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A new cavernicolous species of freshwater crab (Crustacea: Brachyura: Potamidae) from Pulau Tioman, peninsular Malaysia

Darren C. J. Yeo

Raffles Museum of Biodiversity Research, Department of Biological Sciences, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260.

Abstract.—A new freshwater potamid crab species, *Johora gua,* is described from Pulau Tioman, an island off the east coast of Peninsular Malaysia. It differs from most of its congeners by the relatively longer and slenderer ambulatory legs as well as various other characters in the carapace and male first pleopod. This is the fifth species of *Johora* Bott to be described from Pulau Tioman, and the first cavernicolous crab to be reported from Peninsular Malaysia.

Specimens of an unusual freshwater crab recently collected from a cave on Pulau Tioman, an island off the east coast of Peninsular Malaysia, proved to be a new potamid species of the genus *Johora* Bott, 1966. This new species differs from most of its congeners by the relatively longer and slenderer ambulatory legs as well as various other characters of the carapace and male first pleopod. The genus *Johora* Bott, 1966 [type species: *Potamon (Potamon) johorense* Roux, 1936], is endemic to the Malay Peninsula, occurring northwards from Singapore into the southern half of Peninsular Malaysia along the central highlands. Species of this genus are replaced by those of *Stoliczia* Bott, 1966, in the northern half through to southern Thailand (Ng 1988). A total of 13 species have been placed in *Johora,* with Pulau Tioman alone accounting for four species, all island endemics, viz., *J. counsilmani* (Ng, 1985), *J. grallator* Ng, 1988, *J. punicea* (Ng, 1985), and *J. tiomanensis* (Ng & Tan, 1984) (see Ng 1988, 1990; Ng & Takeda 1992; Yeo et al. 1999). In the present study, the fifth *Johora* species known from Pulau Tioman is described, bringing the total number in the genus to 14.

Ng (1988: 142) earlier referred to the "...existence of an unknown species of white crab in Malayan caves..." but this has yet to be discovered. The new species of *Johora* herein described is the first true cavernicolous freshwater crab to be reported from Peninsular Malaysia. The cave-dwelling habits of this species are, to some extent, reflected in slight troglomorphic features although these are less significant when compared with other known cavernicolous crabs.

The following abbreviations are used: G1, male first pleopod; G2, male second pleopod; cw, carapace width; and asl, above sea level. Measurements are given in millimeters (mm) as carapace width × length. Terminology used essentially follows Ng (1988). Malay words used in the text are 'Pulau', island; 'Gua', cave; and 'Gunung', mountain. Specimens remain deposited in the Zoological Reference Collection, Raffles Museum of Biodiversity Research, Department of Biological Sciences, National University of Singapore (ZRC). As comparative material, the types and supplementary specimens of the other four *Johora* species from Pulau Tioman in the ZRC were examined. A detailed listing of this material can be found in Yeo et al. (1999).

Johora gua, new species
Figs. 1A–C, E–H, 2A–G

Material examined.—Holotype: male 11.4 × 8.5 mm (ZRC 2000.2236), Gua

Tengkuk Ayer, route to Gunung Kajang from Juara, Pulau Tioman, ca. 900 m asl., Peninsular Malaysia, coll. H. H. Tan & T. M. Leong, 1 Sep 2000. Paratype: male 9.5 × 7.2 mm (ZRC 2000.2237), same data as holotype.

Diagnosis.—Carapace distinctly broader than long, not elevated; dorsal surface flat, glabrous. Epigastric cristae distinctly rugose; postorbital cristae not sharp, rugose. Frontal region smooth; antennular fossae broadly subrectangular; corneas slightly reduced, about 0.4 times length of eyestalks. External orbital angle low, broadly triangular, outer or lateral margin about 4 times longer than inner or medial margin; epibranchial tooth weak, triangular; anterolateral margin gently convex, very weakly cristate; branchial region indistinctly rugose; metabranchial region with distinct oblique striae. Epistome with weak, broadly triangular median tooth on posterior margin. Third maxilliped exopod with well-developed flagellum, longer than merus width. Cheliped with carpus armed with robust subdistal spine on inner margin. Ambulatory legs sparsely setose, long, slender; dactyli elongated, slender, merus unarmed. Suture between anterior thoracic sternites 2 and 3 faint; thoracic sternite 8 completely separated by longitudinal median line, lacking transverse ridge on midline; abdominal cavity reaching imaginary line joining anterior edge of cheliped bases. Male abdomen triangular. G1 terminal segment about 0.4 times length of subterminal segment, very slender, subcylindrical, curved outwards, lacking dorsal flap; subterminal segment distinctly broader in proximal half, not neck-like distally, without shelf or cleft on upper part of outer margin. G2 distal segment distinctly longer than half of basal segment.

