

A new species of the crab genus *Zozymodes* (Crustacea: Decapoda: Xanthidae) from Guam¹

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Abstract.—A new species of xanthid crab, *Zozymodes sculptus* sp. nov., from Guam is described and illustrated. *Zozymodes sculptus* is distinguished from its congeners *Z. cavipes* (Dana, 1852a), *Z. nodosus* Klunzinger, 1913, *Z. pumilus* (Hombron & Jacquinot, 1846), *Z. xanthoides* (Krauss, 1843), and *Z. demani* Odhner, 1925, by its unusual raised crests of the carapace, two anterior-pointing anterolateral teeth, deep furrow formed by parallel crests on the superior margin of the chelae, and proportionately more narrow carapace.

Introduction

The xanthid crab genus *Zozymodes* Heller, 1861, currently contains four species, all from the Indo-West Pacific region: *Z. cavipes* (Dana, 1852a), *Z. nodosus* Klunzinger, 1913, *Z. pumilus* (Hombron & Jacquinot, 1846), and *Z. xanthoides* (Krauss, 1843). Forest and Guinot (1961: 52, figs 36, 37) partially revised the genus, examined the type series from Guam of *Z. pumilus*, selected a lectotype, compared it with *Z. xanthoides*, and provided figures of the male first gonopods of the two species. Serène (1984), in his monograph covering the West Indian Ocean Xanthidae, provided a key, photographs and figures of the male first gonopods of *Z. cavipes*, *Z. pumilus*, and *Z. xanthoides*. Serène also briefly discussed a further species, *Zozymus* (= *Zosimus*) *demani* Odhner, 1925, as possibly being included in *Zosymodes*, but this species is now in *Serenius* Guinot, 1976 (Guinot, 1976), in a separate subfamily, Actaeinae. The status of *Z. nodosus*, is uncertain (see Remarks later). Here, we report a fifth species from Guam.

Material examined is deposited at the following institutions: Florida Museum of Natural History, Gainesville, Florida, USA (UF); United States National Museum of Natural History, Washington DC, Smithsonian Institution (USNM); and the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore,

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Singapore (ZRC). Measurements, in millimeters (mm), are of the carapace width and length, respectively. Conventions for carapace region designations (e.g., 1F, 1M, etc.) follow Dana (1852b). The abbreviations G1 and G2 refer to the male first and second gonopods. This species has been registered with ZooBank, record at urn:lsid:zoobank.org:act:76D518D6-5AA1-41F5-BF44-68ADE0A5F066.

Taxonomic account

Family Xanthidae Macleay, 1838

Subfamily Zosiminae Alcock, 1898

Genus *Zozymodes* Heller, 1861

Type species. *Zozymodes carinipes* Heller, 1861 [junior synonym of *Zozymodes xanthoides* (Krauss, 1843) (ICZN, 1925: Opinion 85)], by monotypy; gender of genus masculine.

***Zozymodes sculptus*, new species**

(Figs. 1–3)

Material examined. Holotype: male (6.2 x 4.3) (USNM 1203986), Taogam Point, Pago Bay, Guam, coll. R. Kropp & J. Dominguez, 3 September 1984. Paratypes: 1 male (5.0 x 3.7) (USNM 1203987), Taogam Point, Pago Bay, Guam, coll. R. Kropp & J. Dominguez, 3 September 1984; 1 male (4.5 x 3.1), 1 female (5.0 x 3.7), 1 ovig. female (7.2 x 5.0) (USNM 1203988), Taogam Point, Pago Bay, Guam, coll. R. Kropp & J. Dominguez, 3 September 1984; 2 males (4.0 x 2.9, 5.9 x 4.3), 2 females (5.3 x 3.8, 6.4 x 4.4), 2 ovig. female (6.8 x 4.8, 5.9 x 4.3) (USNM 1203989) Taogam Point, Pago Bay, Guam, coll. R. Kropp & J. Dominguez, 28 November 1984.

