



<http://dx.doi.org/10.11646/zootaxa.3814.3.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:09BB2494-86F2-4C72-AF1E-DDC75D05A6C8>

Description of two new species of *Arcania* Leach, 1817, from the western Pacific Ocean and redescriptions of *A. undecimspinosa* De Haan, 1841, and *A. elongata* Yokoya, 1933 (Crustacea: Brachyura: Leucosiidae)

TOHRU NARUSE

Tropical Biosphere Research Center, Iriomote Station, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan

Abstract

Arcania undecimspinosa De Haan, 1841, and *A. elongata* Yokoya, 1933, are redescribed, with a lectotype of *A. undecimspinosa* formally designated. Redescription of the two species revealed that there are several specimens and possible undescribed species that have been inaccurately recorded under the name of *A. undecimspinosa* and *A. elongata*. Two such species are described from the western and southern Pacific Ocean as new to science. These four species partially overlap their geographical distributions and are superficially similar to each other, but the present study shows that there are clear differences in the shapes of their male first gonopods, female vulvae, frontal lobes of the carapace and other morphological characters. Literature that cited *A. undecimspinosa* s.l. is also reviewed to highlight possible taxonomic problems.

Key words: *Arcania*, redescription, new species, Indo-West Pacific region, taxonomy

Introduction

Among 19 species of the leucosiid genus *Arcania* Leach, 1817, *A. undecimspinosa* De Haan, 1841, is a relatively well-known species which has been recorded from across the Indo-West Pacific region from the Marquesas Islands to South Africa (Galil 2001; Sakai 2004). Detailed examination of the specimens that have been referred to as *A. undecimspinosa* from Japan (type locality) as well as surrounding waters revealed the presence of a coexisting undescribed species. *Arcania elongata* Yokoya, 1933, an allied species of *A. undecimspinosa*, also turned out to contain an undescribed species. The present study redescribes *A. undecimspinosa* and *A. elongata* in detail and describes two new allied species. Previous records of *A. undecimspinosa* are also reviewed.

Materials and methods

Specimens examined are deposited in the Kitakyushu Museum of Natural History & Human History (KMNH IvR), Fukuoka; Marine Arthropods Depository Bank of Korea (MADBK), Seoul National University, Seoul; Muséum national d'Histoire naturelle (MNHN), Paris; National Museum of Marine Biology and Aquarium, Pingtung, Taiwan (NMMB); National Museum of the Philippines (NMCR), Manila; National Museum of Nature and Science, Tokyo (NSMT); National Taiwan Ocean University (NTOU), Keelung; Naturalis Biodiversity Center (RMNH), Leiden; Ryukyu University Museum, Fujukan (RUMF), University of the Ryukyus, Okinawa; National Museum of Natural History, Smithsonian Institution (USNM), Washington, D.C.; Wakayama Prefectural Museum of Natural History (WMNH), Japan; and the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore.

Measurements provided are carapace length (CL, including frontal lobes) × carapace width (CW, including lateral teeth of the carapace) in millimeters. Analysis for covariance (ANCOVA) for body width (BW, carapace width excluding lateral teeth) and cheliped merus length were conducted. Postfrontal carapace length (PCL) is used as an independent variable. The statistical significance is considered at the 0.05 level of the probability.

Other abbreviations used are as follows: G1, male first gonopod; mxp3, third maxilliped; ovig., ovigerous; stn., station.

Arcania novemspinosa (Lichtenstein, 1816) (RUMF-ZC-1910, 2 males, 23.6 × 21.0, 25.9 × 22.9 mm, Kampong Kandal Fishery Port, Kampot Province, Cambodia, coll. T. Naruse, D.C.J. Yeo, E.C.K. Khoo & S. Leng, 27 Dec. 2010) was examined for comparison.

Synonymies listed are limited to those with confirmed identifications; references to *A. undecimspinosa* s.l. are reviewed and listed in Appendix 1.

Taxonomy

Leucosiidae Samouelle, 1819

Arcania Leach, 1817

Arcania undecimspinosa De Haan, 1841

(Figs. 1–6)

Arcania undecimspinosa De Haan, 1841: 135, pl. 33, fig. 8.—Bell 1855a: 367; 1855b: 309; 1855c: 21.—Herklots 1861: 28.—Ives 1891: 216.—Shen 1931: 107, pl. 10, fig. 1.—Sakai 1937: 123, fig. 15a, pl. 14, fig. 2; 1965: 40 (part?), pl. 16, fig. 2; 1976: 91, pl. 28, fig. 1.—Kamita 1941b, 40, fig. 13.—Holthuis & Sakai 1970: 119, pl. 11, fig. 2.—Miyake 1983: 60, pl. 20, fig. 6.—Dai *et al.* 1986: 66, fig. 33-1, pl. 8, fig. 1.—Huang 1989: 305, fig. 267.—Dai & Yang 1991: 73, fig. 33-1, pl. 8, fig. 1.—Yamaguchi 1993: pl. 21c.—Yamaguchi & Baba 1993: 318, fig. 101; 2003: 33.—Galil 2001: 197 (part), figs. 3D, 7D (part).—Takeda *et al.* 2011: 37, fig. 9–26).

Arcania novemspinosa—Hill 1982: 201, pl. 4D.—Dai *et al.* 1986: 66, fig. 33-2, 3; Dai & Yang 1991: 74, fig. 33-2, 3.

Material examined. Lectotype: RMNH.CRUS.D.790, 1 male, 16.5 × 16.5 mm, Nagasaki, Kyushu, Japan, coll. H. Bürger, 1825–1834.

Paralectotypes: RMNH.CRUS.D.56126, 1 female, 19.2 × 19.2 mm, 3 individuals (sex unknown), 20.3 × 19.9, 21.1 × 21.1 mm, data same as lectotype.

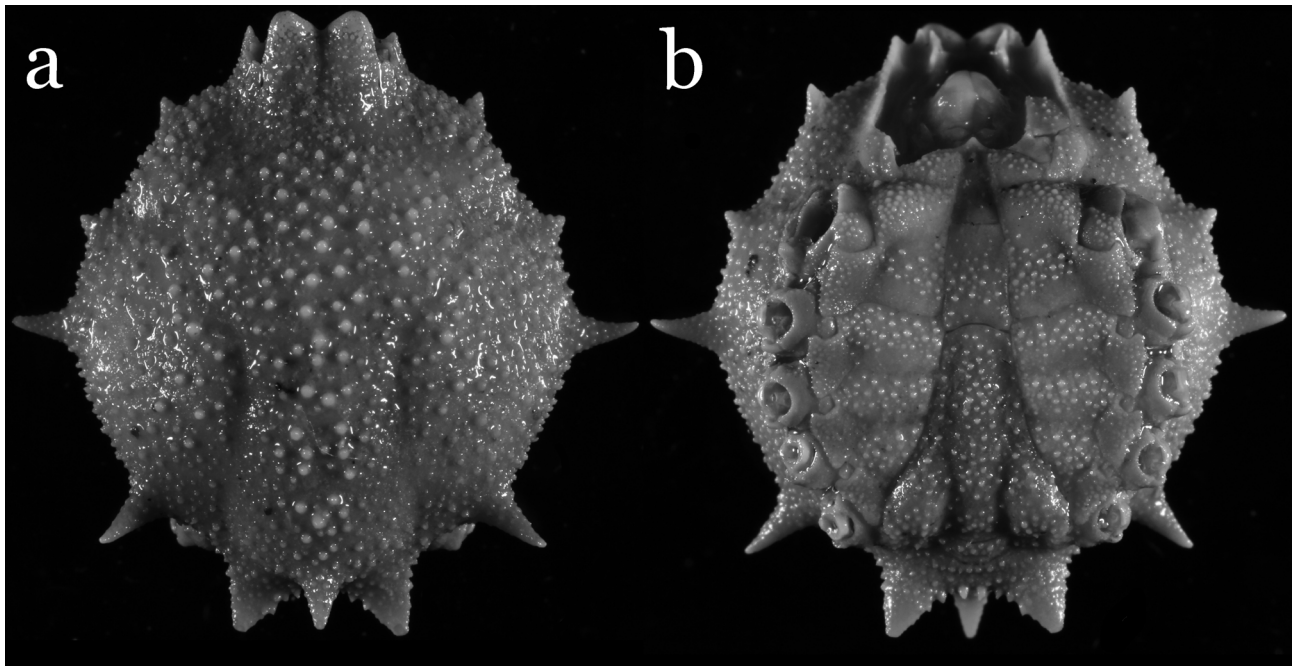


FIGURE 1. *Arcania undecimspinosa* De Haan, 1841. Lectotype. RMNH.CRUS.D.790, male, 16.5 × 16.5 mm, Nagasaki, Kyushu, Japan; a, cephalothorax, dorsal view; b, cephalothorax, ventral view.

