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Hermit crabs of the genus *Diogenes* Dana, 1851 (Crustacea: Decapoda: Diogenidae) collected during the *Albatross* Philippine Expedition, 1907–1910, including descriptions of three new species

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Abstract Hermit crabs of the genus *Diogenes* were reported based on the material collected during the Philippines *Albatross* Expedition, 1907-1910. Five species of the "*edwardsii*" group, and three species of the "*pallescens*" group are reported and discussed, including full descriptions of three new species: *D. crassus, D. haigae*, and *D. magnus*.
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Keywords: taxonomy, *Albatross*, expedition, *Diogenes*, hermit crab, Diogenidae

Introduction

During scientific explorations the aquatic resources of the Philippine Islands conducted on the US Fish Commission Steamer *Albatross* in 1907‑1910, numerous specimens of marine organisms, including decapod crustaceans, were collected. This valuable material is housed in the National Museum of Natural History, Smithsonian Institution, Washington DC, USA (USNM). A study of the hermit crab specimens from this collection of the genus *Diogenes* Dana, 1851, is presented.

Currently, 64 species of *Diogenes* are known from the Indo-West Pacific (McLaughlin et al., 2010; Rahayu, 2012, 2015; Komai et al., 2012, 2013, 2018; Xiao et al., 2015; Igawa & Kato, 2017; Landschoff & Rahayu, 2018; Trivedi et al., 2016). Species of *Diogenes* with a simple rostral process have been divided in two subgroups (Asakura & Tachikawa, 2010). The "*edwardsii*" group contains species in which the antennal peduncles are longer than the ocular peduncles, and the antennal flagella have a pair of long setae on each article. The "*pallescens*" group has species in with the antennal peduncles shorter than the ocular peduncles, and the antennal flagella lack a pair of long setae on each article. In this study, five species of the "*edwardsii*" group, and three of the "*pallescens*" group are reported from the *Albatross* collections, including descriptions of three new species.

Shield length (SL), measured from the tip of the rostrum to the posterior margin of the shield, is used as an indicator of size. The terminology used herein generally follows McLaughlin & Clark (1997). When referring to the surfaces of the chela and carpus of each cheliped, the terms "upper", "lower", "inner" and "outer" are used, as the carpal/meral articulations of the chelipeds in *Diogenes* species are rotated counterclockwise from

the horizontal plane. This means, for example, that the outer surface of the chela represents the morphological dorsal surface of the segment.

In addition to the USNM specimens, comparative material housed in the following museums was examined: Muséum national d'histoire naturelle, Paris, France (MNHN Pg); Australian Museum, Sydney, Australia (AM); Natural History Museum, London, U.K. (NHM); Western Australian Museum, Perth, Australia (WAM).

Systematics

Family DIOGENIDAE Ortmann, 1892
Genus *Diogenes* Dana, 1851

Diogenes crassus sp. nov.

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Figs. 1–4

Type material. Holotype: male, SL = 4.3 mm; Palaboean Ratoe, Java (currently, Pelabuhan Ratu, Java, Indonesia; Lat. 6.98° N., Long. 106.56° E); coll. Eryant and Palmer, 1909–1910, JF 0551 (S7A) USNM 1281041. Paratypes: 10 males, SL = 2.1–4.0 mm; 3 females, SL = 1.8–3.0 mm, data same as holotype, JF 0551 (S7) USNM 1281042.

Description. Shield (Fig. 1A, B) as long as broad; anterior margin between rostral lobe and lateral projections shallowly concave; anterolateral angles each with few spines; lateral margins straight; dorsal surface with scattered setae and many transverse spinulose ridges of various length; rostral lobe broadly rounded; lateral projections each terminating in small spine and often with 1 to several small submarginal spines. Intercalary rostral process simple, slightly shorter than ocular acicles (including distal spines). Branchiostegites (Fig. 1B) each with dorsal margin bearing row of strong spines.

Ocular peduncles (including corneas) (Fig. 1A) 0.7–0.8 length of shield, slightly inflated basally and distally. Corneas moderately dilated. Ocular acicles with many (ca. 10 or more) strong spines distally. Antennular peduncles (Fig. 1A) with ultimate segments exceeding distal margins of corneas by 0.7 length of ultimate segment when fully extended; ultimate, penultimate and basal segments unarmed. Antennal peduncles (Fig. 1A, B) stout, with fifth segments exceeding distal margins of corneas by 0.2 length of fifth segment when fully extended; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle bearing strong spine, dorsomesial distal angle bearing sharp spine, ventrolateral distal margin with few strong spines; first segment with transverse spinulose ridge on dorsal surface laterally; antennal acicles each with row of strong spines on dorsomesial face; antennal flagella very long, with articles each bearing pair of long setae and few short setae.

Third maxilliped (Fig.1C, D) unarmed except for few stout spines on ischium and basis.

Left cheliped (Figs. 2, 3A) large, stout; sparsely setose. Dactyl and fixed finger each terminating in calcareous claw; cutting edges with many calcareous teeth. Dactyl with inner and outer margins of upper surface each with row of small spines or tubercles; outer surface with many small spines, denser near upper face; inner face with row of tubercles or spines on midline and scattered tubercles on lower portion. Fixed finger with outer face bearing few rows of spines on upper half and dense tubercles on lower half; inner face with many tubercles or small spines. Palm with upper face bearing many spines; outer face with many small spines and dense

tubercles on lower portion; lower face with dense, large tubercles; inner face with numerous tubercles or small spines. Carpus with upper face bearing row of strong spines; outer face covered with many spines, distal margin with many small spines; lower face with many small tubercles or spines, distal margin with many spines or tubercles; inner face with many tubercles or spines, distal margin with many spines. Merus with dorsal margin bearing row of strong spines; lateral face with many short, transverse, ridges and often with subdistal spinulose ridge; ventral face with many tubercles or small spines, ventromesial margin bearing row of strong spines; ventrolateral margin with many sharp spines.

Right cheliped (Fig. 3B–D) small, setose. Dactyl and fixed finger each terminating in calcareous claw. Dactyl with upper face bearing 2 rows of spines; outer face with 1 or 2 rows of spines. Fixed finger and palm with lower half of outer face bearing many small spines; lower face with scattered tubercles; dorsal face of palm with spines. Carpus with outer face bearing row of spines, distal margin with few strong spines; upper face with row of spines and 1 strong distal spine. Merus with dorsodistal margin bearing row of spines; ventral face with many small spines.

Second and third pereopods (Fig. 4A–F) similar but armature slightly different. Dactyls 1.2–1.3 length of propodi; each terminating in sharp, semi-transparent claw; dorsal margin with row of small spines except for distal 1/4 – 1/3 and row of setae; lateral and mesial faces each with shallow longitudinal sulcus accompanied with row of widely-separate setae, mesial faces each also with dorsal and ventral rows of setae; ventral margin with row of setae, denser distally. Propodi 1.5–1.7 length of carpi; dorsal faces with many tiny spines; ventral margins unarmed (second) or row of widely-spaced small spines. Carpi elongate, 0.6–0.7 length of meri; each with sharp dorsodistal spine; dorsal faces with row of spines. Meri unarmed.

Sternite XII (sternite of third pereopods) with anterior lobe subdivided in 2 lobes (Fig. 3F).

Fourth pereopods (Fig. 3E) semichelate; dorsodistal angles of palm and carpus each with sharp spine.

Abdomen dextrally twisted. Uropods asymmetrical, left larger than right; endopodal and exopodal rasps well developed.

Telson (Fig. 3H) asymmetrical, left larger than right; right with posterior margins fringed with small spines; left with lateral and posterior margins fringed with numerous small spines and with very strong spines on lateral and posterolateral margins.

Etymology. The specific name is taken from the Latin crassus meaning stout and refers to the very stout left cheliped of this species.

Remarks. This species belongs to the "*edwardsii*" group. This species is characterized by stout ocular peduncles with dilated corneas, a large and scarcely-setose left cheliped covered with dense small spines and tubercles on both outer and inner surfaces of the dactyl, fixed finger, and palm, and presence of rows of small spines on dorsal margins of the dactyls, propodi and carpi of the second and third pereopods. By a suite of these characters, this species is separated from all other species of the "*edwardsii*" group.

This new species is similar to *Diogenes moosai* Rahayu & Forest, 1995, and *D. acanthochela* Komai, Liang & Yang, 2012, in having ocular acicles distally fringed with many spines, a massive, spinulose and scarcely-setose left cheliped, and spinulose right cheliped. However, *D. moosai* has slender ocular peduncles, unarmed dactyls and propodi of the ambulatory pereopods, whereas the ocular peduncles of *D. crassus* are very stout and the dactyls and propodi of the ambulatory pereopods are armed dorsally with row of spines. *Diogenes acanthochela* has slender ocular peduncles and a dorsal row of small spines on meri of the second and third pereopods, whereas *D. crassus* has stout ocular peduncles and unarmed dorsal faces of meri of the second and third pereopods.

Diogenes fasciatus (Figs. 5–11) has also a massive, large and scarcely-setose left cheliped with dense small tubercles on outer faces of the dactyl, fixed finger and palm. However, the inner faces of the same segments of *D. fasciatus* are scarcely tuberculate (Fig. 8A) in contrast to dense small spines covered on the same surface of *D. crassus*. *Diogenes fasciatus* differs from *D. crassus* in having unarmed dactyls of the second and third

pereopods (Fig. 11). The same surfaces in *D. crassus* are armed with row of spines (Fig. 4).

Diogenes fasciatus Rahayu & Forest, 1995

Figs. 5–11

? *Diogenes costatus*: Ahmad & Khan, 1971: 14, figs 8-8a (? not *Diogenes costatus* Henderson, 1893).
Diogenes bicristimanus: Tirmizi & Siddiqui, 1981: fig. 15; Tirmizi & Siddiqui, 1982: 52, figs 27–28. Siddiqui & Kazmi, 2003: 89. (not *Diogenes bicristimanus* Alcock, 1905)
Diogenes fasciatus Rahayu & Forest, 1995: 388, fig. 1. Rahayu, 1996: 340; Rahayu, 2000: 390.
Diogenes? *fasciatus*: Siddiqui & Kazmi, 2003: 89.

Type material. Holotype: SL = 4.0 mm, Muara Karang, Java, Indonesia, MNHN Pg 5158. Paratypes: 4 males, 1 female, data same as holotype; 26 males, 11 females, Barombong, Ujung Pandang, Indonesia, MNHN Pg. Size of paratypes: males, SL = 1.5–4.0 mm; females, SL = 1.5–3.0 mm.

***Albatross* material.** 1 female, SL = 4.0 mm, Singapore, coll. E. Deschamps, (JF0538, S1A) USNM 1283265; 3 males, SL = 3.6–4.5 mm, Singapore, coll. E. Deschamps, JF 0538 (S4A, S4B, S4C), USNM 1283271, 1283272, 1283273; 1 male, Paknam, Siam (currently, Samut Prakan, Thailand; Lat. 13.35o N, Long. 100.35o E), coll. A.S. Pearse, 31 May 1930, JF 0661 (S1B), USNM 1283266.

Remarks. I reexamined the type series of *Diogenes fasciatus* (MNHN) and found the following differences between some of the present specimens and the type specimens.

Variation is seen in armature of antennal acicles in the present material. Some specimens (Fig. 6A, B; USNM S4-A) have a very strong hook-like spine on lateral face of antennal acicle, but others (Fig. 5A, B; USNM S1-A) and the type specimens do not have such spines. Variation of setations is also found in the dactyls of the third maxilliped; some specimens (Fig. 6C, E; USNM S4-A) have very stout setae on distal margin, but others (Fig. 5C, E; USNM S1-A) and the type specimens do not have such setae. The present specimens have scarce setation on lateral face of each segment of left cheliped (Figs. 7, 9), but the same surface of the type specimens has moderately dense fine setae. Armature of left cheliped in males also exhibits variation; some specimens (Fig. 7; USNM S1-A) have curved row of strong spines on proximal portion of outer face of palm, but others (Fig. 9; USNM S4-A) do not have such setae. In the present specimens, propodi of the ambulatory pereopods each has a row of spines on dorsal face (Fig. 11B, D, F), but such spine row is absent in the type specimens.

Diogenes haigae sp. nov.

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Figs. 12–14.

Type material. Holotype: SL = 1.5 mm, *Alpha Helix* Sta. 13, Arafura Sea, 35 fathoms, stone and shell on fine sand, 5 m otter trawl, E. Ball, 10º15.2' S, 136º07' E, 17 March 1975, det. J. Haig as *Diogenes* sp., AM-P37785. Paratype (Albatross material): SL = 2.5 mm, Eastern Palawan, 12.2 ml SW of 30th of June Island, 09.12oN, 118.28o E, 6-foot, Mccormick Trawl, 27 FM, 23 Apr. 1909, sta 5426, JF0251, USNM 1281039.

Description. Shield (Fig. 12A, B) as long as broad; anterior margin between rostral lobe and lateral projections shallowly concave; anterolateral angles each with few to several strong spines; lateral margins slightly convex or straight; dorsal surface with scattered setae and pair of short, posterolateral, transverse ridge; rostral lobe broadly rounded; lateral projections blunt, each with few to several tiny submarginal tubercles. Intercalary rostral process simple or bifid, reaching nearly equal to distal margin of ocular acicles (including distal spines). Branchiostegites (Fig. 12B) each with dorsal margin bearing row of small spines.

Ocular peduncles (including corneas) (Fig. 12A) ca. 0.9 length of shield, slightly inflated basally. Corneas slightly dilated. Ocular acicles with few spines distally. Antennular peduncles (Fig. 12A) with ultimate segments well beyond corneas when fully extended; ultimate, penultimate and basal segments unarmed. Antennal peduncles (Fig. 12A, C, D) stout, with fifth segments overreaching ocular peduncles when fully extended; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle bearing strong spine, dorsomesial distal angle bearing sharp spine; first segment unarmed. Antennal acicles each with row of strong spines on dorsomesial face; antennal flagella very long, with articles each bearing pair of long setae and few short setae.

Left cheliped (Fig. 13) very large, stout. Dactyl and fixed finger covered by dense, long and soft setae; cutting edges with blunt calcareous teeth. Lower margin of dactyl and palm with row of tiny rectangular-shaped projections. Palm with upper face and upper half of outer face covered by dense, soft and long setae; upper margin with irregular rows of small tubercles; lower half of outer face with scattered small tubercles or spines; lower portion of inner face distally with dense long and soft setae. Carpus with upper, outer and distal half of lower faces covered by long setae; upper face with irregular rows of tubercles or spines; outer face and distal portion of inner face with scattered tubercles or spines. Merus with dorsal and lateral faces with tubercles or spines and long setae; ventral and dorsomesial faces with long setae.

Right cheliped (Fig. 12E) small, covered by dense, long and soft setae. Dactyl, fixed finger and palm nearly unarmed. Carpus with outer face bearing few to several tubercles. Merus with scattered tubercles or spines on lateral and dorsal faces.

Second and third pereopods (Fig. 14) similar. Dactyls 1.4–1.5 length of propodi; each terminating in sharp, semi-transparent claw, other portion unarmed; dorsal and ventral margins with row of long setae; lateral and mesial faces with 1 (second) or irregular few (third) rows of setae, mesial faces each also with dorsal row of thick setae. Propodi 1.5–1.7 length of carpi, unarmed; dorsal and ventral faces with long setae; lateral face with setae thicker in third than second. Carpi elongate, 0.6–0.7 length of meri; each with sharp dorsodistal spine; dorsal faces often bearing few to several small spines. Meri with ventral faces bearing small tubercles or spines.

Sternite XII (sternite of third pereopods) with anterior lobe subdivided in 2 lobes.

Fourth pereopods semichelate. Fifth pereopods chelate.

Abdomen dextrally twisted. Uropods asymmetrical, left larger than right; endopodal and exopodal rasps well developed.

Telson (Fig. 12F) asymmetrical, left larger than right, margins with long setae; terminal and left lateral margins with many tiny spines and very strong spines present on right lateroposterial angle, terminal margin and left lateral margin.

Remarks. This species belongs to the "*edwardsii*" group. The holotype selected for this species is a specimen found among the collections of the *Alpha Helix* Expedition in 1975, and determined as "*Diogenes* sp." by the late Janet Haig. For unknown reasons, Haig and Ball (1988) did not include this specimen in their report from that Expedition, and it is most probable that they were not confident in identity of the specimen. While studying the Albatross collections, a second specimen of *Diogenes haigae* sp. nov. was discovered, and is designated as a paratype.

Etymology. The species is named in honor of the eminent crustacean biologist, late Dr. Janet Haig, who first reported this species as *Diogenes* sp. in her report of hermit crabs collected during 1975 *Alpha Helix* Expedition (Haig and Ball, 1988).

Affinities. This species is unique in having dense, soft setae covered on smooth surfaces of the dactyl, fixed finger, and palm of both chelipeds (Figs. 12E, 13). The second and third pereopods are also covered with dense soft setae (Fig. 14). By a suite of these characters, this species is set apart from all other species of the "*edwardsii*" group.

Diogenes penicillatus Stimpson, 1858, similarly has a dense cover of setae on the dactyl, fixed finger, and palm, but such setation is present only on the left cheliped in *D. penicillatus*. Furthermore, the outer faces of palm and carpus of the left cheliped are covered by small, acute spines in *D. penicillatus*, whereas the spination of the same surfaces of *D. haigae* is weak (Fig. 13). The propodi of the right second and third pereopods of *D. penicillatus* are each armed with a row of strong spines, whereas the segments are unarmed in *D. haigae* (Fig. 14A, B, D, F).

Diogenes klaasi Rahayu & Forest, 1995

Figs. 15–17

Diogenes klaasi Rahayu & Forest, 1995: 395, fig. 3; Rahayu & Komai, 2000: 28; McLaughlin, 2002a: 419, Fig. 3D–F; Siddiqui et al., 2004: 187, fig. 14; McLaughlin et al., 2010: 21 (list); Naderloo et al., 2012: 65, fig. 3a; Naderloo & Türkay, 2012: 27.

Diogenes? *klaasi*: Siddiqui & Kazmi, 2003: 89.

Type material. Holotype: SL = 3.0 mm, male, Sepinggan, Balikpapan, Indonesia, MNHN Pg 5075. Paratypes: 80 males, 26 females, data same as holotype, MNHN Pg. Size of paratypes, 1.5–3.0 mm.

***Albatross* material.** 1 female, SL = 3.2 mm, Singapore, E. Deschamps, JF 0538 (S3A) USNM 1283269; 1 male, SL = 2.3 mm, Singapore, E. Deschamps, JF 0538 (S3B), USNM 1283270.

Remarks. I reexamined a type series of this species and found the following differences between the USNM specimens and the type series, although such differences are subtle and fall into intraspecific variation: anterolateral margin of shield between lateral projection and anterolateral angle of the present specimens has a few to several spines (Fig. 15A), but such spines are absent in the type specimens. In the present specimens, the carpi of the ambulatory pereopods each has a strong spine on proximal half of the dorsal face (Fig. 17C, E), although such spine is absent in the type specimens. The morphology of telson (Fig. 17I) is quite different between the present specimens and the type specimens.

Diogenes rectimanus Miers, 1884

Figs. 18–21

D*iogenes rectimanus* Miers, 1884, 262, pl. 27, fig. c; Alcock, 1905, 71, pl. 6, fig. 8, 8a, pl. 7, figs. 2, 2a; Khan & Natarajan, 1984, 20, fig. 17; Haig and Ball, 1988, 167; Wang, 1991, 226, fig. 185; McLaughlin & Clark, 1997, 37, fig. 10b; McLaughlin, 2002b, 414, fig. 2A–C; McLaughlin et al., 2007, 151, unnumbered fig.; McLaughlin et al., 2010, 21.

Not *Diogenes rectimanus* – Lanchester, 1902, 366 (in part). = *Diogenes goniochirus* Forest, 1956

Not *Diogenes rectimanus* – Lanchester, 1902, 366 (in part). = *Diogenes avarus* Heller, 1865.

Type material. Holotype: SL = 4.6 mm, Prince of Wales Channel, Towes Strait, H.M.S. *Alert*, NHM 1882.7.

***Albatross* material.** 1 male, SL = 3.7 mm, Singapore, E. Deschamps, JF 0538 (S2A), USNM 1283267; 1 female, SL = 3.9 mm, Philippine, JF 0192 (= D5208)(S2B), USNM 1283268.

Other material. 1 male, SL = 5.0 mm, 1 female, SL = 5.3 mm, Madras, J. R. Henderson Esq. NHM 1892.7.15, 84–86; 2 males, SL = 3.5–4.7 mm, Sta. 27, John Murray Expedition, Gulf of Aden, 34–91 m, NHM 1952.6.17.13–14.

Remarks. I reexamined the holotype and other comparative material and found that the USNM specimens differ slightly from the NHM material as follows. The spination on outer and lower faces of the palm of the left cheliped in the present specimens (Fig. 19) is much stronger than those in the NHM material. The USNM specimens have thick setae on the lateral face of the dactyl and propodus of right third pereopod (Fig. 20B), which are lacking in the NHM material. However, such differences are slight and are considered to represent intraspecific variation.