Comparative material. *Zozymodes pumilus* (Hombron & Jacquinot, 1846) 28 males (largest male = 8.8 x 6.1), 55 females, 4 ovig. female (ZRC 1965.11.8.51–60), Cocos Keeling Island, Indian Ocean, coll. C. A. Gibson-Hall, 1941; 1 male (7.4 x 5.1) (UF 18509), reef flat, Makemo Atoll, Tuamotu Islands, French Polynesia, coll. P. Bacchet & J. Letourneaux, April 2009; 1 ovig. female (6.8 x 3.9) (UF 18511), reef flat, Makemo Atoll, Tuamotu Islands, French Polynesia, coll. P. Bacchet & J. Letourneaux, April 2009; 1 ovig. female (6.9 x 4.6) (UF 18510), reef flat, Makemo Atoll, Tuamotu Islands, French Polynesia, coll. P. Bacchet & J. Letourneaux, April 2009; 1 male (7.1 x 5.2), 1 female (7.5 x 5.2) (USNM 123230) Hikueru Island, Tuamotu Archipelago, coll. Ranson, 1952; 1 female (8.1 x 5.3) (USNM 134635), 15 ft., Christmas Island, Line Islands, Pacific Ocean, coll. C. H. Edmondson. *Zozymodes cavipes* (Dana, 1852) 1 male (12.2 x 8.6), 1 ovig. female (18.0 x 11.8) (ZRC 1965.11.8.61–62), Christmas Island, Indian Ocean, coll. M. W. F. Tweedie, 8–9/1932. *Zozymodes xanthoides* (Krauss, 1843), 1 male (7.5 x 5.4), 1 female (9.6 x 6.4) (USNM 123231), Sanafir Island, Red Sea, coll. R. P. Dollfus, 14 April 1928.

Diagnosis. Carapace (Fig. 1A, B) transversely ovate, ca. 1.4 times broader than long, anterior regions sculptured with elevated crests; regions