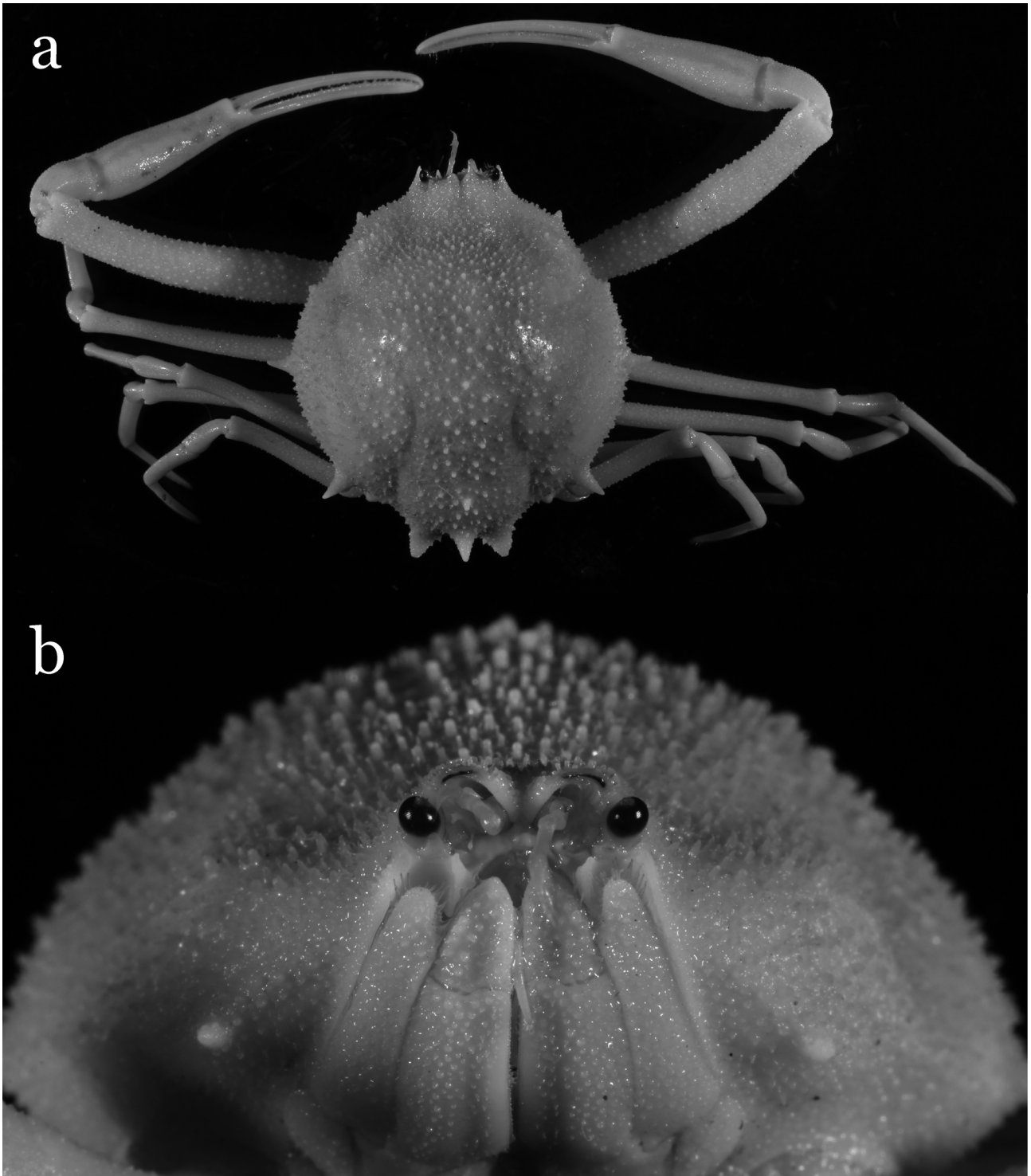


FIGURE 2. *Arcania undecimspinosa* De Haan, 1841. NSMT-Cr 4397, male, ca. 25.9 × 25.1 mm (front damaged), Kochi, Japan; a, habitus; b, cephalothorax, frontal view.

Additional material. *Japan*: USNM 26280, 1 male, 21.1 × 21.1 mm, 1 female, 21.2 × 21.2 mm, 1 ovig. female, 19.9 × 20.3 mm, Nagasaki, Hizen, Kyushu, coll. Jordan & Snyder, 1900.—USNM 45833, 1 ovig. female, 19.7 × 20.2 mm, Nagasaki, Kyushu, exchange with Imperial Tokyo University.—NSMT-Cr 8371, 1 female, 16.7 × 16.2 mm, Ariake Sea, Kyushu, coll. Sep. 1958.—NSMT-Cr 8200, 1 male, 19.9 × 19.1 mm, Ariake, Kyushu, coll. N. Yoshikawa, 15 June 1982.—NSMT-Cr 8009, 1 male, 16.5 × 15.6 mm, off Jogajima, coll. E. Tsuchida, 11 Mar. 1982.—USNM 1199103, 1 male, Shizuoka, Suruga Bay, Seno Umi, *Albatross*, stn. D. 3702, 7 May 1900.—USNM 63676, 1 ovig. female, 26.3 × 25.9 mm, Misaki, Japan, coll. A.S. Pearse (bought from Kuma-san), 1930.—NSMT-

Cr 3839, 1 female, 24.5 × 23.3 mm, Mikawa-Isshiki, Mikawa Bay, coll. 15 Jan. 1966.—USNM 134198, 19.6 × 18.5 mm, 8.8 mi off Nomasaki, Honshu Island, stn. Alb. D-3725, 13 faths. (ca. 23.8 m), 15 May 1900.—RUMF-ZC-2574, 1 female, 12.6 × 9.9 mm, Takehara City, Hiroshima, 15m, coll. D. Uyeno, 14 Oct. 2007.—NSMT-Cr 4397, 2 males, ca 25.9 × 25.1 mm, 1 female, 28.2 × 27.2 mm, Mimase, Kochi, coll. Y. Koyama, 11 May 1973.—USNM 18873, 1 female, 13.2 × 13.1 mm, Japan, coll. Mr. Sakamoto (passed through Garrett Droppers).

Korea: MADBK171803-017, 1 male, 30.3 × 28.7 mm, 1 female, 22.0 × 21.9 mm, Jinhae-gu, Changwon-si, Gyeongsangnam-do, 1 Aug. 1968.—MADBK171803-016, 1 male, 30.1 × 30.8 mm, 2 ovig. female, 29.8 × 30.2, 30.8 × 30.2 mm, Namcheon-dong, Suyeong-gu, Busan, 10 July 1968.

China: ZRC 2002.0495, 4 males, 27.2 × 26.7—31.0 × 29.8 mm, 1 ovig. female, 31.6 × 31.8 mm, Tuandao, off Qindao, coll. P.K.L. Ng via fishermen, 23–28 Aug. 2002.—USNM 57771, 2 males, 23.9 × 24.8, 31.7 × 31.1 mm, 1 female, 32.1 × 35.1 mm, 1 juv. female (damaged), Tsimei (=Jimei, Fujian), coll. S.F. Light, June 1923.

Taiwan: ZRC 1997.0382, 1 male, 18.3 × 16.7 mm, Donggang, Pingtung, coll. P.K.L. Ng, 5 Aug. 1996.

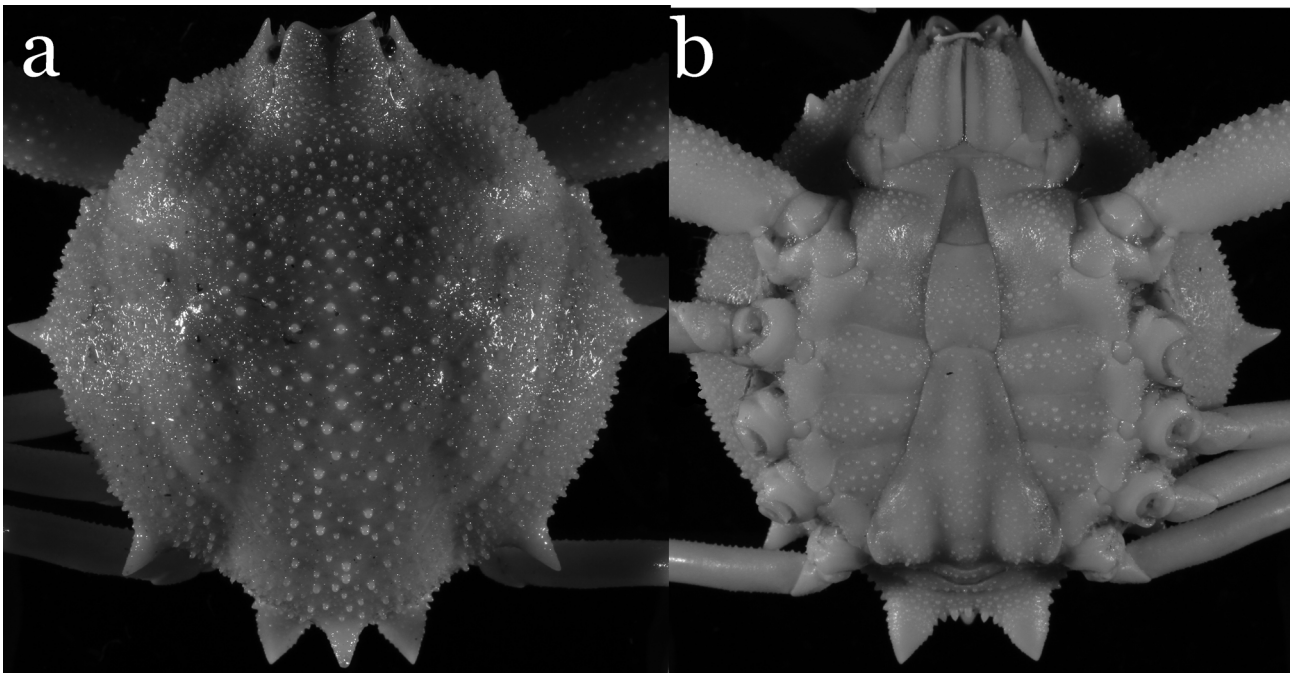


FIGURE 3. *Arcania undecimspinoso* De Haan, 1841. ZRC 2002.0495, male, 31.0 × 29.8 mm, Qindao, China; a, cephalothorax, dorsal view; b, cephalothorax, ventral view.

