Fig. 8D). In *O. turboe* and *O. haliotidis*, the ischiomerus is relatively shorter (Figs. 2D, G; 5B, D) with the anteromesial part somewhat weakly angular to angular in *O. turboe* (Fig. 2D, G) and distinctly angular in *O. haliotidis* (Fig. 5B, D; Geiger & Martin, 1999: figs. 3A, 4). In *O. baoyu*, only when the ischiomerus is tilted at a 30° angle does the anterointernal part appear angular (Fig. 8E), but is distinctly rounded when it is observed flat down (Fig. 8D). The female chela of *O. baoyu* is distinct in that it is proportionately the longest, and the occlusal margin behind the large subproximal tooth on each finger is entire (Fig. 8C). In *O. turboe* and *O. haliotidis*, the female chelae are distinctly shorter and the occlusal margin behind the large subproximal tooth on each finger is lined with several denticles (Figs. 3C; 6M). The proportions of the ambulatory legs differ. In *O. turboe* and *O. baoyu*, the merus of P2–P4 is proportionately longer (Figs. 3A, D, F; 9A–G) than in *O. haliotidis* (Fig. 6F, G, I). For the P5, the propodus of *O. turboe* and *O. baoyu* (Figs. 3B, H; 9H, I) is distinctly longer than that of *O. haliotidis* (Fig. 6H, K). The female abdomen is relatively widest in *O. turboe* (Fig. 2B) compared to those of *O. haliotidis* (Fig. 5G, H) and *O. baoyu* (Figs. 8C; 9B).

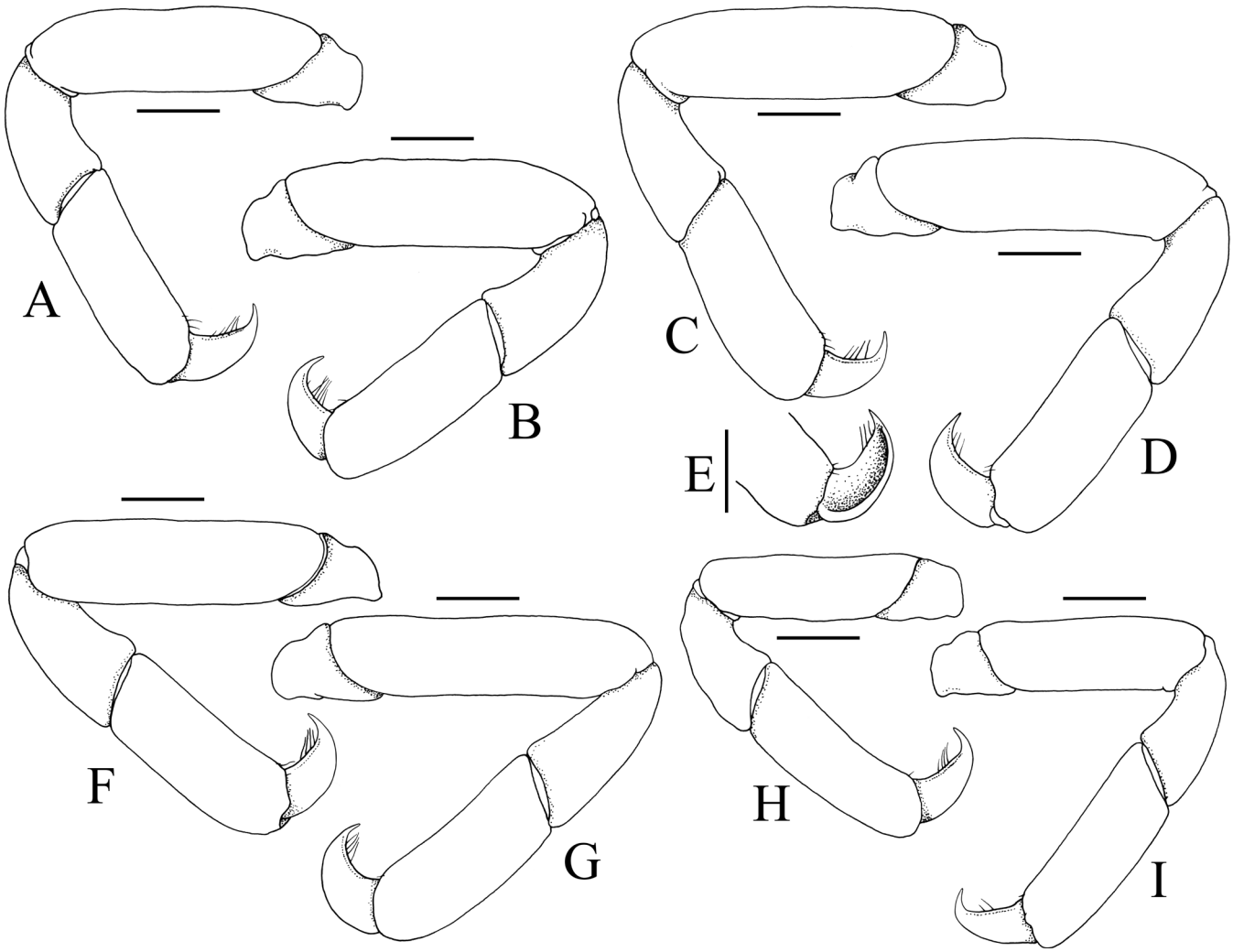

Fig. 9. *Orthotheres baoyu* n. sp., holotype ovigerous female (12.7 × 9.4 mm) (NTOU CP 20020627), ambulatory legs. A, left P2; B, right P2; C, left P3; D, right P3; E, ventral view showing concave surface of right P3 dactylus; F, left P4; G, right P4; H, left P5; I, right P5. Scale bars = 1.0 mm.

In males, the carapaces do not differ substantially. However, the frontal margin of the male *O. turboe* (Figs. 1A; 2F) is like that of the female, being distinctly more sinuous than that of *O. haliotidis* (Fig. 4A). There are no major differences in the structure of the MXP3 between the sexes of the two species (*O. turboe* and *O. haliotidis*) in which males and females are known (e.g., Fig. 2B, G). The male chelae of *O. turboe* and *O. haliotidis* are also very similar in shape and proportions (Figs. 3I; 6L). For the ambulatory legs, the P5 propodus of *O. turboe* (Fig. 3M) is proportionately shorter than that of *O. haliotidis* (Fig. 6D). The male abdomens of the two species also differ, with that of *O. turboe* (Fig. 2H) being transversely broader than that of *O. haliotidis* (Fig. 5F). The G1s of *O. turboe* and *O. haliotidis* are very similar, but the distal third of *O. turboe* (Fig. 2I, J) is more gently curved than that of *O. haliotidis*, which is more distinctly bent (Fig. 5I, K).

In any case, their hosts are different: *O. turboe* has been found only with the top shell *Turbo* (cf. Sakai, 1969: 277) while *O. baoyu* and *O. haliotidis* are from the same species of abalone.

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