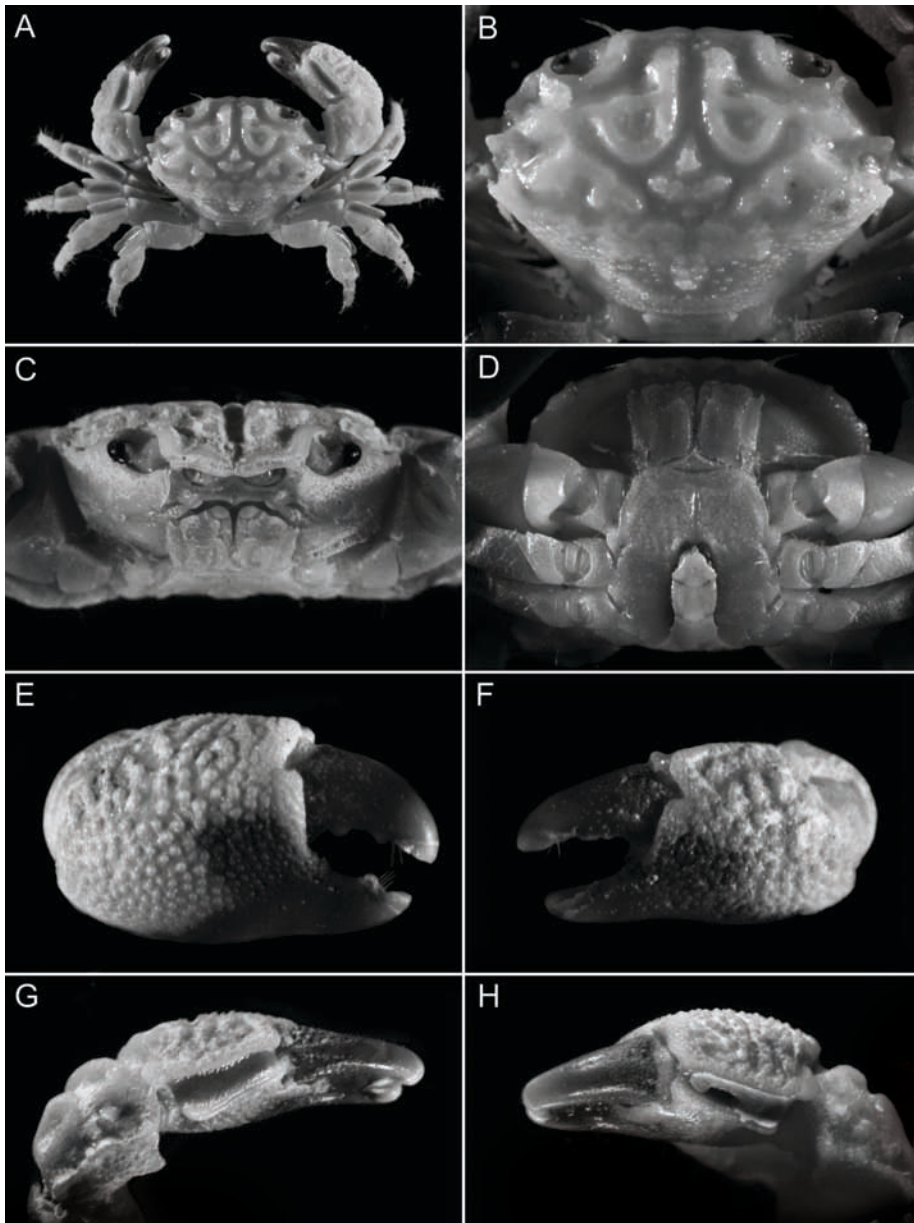


Figure 1. *Zozymodes sculptus* sp. nov., holotype male (6.2 x 4.3) (USNM 1203986), Guam; A, dorsal view; B, carapace, dorsal view; C, frontal view; D, ventral view; E, major chela, external view; F, minor chela, external view; G, minor chela, dorsal view; H, major chela, dorsal view.

2F, 1M and 2M conjoined into elevated, d-shaped and b-shaped crests on left and right sides, respectively; 3M indicated by longitudinal and transverse elevations forming upside-down T-shaped crest. Front (Fig. 1C) deflexed ventrally, bilobed, with 2 rims. Anterolateral margin with 4 teeth excluding external orbital tooth; first and second teeth low, obtuse, third and fourth