Redescription. Carapace rounded, dorsal surface covered somewhat sparsely by columnar granules, granules larger at gastric to intestinal regions (Figs. 1a, 2, 3a); pterygostomial, subhepatic regions evenly covered with rounded granules (Fig. 2b). Front divided into 2 triangular lobes by obtuse triangular gap, lobes not strongly produced, weakly rounded in some large individuals (Figs. 1a, 2a). Carapace with subhepatic, anterolateral, lateral, posterolateral, posterior, intestinal spines. Anterolateral spines smallest, followed in size by subhepatic spine, other spines of almost same length. Only branchiocardiac groove distinct. Antennular fossae oblique, antenna excluded from antennular fossa by plate extended from posterior margin of antennular basal segment, plate with triangular lobe anteriorly, seta posteriorly. Mesial end of infraorbital margin forming dorsoventrally compressed, sharp, triangular spine. Anteromesial corner of pterygostomial region, anterolateral margin of buccal cavern forming laterally compressed triangular spines fitting distal part of exopod of closed mxp3; distance between spines relatively narrow due to slender exopod of mxp3.

Eyes fitting within orbit, only corneal part slightly exposed.

Mxp3 (Figs. 2b, 3b) sparsely covered with rounded granules; merus length about two-fifths of ischium; ischium, merus each with longitudinal groove on mesial third, half; female merus with longitudinal row of setae along longitudinal groove. Exopod narrowed at level of proximal two-fifths of merus, gap between narrowed part of exopod, merus thus fitting triangular spine of anterolateral margin of buccal cavern.

Thoracic sternites 4–7 (Fig. 1b) covered with rounded granules; granulation sparser than pterygostomial

region. Sternal button of abdominal holding on anterior end of thoracic sternite 5 at lateral slope of thoracic cavity, button fitting proximolateral cup of somite 6. Penis coxal. Vulva on mesial end of thoracic suture 5/6, on somite 6 but extending mesial end of suture 5/6 anteriorly (Fig. 6); posterolateral part of vulva swollen; opening narrowed laterally, entire mesially.

Chelipeds (Fig. 2a) moderately long, subequal. Merus slender, shorter than chela, entirely covered with rounded granules, granules smaller on lower surface. Carpus, palm sparsely covered with minute granules, carpus smooth without knob on external margin. Fingers slender, gape absent when closed, with 14–18 almost equidistantly placed, small teeth with much smaller teeth throughout. Ambulatory legs slender; merus longest of articles, covered with minute rounded granules. Carpus, propodus covered with minute granules. Dactylus mesiolaterally depressed in cross-section, with sharp keels on mid-lines of mesial, lateral surfaces, keel on lateral surface flanked by rows of setae.

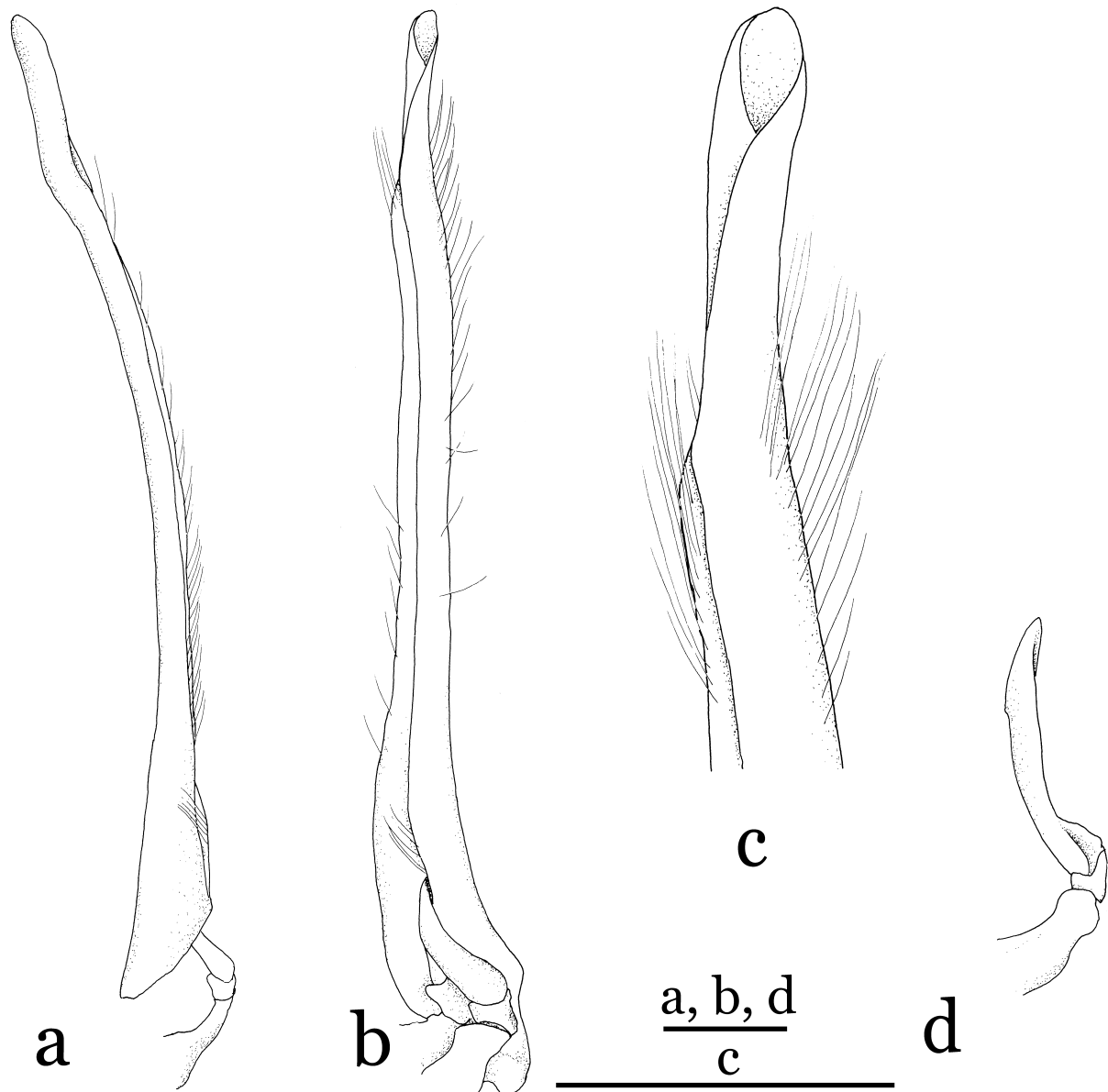


FIGURE 4. G1 and G2 of *Arcania undecimspinosa* De Haan, 1841. Lectotype. RMNH.CRUS.D.790, male, 16.5 × 16.5 mm; a, left G1, mesial view; b, left G1, ventral view; c, distal part of left G1, ventral view; d, left G2. Scales = 1 mm.

Abdomen (Fig. 1b) with sparse, rounded granules; somites 3–5 fused, with proximolateral protuberances on external surface, each protuberance not distinctly larger than central part between two protuberances. Lateral margins of somite 6 convex in large individuals. G1 (Figs. 4a–c, 5) slender, nearly straight, slightly curved dorsally

in mesial view; distal part only slightly upcurved in mesial view, lateral margin wrapping onto mesial margin submedially, forming pipe-like opening. G2 (Fig. 4d) short, opening facing dorsally *in situ*.

Coloration. Body and cheliped merus pinkish dorsally, with a pair of reddish lines and semicircular marks on the dorsal surface (Takeda *et al.* 2011: fig. 9–26).

Geographical distribution. Japan (Pacific coast: from Sagami Bay to Kochi; Kyushu: Ariake, Nagasaki [type locality]); Korea (Namcheon-dong, Jinhae-gu); China (Qingdao; Tsimei; Fukien; Hangzhou; Kwangtung; Cheung Chau Island, Hong Kong); Taiwan (Donggang). (De Haan 1844; Shen 1931; Sakai 1937; Miyake 1983; Huang 1989; present study).