Diogenes biramus Morgan, 1987

Figs. 22–25

Diogenes biramus Morgan, 1987: 177, fig. 2; Morgan, 1990: 17, fig. 3; McLaughlin et al., 2007: 277.

Type material. Holotype: male, SL = 3.1 mm, Coral Bay near headland, Port Essington, Northern Territory, 4 m, in *Rhinoclavis bituberculatum* (Sowerby) shell, 12 Aug. 1986, WAM 156-87. Paratype: male, SL = 2.4 mm, Coral Bay, 4–6 m, 11 Aug. 1986, WAM 157-87.

***Albatross* material.** 1 male, SL = 2.0 mm, Singapore, E. Deschamps, JF0841(G2). 1 male, SL = 2.0 mm, Singapore, E. Deschamps, JF0841(G3), USNM 1283278.

Remarks. I reexamined the type specimens of *D. biramus* and found the following differences between the holotype and the USNM specimens that are subtle and considered to fall into intraspecific variation. In the USNM specimen, the dorsomesial distal angle of the second segment of the antenna has 2 strong spine (Fig. 22A, B), although there is only a single spine in the type specimens. The third maxilliped merus has a very strong spine on ventral margin in the present specimen (Fig. 22C). Such spine is absent in the type specimens. The distal margins of mesial faces of the propodi of the ambulatory pereopods each is armed with row of sharp spines in the present specimen (Figs. 24B, C, 25B) although such armature is lacking in the type specimens. Dorsal margins of carpi of the second and third pereopods each is armed with 2 strong spines in addition to strong dorsodistal spine in the present specimen (Fig. 24A, B, Fig. 25B). In the type specimens, however, the dorsal margin of the carpus of the second pereopod is unarmed (except for dorsodistal spine), and the dorsal margin of the carpus of the third pereopod bears a single subproximal spine in addition to a dorsodistal spine.

Diogenes magnus sp. nov.

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Figs. 26–29

Type material (*Albatross* material). Holotype: 1 male, SL = 4.9 mm, Port Langoan, Dunaran Is. Philippines, April 2, 1909, JF0460 (G1A), USNM 1283263.

Comparative material. *Diogenes patae* Asakura and Godwin, 2006: holotype, female, SL = 1.6 mm, southwest side of Tau Island at Si'ufa'alele Point, Manua Islands, American Samoa, Polynesia, Cruise TC0201, R/V Townsend Cromwell, 14°14.824'S, 169°25.127'W, 15 m, carbonate pavement with low-growing corals, 11.II.2002, SCUBA, coll. Scott Godwin (BPBM-S-12268). *Diogenes pallescens* Whitelegge, 1897: syntypes, 3 males, 4 females, SL = 1.8–2.6 mm, Funafuti, Ellice Islands, coll. G. Hedley, AM G1402; 1♂, SL = 2.3 mm, Baie de Cauda, Vietnam, coll. R. Sérene, 11 Sept. 1953, Rte 1379, MNHN Pg 1502 (= lectotype of *Diogenes serenei* Forest, 1956); 2 males, SL = 1.7–1.8 mm, Mahlos, Maldives, coll. S. Gardiner, MZCU (= syntypes of *Diogenes gardineri* Alcock, 1905). *Diogenes leptocerus* Forest, 1956: syntype, 1 male, SL = 2.0 mm, Emboucheere due Cuobe, Vietnam, 14 Apr. 1954, Rte 1448, MNHN Pg 1416. *Diogenes tumidus* Rahayu & Forest, 1995: holotype, male, SL = 2.4 mm, Sorong, Irian (= New Guinea), Indonesia, MNHN Pg 5061; 6 males, SL = 1.4-2.3 mm, 3 females, SL = 1.3-1.4 mm, Indonesia, Oct 1991, MNHN Pg. 5085. *Diogenes spinicarpus* Rahayu & Forest, 1995: holotype, male, SL = 1.8 mm, Tanjung Tiram, Amboine, Indonesia, MNHN Pg 5071; paratype, 1 female, SL = 1.8 mm, Tanjung Tiram, Amboine, Indonesia, MNHN Pg. 5072; 1 male, SL = 2.0 mm, Marsegu, Cerum, Indonesia, 16 Sept. 1993, MNHN Pg. *Diogenes biramus* Morgan, 1987: holotype, male, SL = 3.1 mm, 4 m, Coral Bay near headland, Port Essington, Northern Territory, Australia, 12 Aug. 1986, WAM 156-87; 1 female, SL = 2.5 mm, 4–12 m, Beagle Reef, Kimberleys, Australia, coll. Gary J. Morgan, 24 Aug. 1991, WAM 173.91. *Diogenes capricorneus* Grant & McCulloch, 1906: holotype, female, SL = 2.5 mm, Coral sand, Masthead Island, Queensland, Australia, 23°32'S, 151°44E, coll. F. E. Grant, 1904, AM G-5626.

Description. Shield (Fig. 26A) 1.2 times longer than broad; anterior margins between rostral lobe and lateral projections shallowly concave; anterolateral margins each with 1 to few small spines; lateral margins convex; dorsal surface with scattered setae; rostral lobe broadly rounded; lateral projections each with 1 to few small spines. Intercalary rostral process bifid, slightly shorter than acicles (including distal spines). Branchiostegites (Fig. 26C) each with dorsal margin unarmed; distal margin with strong sharp spine.

Corneas and ocular peduncles missing. Ocular acicles (Fig. 26A) with 2 spines distally. Antennal peduncles (Fig. 26A, C) slender; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle bearing small spine, dorsomesial distal angle bearing small spine; first segment unarmed; antennal acicles each with 1 spine on dorsomesial face; dorsolateral face also with 2 spines; antennal flagella with articles each bearing few short setae.

Third maxilliped (Fig. 24D) with merus bearing 2 sharp spines on ventral margin distally.

Left cheliped (Fig. 28) very large, stout; outer and upper faces covered with short setae. Dactyl and fixed finger each terminating in strong calcareous claw; cutting edges with many calcareous teeth; dactyl with upper surface bearing 2 rows of strong spines; lower margin of fixed finger and distal half of palm with 2 rows of small spines, one extending to single row of small spines on reminder of lower margin of palm. Palm with upper face bearing 2 rows of very strong spines; outer face with many strong spines, especially on proximal half of midline. Carpus with upper face bearing row of very strong spines; outer and inner faces with strong spines, distal margin with row of very strong spines. Merus with ventromesial margin bearing 2 strong spines and ventrolateral margin bearing six strong spines; distal margin of mesial face with row of strong spines.

Right cheliped (Fig. 26E–G) small, setose. Dactyl and fixed finger each terminating in calcareous claw; cutting edges with numerous small teeth; outer face of each finger bearing single row of sharp spines. Palm with outer face bearing variously-sized spines. Carpus with outer face bearing 2 rows of strong spines. Merus with ventrolateral margin bearing 2 spines distally.

Second pereopods (Fig. 28) similar from left to right. Dactyls 1.2–1.3 length of propodi; each terminating in sharp, semi-transparent claw; dorsal and ventral margins with rows of tufts of setae; lateral and mesial faces

each with row of tufts of setae. Propodi 1.5–1.7 length of carpi; dorsal and mesial faces with tufts of setae. Carpi elongate, each with sharp dorsodistal spine; dorsal face with or without spine medially. Meri with 1 or 2 spines on ventrolateral margin distally, other portion broken.

Third pereopods (Fig. 29) with morphologically similar but setation different from left to right. Dactyls 1.2–1.3 length of propodi; each terminating in sharp, semi-transparent claw; dorsal and ventral margins with rows of tufts of setae; lateral and mesial faces each with row of tufts of setae. Propodi 1.5–1.7 length of carpi; lateral face of left covered with dense setae, lateral face of right moderately setose; dorsal and ventral margins with rows of tufts of setae. Carpi elongate, each with sharp dorsodistal spine and 1 sharp medial spine. Meri with several spines on ventral margin of mesial face.

Sternite XII (sternite of third pereopods) with anterior lobe subsquare, bearing tiny spine at each anterolateral angle (Fig. 29F).

Fourth pereopod with carpus and propodus each lacking dorsodistal spine.

Uropods and telson missing.

Etymology. The specific name is taken from the Latin *magnus* meaning great or big, and refers to a very large size of this species among known species of the "*pallescens*" group.

Remarks. This new species belongs to the "*pallescens*" group, which includes *D. pallescens* Whitelegge, 1897, *D. leptocerus* Forest, 1956, *D. biramus* Morgan, 1987, *D. capricorneus* Grant & McCulloch, 1906, *D. viridis* Haig & Ball, 1988, *D. spinicarpus* Rahayu & Forest, 1995, *D. tumidus* Rahayu & Forest, 1995, and *D. patae* Asakura & Godwin, 2006. Although *D. gardineri* Alcock, 1905, and *D. serenei* Forest, 1956, have characters shared with the species of this group, McLaughlin (2002b) clarified that *D. pallescens*, *D. gardineri* and *D. serenei* were synonyms, with *D. pallescens* being the senior synonym.

This new species is close to *D. pallescens* in having a shield with length as long as or slightly larger than breadth, a left cheliped with a spinulose outer face, the second and third pereopods with dactyls and propodi slender and unarmed, carpi each with a dorsodistal spine and a dorsal medial spine, meri with ventral margins bearing 1 or more spines.

However, *D. magnus* differs from *D. pallescens* in many features, as follows. He shape of the shield is oval in *D. magnus* (Fig. 26A), although it is sub-rectangular in *D pallescens*. *Diogenes magnus* has a single strong spine on the distal margin of the branchiostegite (Fig. 26C), although such spine is lacking in *D. pallescens*. The dorsal margin of the branchiostegite is unarmed in *D. magnus* (Fig. 26C). The same portion is armed with a row of spines in *D. pallescens*. *Diogenes magnus* has 2 rows of strong spines on the upper margins of the dactyl and palm of the left cheliped (Fig. 27B). In *D. pallescens*, however, these is generally just 1 row of spines on the same margins. In *D. magnus*, setation of the third pereopods is asymmetrical; the propodus of left has very dense setae on lateral face (Fig. 29A), although such setation is absent on right (Fig. 29C). On the other hand, setation on ambulatory pereopods is symmetrical in *D. pallescens*, and such dense setation is not found on any ambulatory pereopods of this species. In *D. pallescens*, a dorsodistal spine is present on the merus of the third maxilliped and also a dorsodistal spine is present on the carpus and propodus of the fourth pereopods. However, in *D. magnus*, no dorsodistal spine is present on the merus of the third maxilliped (Fig. 26C) as well as on the carpus and propodus of the fourth pereopods (Fig. 29E).

In having asymmetrical setation on the pereopods, *D. magnus* is similar to *D. patae*. However, in *D. patae*, very dense setation occurs not only on the left third pereopod, but also on the left cheliped and the left second pereopod.

***Diogenes spinicarpus* Rahayu & Forest, 1995**
Figs. 30–33

Diogenes spinicarpus Rahayu & Forest, 1995: 406, figs. 6a–f, 7a–h; Rahayu, 2004: 75

Type material. Holotype: SL = 2.0 mm, Tanjung Tiram, Amboine Island, Indonesia, MNHN Pg 5071. Paratypes: 20 males, 4 females, Kendari Mata, Indonesia; 65 males, 36 females, data same as holotype; 2 females, Osi, Indonesia; 4 males, 7 females, Tanjung Kasuari, Irian, Indonesia, MNHN Pg. Size of paratypes: males, SL = 1.5–3.0 mm; females, SL = 1.0–3.0 mm.

***Albatross* material.** 1 male, SL = 2.0 mm, Iloilo, Philippine, Apr., 1929, H.C. Kellers coll., JF 0608 (G2A), USNM 1283274; 1 male, SL = 1.75 mm, Iloilo, Philippine, Apr., 20, 1929, H.C. Kellers coll., JF 0618g (G2B), USNM 1283275; 1 male, SL = 1.95 mm, Iloilo, Philippine, Apr., 3, 1929, H.C. Kellers coll., JF 0611 (G2C), USNM 1283276; 4 females, SL = 1.55 - 2.00 mm, Iloilo, Philippine, Apr., 20, 1929, JF 0618 (G2D), USNM 1283277.

Remarks. I reexamined a type series of this species and found the following differences between the present specimens and the type series, but such differences are subtle and fall into intraspecific variation.

Dorsal margin of branchiostegite is armed with strong spines in the present specimens (Fig. 30A, B), although the same margin is unarmed in the type specimens. Carpus of the left cheliped is covered with tubercles in the present specimens (Fig. 31), whereas the same surface is armed with dorsal spines in the type specimens. Midline of outer face of the left cheliped palm is armed with strong sharp spines in the type specimens, although there are tubercles on same surface of the present specimens (Fig. 31).

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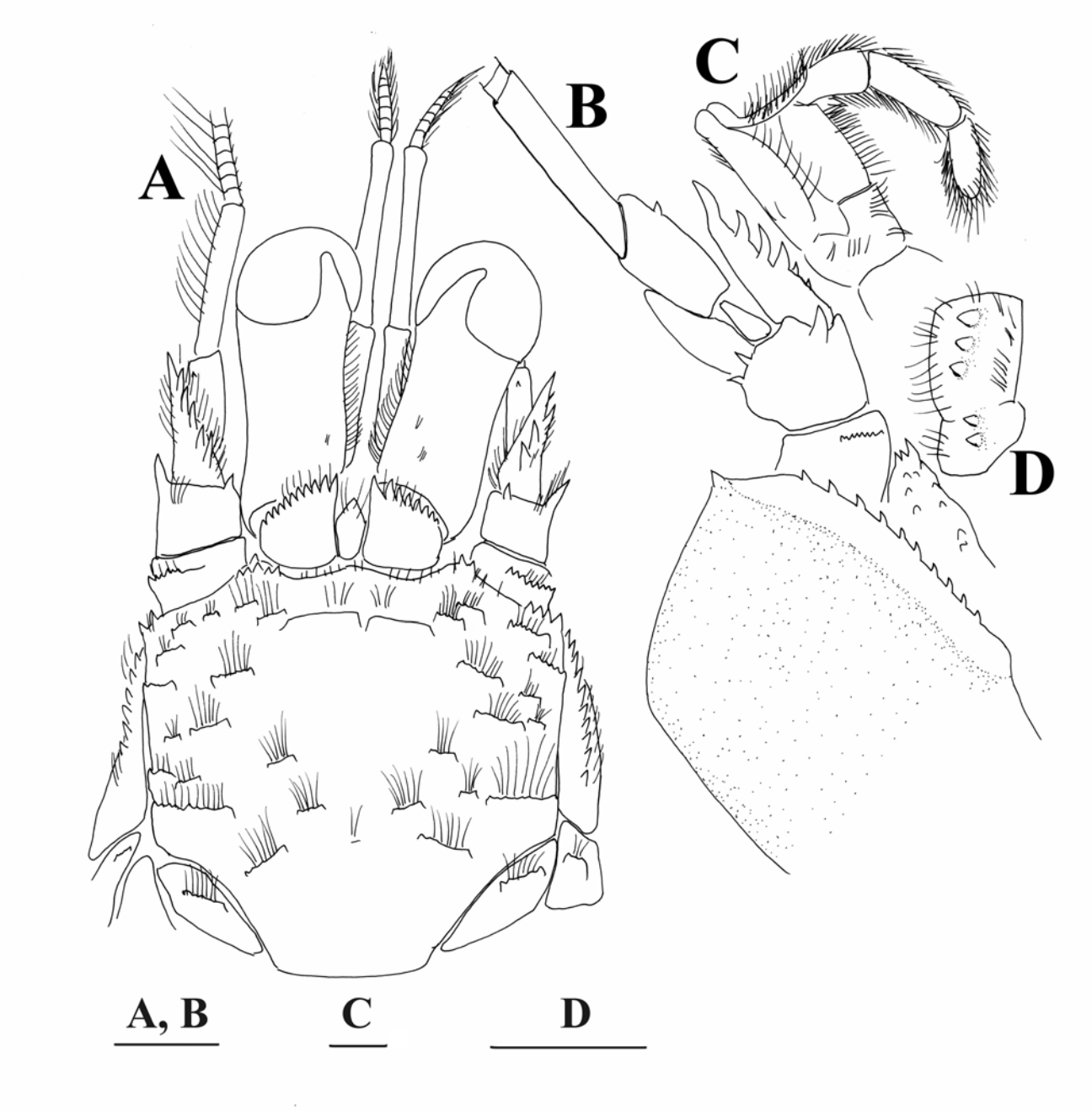

Figure 1. *Diogenes crassus* sp. nov.: holotype, male, USNM 1281041 (JF 0551, S7A).
A, shield and cephalic appendages, dorsal. B, anterior portion of shield, branchiostegite, and antennal peduncle, left, lateral, setae omitted. Right third maxilliped: C, lateral; D, ischium and basis, mesial. Scales equal 1 mm.

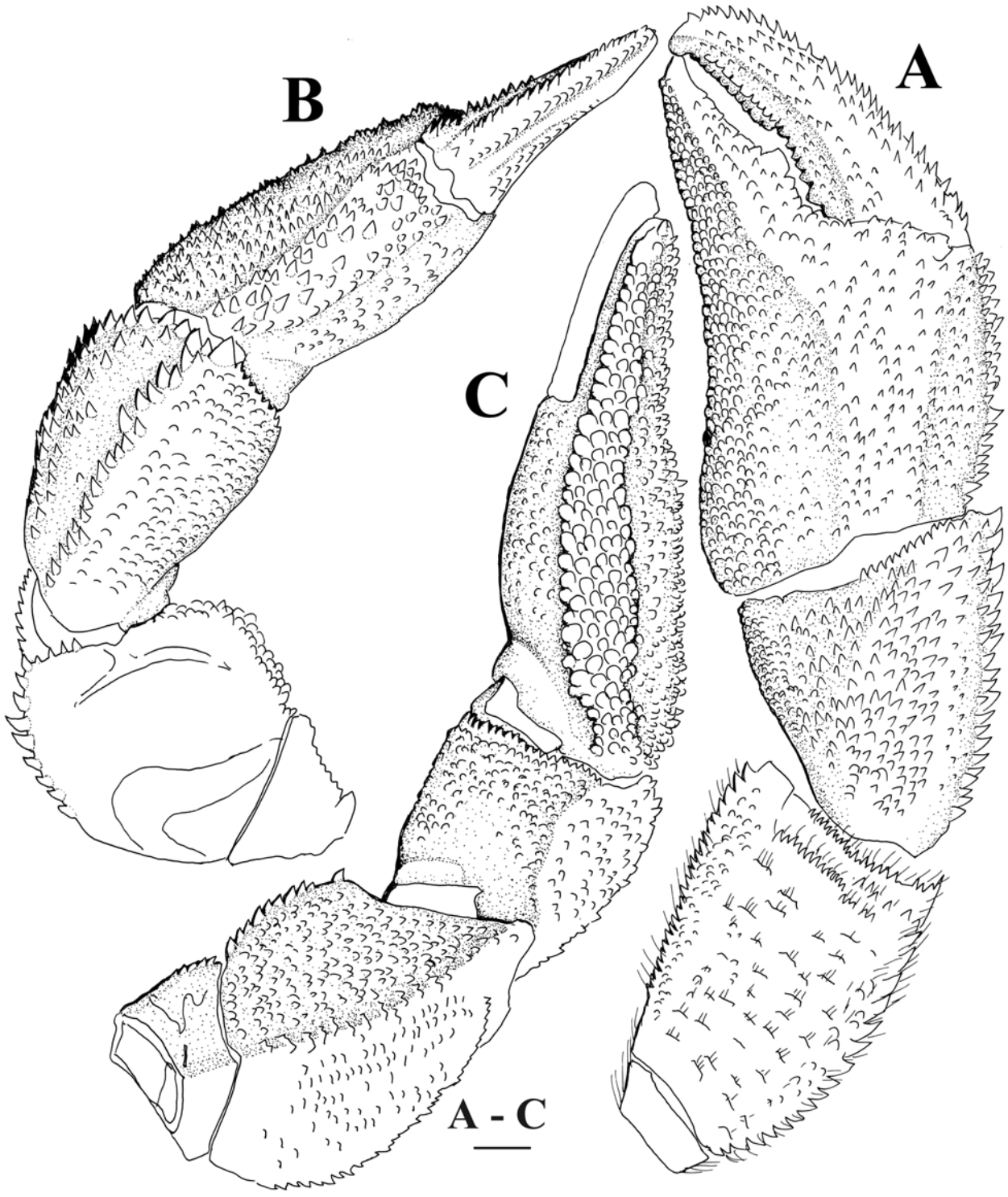

Figure 2. *Diogenes crassus* sp. nov.: holotype, male, USNM 1281041 (D1a, JF 0551, S7A). Left cheliped: A, outer; B, upper; C, lower. Scale equals 1 mm.