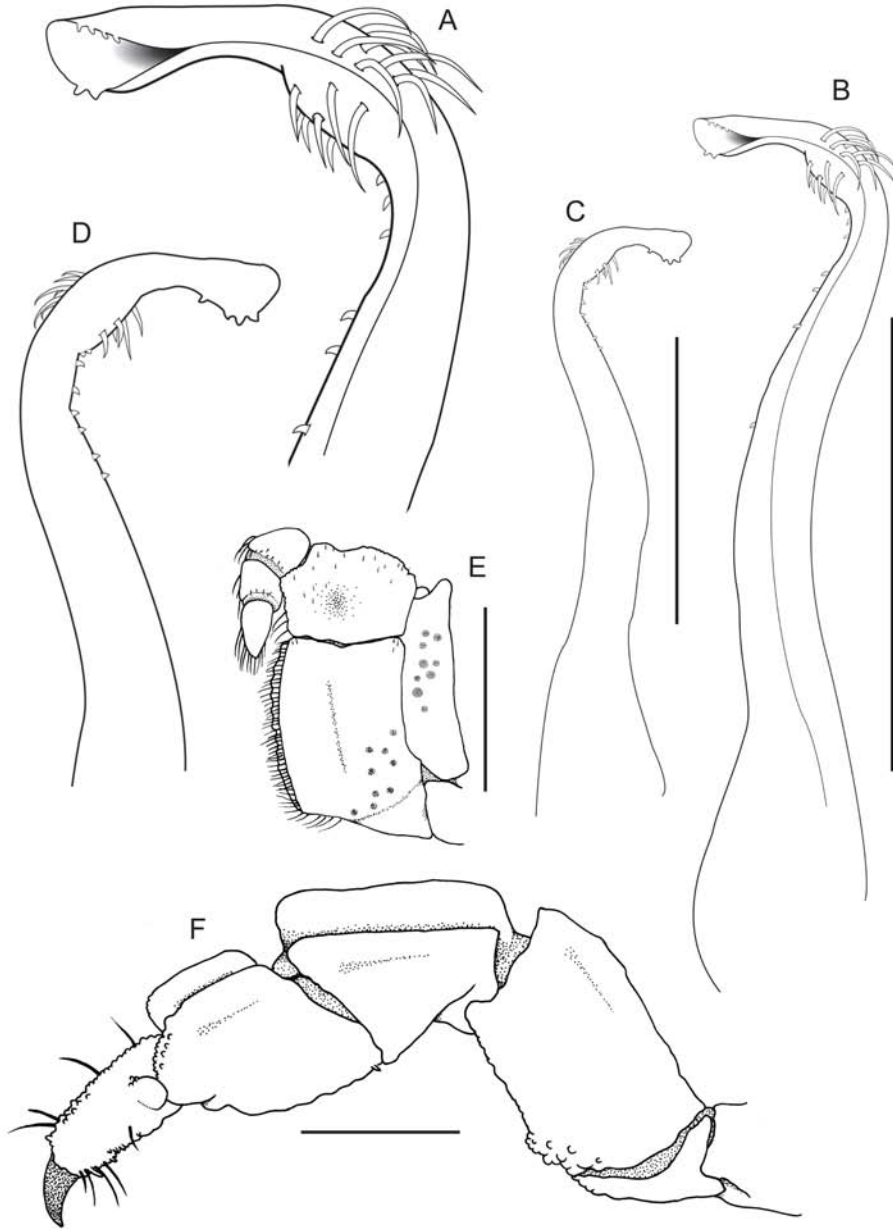


Figure 2. *Zozymodes sculptus* sp. nov., holotype male (6.2 x 4.3) (USNM 1203986), Guam; A, right G1, external view, detail; B, right G1, external view; C, right G1, internal view; D, right G1, internal view, detail; E, left third maxilliped; F, left fourth walking leg. Scales 1.0 mm.

teeth pointing obliquely laterally, confluent with transverse crests of carapace. Basal antennal article subrectangular, longer than broad, flagellum not entering orbital hiatus. Third maxilliped (Fig. 2E) merus subquadrate, with numerous short plumose setae, anterior margin with distinct median notch. Chelipeds (Fig. 1E–H) subequal, robust; palm robust, with 2 dorsal,

longitudinal crests, forming smooth longitudinal depression between. Ambulatory legs (Figs. 1A, 2F) with superior margin of carpus and propodus possessing 2 high, longitudinal, parallel crests forming deep, smooth hollow with minute punctae; dactylo-propodal locking mechanism distinct. Male abdomen (Figs. 1D, 3B) long, narrow, somites 3–5 fused. G1 (Figs. 2A–D, 3D) distal 1/4 curving ventrally then posteriorly; with several stout setae on mesial and posterior margin of curve; bulging mid-curve; tip spoon-like.

Description. Carapace (Fig. 1A,B) transversely ovate, ca. 1.4 times broader than long, anterior regions sculptured with elevated crests, separated by low, broad depressions with numerous or sparse short setae; regions 2F, 1M and 2M conjoined into elevated, d-shaped and b-shaped crests on left and right sides, respectively; 3M indicated by longitudinal and transverse elevations forming upside-down T-shaped crest; transverse crest linking anterolateral border of 2M and crest of third anterolateral tooth; 5L and 6L fused, elevated, tilted, F-shaped. Front (Fig. 1C) deflexed ventrally, bilobed, with 2 rims; lower rim sinuous, lobes separated by V-shaped median cleft, laterally separated from inner orbital angle by short groove. Supraorbital margin elevated; mesial margin forming slightly greater than right angle with front, longer than posterior transverse margin. Suborbital margin sinuous, external orbital angle barely discernible, smoothly joining anterolateral margin. Anterolateral margin with 4 teeth; first and second teeth low, obtuse, third and fourth teeth directed obliquely laterally, confluent with transverse crests of carapace. Posterolateral margin straight; posterior and anterior carapace divided by discontinuous transverse crest across fourth anterolateral teeth. Posterior regions of carapace granulate.

Eyestalks minutely granulate, dorsal margin markedly concave. Antennules folding obliquely transversely. Basal antennal article subrectangular, longer than broad, not entering orbital hiatus, flagellum free to enter orbit. Epistome and endostome smooth; endostome without longitudinal ridges. Third maxilliped (Fig. 2E) exopod moderately stout, microscopically punctate, with sparse short plumose setae mostly on lateral margin and posterior surface; endopod with ischium stout, minutely granulate, about 3/4 wide as long (medial width by medial length), with scattered short plumose setae, longitudinal sulcus near extensor margin, lined with short plumose setae, mesial margin thin with fringe of setae; merus subquadrate, wider than long, with numerous short plumose setae, anterior margin with distinct median notch, angular towards concave junction with carpus; carpus, dactylus and propodus minutely granulate with few short plumose setae and long stout terminal setae.