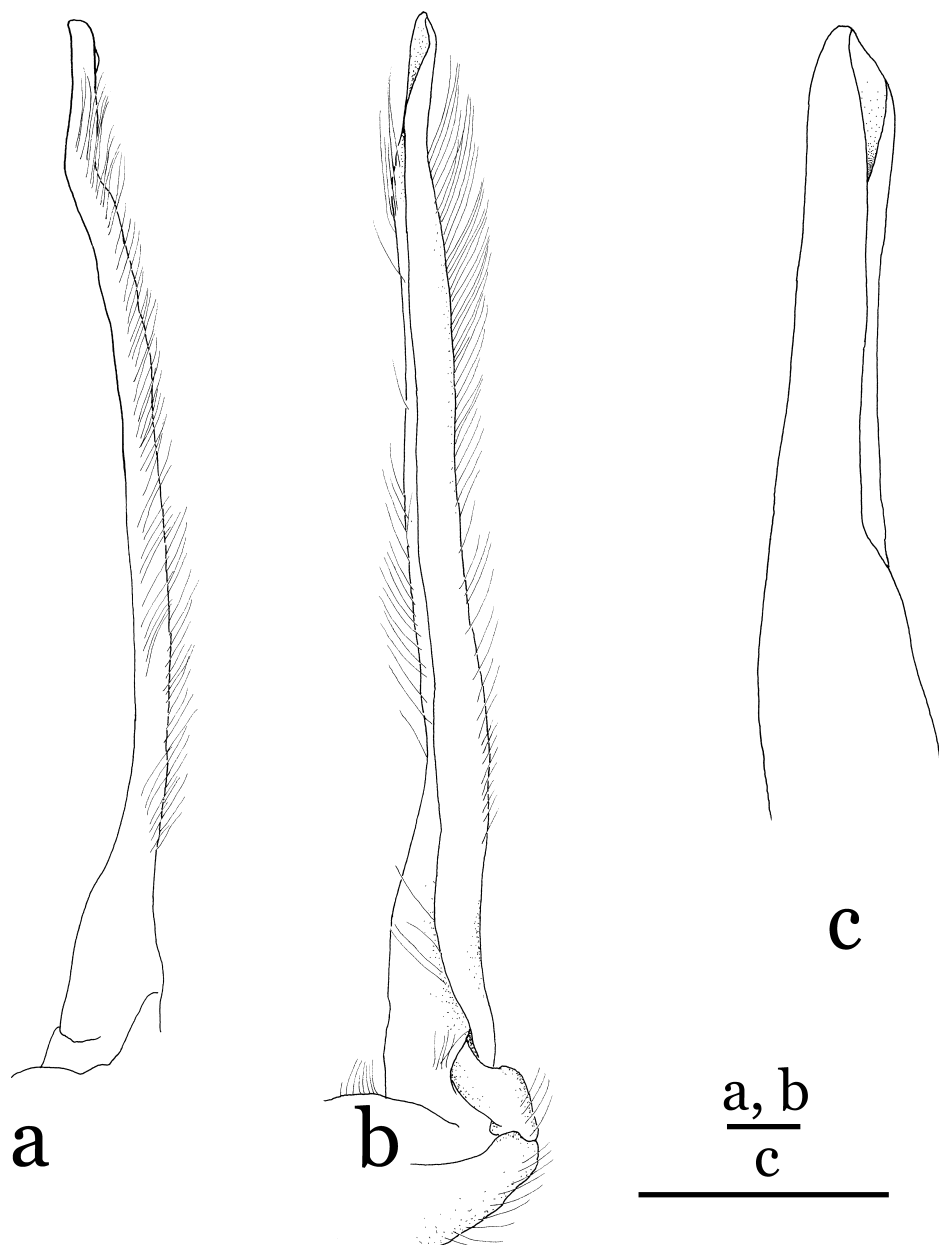


FIGURE 5. G1 of *Arcania undecimspinosa* De Haan, 1841. ZRC 2002.0495, male, 31.0 × 29.8 mm, Qindao, China; a, left G1, mesial view; b, left G1, ventral view; c, distal part of left G1, ventromesial view. Scales = 1 mm.

Remarks. *Arcania undecimspinosa* De Haan, 1841, was described from material collected at Nagasaki, western Kyushu, Japan. Yamaguchi & Baba (1993) and Fransen *et al.* (1997) listed 15 syntypes, of which five specimens are preserved in ethanol and the rest are dried. The ethanol-preserved specimens comprise three males (two of which are confirmed by the presence of fragmented male thoracic sternites), one female, and one individual (sex unknown). Yamaguchi & Baba (1993) indicated that the ethanol-preserved lot contained a lectotype and

paralectotypes, but they did not note nor indicate which individual was selected as lectotype. Since Yamaguchi & Baba's (1993) lectotype designation is invalid, the lectotype is here designated for a male (RMNH.CRUS.D.790; 16.5 × 16.5 mm) from the ethanol-preserved specimens (Figs. 1, 4). The lectotype is in a relatively good condition, allowing the observation of the G1 (Fig. 4a–c). *Arcania undecimspinosa* is characterized by a rounded carapace (Figs. 1a, 2, 3a), front with triangular lobes with an almost regular triangular gap between the lobes (Figs. 1a, 2a, 3a), distinct marginal spines in the carapace (Figs. 1a, 2a, 3a), dorsal surface of the carapace being rather sparsely covered by columnar granules (granules larger from gastric to intestinal regions) (Fig. 2b), almost straight G1 with pipe-like distal end (Figs. 4a–c, 5) and a vulva consisting of a narrowed lateral end and with an entire mesial margin (Fig. 6).

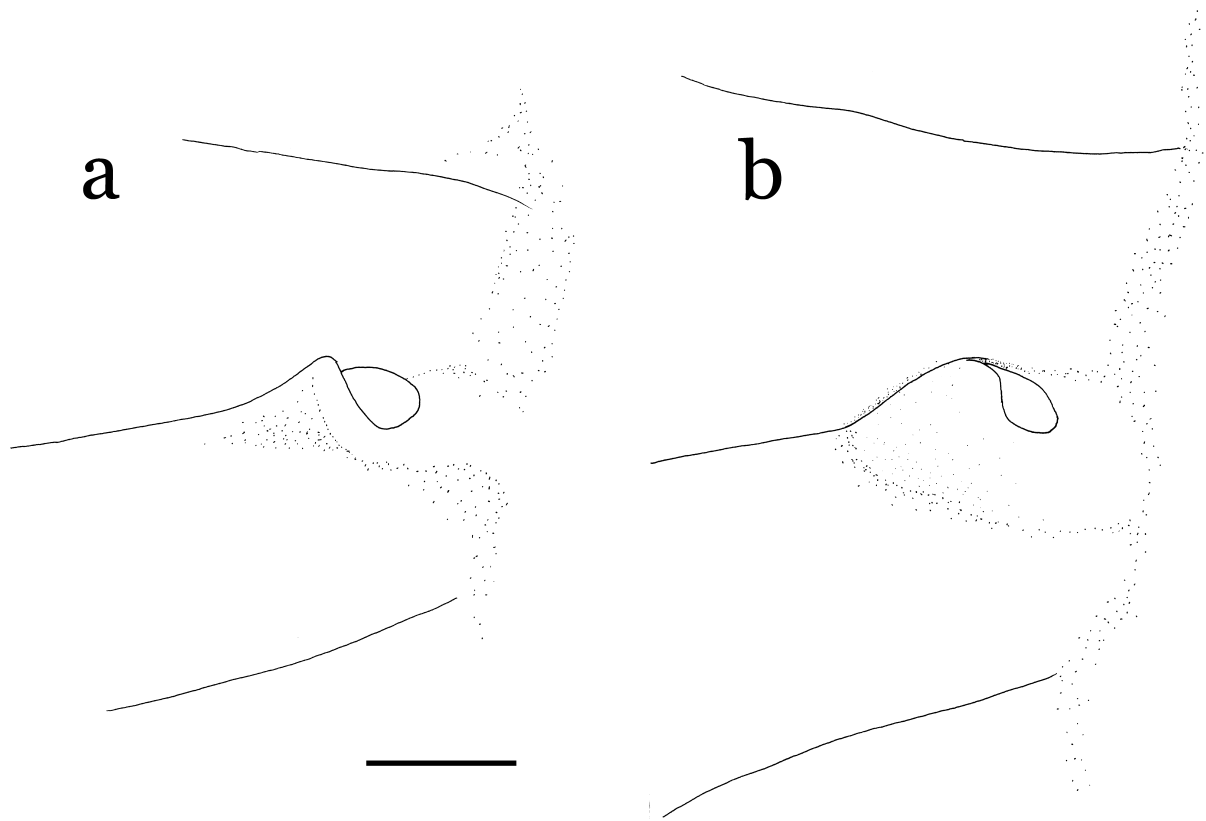


FIGURE 6. Right vulva of *Arcania undecimspinosa* De Haan, 1841; a, NSMT-Cr 3839, 24.5 × 23.3 mm, Mikawa Bay, Japan; b, NSMT-Cr 4397, 28.2 × 27.0 mm, Kochi, Japan. Scale = 1 mm.

Arcania undecimspinosa is morphologically most similar to *A. cornigera* **n. sp.** (see **Remarks** under *A. cornigera* **n. sp.**). It should be noted that *A. undecimspinosa* and *A. cornigera* **n. sp.** have been collected from the same areas (e.g. Kochi, Pacific coast of Shikoku, Japan; Donggang, southwestern Taiwan). This superficial similarity and overlapping distribution may have led to misidentifications. Among the *A. undecimspinosa* specimens recorded by Yokoya (1933), the specimens from Kyo-gasaki (KMNH IvR 400,102; st. 540), Goto Islands (KMNH IvR 400,104; st. 451) and Jeju Island (KMNH IvR 400,103; labelled as Saishu-to, st. 454) are indeed *A. cornigera* **n. sp.** Sakai (1965) also figured the anterior part of the cephalothorax of *A. cornigera* **n. sp.** (Sakai 1965: fig. 6a) and the habitus of *A. undecimspinosa* s.s. as *A. undecimspinosa* (Sakai 1965: pl. 16, fig. 2).

Miers (1877) described *A. granulosa* from Moreton Bay, Australia, which was cited by Haswell (1880; 1882). Miers (1879) subsequently synonymized *A. granulosa* under *A. undecimspinosa*. Subsequent authors (e.g. Miers, 1884; Henderson, 1893; Campbell 1971; Davie & Short 1989) recorded “*A. undecimspinosa*” from Moreton Bay as well. Miers's (1877) specimen is, however, only about 1/3 inch carapace length by 1/4 inch carapace width (about 8.5 × 6.4 mm), which is too small to allow the correct identification of *A. undecimspinosa* and allied species. Galil (2001) identified Campbell & Stephenson's (1970) *A. novemspinosa* from Moreton Bay as *A. undecimspinosa*. Campbell & Stephenson's drawing (1970: fig. 13), however, shows a distally curved G1 with an oblique line of setae, proportionally too broad posterior teeth and almost indiscernible anterolateral teeth of the carapace. This is

clearly neither *A. undecimspinosa* (Figs. 1a, 2a, 3a, 4a–c, 5) nor *A. novemspinosa* (Galil 2001, figs. 2F, 6C; Fujii & Naruse 2013: figs. 1, 2A). The condition of the G1 and the posterior teeth of the carapace of Campbell & Stephenson's (1970) "*A. novemspinosa*" are rather closer to *A. foliolata* Galil, 2001. The taxonomic status of *A. granulosa* as well as the *Arcania* species collected from Moreton Bay, including "*A. elongata*" of Campbell (1971) (see **Remarks** for *A. elongata*), should be reconsidered in future studies.

Alcock (1896: 267) and Tan (1996: 1028) mentioned that *A. novemspinosa* may be synonymous with *A. undecimspinosa*, but they are clearly different species (see Galil 2001; Fujii & Naruse 2013; present study).