Color.—Live specimens are light orange in overall coloration.

Etymology.—The specific name, "gua", is Malay for cave, alluding to its cavernicolous habitat. Used as a noun in apposition.

Ecological notes.—The specimens of *Johora gua,* new species, were obtained several meters inside a small granite cave, not higher than 1 m in height, with a shallow underground stream, about 2–15 cm deep, flowing slowly over sandy and rocky substratum. The water pH was 7.8. No surface (epigeal) streams were found in the vicinity (T. M. Leong & H. H. Tan, pers. comm.; Ng et al. 1999: 171). Organic input into this system include swiftlet and porcupine droppings. Tadpoles of a species of megophyrid frog, *Leptolalax gracilis* (Günther), and a species of fish, the blind cave loach, *Sundoreonectes tiomanensis* Kottelat, were found syntopically, along with the fully aquatic freshwater crab species *J. tiomanensis* (T. M. Leong & H. H. Tan, pers. comm.). Despite its presence in the cave, and the absence of surface streams nearby, *J. tiomanensis* is still regarded as an epigeal species, as it is commonly found in surface streams at lower altitudes throughout the southern half of the island (see Yeo et al. 1999).

Remarks.—*Johora gua,* new species, is immediately separated from all its congeners except *J. grallator* Ng, 1988, by its much longer and slenderer ambulatory legs. *Johora gua* could be mistaken for a juvenile of *J. grallator,* as they are superficially similar in the long, slender legs as well as light orange live coloration (see Yeo et al. 1999). However, specimens of *J. gua* are much smaller, similar in size to the holotype (11.4 × 8.5 mm, ZRC 2000.2236), which clearly possesses well-developed adult G1s. In contrast, two similar sized male specimens of *J. grallator* (largest 11.7 × 8.9 mm, ZRC 1996.1730) have undeveloped G1s and are clearly juvenile. The ambulatory legs of *J. gua* are relatively stouter than those of *J. grallator,* as reflected in the proportions of the merus of the second leg (4.3–4.4 vs. 5.3–5.7 times longer than broad); and merus of the fourth leg (3.4–3.6 vs. 4.4–4.7 times longer than broad) (Fig. 2A, B; Ng 1988: fig. 23A). Furthermore, *J. gua* differs from *J. grallator* in the following characters: postorbital cristae relatively more ru-

gose and less sharp (vs. postorbital cristae distinctly smoother and sharper); corneas reduced, shorter than half the length of the eyestalks (vs. normal-sized corneas, about half the length of the eyestalks); antennular fossae distinctly broader than the epistome (vs. antennular fossae as broad as epistome); and epistome posterior margin with poorly developed median tooth (vs. epistome posterior margin with well-developed median tooth) (Fig. 1A, C; Ng 1988: fig. 23A, B; Yeo et al. 1999: fig. 5A, B). The shape of the G1 of *J. grallator* is unknown, as no mature males have been collected (see Ng 1988; Yeo et al. 1999). However, the external morphological differences discussed are sufficient to show that the two species are clearly not conspecific. Most of these external differences are also applicable in distinguishing *J. gua* from *J. tiomanensis* (Ng & Tan, 1984), and *J. counsilmani* (Ng, 1985), two other large, fully aquatic *Johora* species that are endemic to Pulau Tioman (see Ng 1988: figs. 20A, B, 21A, B). In addition, *J. gua* can be further separated from these species by its almost smooth sub-branchial, sub-hepatic and pterygostomial regions (vs. sub-branchial, sub-hepatic and pterygostomial regions distinctly rugose); and by its G1 terminal segment always lacking a dorsal flap (vs. G1 terminal segment with dorsal flap); and G1 subterminal segment lacking a distal cleft on the outer margin (vs. G1 subterminal segment with a distinct subrectangular distal cleft on the outer margin) (Figs. 1C, 2C–F; Ng 1988: figs. 20B, 21B; Yeo et al. 1999: figs. 4A–C, F–H, 7B–E, G–H).