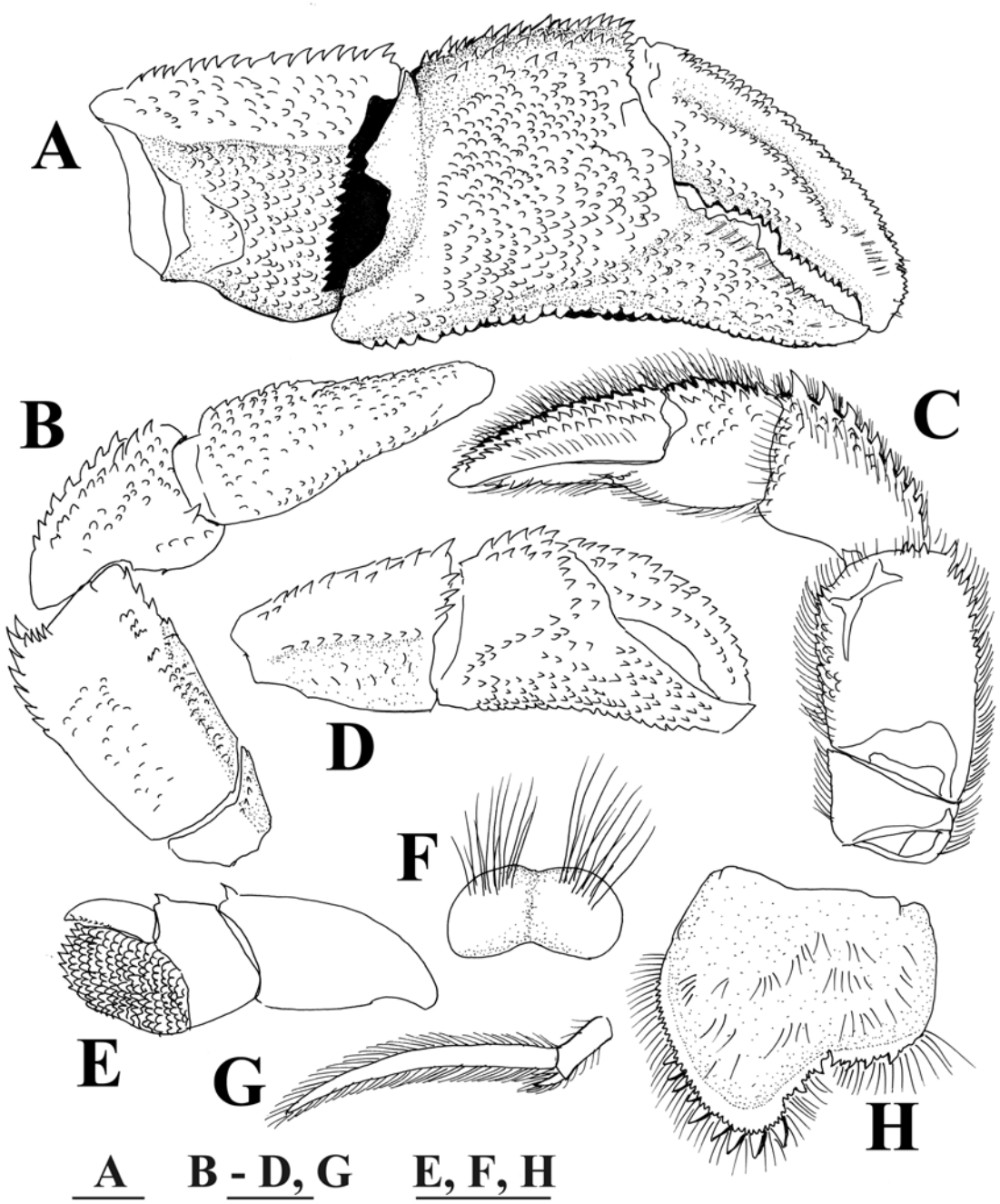

Figure 3. *Diogenes crassus* sp. nov.: holotype, male, USNM 1281041 (D1a, JF 0551, S7A).
A, left cheliped, inner. Right cheliped: B, lower; C, upper, setae omitted; D, chela and carpus, outer, setae omitted. E, fourth pereopod: chela and carpus, lateral, setae omitted. F, sternite XII. G, pleopod 2. H, telson, dorsal. Scales equal 1 mm.

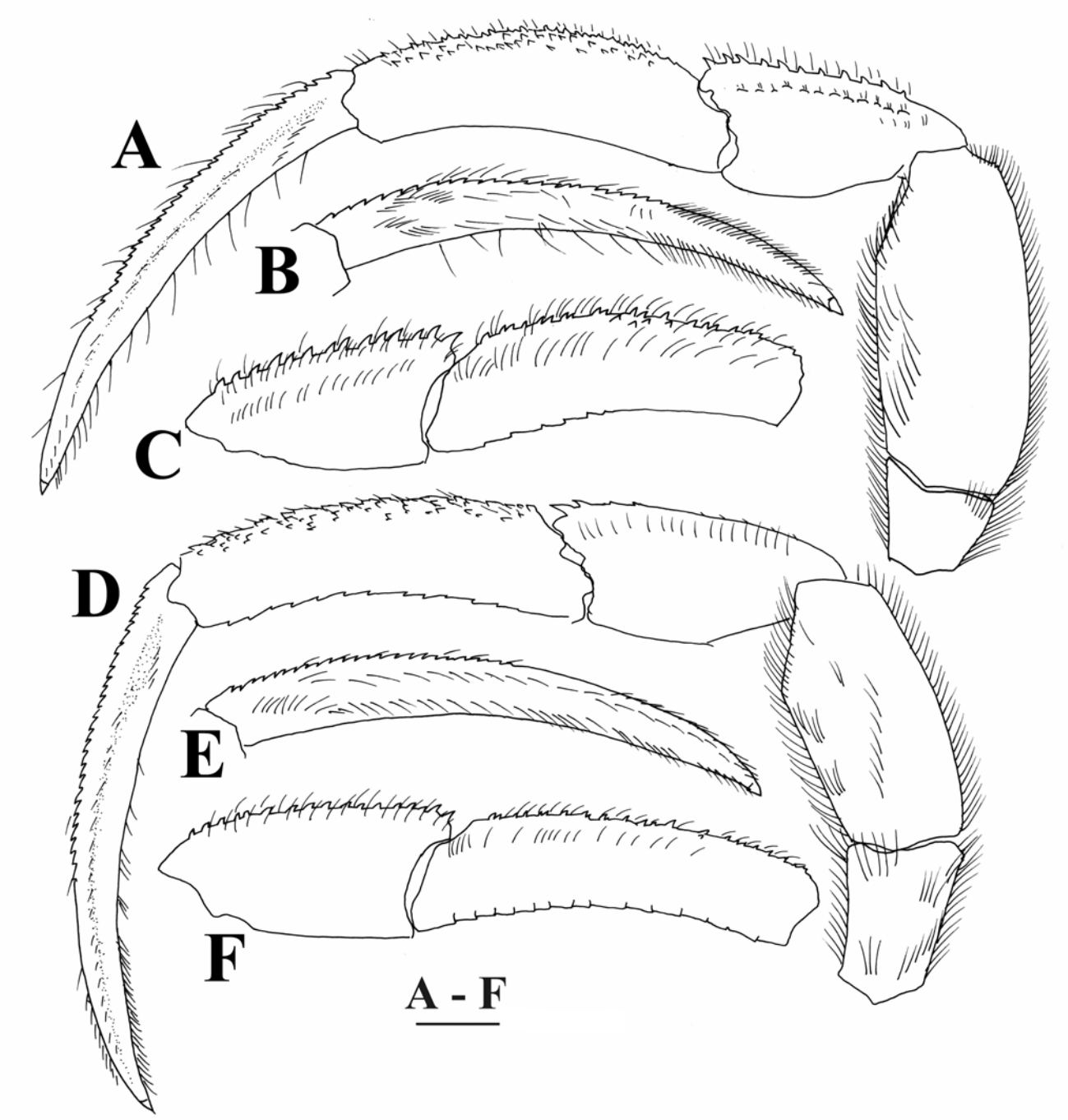

Figure 4. *Diogenes crassus* sp. nov.: holotype, male, USNM 1281041 (D1a, JF 0551, S7A).
Left second pereopod: A, lateral; B, dactyl, mesial; C, propodus and carpus, mesial.
Left third pereopod: D, lateral; E, dactyl, mesial; F, propodus and carpus, mesial. Scales equal 1 mm.

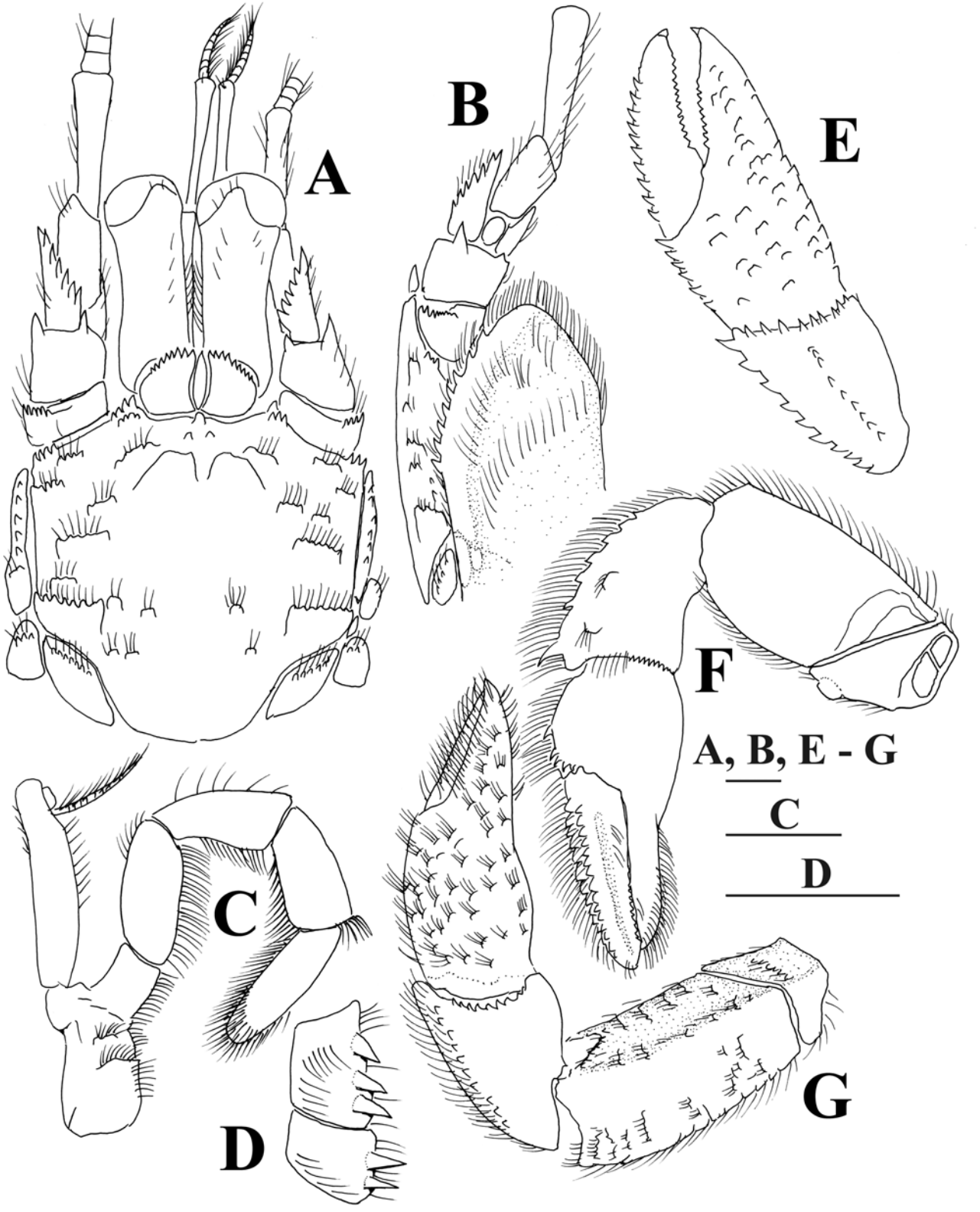

Figure 5. *Diogenes fasciatus* Rahayu & Forest, 1995: female, USNM 1283265 (JF0538, S1A).
A, shield and cephalic appendages, dorsal. B, shield, branchiostegite, and antennal peduncle, right, lateral. Right third maxilliped: C, lateral; D, ischium and basis, mesial. Right cheliped: E, chela and carpus, outer, setae omitted; F, lower; G, upper. Scales equal 1 mm.

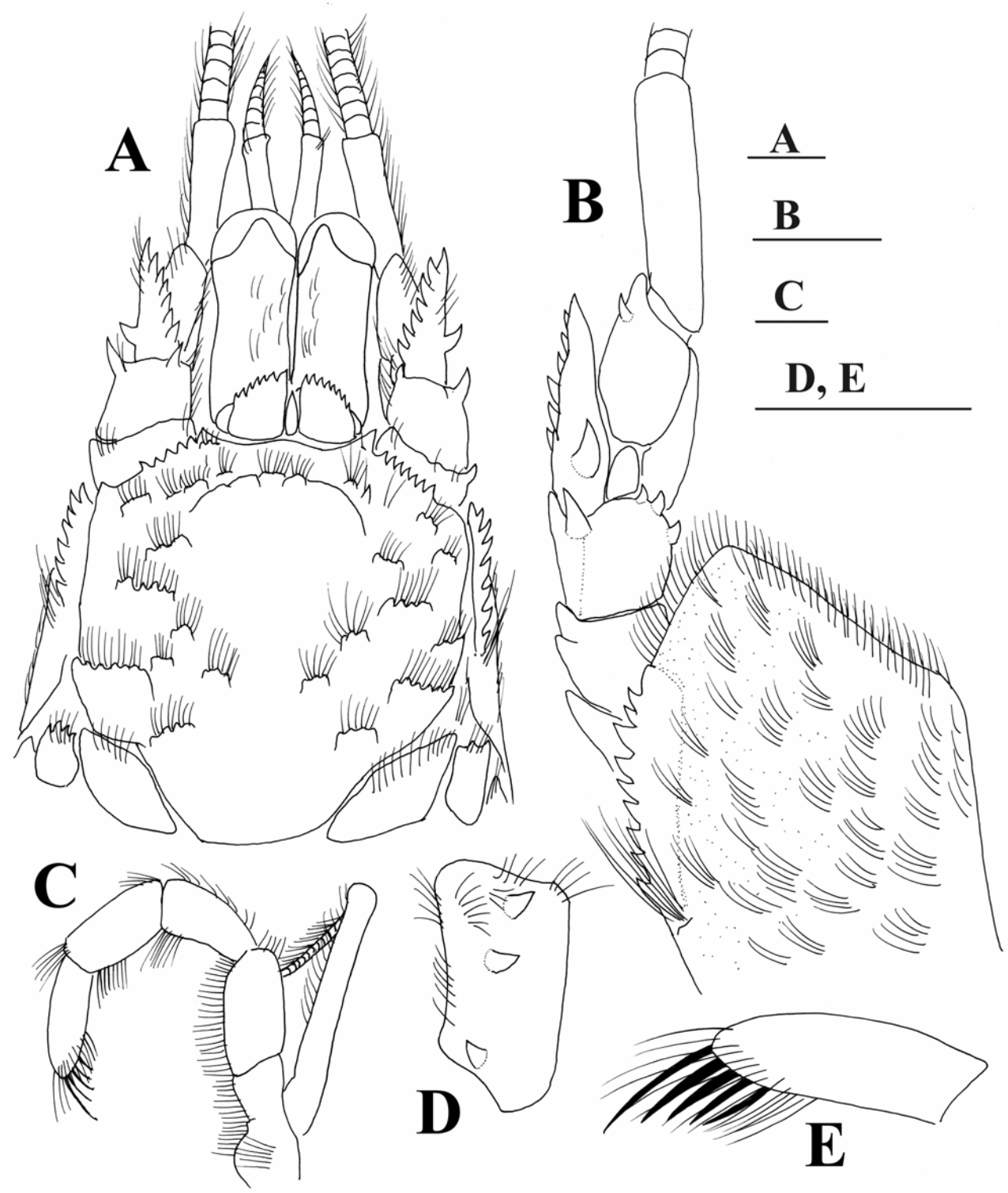

Figure 6. *Diogenes fasciatus* Rahayu & Forest, 1995: male, USNM 1283271 (JF 0538, S4A).
A, shield and cephalic appendages, dorsal. B, branchiostegite and antennal peduncle, right, lateral, setae on antennal peduncle omitted. Left third maxilliped: C, lateral; D, ischium, mesial; E, dactyl, lateral. Scales equal 1 mm.

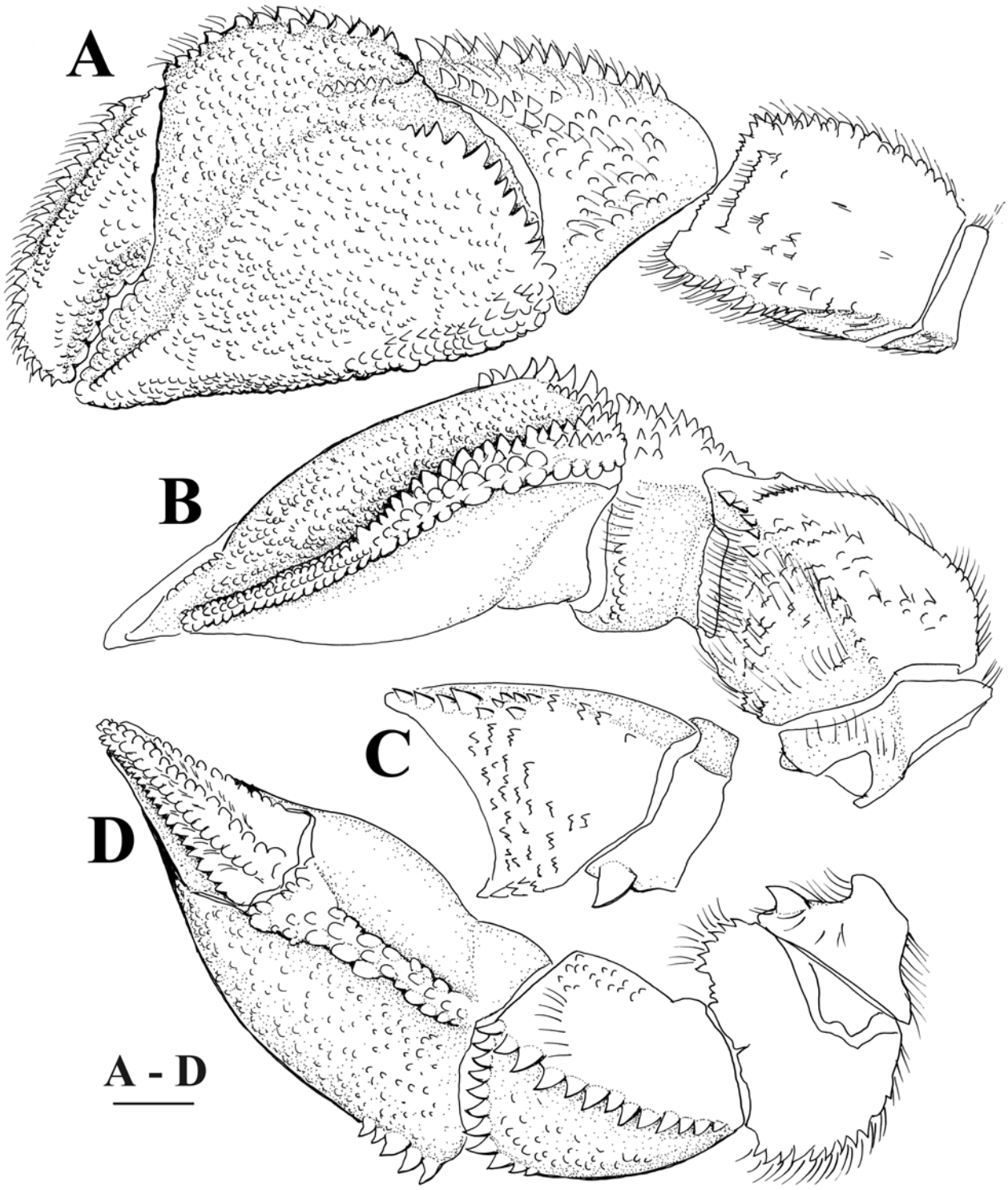

Figure 7. *Diogenes fasciatus* Rahayu & Forest, 1995: female, USNM 1283265 (JF0538, S1A). Left cheliped: A, outer; B, lower; C, merus, ventral, setae omitted; D, upper. Scales equal 1 mm.