Hill (1982: 201, pl. 4D) recorded "*A. novemspinosa*" from Hong Kong, but its less produced and obtuse frontal lobes indicate that it is *A. undecimspinosa*. He also noted the body color of the specimen as "uniformly pinkish-brown with two faint broad darker stripes dorsally down the carapace" (Hill 1982: 201), which agrees with the coloration of *A. undecimspinosa*.

Galil (2001) listed a record of *Arcania erinacea* from Pakistan by Tirmizi & Kazmi (1988: 72) in the synonymy list of *A. undecimspinosa*. The drawing by Tirmizi & Kazmi (1988: fig. 20), however, clearly shows serrate meri of the cheliped and fourth ambulatory leg, which are not observed in *A. undecimspinosa*. Tirmizi & Kazmi (1988: 76, fig. 22) provisionally identified other specimens from Karachi, Pakistan as *A. undecimspinosa*. As Tirmizi & Kazmi (1988) noted, the G1 of the Pakistani specimen differs markedly from that of *A. undecimspinosa* s.s. in its strong distal curvature over the distal third (Tirmizi & Kazmi 1988: fig. 22G). The distally bent G1 of the Pakistani specimen may be similar to that of *A. brevifrons* Chen, 1989, but the former differs from the latter by "half tube bent portion" of the distal part of the G1 (Tirmizi & Kazmi 1988: 79) (flattened in Chen 1989: fig. 32e; Galil 2001: fig. 4A). The identities of the two Pakistani species remain questionable.

Arcania cornigera n. sp

(Figs. 7–11)

Arcania undecimspinosa—Sakai 1965: 40 (part?), fig. 6a.—Chen 1989: fig. 8, pl. 2, fig. 4.—Marumura & Kosaka 2003: 27.
Arcania sp.—Fujii & Naruse 2013: 3.

Material examined. Holotype. NMCR 39101, male, 27.1 × 25.7 mm, Maribojoc Bay, Bohol, Philippines, coll. J. Arbasto, Nov. 2003 to Aug. 2004.

Paratypes. *Philippines*: NSMT-Cr 13007, 1 male, 20.8 × 19.7, 1 female, 24.9 × 23.5 mm, Balicasag I., Bohol, coll. T. Kase, Sept. 1998.—MNHN-IU-2013-13314, 9 males, 18.1 × 16.4–25.4 × 25.0 mm, 6 females, 22.4 × 20.7–24.5 × 23.5 mm, Balicasag Island, Bohol, 50–500 m, tangle net, coll. local fishermen, 28 Nov. 2001.—MNHN-IU-2013-13315, 6 males, 22.3 × 21.2–25.1 × 23.9 mm, 4 females, 27.9 × 27.3–23.0 × 23.0 mm, 2 ovig. females, 25.2 × 24.8, 23.4 × 21.2 mm, Balicasag Island, Bohol, 50–500 m, tangle net, coll. local fishermen, 28 Nov. 2001.—ZRC 2008.0098, 7 males, 24.8 × 23.5–28.9 × 28.1 mm, 2 females, 16.8 × 17.2, 20.5 × 19.0 mm, 4 ovig. females, 24.0 × 22.9–26.0 × 25.7 mm, Balicasag Island, Bohol, 200–300 m, coll. local fishermen, June 2002.—ZRC 2012.0493, 3 males, 21.3 × 18.9–23.2 × 21.9 mm, 5 females, 24.5 × 22.1–28.5 × 26.4 mm, 6 ovig. females, 24.0 × 22.1–27.1 × 25.7, Balicasag Island, Bohol, coll. local fishermen, June 2002.—NSMT-Cr 15794, 4 males, 20.3 × 19.3–26.0 × 23.9 mm, 2 females, 23.7 × 22.5, 25.9 × 24.8 mm, Balicasag Island, Bohol, tangle nets, coll. M. Takeda, M. Manuel-Santos & H. Komatsu, Feb. 2003.—ZRC 2012.0620, 5 males, 21.0 × 19.8 mm, 3 females, 24.3 × 22.6–28.5 × 27.3 mm, 3 ovig. females, 24.7 × 23.8–30.3 × 29.0 mm, same data as holotype.—ZRC 2012.0507, 7 males, 19.6 × 18.2–24.7 × 23.0 mm, 4 females, 14.4 × 14.6–23.2 × 21.9 mm, 3 ovig. females, 21.4 × 20.6–25.1 × 24.1 mm, Balicasag Island, Bohol, coll. local fishermen, Nov. 2003.—ZRC 2012.0619, 4 males, 20.6 × 19.6–24.9 × 23.2 mm, Balicasag Island, Bohol, coll. local fishermen, Dec. 2003.—ZRC 2013.0376, 1 female, 25.0 × 24.9 mm, Balicasag Island, Bohol, Apr. 2004.—RUMF-ZC-2355, 2 males, 22.3 × 20.0, 24.2 × 23.6 mm, 1 ovig. female, 28.0 × 25.5 mm, Balicasag, Bohol, Jan. 2004.—RUMF-ZC-2356, 1 female, 27.5 × 25.9 mm, Balicasag, Bohol, Feb. 2004.—ZRC 2001.0487, 2 males, 19.3 × 17.8, 21.8 × 20.0 mm, Balicasag Island, Bohol, Apr. 2004.—ZRC 2012.0481, 1 male, 19.6 × 19.3 mm, 1 female, 22.7 × 21.5 mm, Balicasag Island, Bohol, 29 May 2004.—ZRC 2008.0088, 1 male, 30.2 × 29.3 mm, Balicasag Island, Bohol, 29 May 2004.—ZRC 2012.0614, 7 males, 20.4 × 18.5 mm, 4 females, 18.1 × 17.8–27.0 × 24.8 mm, Balicasag Island, Bohol, coll. local fishermen, 31 May 2004.—ZRC 2012.0506, 2 males, 27.4 × 25.3, 27.2 × 24.3 mm, Pamilacan Island, Bohol, PANGLAO 2004, stn. P5, ca. 100 m, 3 June 2004.—NMCR 39102, 3 males, 23.7 × 21.4–28.1 × 24.4 mm, 4 females, 23.2 ×

21.6–26.2 × 24.4 mm, Balicasag Island, Bohol, coll. J. Arbasto, May 2004.—ZRC 2012.0615, 1 male, 27.9 × 24.5 mm, Bohol Island, Cortes, PANGLAO 2004, stn. T17, 132–137 m, 19 June 2004.—ZRC 2012.0482, 3 males, 21.1 × 18.7–21.6 × 20.7 mm, 1 female, 21.1 × 20.0 mm, Balicasag Island, Bohol, Nov. 2004.

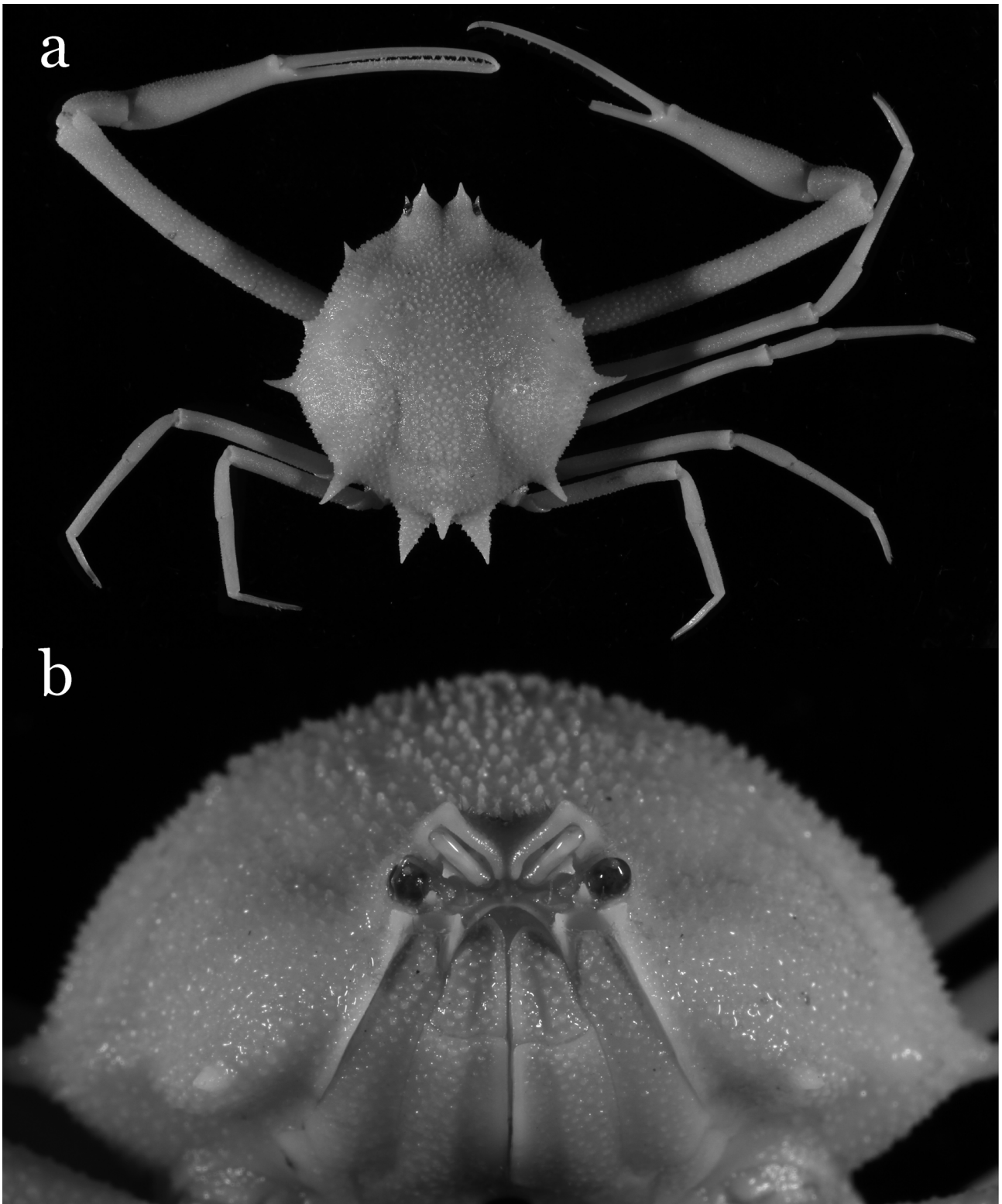


FIGURE 7. *Arcania cornigera* n. sp. Holotype. NMCR 39101, male, 27.1 × 25.7 mm, Maribojoc Bay, Philippines; a, habitus; b, cephalothorax, frontal view.