Johora gua is most similar to *J. punicea* (Ng, 1985), also from Pulau Tioman. Both species share a relatively smooth carapace dorsal surface, with weakly cristate anterolateral margins, and relatively blunt postorbital cristae, and very low, poorly developed epistome posterior margin median tooth (Fig. 1A, C; Ng 1988: fig. 22A, B). The G1 structure in both species is also very similar in having a long, slender outwardly curved or sickle-shaped terminal segment that lacks a dorsal flap, and a relatively broad subterminal segment that lacks a distinct distal cleft on the outer margin (see Fig. 2C–F, H; Yeo et al. 1999: fig. 6B–D). However, *J. gua* can be distinguished from *J. punicea* by the distinctly slenderer ambulatory legs (e.g., dactylus of second leg 11.4–15.0 vs. 5.9–7.5 times longer than broad; second ambulatory leg merus 4.3–4.4 vs. 3.5–4.0 times longer than broad) (Fig. 2A, B; Ng & Chong 1986; Ng 1988: pl. 1 fig. D, fig. 22A); G1 terminal segment being less strongly hooked or outwardly curved (vs. G1 terminal segment more strongly hooked or curved outwards in appearance); and G1 subterminal segment being relatively slenderer (vs. G1 subterminal segment relatively broader) (Fig. 2C–F, H; Yeo et al. 1999: fig. 6B-D). Furthermore, specimens of *J. punicea* are larger than those of *J. gua,* with specimens of *J. punicea* (e.g., male, 11.3 × 8.8 mm, ZRC 1996.1733) similar in size to the holotype of *J. gua* (11.4 × 8.5 mm, ZRC 2000.2236), possessing undeveloped juvenile G1s (Fig. 2I, J).

In addition to the above primary differences, *J. gua* can also be immediately separated from juvenile as well as adult specimens of *J. punicea* by its light orange live coloration (vs. deep purple in large adults; pink to light purple in juveniles) and proportionately smaller corneas, about 0.4 times length of the eyestalks (vs. normal-sized corneas, subequal to half length of eyestalks) (Fig. 1A, C, D; Ng & Chong 1986; Ng 1988: pl. 1 fig. D, fig. 22A, B). These secondary characters, together with the long and slender ambulatory legs seem to reflect the cave-dwelling habit of *J. gua.* It is interesting to note here that *J. gua* is more similar to juvenile specimens of *J. punicea,* which have relatively slenderer albeit undeveloped G1s, lighter pigmentation and slenderer ambulatory leg segments compared to adult specimens, suggesting a possible progenetic origin for *J. gua* from *J. punicea.*