Chelipeds (Fig. 1E–H) subequal, robust. Dorsal margin of merus with longitudinal crest flush with carapace, distal, dorsal margin expanded. Dorsal, internal margin of carpus with slight granular crest, dorsal surface with elevations forming septa of several ovate depressions. Palm of chelae robust, with 2 dorsal, longitudinal crests, forming smooth longitudinal depression between; outer surface granulate; lower margin with minute pits; inner margin granulate with minute pits on fixed finger. Fingers black; tips white,

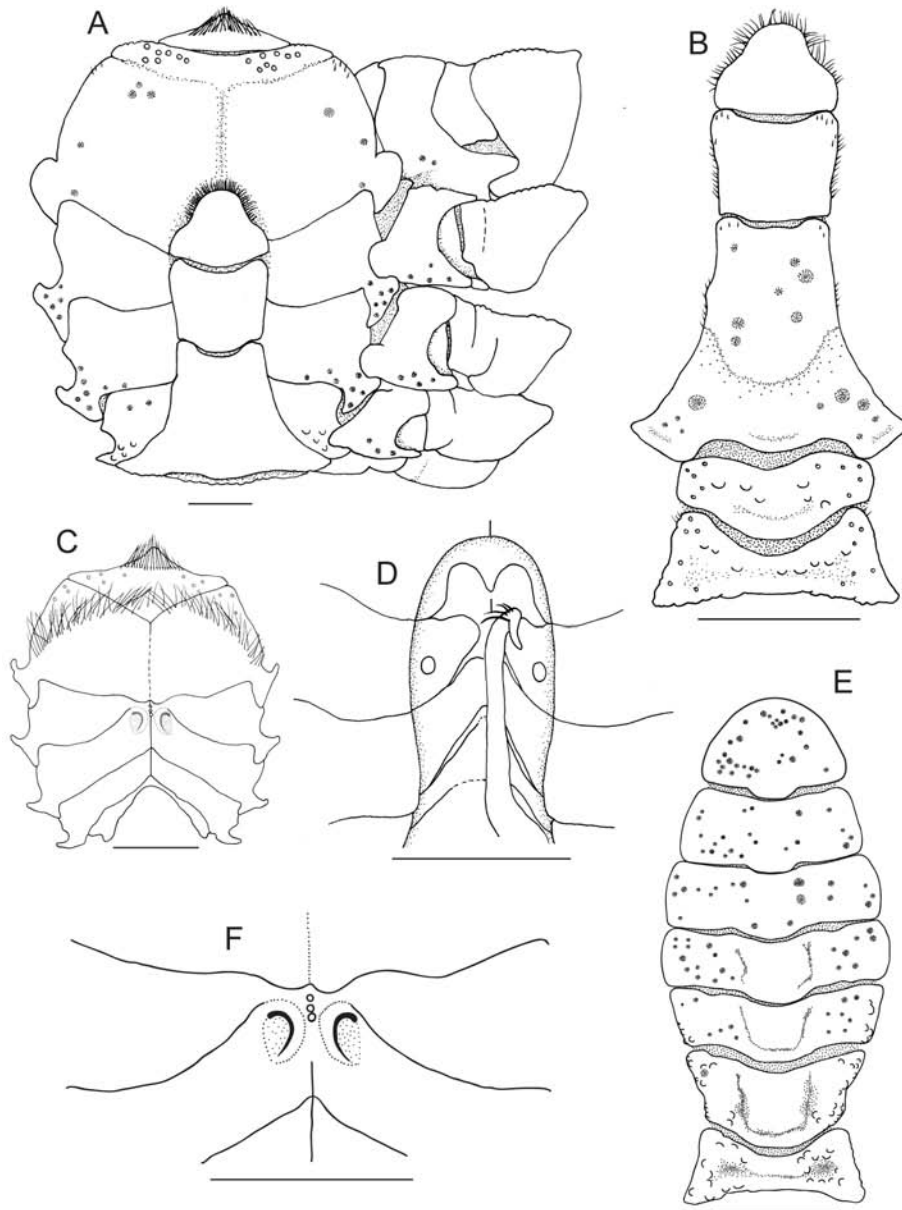


Figure 3. *Zozymodes sculptus* sp. nov., holotype male (6.2 x 4.3) (USNM 1203986), Guam; A, male thoracic sternum; B, male abdomen; D, male sternoabdominal cavity. *Zozymodes sculptus* sp. nov., paratype female (6.4 x 4.4) (USNM 1203989), Guam; C, female thoracic sternum; E, female abdomen; F, vulvae. Scales 1.0 mm.

hollowed, spoon-like, with subapical brush of setae on cutting edge, black pigment not restricted to fixed finger, extending 2/3 length of dorsal surface of propodus. Dactylus less than half length of dorsal margin of propodus. Major chela more robust, with more concave ventral margin of dactylus than minor chela.