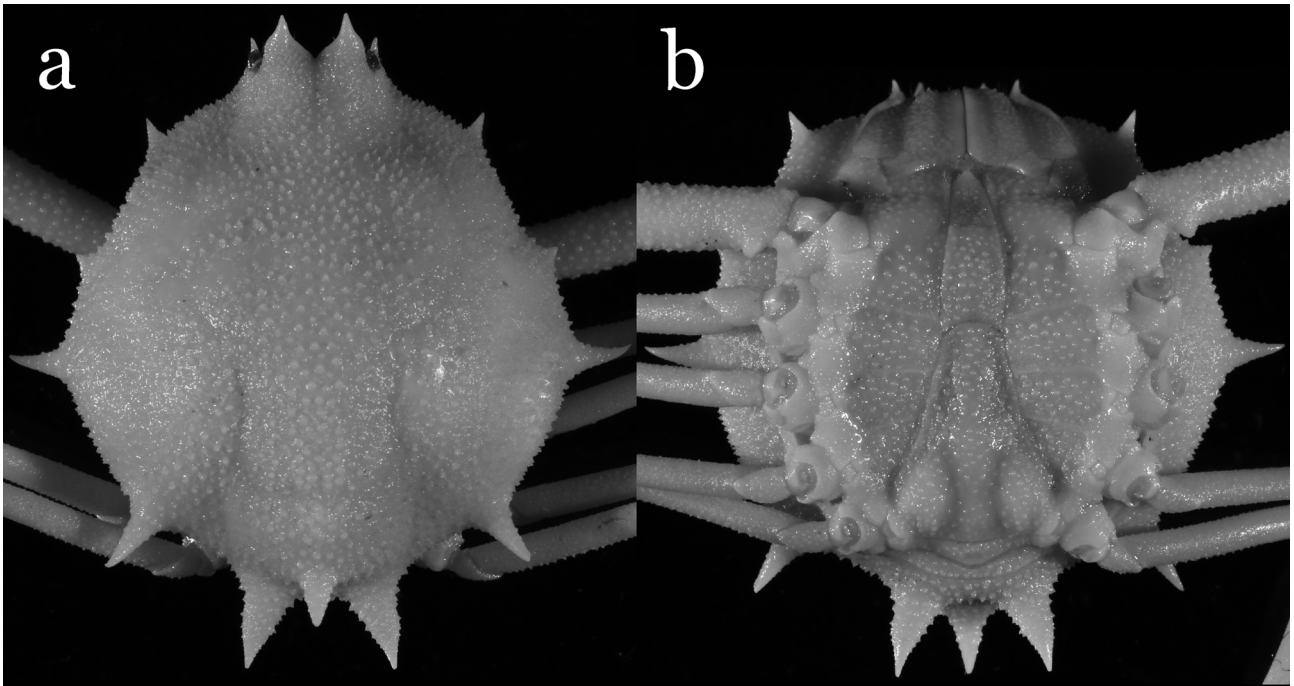


FIGURE 8. *Arcania cornigera* n. sp. Holotype. NMCR 39101, male, 27.1 × 25.7 mm, Maribojoc Bay, Philippines; a, cephalothorax, dorsal view; b, cephalothorax, ventral view.



FIGURE 9. Coloration of *Arcania cornigera* n. sp. RUMF-ZC-2364, male, 29.7 × 28.2 mm, Kochi, Japan.

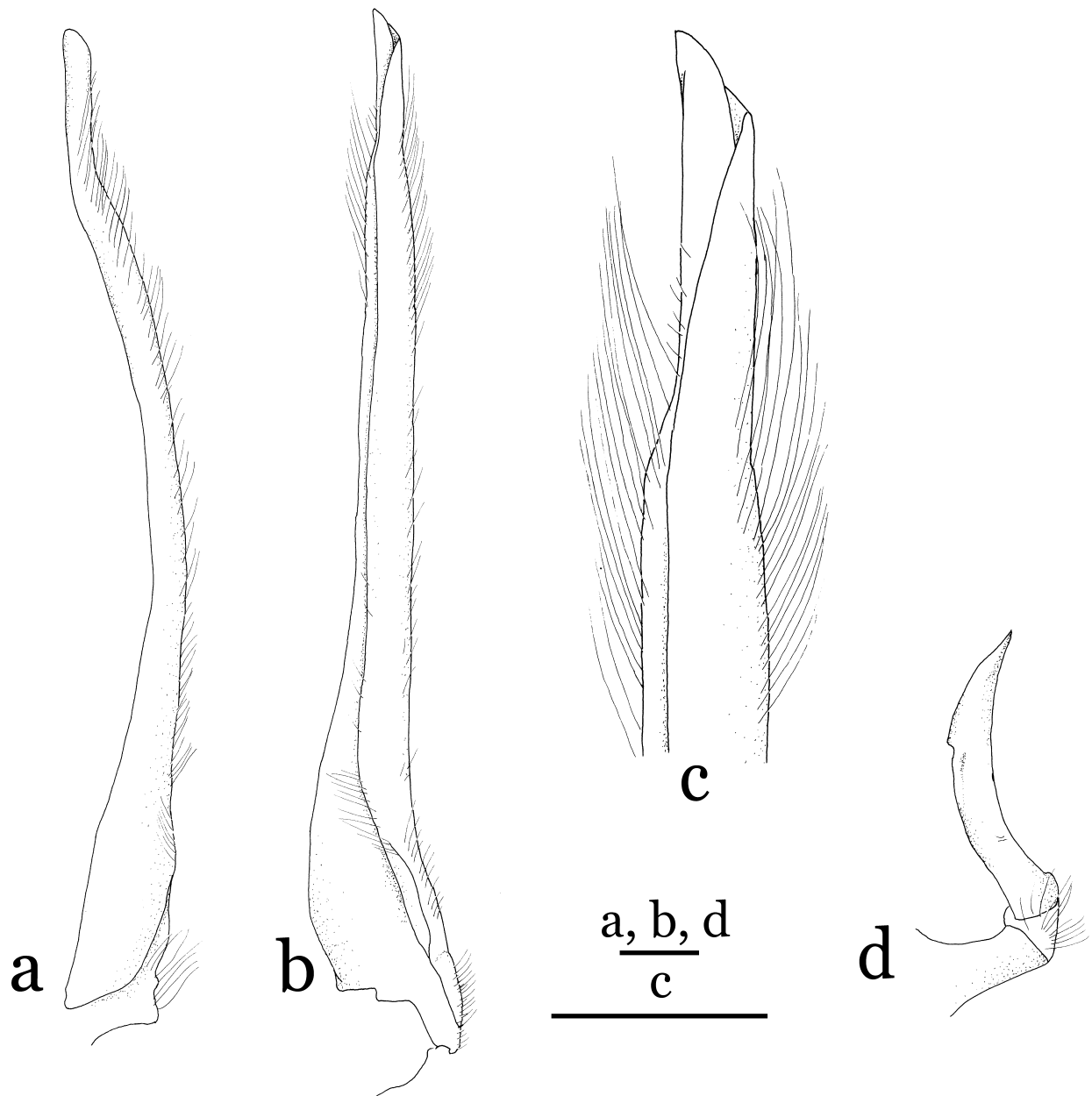


FIGURE 10. G1 and G2 of *Arcania cornigera* n. sp. Holotype. NMCR 39101, male, 27.1 × 25.7 mm, Maribojoc Bay, Philippines; a, left G1, mesial view; b, left G1, ventral view; c, distal part of left G1, ventral view; d, left G2. Scales = 1 mm.

Additional material. *Japan*: KMNH IvR 400,102, 1 male, 17.6 × 17.4 mm, stn. 540, near Kyoga-saki, 123 m, 25 Aug. 1929; KMNH IvR 400,104, 1 male, 21.8 × 20.7 mm, stn. 451, west of Goto Islands, 187 m, 22 July 1929.—USNM 17660, 1 female (damaged), Kagoshima Bay, Kyushu, 31.6375 130.7806, Northwestern Pacific Expedition, stn. 4944, *Albatross*, 17 Aug. 1906.—NSMT-Cr 6368, 1 male, 19.8 × 19.2 mm, Kamiura, Kushimoto, Wakayama, 40–70m, dredge, coll. S. Nagai.—WMNH-Na-Cr-0186, 2 males, 21.3 × 19.9, 16.2 × 16.1 mm, Kamiura, Kii Kushimoto, 60m, coll. S. Nagai.—KMNH IvR 400,105, 1 male, 18.4 × 19.1 mm, Tosa, Kochi, coll. unknown, 16 Jan.–14 Feb. 1963.—NSMT-Cr 13220, 2 males, 20.5 × 19.6, 22.1 × 21.3 mm, 2 females, 28.2 × 26.2, 28.4 × 26.0 mm, 2 ovig. females, 25.9 × 23.8, 34.5 × 33.0 mm, 1 juvenile, 13.2 × 13.3 mm, Saga Fishing Port, Kochi, 100–150 m, coll. T. Kubodera, 24 Nov. 1999.—RUMF-ZC-2573, 1 female, 28.0 × 26.3 mm, Tosa-saga, Kochi, Japan, coll. D. Uyeno, 11 May 2006.—RUMF-ZC-2364, 7 males, 20.8 × 19.9–28.6 × 26.2 mm, 5 ovig. females, 20.7 × 20.8–29.7 × 28.2 mm, Tosa-Saga Fishing Port, Kochi, coll. T. Naruse, D. Ueno & Y. Ota, 7 July 2009.