Johora gua appears to be a true caver-

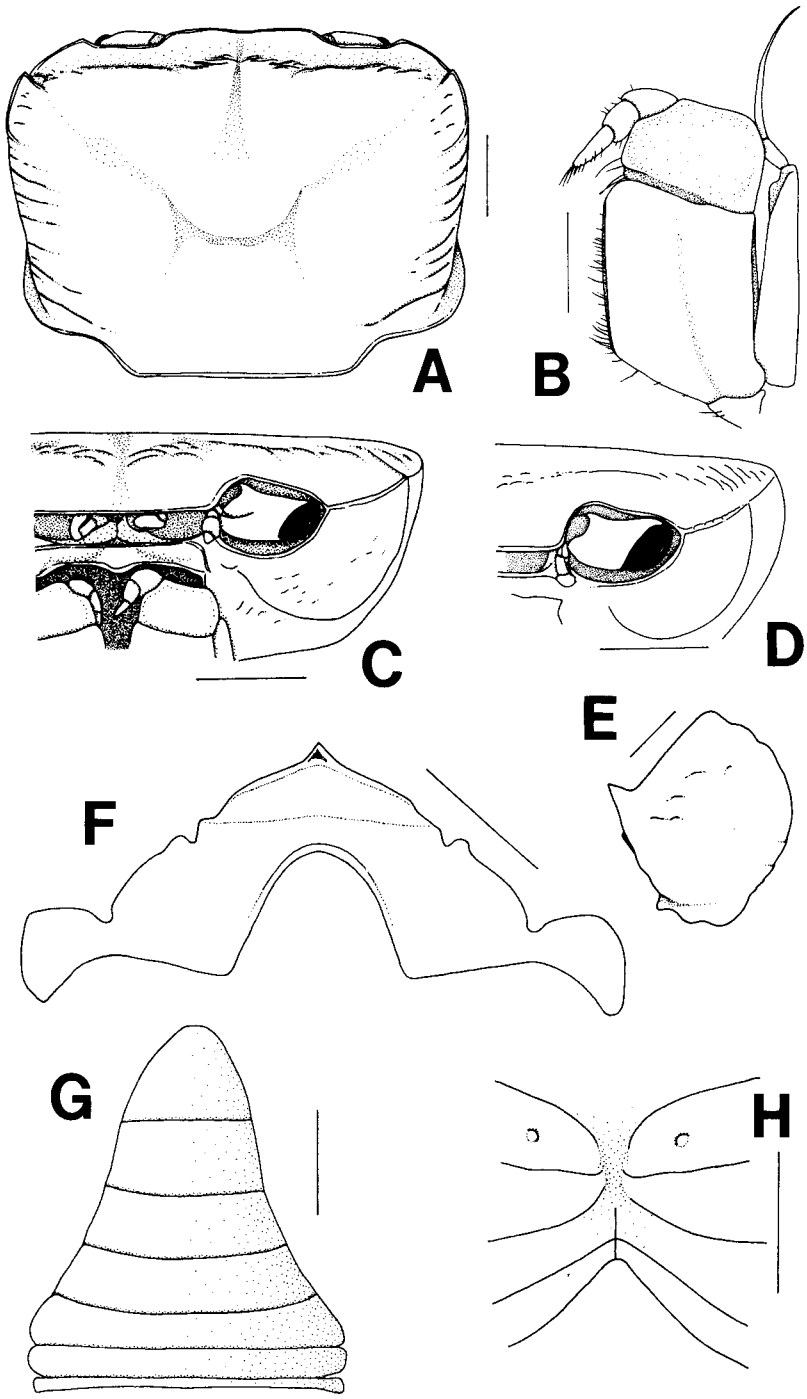

Fig. 1. A–C, E–H, *Johora gua,* new species, holotype male (11.4 × 8.5 mm) (ZRC 2000.2236); D, *Johora punicea* (Ng, 1985), male (11.3 × 8.8 mm) (ZRC 1996.1733). A, dorsal view of carapace; B, left third maxilliped; C, D, frontal view of carapace, left side; E, dorsal view of carpus of right cheliped; F, anterior thoracic sternum (sternites 1–4); G, male abdomen; H, posterior thoracic sternum (sternites 5–8). Scales = 2.0 mm (A, C, D, F–H); 1.0 mm (B, E).