Ambulatory legs (Figs. 1A, 2F) with surfaces granulate, sparsely setose distally, length subequal to carapace width, merus of fourth leg reaching 2/3 distance to fourth anterolateral tooth. Superior margin of merus cristate, culminating in distal point. Carpus and propodus superior margin with 2 high, longitudinal, parallel crests forming deep, smooth hollow with minute punctae. Dactylo-propodal locking mechanism formed by lamillar extension of distal margin of propodus that slides beneath bulbous flange on dactylus; tip of dactylus with single terminal spine.

Male thoracic sternum (Figs. 1D, 3A) broad, not covered with setae, punctate; sternite 2 granulate, setose; suture between sternites 1 and 2 hidden behind stout, simple setae; suture between sternites 3 and 4 evident as faint sinuous sulci intersected medially by distinct longitudinal depression (median line) on sternite 4. Sternite 7 not divided by transverse sulcus near coxo-sternal condyle of third ambulatory leg. Sternabdrominal cavity (Fig. 3D) relatively deep; sternite 4 with anterior concavities to accommodate G1 tip in situ. Press-button of abdominal locking mechanism on sternite 5, midway between sutures 4/5 and 5/6; median line visible on posterior portion of sternite 4 but interrupted on anterior portion of sternite 4; not present on sternite 5, only faintly visible on sternite 6; visible on sternites 7 and 8.

Male abdomen (Figs. 1D, 3B) long, narrow, with somites 3–5 fused, appearing smooth to naked eye but minutely punctate; somites 1 and 2 granular, suture between somites 3 and 4 faintly indicated, somite 6 broadest distally, greatest width less than length. Telson subtriangular, longer than broad, distolateral margins concave, tip rounded, reaching coxo-sternal condyle of first walking leg.

G1 (Figs. 2A–D, 3D) diameter moderate; distal 1/4 curving ventrally then posteriorly; with several stout setae on mesial and posterior margin of curve; bulging subterminally; tip tubular, ultimately spatuliform, formed from mesially splaying folds. G2 short with spatuliform distal part.

Variations. – Other than sexual features, adult females conform closely to the morphology of the male holotype. The female abdomen (Fig. 3E) is an elongate ovate structure. The vulvae (Fig. 3C, F) of mature females on sternite 6 are circular, moderately large in size and positioned close to the suture between sternites 5 and 6. The vulvar cover is semicircular, depressed and covers most of the vulva, leaving only the mesial periphery of the vulva exposed. Smaller specimens (e.g., small male paratypes, USNM 1203989, USNM 1203988) tend to have relatively lower crests of the anterior regions of the carapace. The G1s are variable in the position at which the tip splays distally. That is, the fold begins to open closer to the tip in some, like the holotype specimen, resulting in a closed tube distally opening in a spatuliform tip. The G1s of other specimens (e.g., male paratypes, USNM 1203989, USNM 1203988) have a more unfolded look; with the folds opening nearer to the setae, resulting in a dugout-like distal shaft splaying wider distally, much like the G1 of *Z. pumilus* (see Forest & Guinot 1961: fig. 36; Serène, 1984: fig. 90).

Type locality. Pago Bay, Guam, Mariana Archipelago.

Etymology. The species name refers to the unique sculpture of the carapace.

Distribution. Presently only known from the type locality, Guam.

Remarks. Ng *et al.* (2008) recognized four species of *Zozymodes*: *Z. nodosus* Klunzinger, 1913 (type locality: Red Sea), *Z. cavipes* (Dana, 1852) (type locality unknown), *Z. pumilus* (Hombron & Jacquinot, 1846) (type locality: Guam), and *Z. xanthoides* (Krauss, 1843) (type locality: South Africa). Of these, the latter three are well established in the literature. Forest & Guinot (1961: 52, fig. 36, 37) examined the type series of *Z. pumilus* and selected a lectotype. They also compared *Z. pumilus* with *Z. xanthoides* and provided figures of the G1s of the two species. The G1 of *Z. xanthoides* was also figured by Stephensen (1946: fig. 39C) and Barnard (1950: fig. 39b, c). Later, Guinot (1967: 269) listed the three species present in the Indian Ocean and the Red Sea: *Z. cavipes*, *Z. pumilus*, and *Z. xanthoides*; and Serène (1984) provided a figure of the G1 of *Z. cavipes* and a key to these three species.