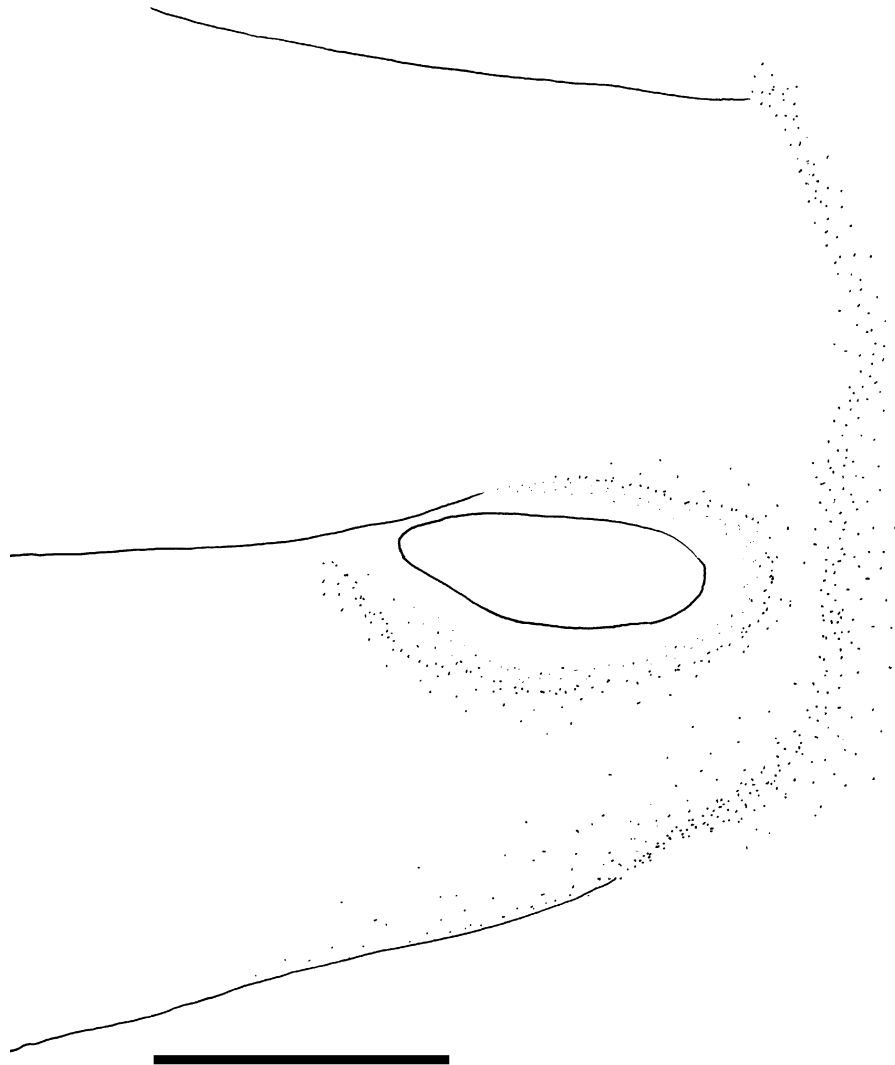


FIGURE 11. Right vulva of *Arcania cornigera* n. sp. RUMF-ZC-2356, female, 27.5 × 25.9 mm, Bohol, Philippines. Scale = 1 mm.

Korea: KMNH IvR 400,103, 1 female, 21.3 × 20.6 mm, stn. 454, east of Jeju Island (as “Saishu-to”), 113 m, 23 July 1929.

Taiwan: NTOU B00100, 1 female, 29.2 × 28.4 mm, Dasi, Ilan, coll. H.-P. Yu, 3 Feb. 1983.—ZRC 1997.0386, 1 male, 21.0 × 17.3 mm, Taichi fishing port, Ilan, coll. P.K.L. Ng, 3–4 Aug. 1996.—NTOU B00101, 1 male, 19.2 × 17.3 mm, Donggang, Kaohsiung, coll. 25 Mar. 1996.—NTOU B00102, 1 male, 20.7 × 19.8 mm, Donggang, Kaohsiung, coll. P.K.L. Ng, 30 May 1997.—ZRC 2001.0042, 1 male, 25.6 × 22.5 mm, Donggang, Kaohsiung, coll. P.K.L. Ng, 6 Nov. 2000.

Philippines: ZRC 2009.0266, 1 male, 27.8 × 24.7 mm, Aurora, Luzon Island, stn. CC2746, 220 m, 2 June 2007.—USNM 1192283, 1 male, 22.3 × 21.4 mm, 1 female, 14.8 × 13.7 mm, S Calach Town, Balayan Bay, Batangas, 219–238 m., TR MB. acc. No. 322873, coll. 19 July 1966.

Description. Carapace rounded, with anterior half less convex anterolaterally, dorsal surface densely, uniformly covered with conical granules (Figs. 7, 8a, 9); pterygostomial, subhepatic regions evenly covered with rounded granules (Fig. 8b). Front divided into 2 triangular lobes by acute triangular gap (gap slightly obtuse in large individuals), lobes strongly produced anteriorly, with acute tip (Figs. 7a, 8a, 9). Carapace with subhepatic, anterolateral, lateral, posterolateral, posterior, intestinal spines. Anterolateral spines smallest, followed in size by subhepatic spine, lateral, posterolateral, intestinal spines subequal, posterior spine longest; intestinal spine sometimes smaller than lateral-posterolateral spines, distal end of intestinal spines much shorter than distal end of posterior spines in dorsal view, small individuals with relatively longer intestinal spines, tip almost reaching tips of

posterior spines in dorsal view. Posterior spines with dorsoventrally compressed, wide bases. Branchiocardiac, cardio-intestinal grooves distinct. Antennular fossae oblique, basal antennular segment with acutely triangular lobe, setum on distoposterior margin. Mesial end of infraorbital margin forming sharp triangular spine. Anteromesial corner of pterygostomial region, anterolateral margin of buccal cavern forming laterally compressed triangular, sharp spines fitting distal part of exopod of closed mxp3; distance between spines moderate despite of slender mxp3 exopod.

Eyes fitting within orbit, only corneal part slightly exposed.

Mxp3 (Figs. 7b, 8b) covered with rounded granules; merus about two-fifths of ischium; ischium, merus each with longitudinal groove on mesial third, half; female merus with longitudinal row of setae along longitudinal groove. Exopod narrowed at level of proximal half of merus, gap between narrowed part of exopod, merus thus fitting triangular spine of anterolateral margin of buccal cavern.

Thoracic sternites 4–7 (Fig. 8b) covered with rounded granules; granulation about equal to pterygostomial region. Sternal button of abdominal holding on anterior end of thoracic sternite 5 at lateral slope of thoracic cavity, button fitting proximolateral cup of somite 6. Penis coxal. Vulva on mesial end of thoracic suture 5/6, placed on somite 6, narrow, elliptical, lightly oblique, no sternal cover (Fig. 11).

Chelipeds (Figs. 7a, 9) long, subequal. Merus as long as chela, entirely covered with granules. Carpus, palm covered with minute granules, carpus without knob on external margin. Fingers slender, gape absent when closed, with 8–10 almost equidistantly placed small teeth with much smaller teeth throughout. Ambulatory legs slender, merus longest of articles, covered with minute granules. Carpus, propodus covered with minute granules. Dactylus with low keels on mid-lines of mesial, lateral surfaces, keel on lateral surface flanked by rows of setae.

Abdomen (Fig. 8b) with rounded granules; somites 3–5 fused, with proximolateral protuberances on external surface, each protuberance higher, slightly wider than central part between two protuberances. Lateral margins of somite 6 slightly convex. G1 (Fig. 10a–c) slender, straight, slightly curved dorsally in mesial view; distal part only slightly upcurved in mesial view, lateral margin wrapping onto mesial surface, distal end oblique. G2 (Fig. 10d) short, opening facing dorsally *in situ*.

Variation. Carapace is slightly more rounded in large individuals, which makes carapace spines proportionally smaller than those in smaller individuals. The intestinal spine of small individuals sometimes reaching beyond the tips of posterior spines in dorsal view.

Coloration. Frontal, gastric to epibranchial regions reddish, other part of carapace and chelipeds orange (Fig. 9).

Geographical distribution. Philippines (Bohol [type locality]; Aurora; Batangas); Japan (Pacific coast: Kushimoto, Kochi; Sea of Japan, Kyoga-saki; Kyushu, W Goto Islands; Kagoshima); Korea (Jeju Island); Taiwan (Dasi; Donggang).

Etyymology. The species name is derived from the Latin *cornigera* (=horned), alluding the produced, horn-like frontal lobes.

Remarks. Based on the material examined, the geographical distribution of *A. cornigera* **n. sp.** overlaps with the other three congeners studied (*A. undecimspinosa*, *A. elongata* and *A. tropicalis* **n. sp.**). *Arcania cornigera* **n. sp.** can be distinguished from the three species by several key characters listed in Table 1. *Arcania cornigera* **n. sp.** is best distinguished by its very sharp frontal lobes (Figs. 7a, 8a, 9), the proportionally long cheliped merus (Fig. 7a, 8; also see “Morphometric analysis”), straight G1 with sharply oblique distal end (Figs. 10a–c), and narrow, elliptical vulvae without sternal cover (Fig. 11).