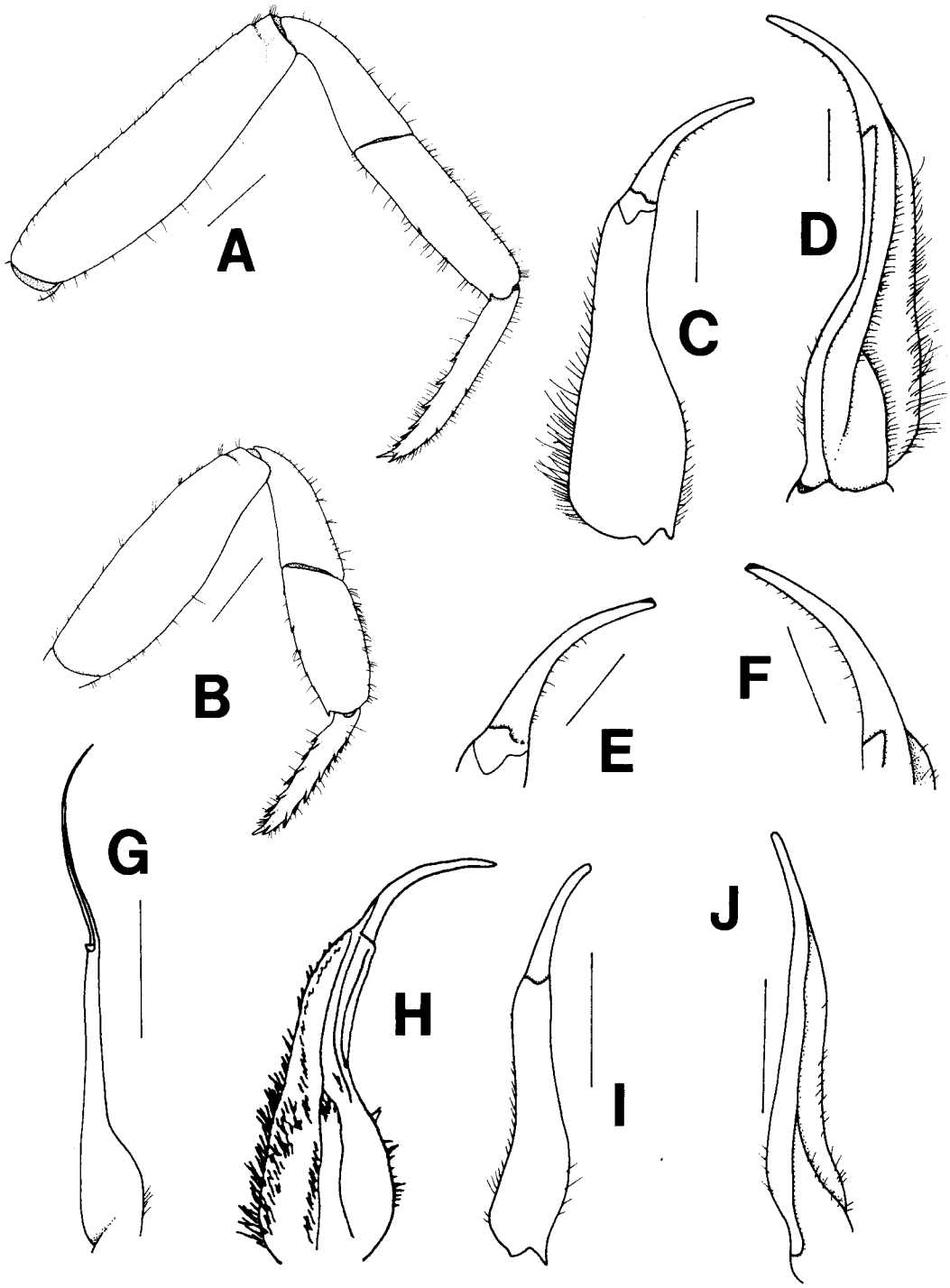

Fig. 2. A–G, *Johora gua,* new species, holotype male (11.4 × 8.5 mm) (ZRC 2000.2236); H–J, *Johora punicea* (Ng, 1985), H, holotype male (19.7 × 15.5 mm) (ZRC 1984.6803) (after Ng, 1988), I, J, male (11.3 × 8.8 mm) (ZRC 1996.1733). A, right second ambulatory leg; B, right fourth ambulatory leg; C, I, dorsal view of right G1; D, J, ventral view of right G1; E, dorsal view of right G1 terminal segment; F, ventral view of right G1 terminal segment; G, right G2; H, ventral view of left G1. Scales = 2.0 mm (A, B); 1.0 mm (G, I, J); 0.5 mm (C–F).

nicolous species, as it has not been found in any surface streams on Pulau Tioman despite extensive and intensive sampling on the island over several years (see Yeo et al. 1999). In addition, *J. gua* possesses a combination of troglomorphic features in its proportionately long, slender ambulatory legs, slightly reduced corneas and reduced pigmentation (relative to *J. punicea* adults). Such features are commonly seen in various combinations and degrees in troglobitic crabs in response to life in a cave habitat, where light is either severely reduced or entirely absent, and the sense of touch becomes more important than sight (see Guinot 1988; Ng & Sket 1996; Yeo & Ng 1999). *Johora gua,* however, may be an incipient troglobite as its troglomorphic features are not as highly specialized as that of other known troglobitic crabs, such as the potamid *Erebusa calobates* Yeo & Ng, 1999, from Laos, which has much longer and slenderer legs together with reduced eyestalks and corneas; the parathelphusid *Sundathelphusa sottoae* Ng & Sket, 1986, from Philippines, which has very reduced pigmentation as well as corneas; and the hymenosomatid *Cancrocaeca xenomorpha* Ng, 1991, from Sulawesi, which has very long, slender legs, and no pigmentation, eyes or orbits (see Ng 1991; Ng & Sket 1996; Yeo & Ng 1999).

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