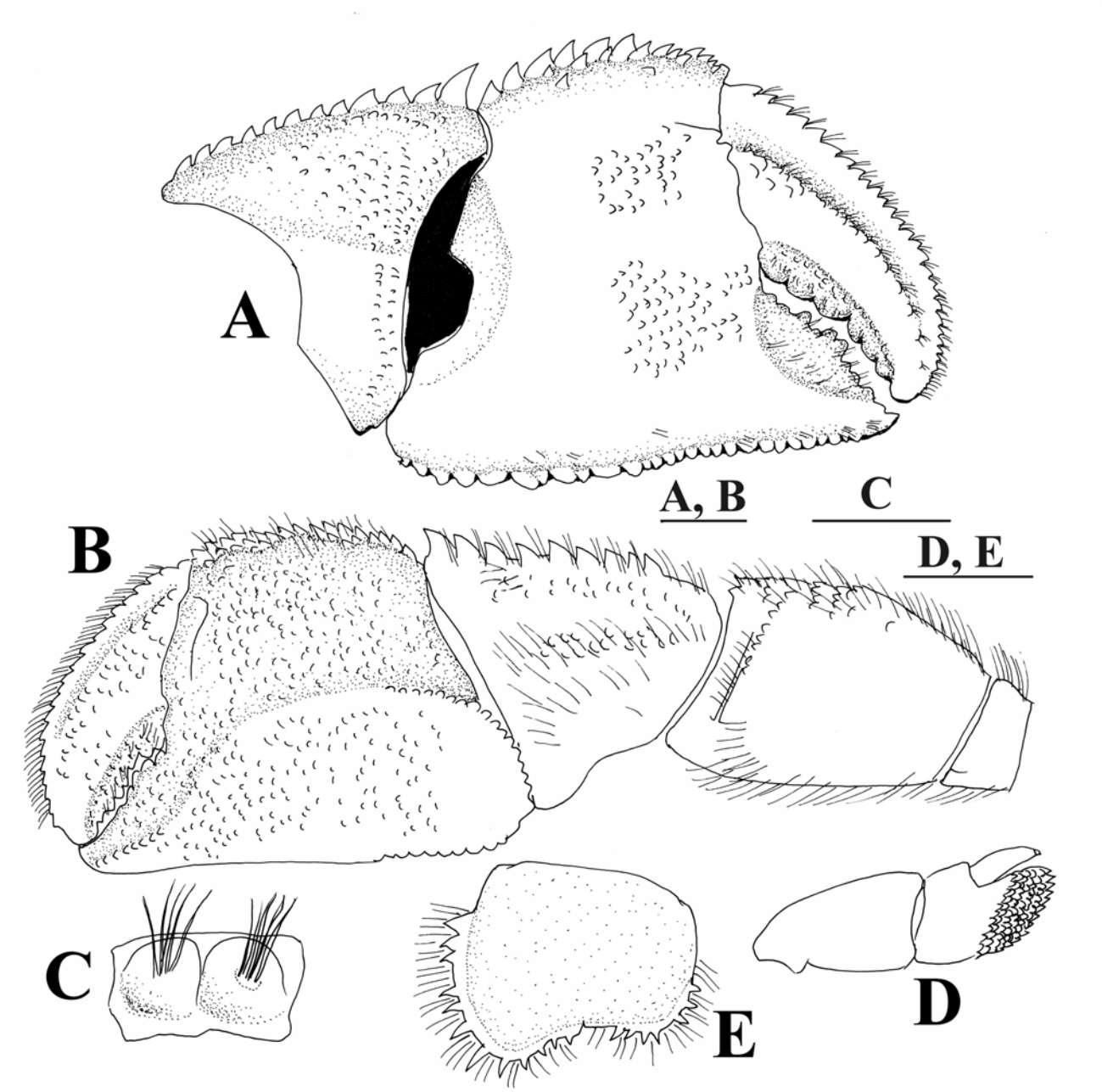

Figure 8. *Diogenes fasciatus* Rahayu & Forest, 1995: female, USNM 1283265 (JF0538, S1A).
Left cheliped: A, chela and carpus, inner; B, outer. C, anterior lobe of sternite XII. D, chela and carpus of fourth pereopods, outer, left. E, telson. Scales equal 1 mm.

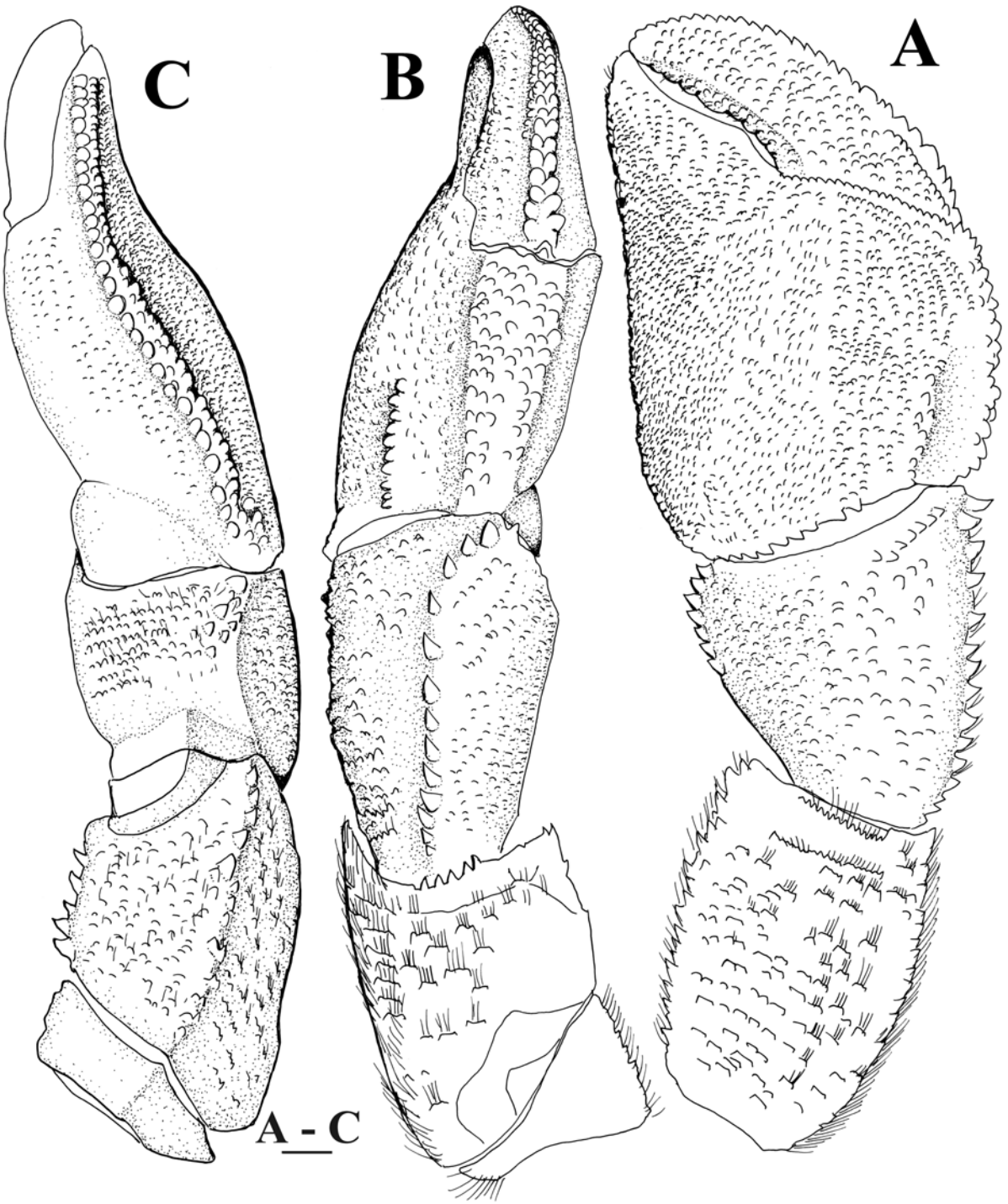

Figure 9. *Diogenes fasciatus* Rahayu & Forest, 1995: male, USNM 1283271 (JF 0538, S4A). Left cheliped: A, outer; B, upper; C, lower. Scale equals 1 mm.

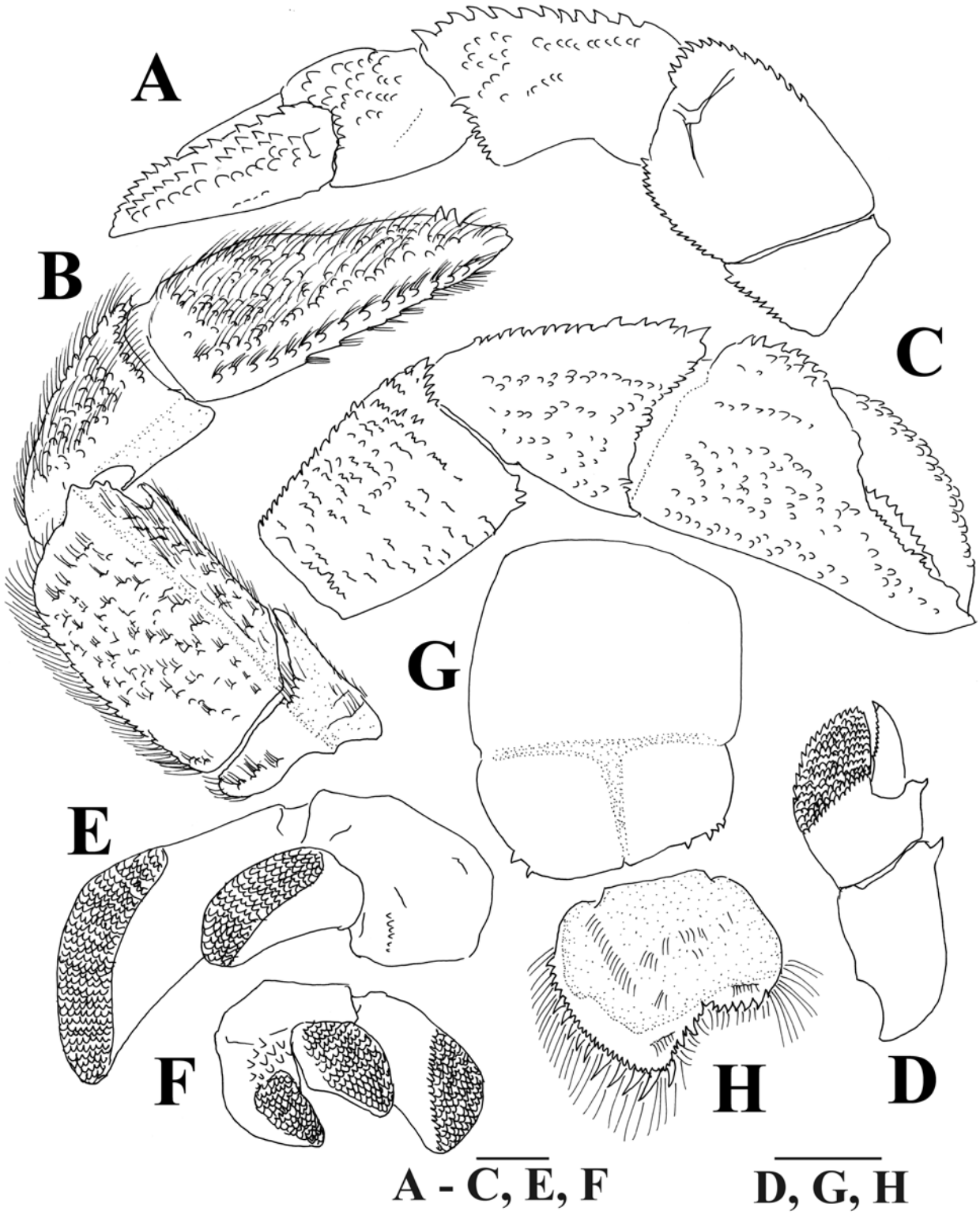

Figure 10. *Diogenes fasciatus* Rahayu & Forest, 1995: male, USNM 1283271 (JF0538, S4A). Right cheliped: A, upper, setae omitted; B, lower; C, outer, setae omitted. D, fourth pereopod: chela and carpus, left, lateral, setae omitted. Uropods: E, left, dorsal, setae omitted; F, right, dorsal, setae omitted. G, sixth tergite, dorsal. H, telson, dorsal. Scales equal 1 mm.

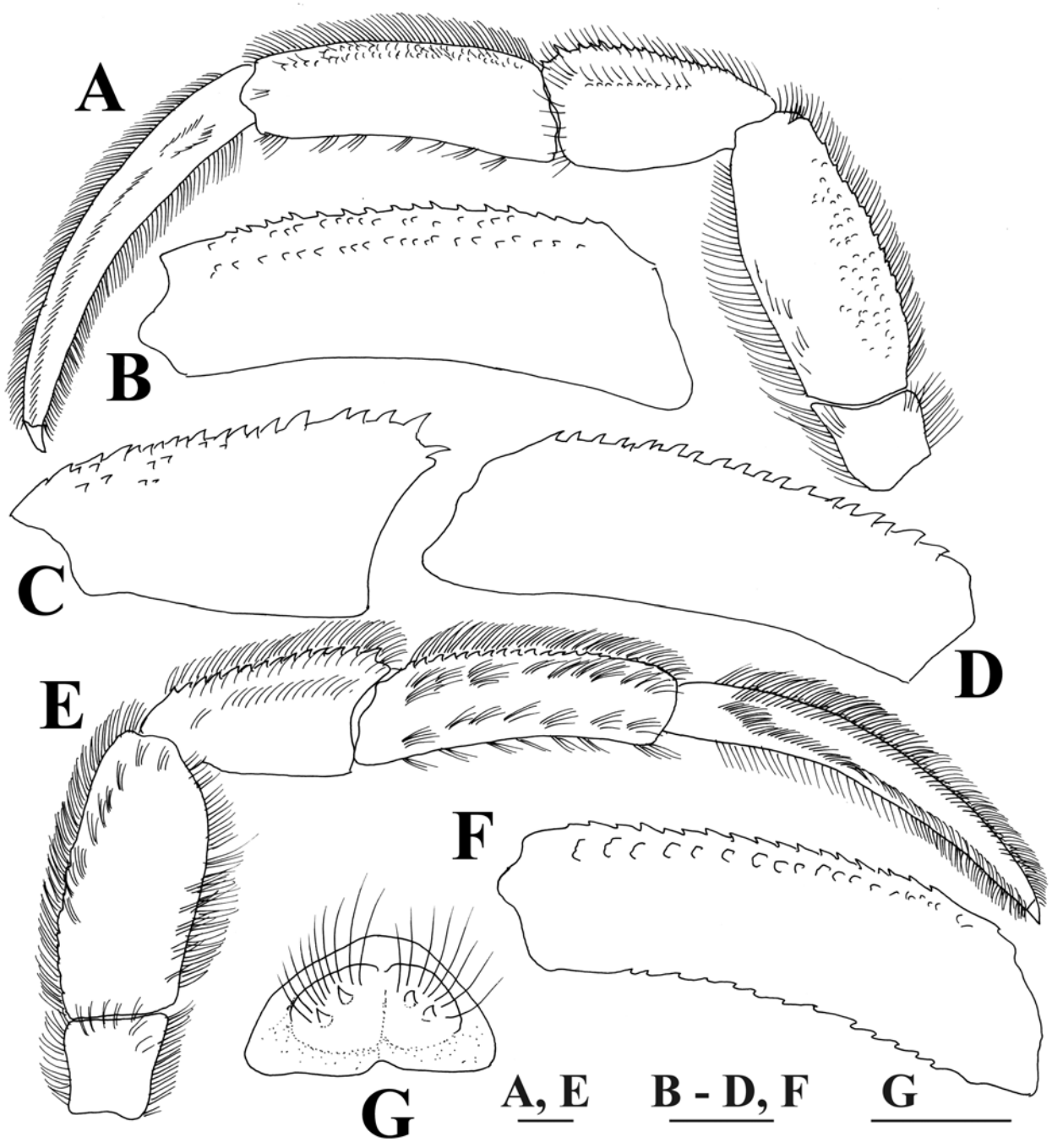

Figure 11. *Diogenes fasciatus* Rahayu & Forest, 1995: male, USNM 1283271 (JF0538, S4A).
Left second pereopod: A, lateral; B, propodus, lateral, setae omitted. Left second pereopod; C, carpus, mesial, setae omitted; D, propodus, lateral, setae omitted. Right third pereopod: E, lateral; F, propodus, setae omitted. G, antrior lobe of sternite XII. Scales equal 1 mm.

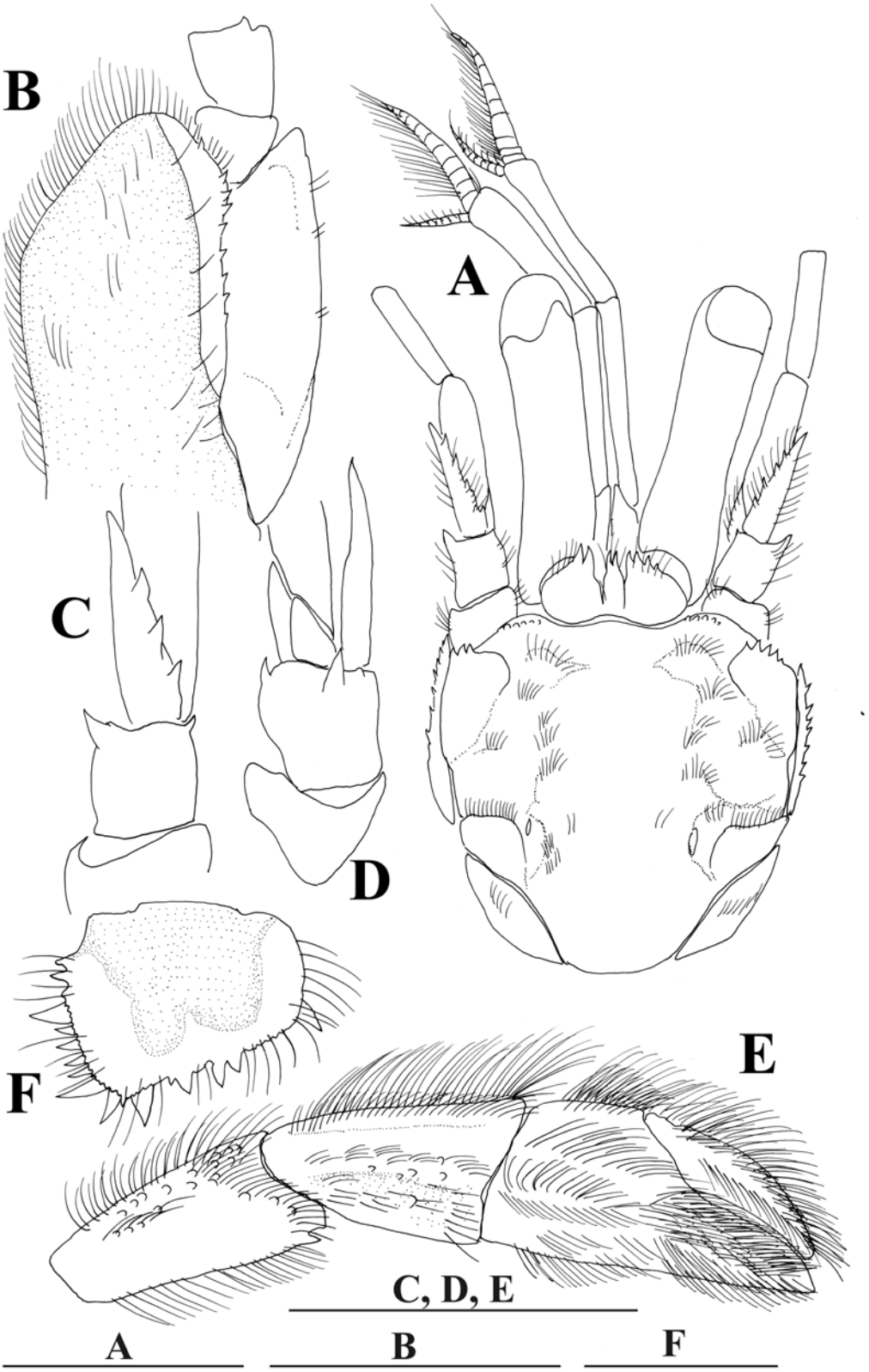

Figure 12. *Diogenes haigae* sp. nov.: holotype, male, AM-P37785. A, shield and cephalic appendages, dorsal. B, shield, branchiostegite, and first and second segments of antennal peduncle, left, lateral. Antennal peduncle: C, first and second segments and antennal acicle, left, dorsal; D, right, mesial. E, right cheliped, outer. F, telson, dorsal. Scales equal 1 mm.