There are also two other available names: *Z. carinipes* Heller, 1861 and *Leptodius (Xanthodius) cristatus* Borradaile, 1902. The type species of *Zozymodes*, *Z. carinipes*, from the Red Sea, is now a subjective junior synonym of *Z. xanthoides* (ICZN, 1923: Opinion 85). *Leptodius (Xanthodius) cristatus* Borradaile, 1902 (type locality: Minicoy, Maldives), also recorded by Rathbun (1911) from Peros, Coin and Coetivy, as well as by other authors from various localities (including Gilber I. Marianna Is., Caroline Is., and Tuamotu Archipelago), was made a junior synonym of *Z. pumilus* by Forest & Guinot (1961), although, they recommended that the G1s from the type localities be checked to verify this hypothesis.

Zozymodes sculptus sp. nov., has the two distinctive high, subparallel crests on the superoexternal margin of the carpus of the ambulatory legs, that clearly marks it as a member of the genus. However, the striking elevated crests on the anterior carapace regions of *Z. sculptus* sp. nov., are unique. All other *Zozymodes* species have their anterior carapace regions defined by shallow to moderately deep furrows and are covered with granules. In other characters *Z. sculptus* is perhaps closest to *Z. xanthoides* and *Z. pumilus* (Fig. 4C–F). These three species have distinct dactylo-propodal locking mechanisms on the ambulatory legs, a longitudinal depression on the dorsal margin of the chelae, relatively high, distinct parallel crests of the ambulatory legs, and a similarly wrinkled, almost honeycomb-like, texture of the cheliped carpus, although the latter character is variable in *Z. xanthoides* and *Z. pumilus*. The G1 morphology of these three species is also similar, i.e., ventrally curving with a hollowed, splayed tip (Figs. 2A–D, 3D; Serène 1984: figs. 89, 90).

Zozymodes sculptus particularly resembles *Z. pumilus* in the morphology of the male thoracic sternum, male abdomen, and third maxillipeds. Both have conspicuous anterior cavities on sternite 4 in the sternoabdominal cavity to accommodate the G1s; the press-buttons of the male abdominal locking mechanism are positioned on sternite 5 midway between the sutures; and a