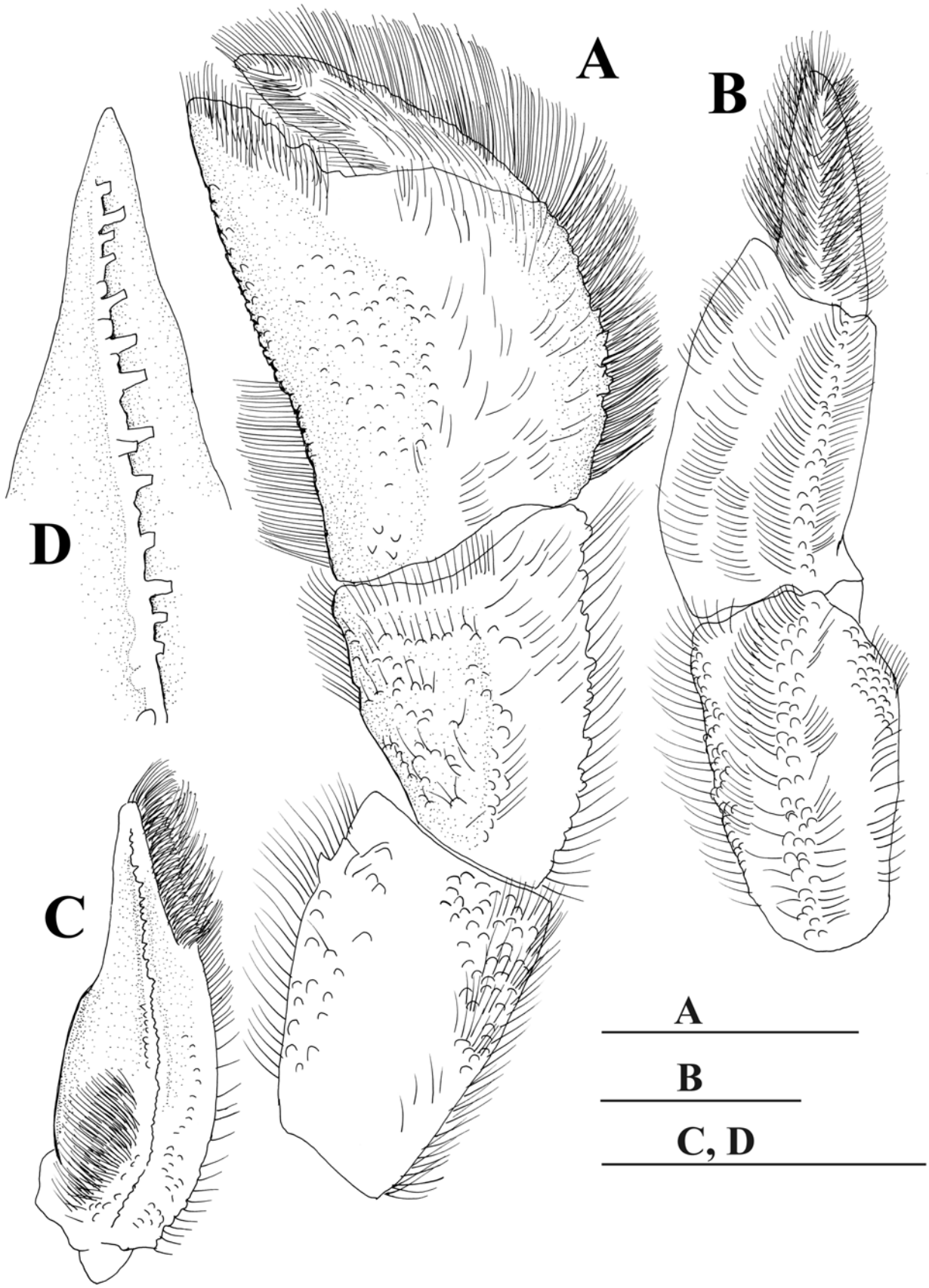

Figure 13. *Diogenes haigae* sp. nov.: holotype, male, AM-P37785. Left cheliped: A, outer; B, chela and carpus, upper; C, fixed finger and palm, lower; D, distal portion of palm and fixed finger, lower, enlarged. Scales equal 1 mm.

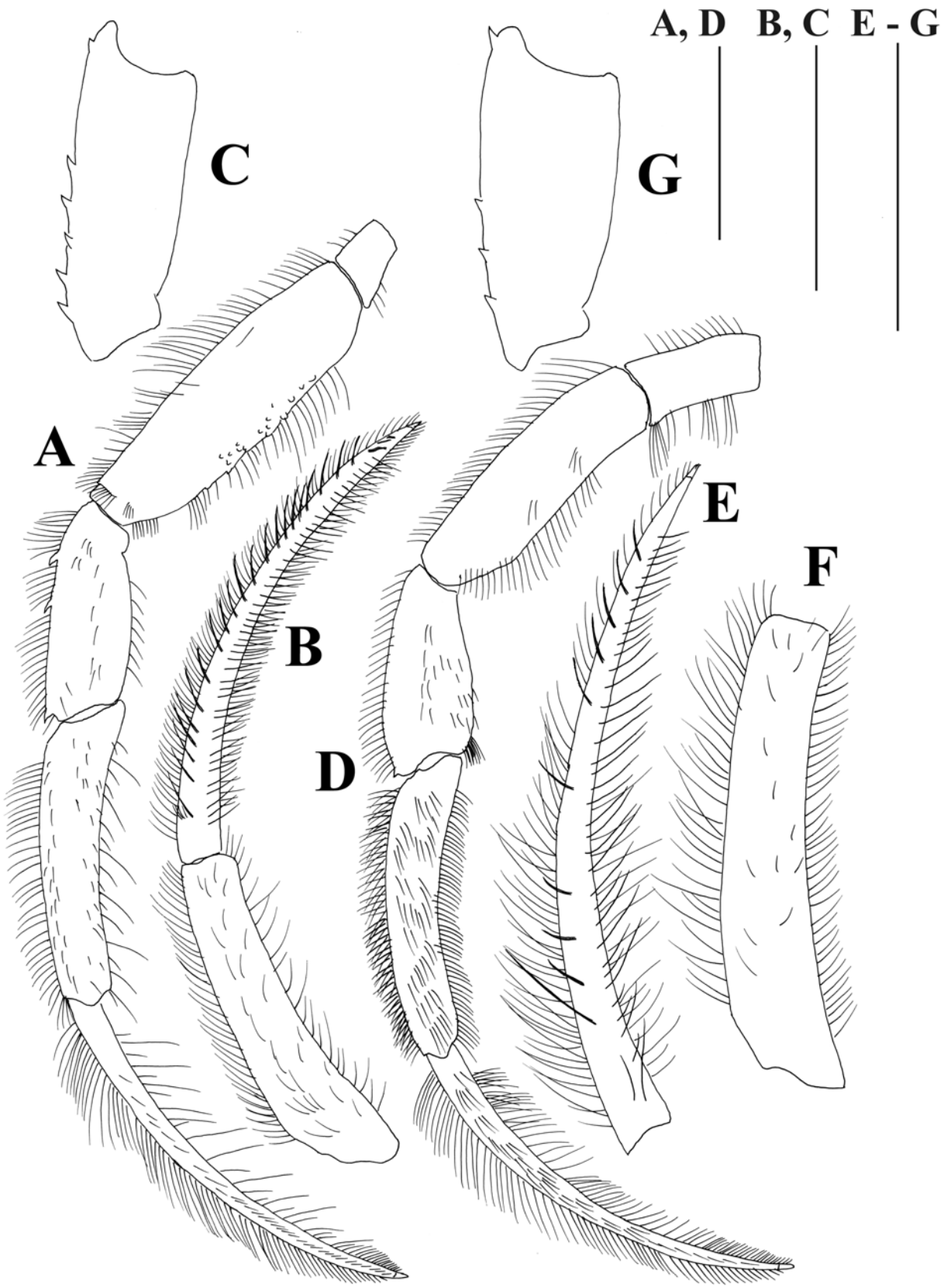

Figure 14. *Diogenes haigae* sp. nov.: holotype, male, AM-P37785. Left second pereopod: A, lateral; B, dactyl and propodus, mesial. C, right second pereopod: carpus, lateral, setae omitted. Left third pereopod: D, lateral; E, dactyl, mesial; F, propodus, mesial. G, right third pereopod: carpus, lateral, setae omitted.

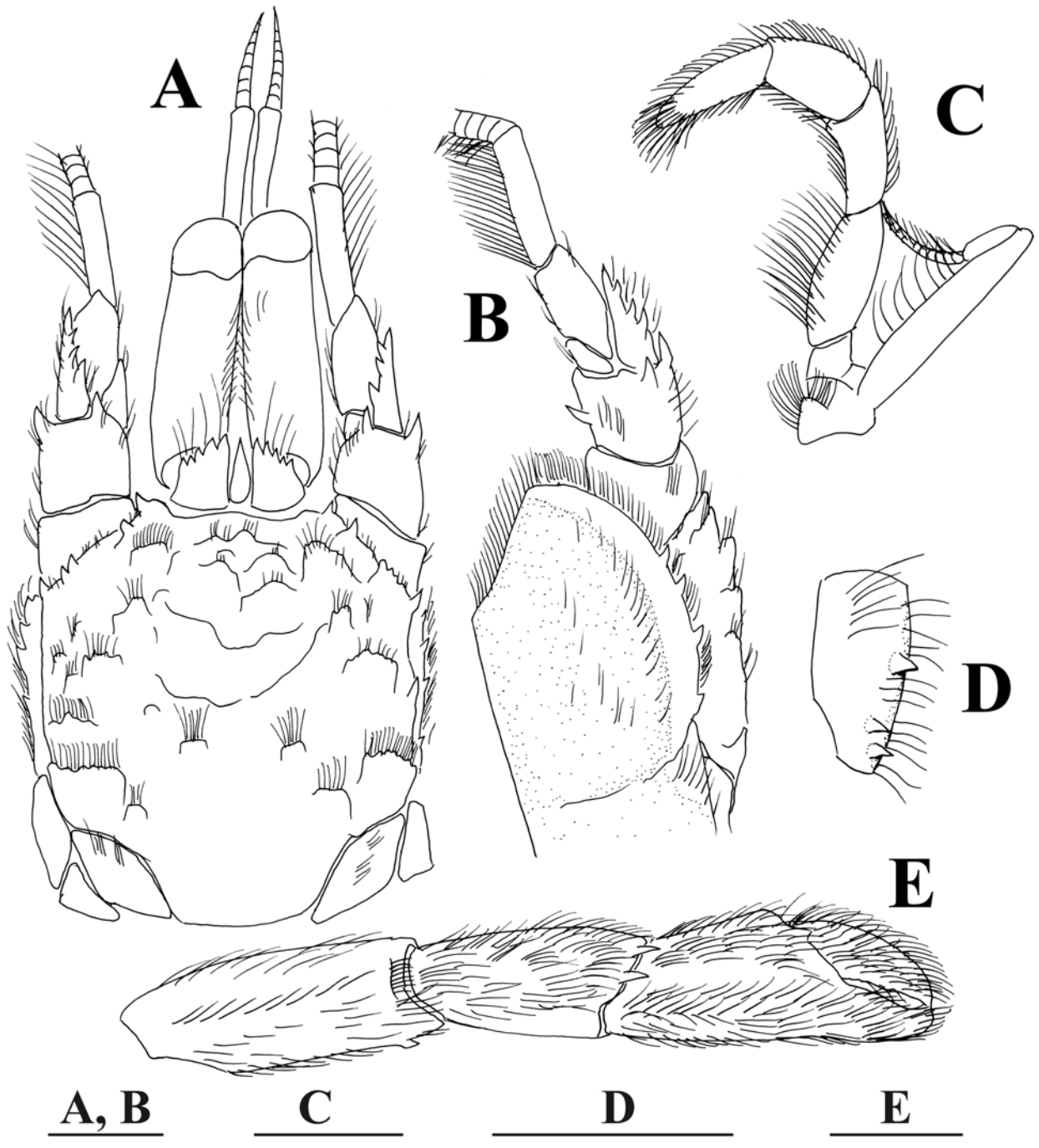

Figure 15. *Diogenes klaasi* Rahayu & Forest, 1995: female, USNM 1283269 (JF 0538, S3A).
A, shield and cephalic appendages, dorsal. B, shield, branchiostegite, and antennal peduncle, left, lateral. Left third maxilliped: C, lateral; D, ischium, mesial. E, right cheliped, outer. Scales equal 1 mm.

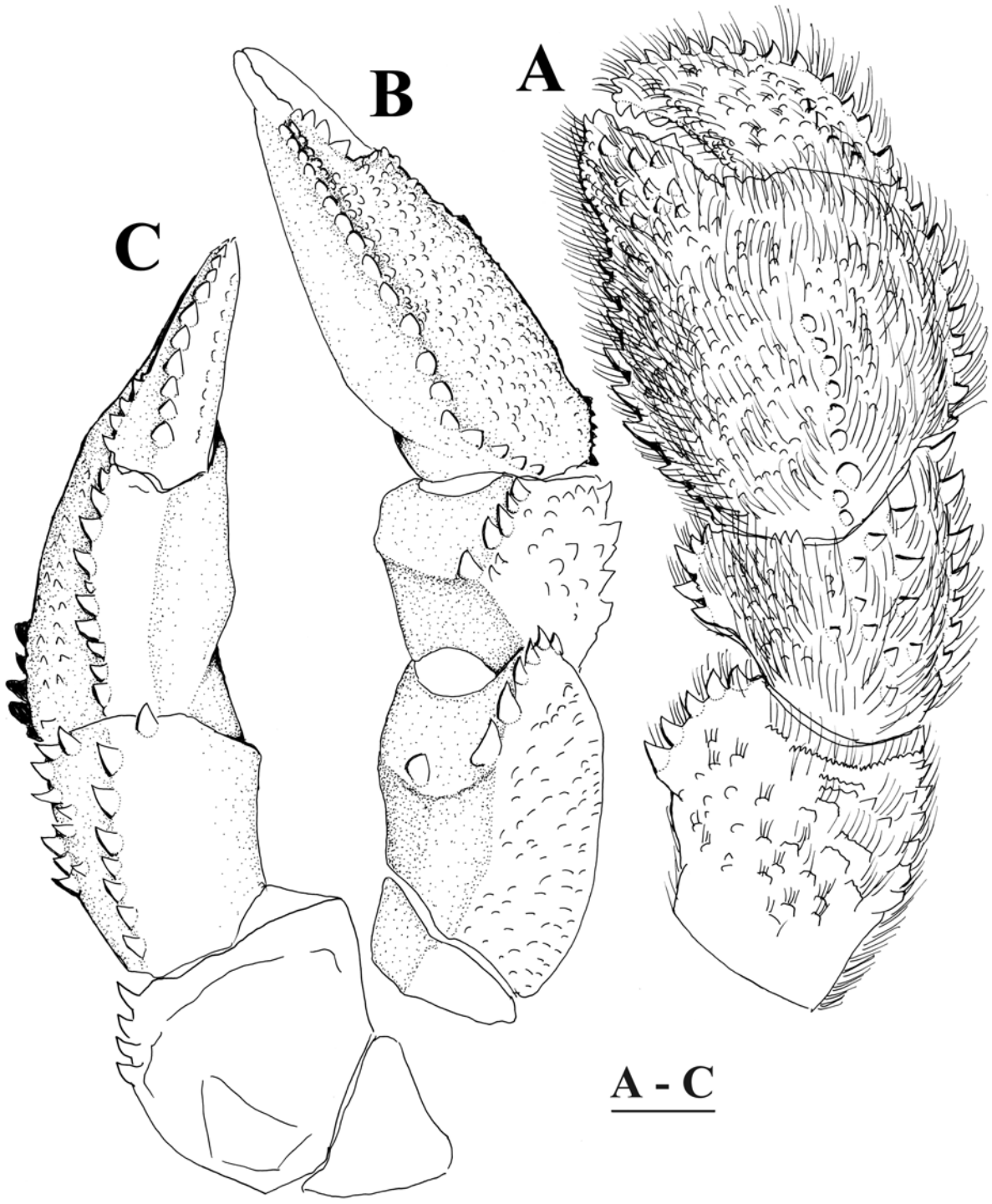

Figure 16. *Diogenes klaasi* Rahayu & Forest, 1995: female, USNM 1283269 (JF 0538, S3A).
Left cheliped: A, outer; B, lower, setae omitted; C, upper, setae omitted. Scale equals 1 mm.

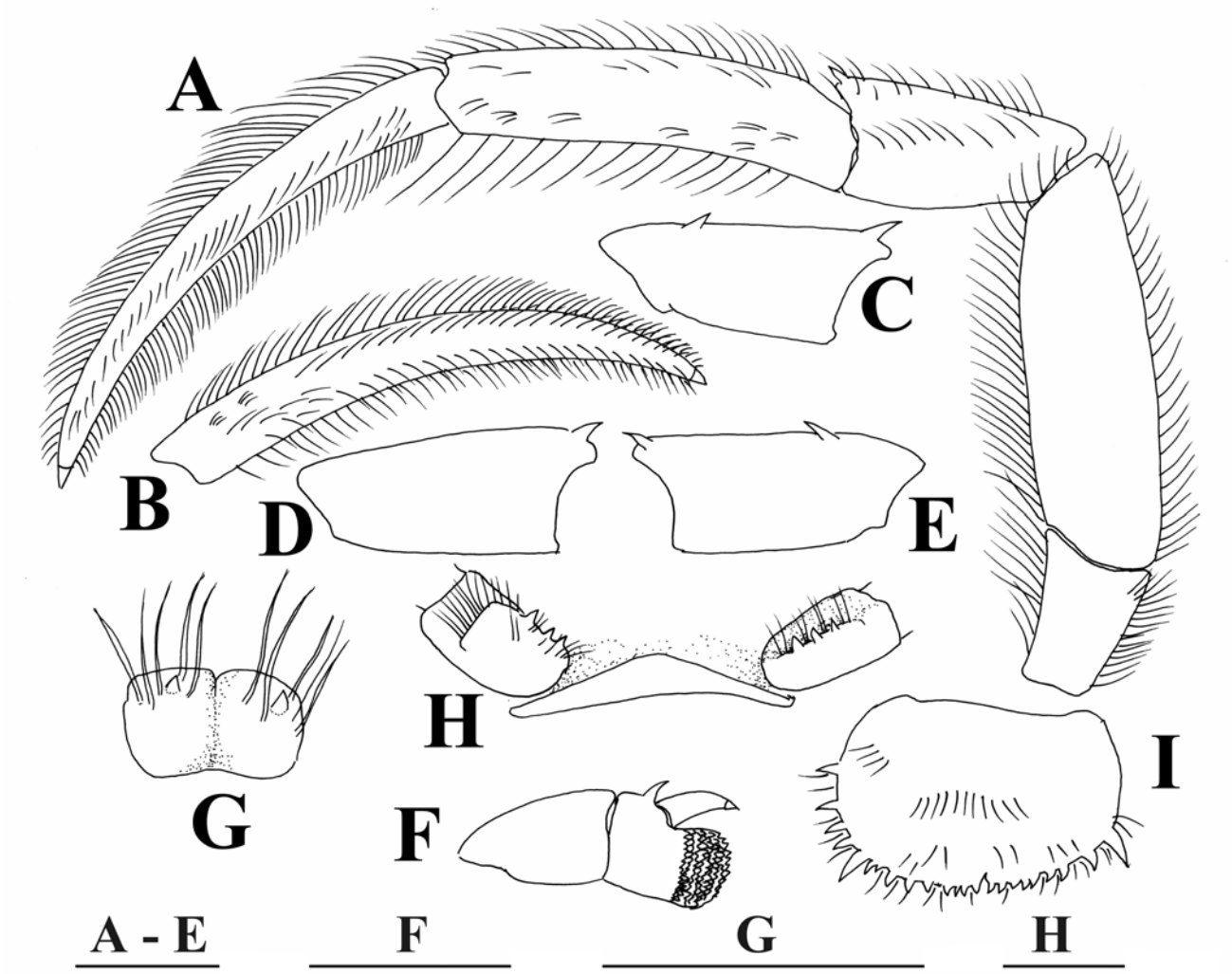

Figure 17. *Diogenes klaasi* Rahayu & Forest, 1995: female, USNM 1283269 (JF 0538, S3A).
Left second pereopod: A, lateral; B, dactyl, mesial; C, carpus, mesial, setae omitted. D, right second pereopod: carpus, lateral, setae omitted. E, right third pereopod: carpus, mesial, setae omitted. F, Fourth pereopod: chela and carpus, right, lateral, setae omitted. G, anterior lobe of sternite XII. H, sternite XIII and coxae of fourth pereopods. Scales equal 1 mm.

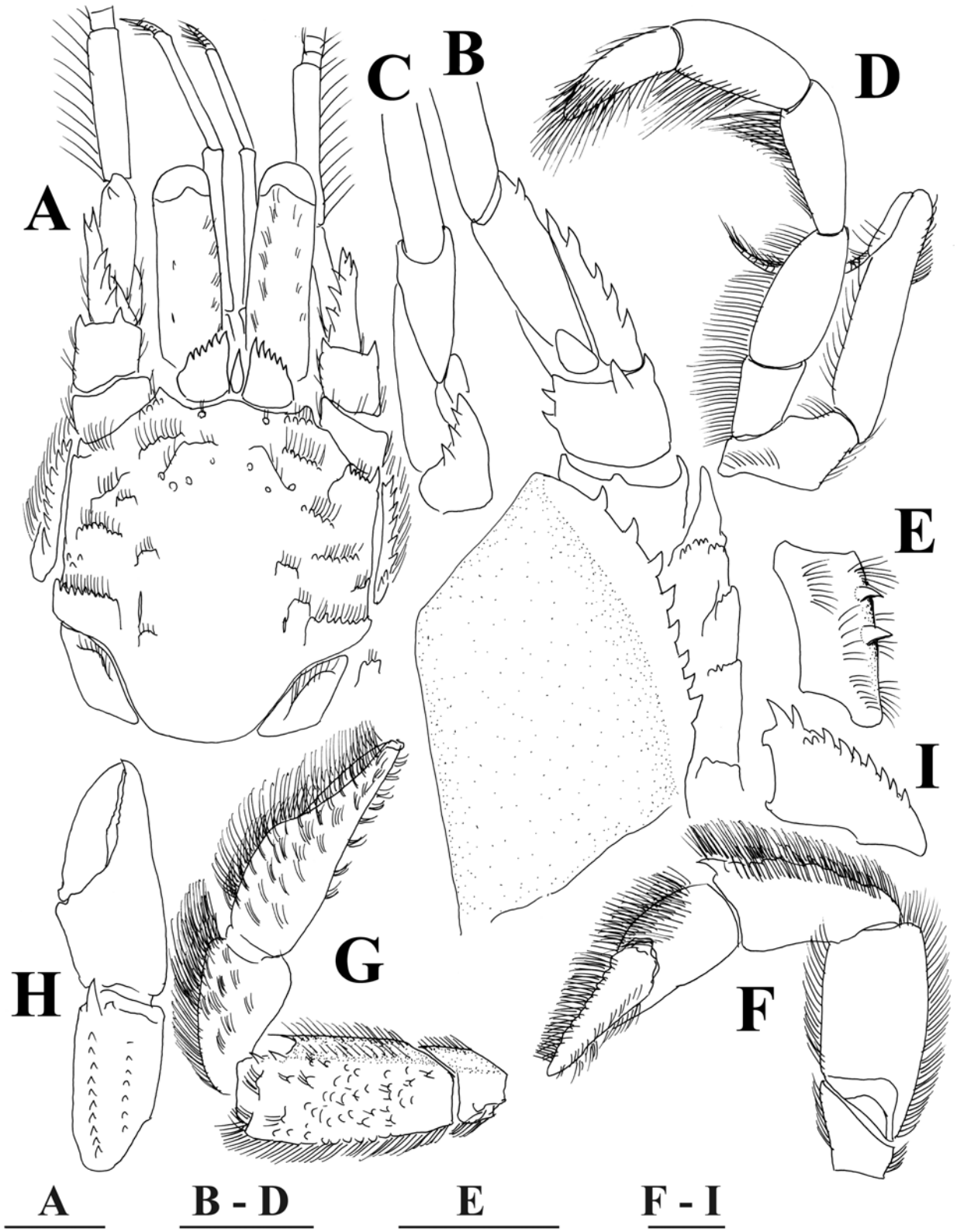

Figure 18. *Diogenes rectimanus* Miers, 1884: male, USNM 1283267 (JF 0538, S2A). A, shield and cephalic appendages, dorsal. B, shield, branchiostegite, and antennal peduncle, left, lateral, setae omitted. C, antennal peduncle, left, ventral, setae omitted. Left third maxilliped: D, lateral; E, ischium, mesial. Right cheliped: F, upper; G, lower; H, chela and carpus, outer, setae omitted; I, carpus, inner, setae omitted. Scales equal 1 mm.

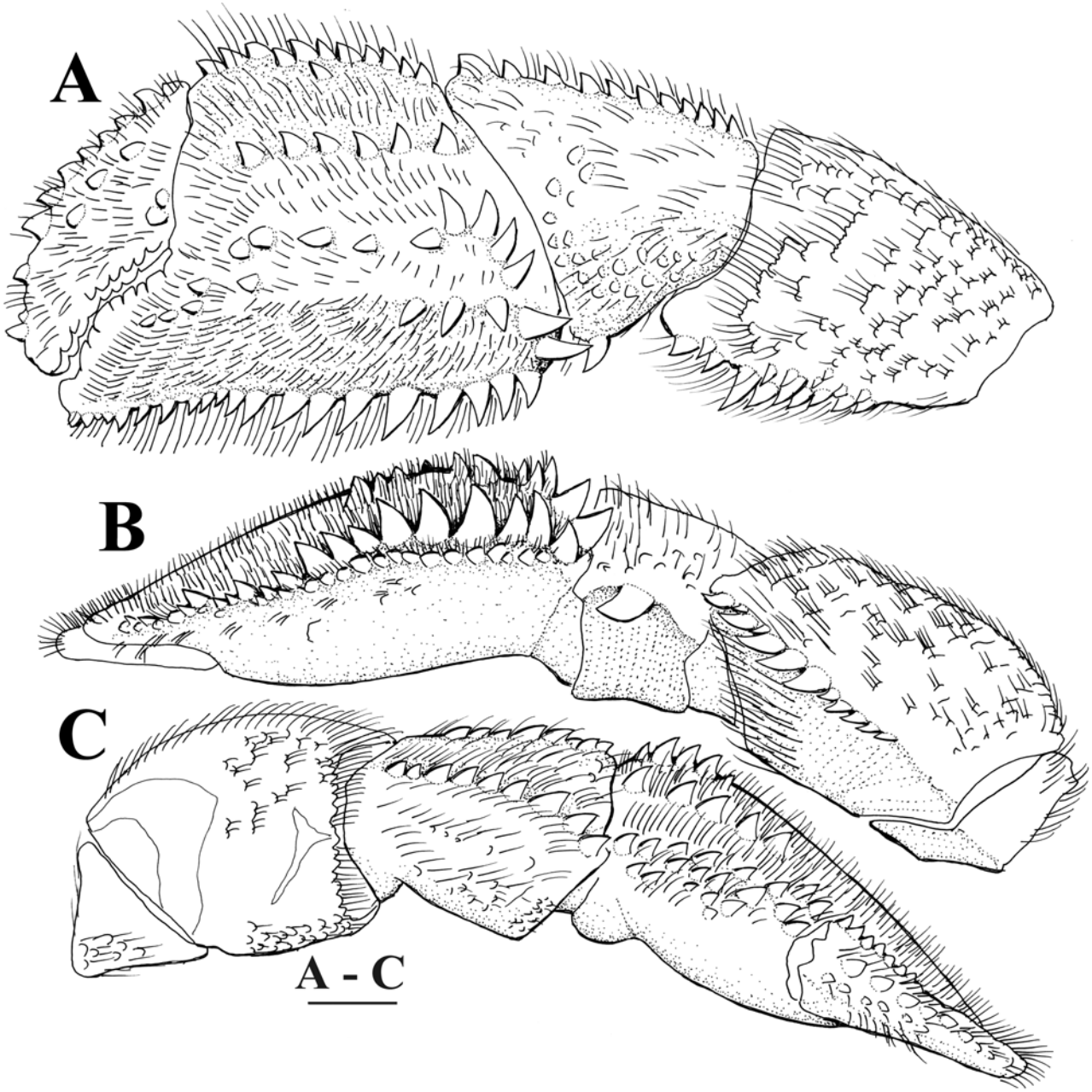

Figure 19. *Diogenes rectimanus* Miers, 1884: male, USNM 1283267 (JF 0538, S2A). Left cheliped: A, outer; B, lower; C, upper. Scales equal 1 mm.

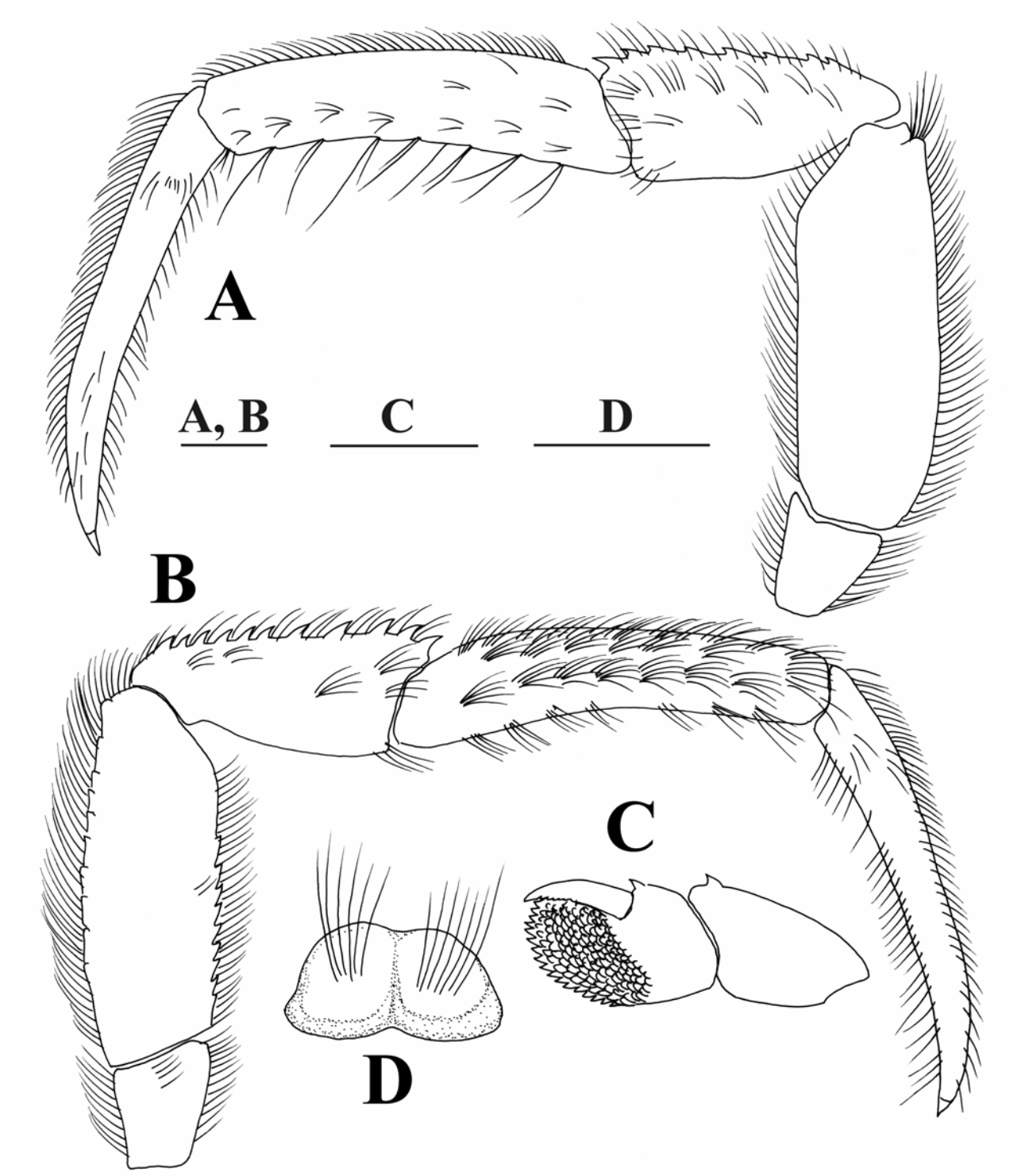

Figure 20. *Diogenes rectimanus* Miers, 1884: male, USNM 1283267 (JF 0538, S2A). A, left second pereopod, lateral. B, right second pereopod, lateral. C, fourth pereopod: chela and carpus, left, lateral, setae omitted. D, anterior lobe of sternite XII. Scales equal 1 mm.

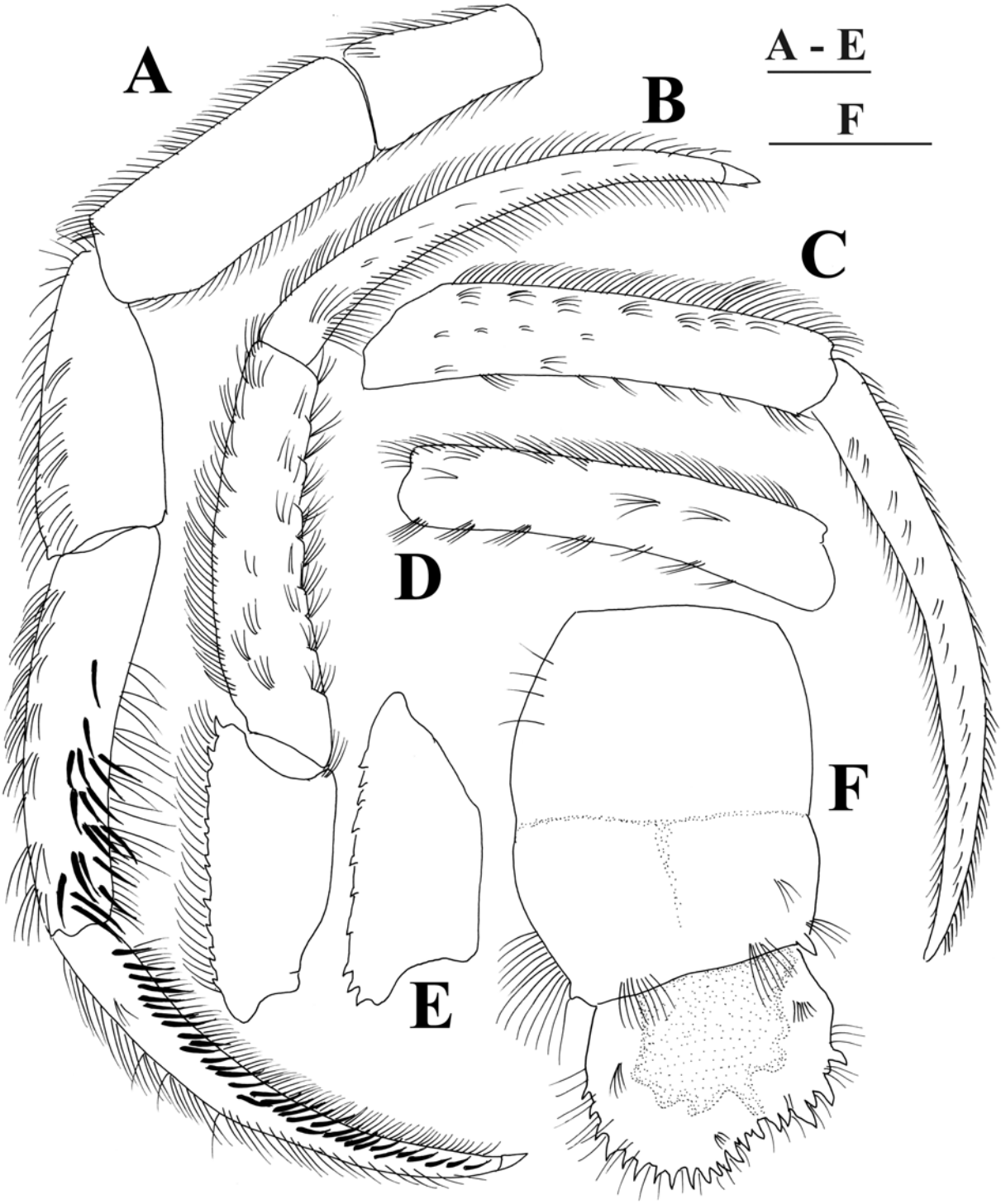

Figure 21. *Diogenes rectimanus* Miers, 1884: male, USNM 1283267 (JF 0538, S2A). Left third pereopod; A, lateral; B, dactyl, propodus, and carpus, mesial. Right third pereopod: C, dactyl and propodus, lateral; D, propodus, mesial. E, left third pereopod: carpus, lateral, setae omitted. F, sixth tergite and telson, dorsal. Scales equal 1 mm.

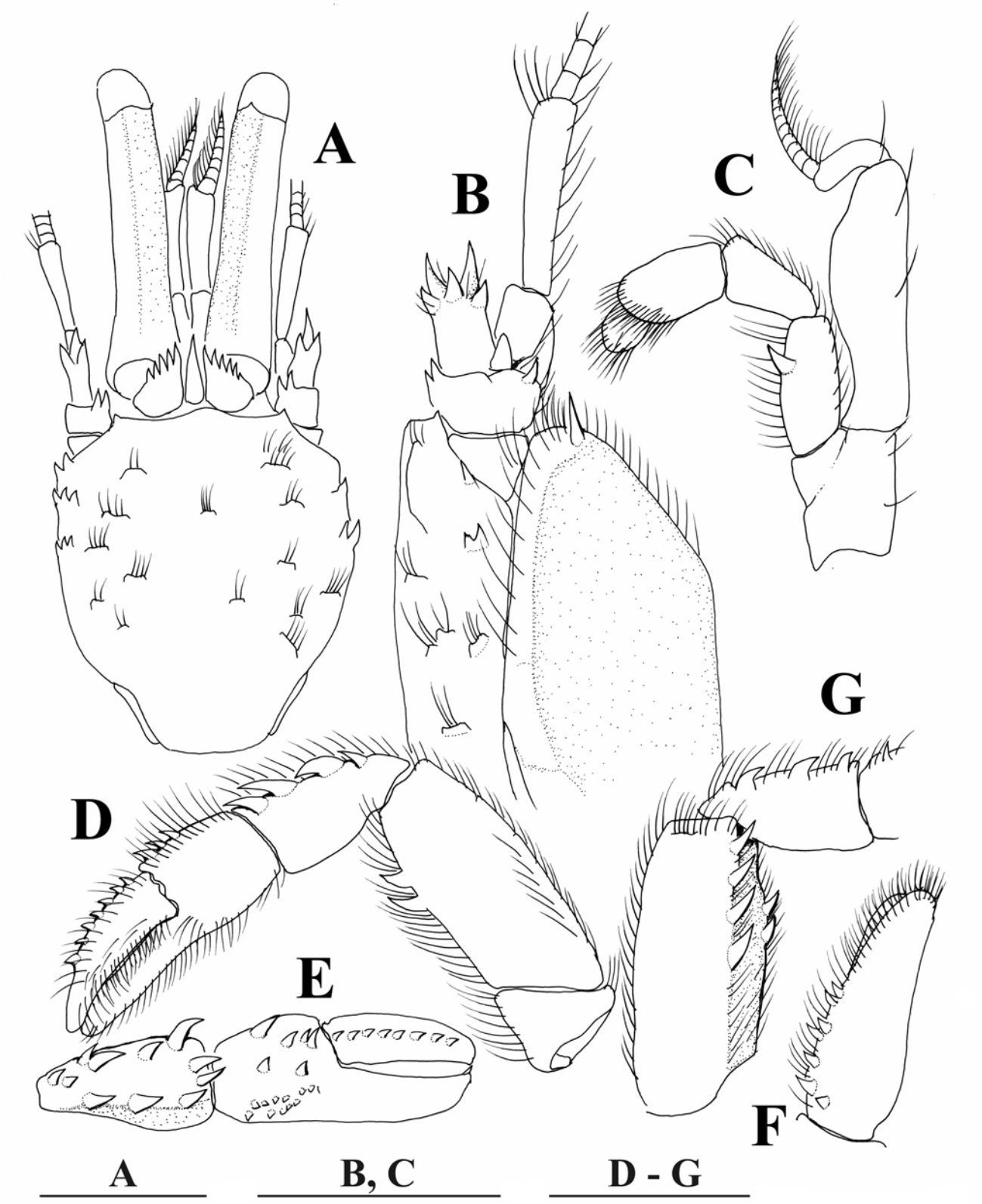

Figure 22. *Diogenes biramus* Morgan, 1987: male, USNM 1283278 (JF0841, G3). A, shield and cephalic appendages, dorsal, setae omitted. B, shield, branchiostegite, and antennal peduncle, right, lateral. C, left third maxilliped, lateral. Right cheliped: D, upper; E, chela and carpus, outer, setae omitted; F, chela, lower; G, merus and carpus, lateral or outer. Scales equal 1 mm.

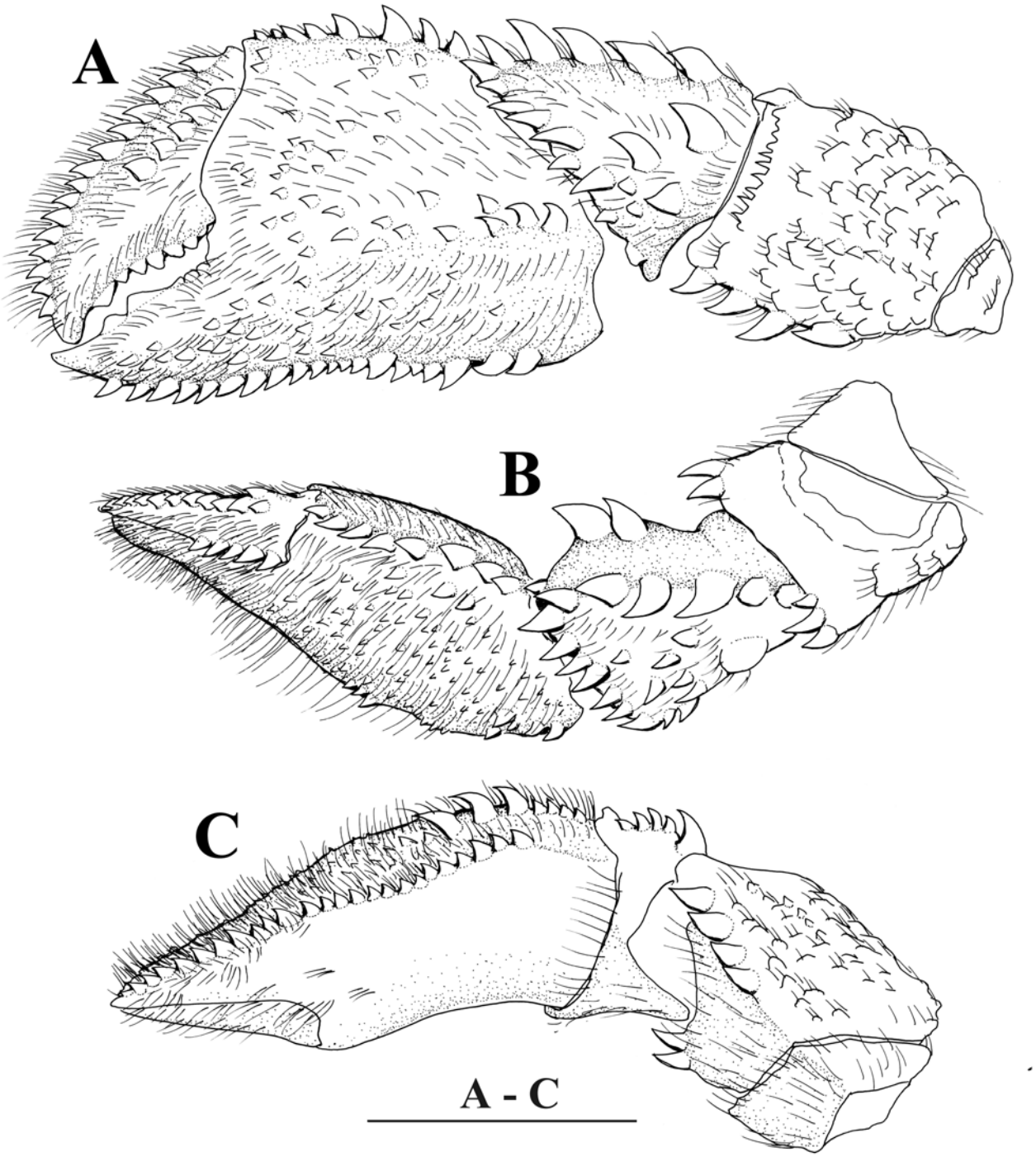

Figure 23. *Diogenes biramus* Morgan, 1987: male, 1283278 (JF0841, G3). Left cheliped: A, outer; B, upper; C, lower. Scale equals 1 mm.