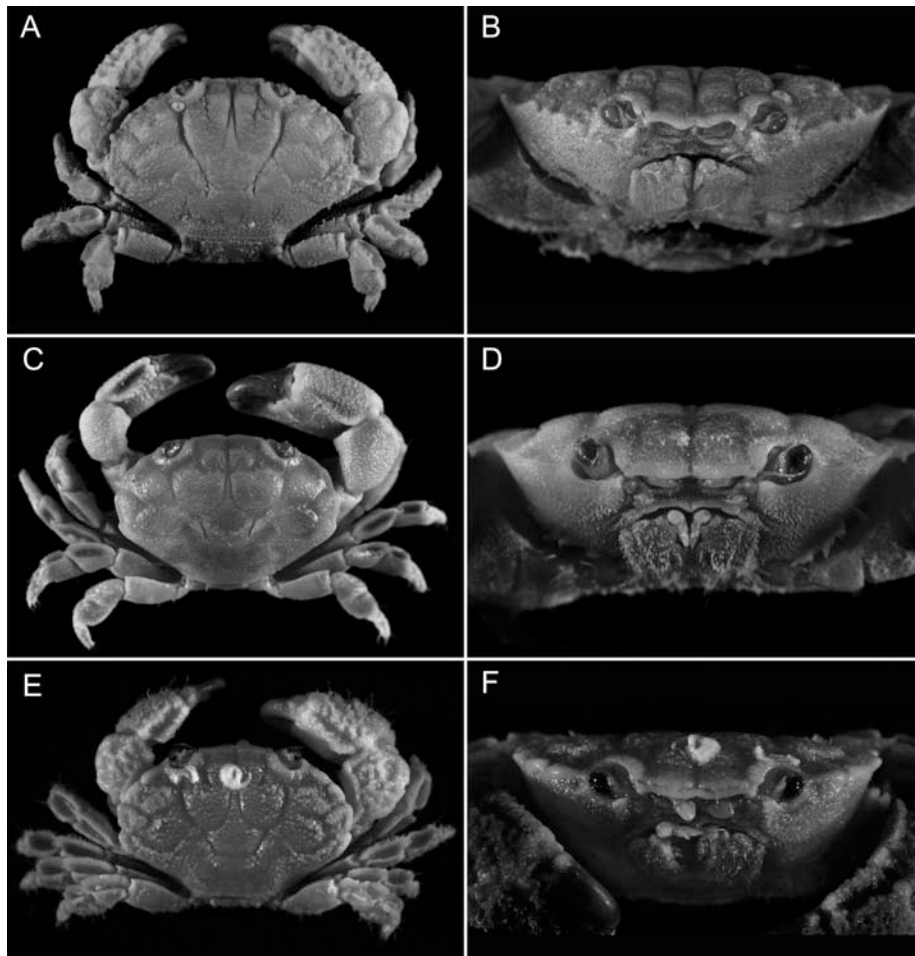


Figure 4. *Zozymodes cavipes* (Dana, 1852), male (12.2 x 8.6) (ZRC 1965.11.8.61–62), Christmas Island; A, dorsal view; B, frontal view. *Zozymodes pumilus* (Hombron & Jacquinot, 1846) male (8.8 x 6.1) (ZRC 1965.11.8.51–60), Cocos Keeling Island; C, dorsal view; D, frontal view. *Zozymodes xanthoides* (Krauss 1843), male (7.5 x 5.4) (USNM 123231), Sanafir Island; E, dorsal view; F, frontal view.

median line is visible on sternites 4, 6, 7, and 8 but not on sternite 5. These two species also have similar subquadrate third maxilliped meri which are a little wider than long, and covered with short, plumose setae (versus relatively narrower third maxilliped meri in *Z. xanthoides*). Moreover, *Z. sculptus* sp. nov., and *Z. pumilus* have similarly shaped and relatively short male telsons.

Zozymodes cavipes (Fig. 4A–B) is quite different from its congeners in all the above characters, possibly warranting its removal from the genus when it is revised. *Zozymodes cavipes* has carapace granules arranged in short striae (versus lacking in other *Zozymodes* species), an antero-lateral margin that meets the orbits ventrally (versus more dorsally in other *Zozymodes* species), much smaller orbits (versus larger in other *Zozymodes*

species), ambulatory legs lacking dactylo-propodal locking mechanisms (versus present in *Z. sculptus* sp. nov., *Z. pumilus*, *Z. xanthoides*), and, in males, a relatively wider abdomen (versus narrower in congeners) and the G1 (see Serène 1984: fig. 88) with relatively longer setae and distinct lateral ridges (versus shorter setae and less distinct lateral ridges in *Z. sculptus* sp. nov. (Fig. 2A–D), *Z. pumilus*, and *Z. xanthoides*; see Forest & Guinot 1961: figs. 36, 37). However, the sternoabdominal cavity of *Z. cavipes* does share similarities with other *Zozymodes* species. For instance, sternite 4 has anterior concavities to accommodate the G1s, although this feature is more conspicuous in *Z. sculptus* sp. nov., and *Z. pumilus*. *Zozymodes cavipes* also possesses a median line along sternites 4, 6, 7, and 8 but not visible on sternite 5 (as in *Z. sculptus* sp. nov., and *Z. pumilus*); although, the press-button is located on sternite 5 near the suture between sternites 5 and 6 (versus midway between the sutures in *Z. sculptus* sp. nov., and *Z. pumilus*).

Zozymodes nodosus is problematic in that it is mentioned very little in the literature, the G1 morphology is unknown and, based on the original description (Klunzinger 1913: 169, pl. 5, figs. 13a, b), possesses features uncharacteristic of the genus (especially chelae with pointed, crossing tips). For these reasons the species was questionably attributed to the genus by Ng *et al.* (2008). In any event, the species is distinctly different from *Zozymodes sculptus* sp. nov., not only by the aforementioned chela morphology, but also in having pearliform granules on carapace region 2L.

Zozymodes sculptus sp. nov., bears a striking resemblance to species of the pilumnid genus *Vellumnus* Ng, 2010. Members of this genus, especially *V. labyrinthicus* (Miers, 1884), have a transversely ovate carapace with raised crests remarkably similar to *Z. sculptus* sp. nov. (see Ng 2010, figs. 13–15). It would be interesting to investigate if this may be a case of morphological convergence resulting from ecological selection pressure.

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