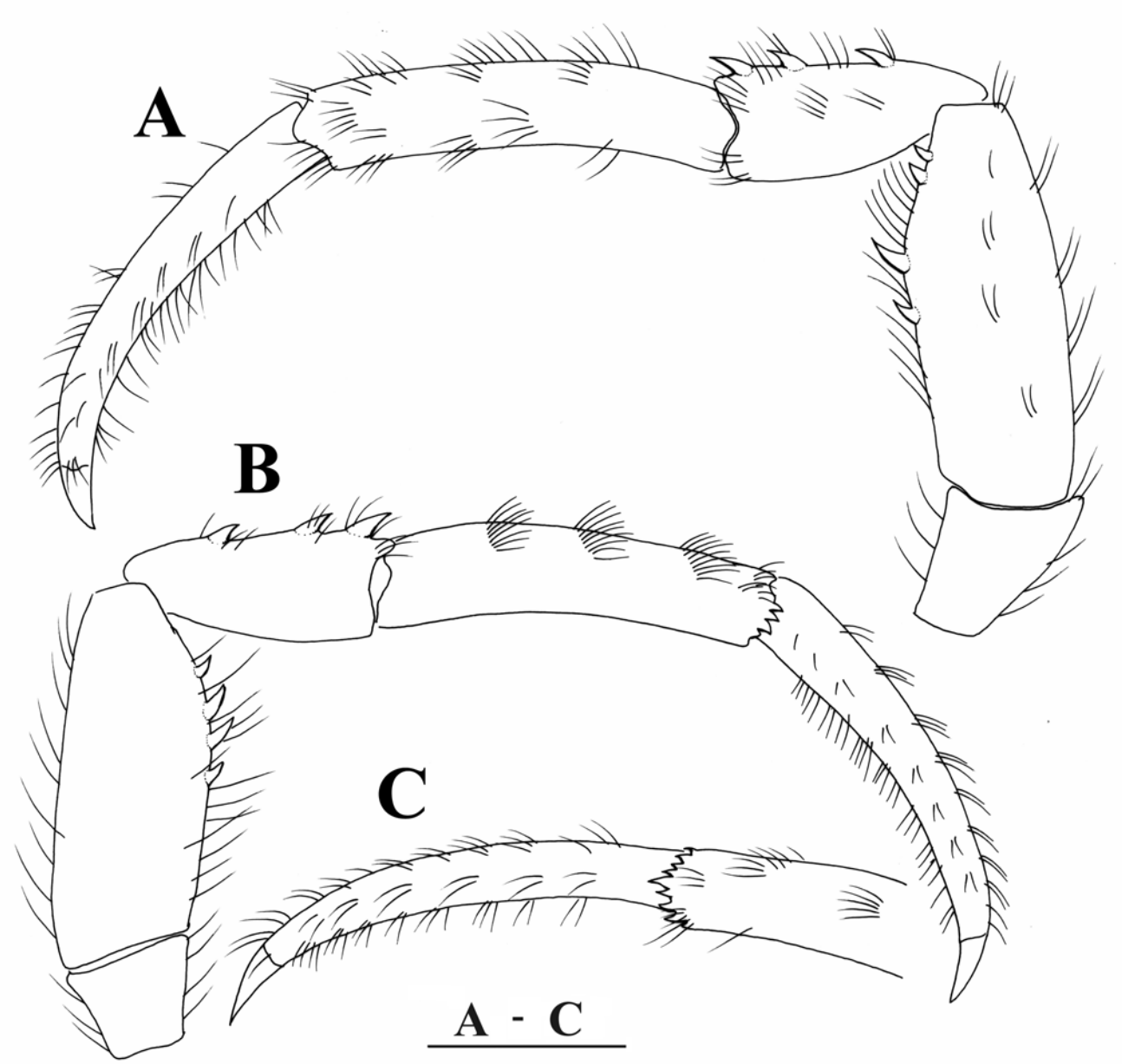

Figure 24. *Diogenes biramus* Morgan, 1987: male, USNM 1283278 (JF0841, G3). Left second pereopod: A, lateral; B, mesial. C, right second pereopod: dactyl and distal portion of propodus, mesial. Scales equal 1 mm.

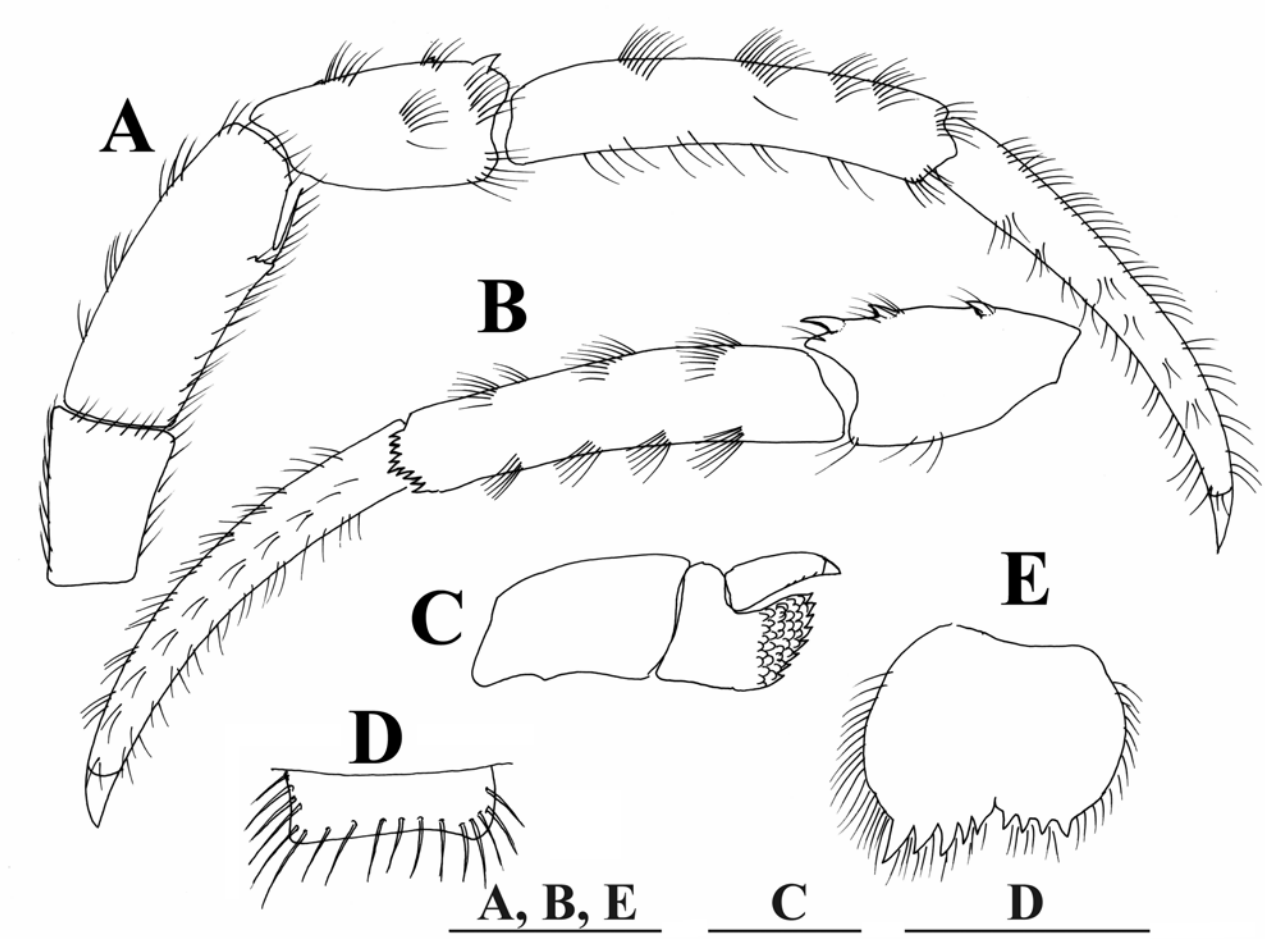

Figure 25. *Diogenes biramus* Morgan, 1987: male, USNM 1283278 (JF0841, G3). Right third pereopod; A, lateral; B, dactyl, propodus, and carpus, mesial. C, right fourth pereopod: chela and carpus, lateral, setae omitted. D, anterior lobe of sternite XII. E, telson, dorsal. Scales equal 1 mm.

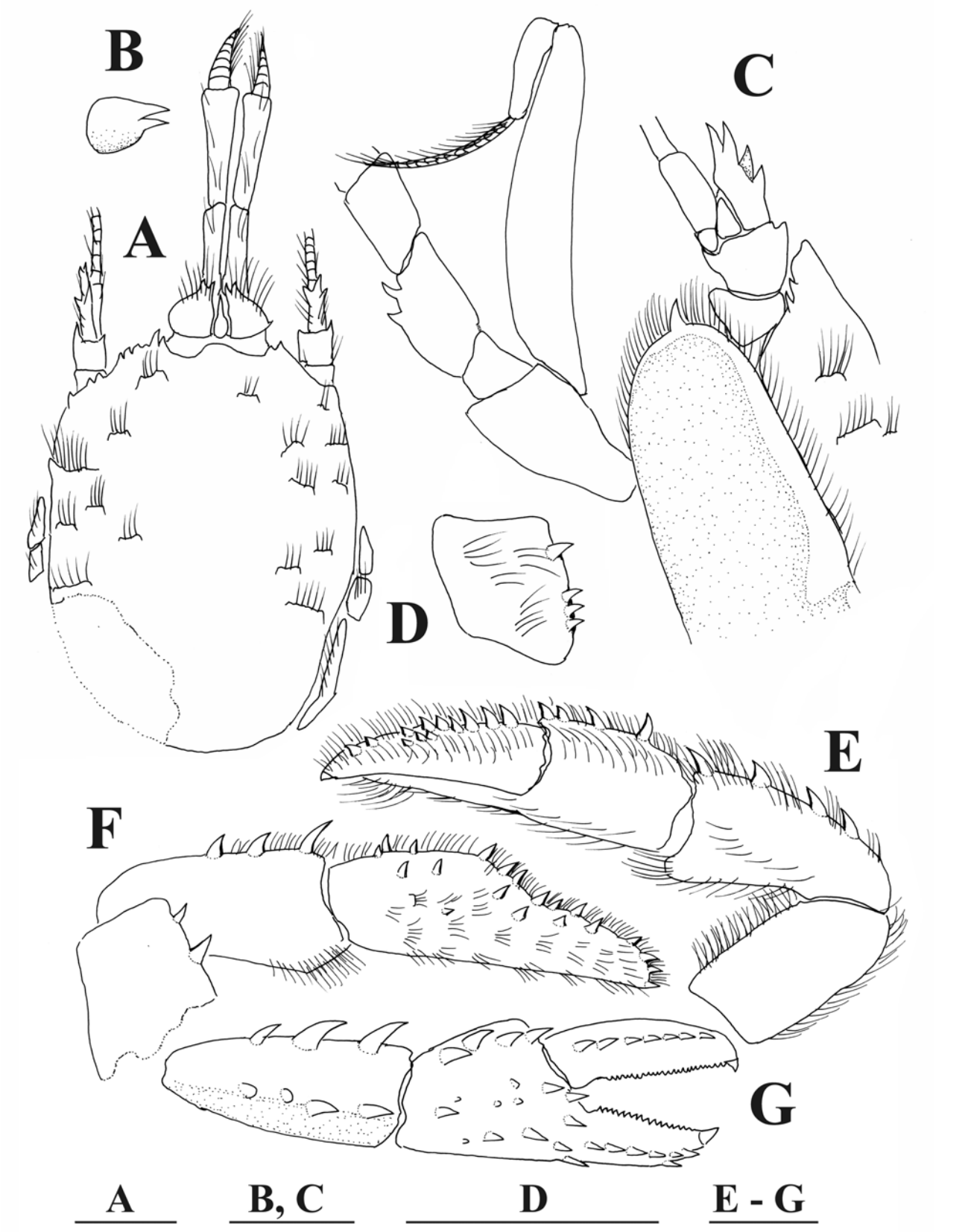

Figure 26. *Diogenes magnus,* sp. nov.: holotype, male, USNM 1283263 (JF0460, G1A). A, shield and cephalic appendages, dorsal. B, intercalary rostral process, right, lateral. C, shield, branchiostegite, and antennal peduncle, left, lateral. D, left third maxilliped: ischium, mesial. Right cheliped: E, upper; F, lower, setae omitted; G, chela and carpus, outer, setae omitted. Scales equal 1 mm.

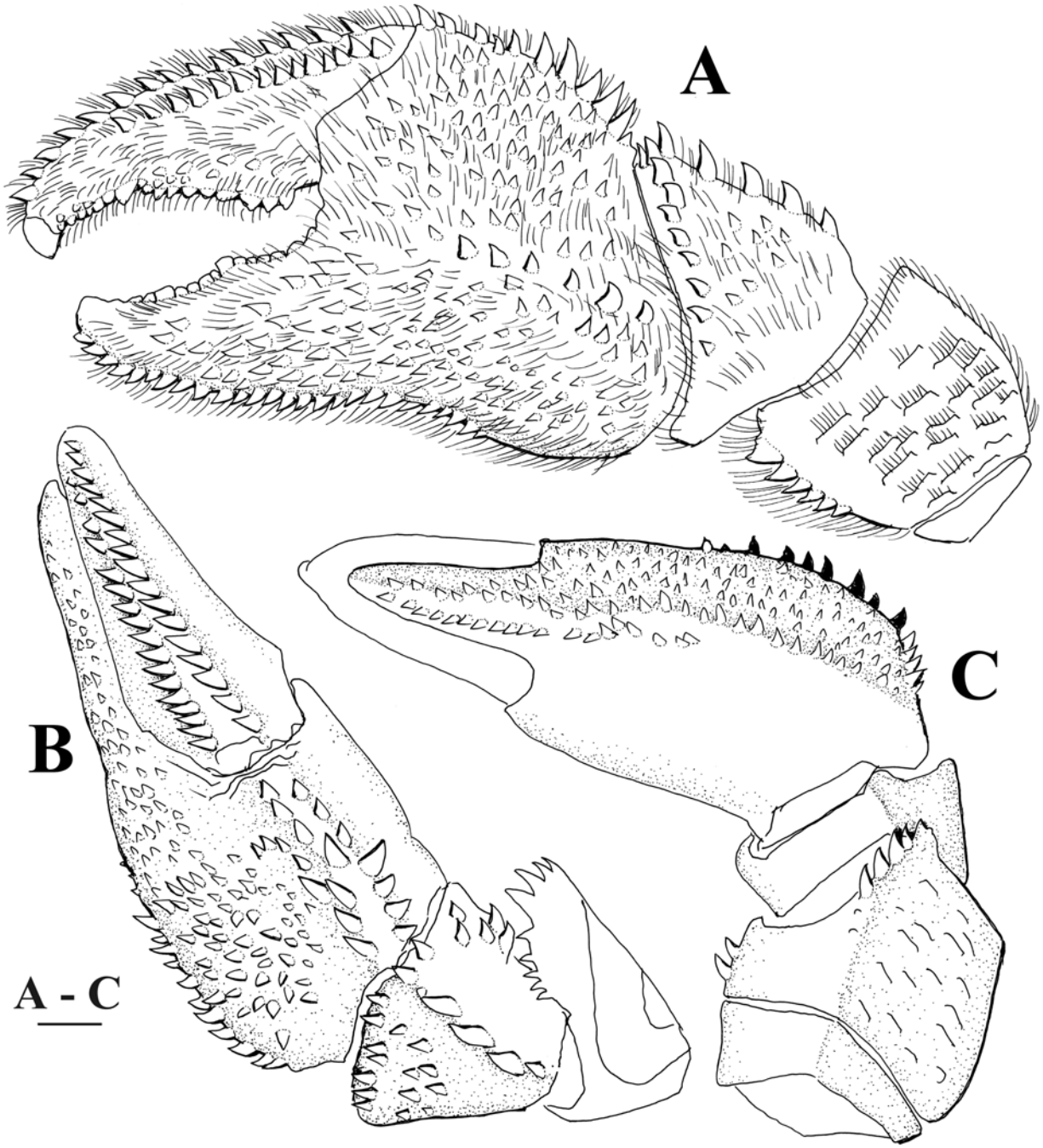

Figure 27. *Diogenes magnus,* sp. nov.: holotype, male, USNM 1283263 (JF0460, G1A). Left cheliped: A, outer; B, upper, setae omitted; C, lower, setae omitted. Scale equals 1 mm.

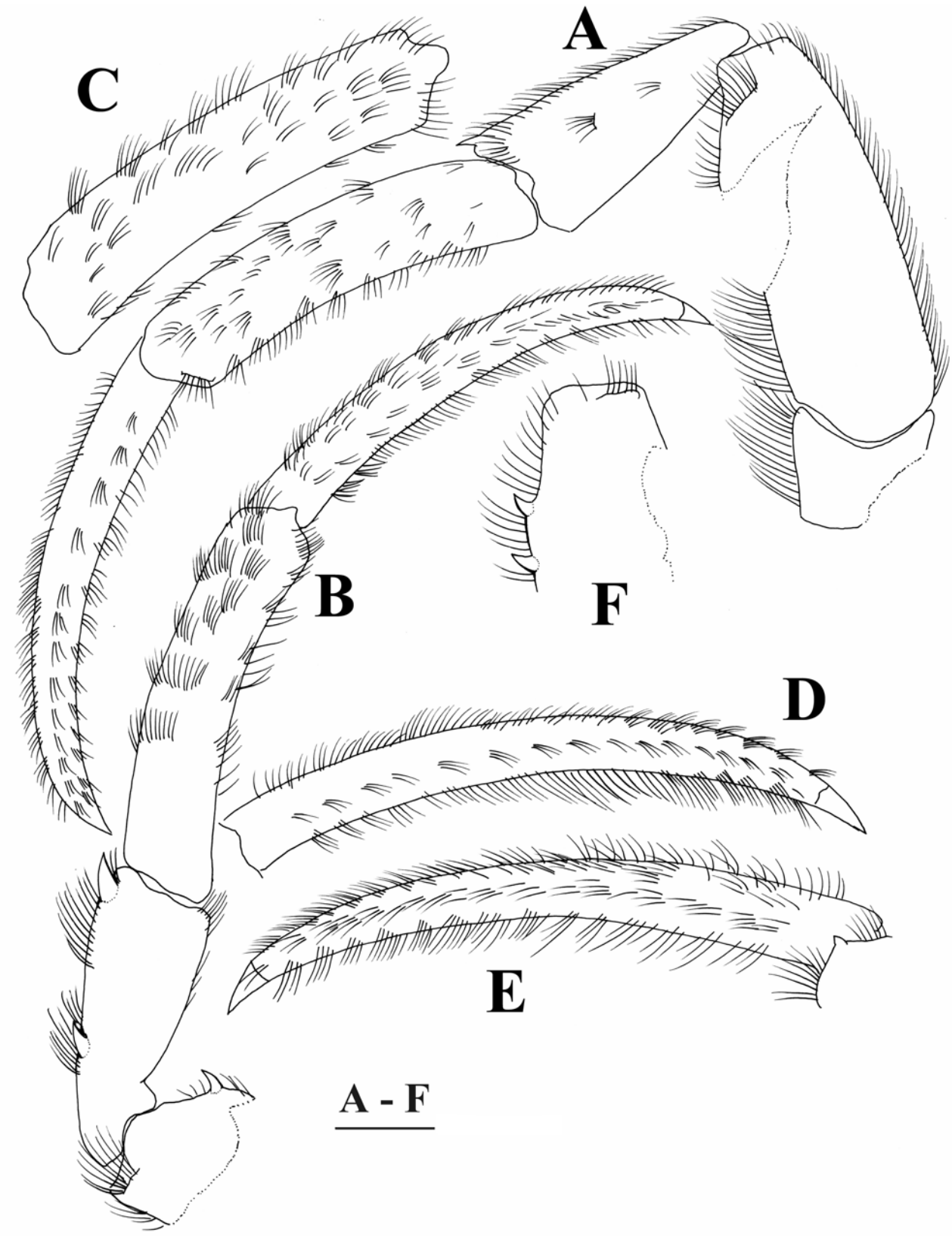

Figure 28. *Diogenes magnus,* sp. nov.: holotype, male, USNM 1283263 (JF0460, G1A). Left second pereopod: A, lateral; B, mesial. Right second pereopod: C, propodus, lateral; D, dactyl, lateral; E, dactyl, mesial; F, distal portion of merus, mesial.

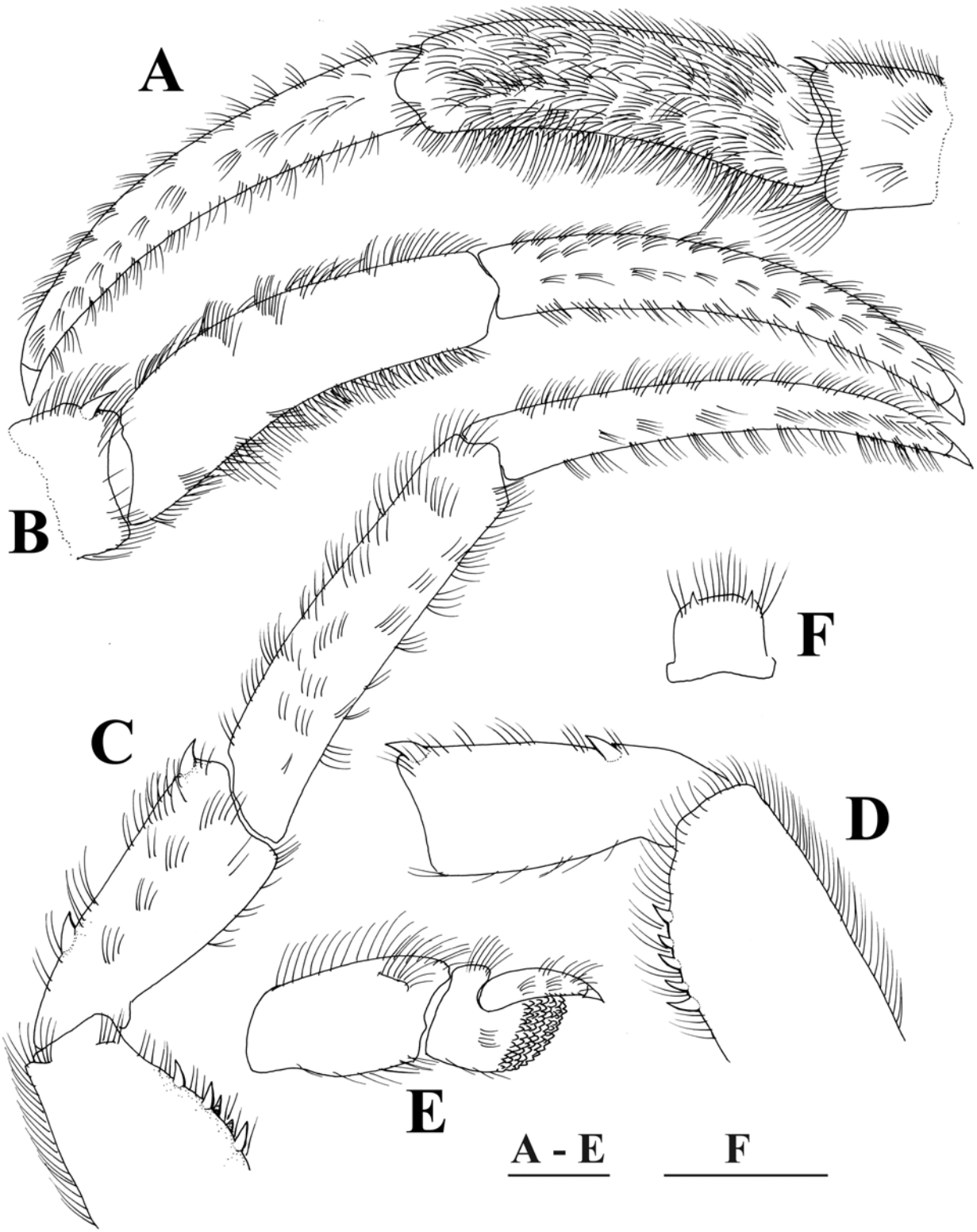

Figure 29. *Diogenes magnus,* sp. nov.: holotype, male, USNM 1283263 (JF0460, G1A). Left third pereopod: A, dactyl, propodus, distal portion of carpus, lateral; B, same, mesial. Right third pereopod: C, lateral; D, carpus and distal portion of merus, mesial. E, right fourth pereopod: chela and carpus, lateral.

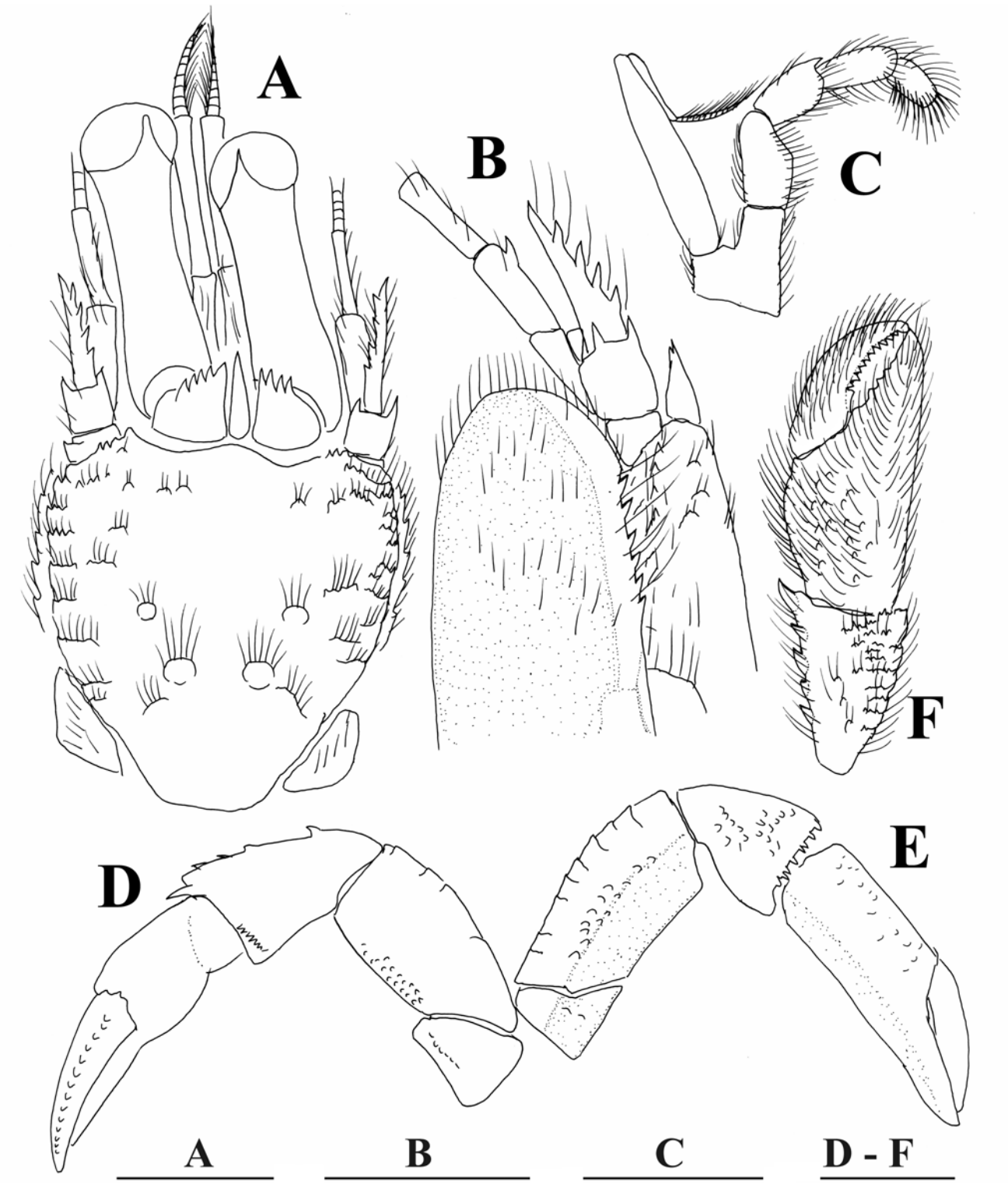

Figure 30. *Diogenes spinicarpus* Rahayu & Forest, 1995: male, USNM 1283274 (JF 0608, G2A). A, shield and cephalic appendages, dorsal. B, shield, branchiostegite, and antennal peduncle, left, lateral. C, right third maxilliped, lateral. Right cheliped: D, upper, setae omitted; E, outer (slightly lower), setae omitted; F, chela and carpus, outer. Scales equal 1 mm.

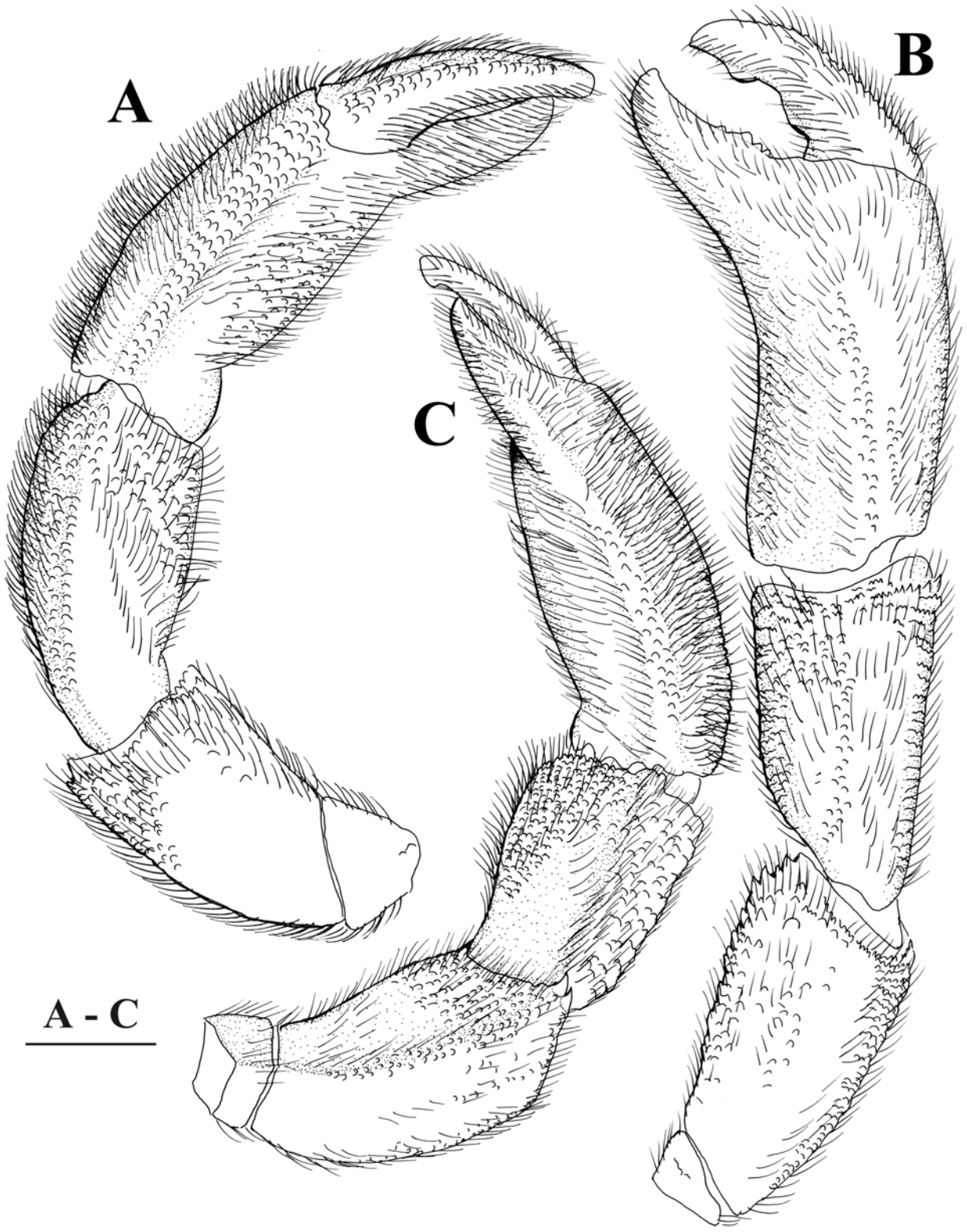

Figure 31. *Diogenes spinicarpus* Rahayu & Forest, 1995: male, USNM 1283274 (JF 0608, G2A). Left cheliped: A, upper; B, outer; C, lower. Scale equals 1 mm.

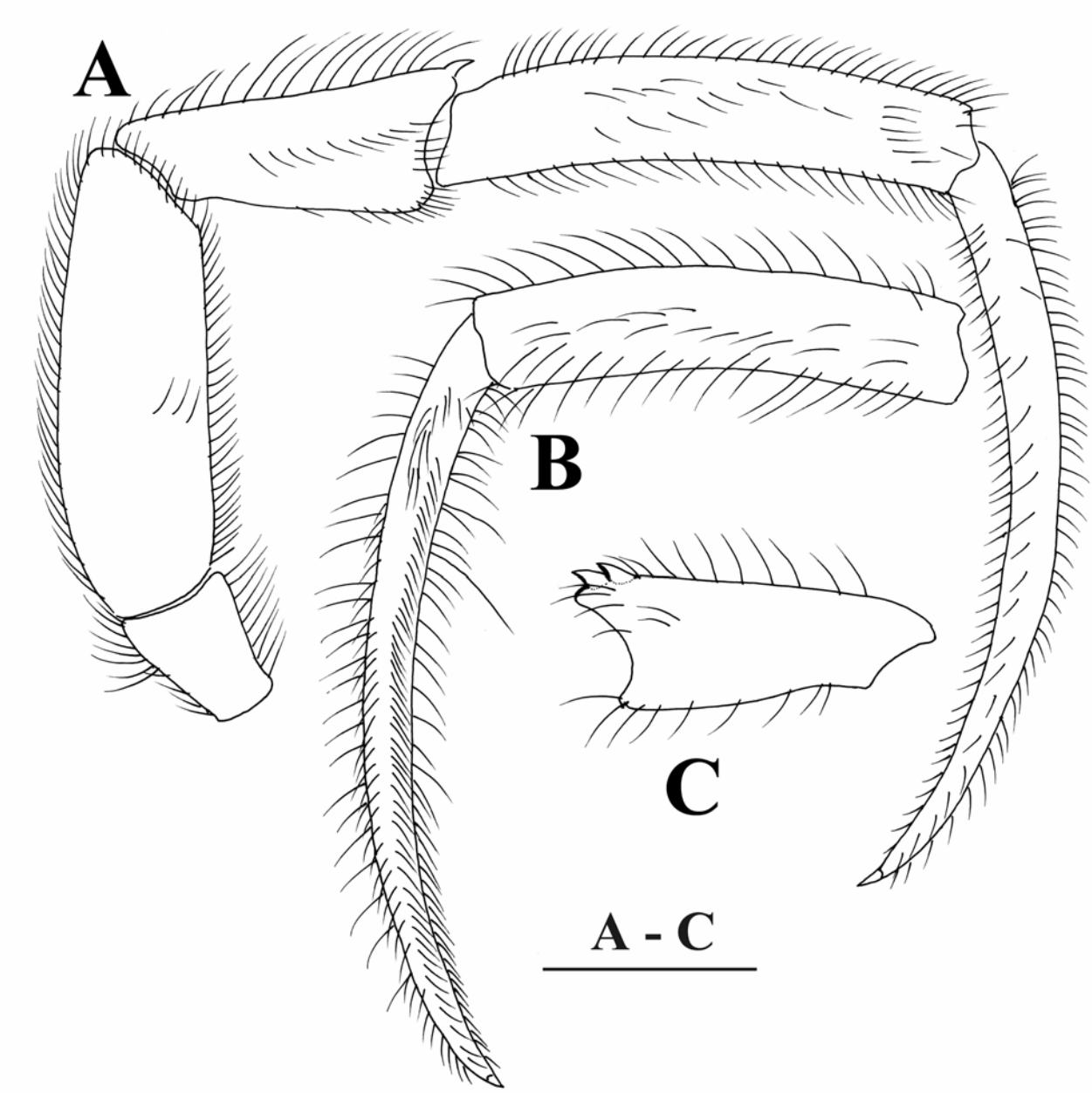

Figure 32. *Diogenes spinicarpus* Rahayu & Forest, 1995: male, USNM 1283274 (JF 0608, G2A). Right second pereopod: A, lateral; B, dactyl and propodus, mesial. C, left second pereopod: carpus, lateral. Scales equal 1 mm.

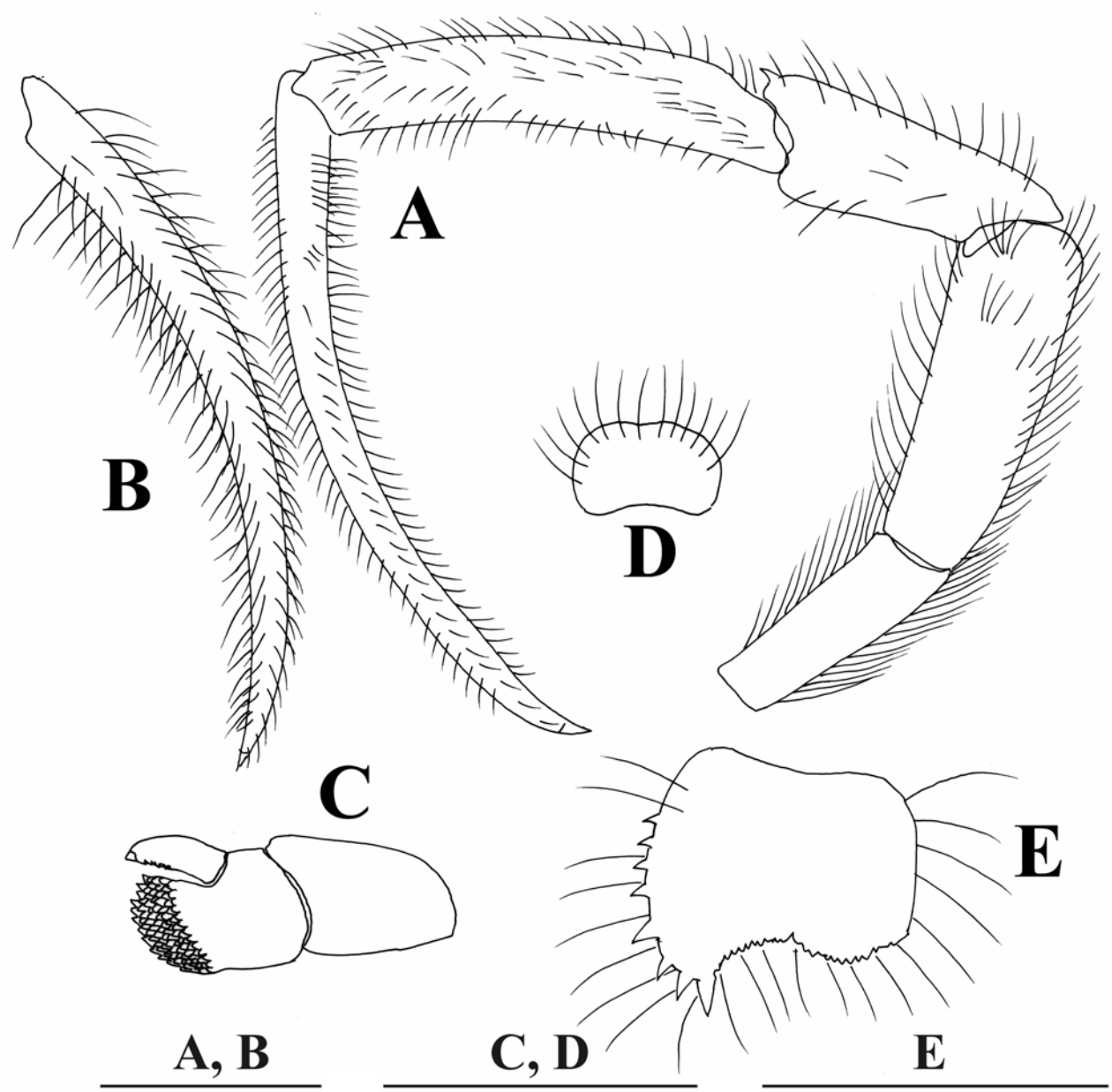

Figure 33. *Diogenes spinicarpus* Rahayu & Forest, 1995: male, USNM 1283274 (JF 0608, G2A). Left third pereopod: A, lateral; B, dactyl, mesial. C, left fourth pereopod: chela and carpus, lateral, setae omitted. D, anterior lobe of sternite XII. E, telson, dorsal. Scales equal 1 mm.