Chen (1989) provided a photograph of a male “*A. undecimspinosa*” (pl. 2, fig. 4, 11.0 × 10.2 mm). The only specimen with the size of “11.0 × 10.2 mm” listed in her examined material was collected from the northeast of Lubang Island, Philippines. Its very sharp frontal lobes are closer to the condition of *A. cornigera* **n. sp.**, although the photographed specimen has a long intestinal spine that exceeds the level of the tip of posterolateral spines. Closer-sized small specimens of *A. cornigera* **n. sp.** (e.g. KMNH IvR 400,102, 17.6 × 17.4 mm) tend to have relatively longer intestinal spine than in fully-grown specimens (e.g. NMCR 39101, 27.1 × 25.7 mm, Fig. 7a). Chen (1989) also illustrated the G1 of “*A. undecimspinosa*” (without specifying the size and collection data of the specimen), and its morphology is similar to relatively small specimens of *A. cornigera* **n. sp.** (e.g. NTOU B00102, 20.7 × 19.8 mm), which suggests that at least the illustrated specimen(s) of Chen (1989) are referable to *A. cornigera* **n. sp.**

TABLE 1. Discriminative characters of *Arcania undecimspinosa* De Haan, 1841, *A. elongata* Yokoya, 1933, and allied species.

	<i>A. undecimspinosa</i>	<i>A. cornigera</i> n. sp.	<i>A. elongata</i>	<i>A. tropicalis</i> n. sp.
Frontal lobes	Lobes divided by obtuse triangular gap; lobes not strongly produced, even weakly rounded in large individuals.	Lobes divided by v-shaped gap (gap slightly wider in large individuals); lobes strongly produced anteriorly with especially acute tip.	Lobes divided by obtuse triangular gap; tip of lobes not acute.	Lobes divided by blunt triangular gap; lobes obtuse triangular, weakly produced anteriorly, tip not acute.
Carapace contour	Rounded.	Rounded, with anterior half not well convex anterolaterally.	Roundly elliptical, longer than wide.	Roundly elliptical, longer than wide.
Dorsal surface of carapace	Covered rather sparsely by columnar granules, granules larger at gastric to intestinal regions.	Densely, uniformly covered with conical granules.	Uniformly covered by columnar granules.	Densely, uniformly covered with columnar granules.
Marginal spines of carapace	All spines distinct. Spine size: anterolateral < subhepatic < other spines. Posterior spine with base slightly compressed dorsoventrally.	All spines distinct. Spine size: anterolateral < subhepatic < lateral-posterolateral-intestinal < posterior spines. Intestinal spine sometime smaller than lateral-posterolateral spines. Posterior spine with base strongly compressed dorsoventrally.	Spine size: anterolateral < subhepatic < other spines. Subhepatic spine present when small (e.g. NSMT-Cr 3559, male), reduced in large individuals. Posterior spine with base slightly compressed dorsoventrally.	All spines distinct. Spine size: anterolateral < subhepatic-lateral < posterolateral-intestinal < posterior spines. Posterior spine with base slightly compressed dorsoventrally.
Cheliped length	Various trends in males and females of these four species; see section of Morphometric analysis and Fig. 22.			
G1	Slender, nearly straight, slightly curved dorsally in mesial view; distal part pipe-like, only slightly upcurved in mesial view.	Slender, straight, slightly curved dorsally in mesial view; distal part only slightly upcurved in mesial view, distal end oblique.	Almost straight over proximal four-fifths; distal part curved laterally on distal fifth, further distal part curved anteriorly; distal end flap like, opening facing anteriorly.	Strongly curved dorsally, distal part weakly recurved anteriorly; distal end with complicated flaps fringing opening.
Vulvae	On mesial end of thoracic suture 5/6, pushing mesial end of suture 5/6 anteriorly; posterolateral part swollen, opening narrowed laterally, entire mesially.	On mesial end of thoracic suture 5/6, narrow, elliptical, lightly oblique, entire, no sternal cover.	On mesial end of thoracic suture 5/6, narrowed laterally, with distinct sternal cover on anterolateral corner.	On mesial end of thoracic suture 5/6, mesial end converged, sternal cover developed from sublateral part of anterior margin.

***Arcania elongata* Yokoya, 1933.**

(Figs. 12–17)

Arcania undescimspinosa var. *elongata* Yokoya 1933: 133, fig. 47.

Arcania undescimspinosa elongata—Sakai 1937: 124, figs. 15b, 16; 1965: 40, fig. 6b, pl. 16, fig. 2; 1976: 91, pl. 28, fig. 2.

Arcania elongata—Dai *et al.* 1986: 67, fig. 34-1, pl. 8, fig. 2.—Dai & Yang 1991: fig. 34-1, pl. 8, fig. 2.—Ng & Huang 1997: 262, fig. 1E.—Tan 1996: 1024 (part?).—Galil 2001: figs. 1D, 4D (part); Marumura & Kosaka 2003: 27.

Material examined. *Japan*: ZRC 2005.0068, 12 males, 17.6 × 17.4–26.1 × 21.7 mm, 5 females, 23.9 × 22.0–29.3 × 22.0 mm, 4 ovig. females, 18.3 × 18.7–23.7 × 22.6 mm, Tomioka, Amakusa, Kyushu, coll. J.C.Y. Lai & S. Arakaki from local fishermen, 3 Sep. 2003.—NSMT-Cr 3559, 1 male, 18.6 × 17.0 mm, 2 females, 20.1 × 19.3, 27.7 × 24.7 mm, Mikawa-Isshiki, coll. 9 Nov. 1962.—NSMT-Cr 5812, 1 ovig. female, 18.7 × 17.7 mm, 1 juvenile, 7.9 × 8.2 mm, Kushimoto, Wakayama, stn. 13, coll. M. Takeda, 17 July 1978.—NSMT-Cr 3842, 1 male, 24.4 × 22.5 mm, Tanabe Bay.—NSMT-Cr 22338, male, 30.3 × 26.4 mm, off Irino, Tosa Bay, Kochi, 50–100m, coll. I. Soyama, 29 Jan. 1988.—NSMT-Cr 10041, 1 male, ca. 30.4 × 26.8 mm, 1 female, 31.2 × 27.4 mm, same data as NSMT-Cr 22338.—NSMT-Cr 22339, 2 males, 22.6 × 20.0, 25.5 × 23.0 mm, 4 females, 18.9 × 18.1–31.4 × 26.9 mm, Saga Fishing Port, Kochi, 100–150 m, coll. T. Kubodera, 24 Nov. 1999.—RUMF-ZC-1100, 2 males, 21.1 × 18.7, ca. 25 × 26.5 mm, 7 females, 22.5 × 19.8–31.5 × 29.0 mm, 1 ovig. female, 31.4 × 29.7 mm, Tosa-Saga Fishing Port, Kochi, coll. T. Naruse, D. Ueno & Y. Ota, 7 July 2009.—WMNH-Na-Cr-0187, 1 female, dry, 24.1 × 20.8 mm, off Kochi, 40m, coll. S. Nagai.—NSMT-Cr 10037, 1 ovig. female, 32.3 × 29.6 mm, East China Sea, coll. T. Miura, 3 July 1985.

Taiwan: NTOU B00108, 1 female, 28.8 × 26.4 mm, Penghu, coll. T.-Y. Chan, 9 Oct. 1984.—NTOU B00106, 1 ovig. female, 27.4 × 25.8 mm, Dasi, Yilan, Y. Wong, 6 Apr. 1986.—NTOU B00103, 1 male, 24.1 × 21.1 mm, Dasi, Yilan, coll. J.-F. Huang, 1 Apr. 1989.—NTOU B00105, 1 male, 24.5 × 20.1 mm, Dasi, Yilan, coll. J. F. Huang, 24 Oct. 1992.—NTOU B00110, 1 male, 23.4 × 20.1 mm, Dasi, coll. S.-H. Wu, 21 Aug. 1997.—NTOU B00107, 1 ovig. female, 33.5 × 29.4 mm, Dasi, Yilan, S.-H. Wu, 4 Dec. 1997.—NTOU B00104, 1 male, 28.4 × 23.8 mm, Dasi, Yilan, coll. C.-W. Lin, 2 Nov. 1998.—NTOU B00109, 1 ovig. female, 32.0 × 30.3 mm, Donggang, Pingtung, coll. 18 Dec. 1999.—ZRC 2014.0014, 1 female, 23.7 × 21.2 mm, Donggang, Pingtung, coll. P. K. L. Ng, 5 Aug. 1996.—NMMBCD 4025, 1 male, 22.2 × 19.6 mm, Kezailiao fishing port, Kaohsiung, 25 Apr. 2013.

Redescription. Carapace elliptical, longer than wide, dorsal surface evenly covered by columnar granules (Figs. 12, 13a, 14); pterygostomial, subhepatic regions evenly covered with rounded granules (Fig. 12b). Front divided into 2 triangular lobes by obtuse triangular gap, tip of lobes moderately acute (Figs. 12a, 13a, 14). Carapace with subhepatic, anterolateral, lateral, posterolateral, posterior, intestinal spines. Anterolateral spines smallest, followed in size by subhepatic spine, length of other spines subequal; distal end of intestinal spines exceeding those of posterior spines. Intestinal, cardiac, branchial regions divided by shallow grooves. Antennular fossae oblique, antenna excluded from antennular fossa by triangular, thin plate. Mesial end of infraorbital margin forming dorsoventrally compressed, sharp, triangular spine. Anteromesial corner of pterygostomial region, anterolateral margin of buccal cavern forming laterally compressed triangular spines fitting closed exopod of mxp3; distance between spines relatively narrow due to slender mxp3 exopod.

Eyes fitting orbit, only corneal part slightly exposed.

Mxp3 (Fig. 13b) sparsely covered with rounded granules; merus length about two-fifths of ischium; each with longitudinal groove on mesial third, half. female merus with longitudinal row of setae along longitudinal groove. Exopod narrowed at level of proximal two-fifths of merus, gap between narrowed part of exopod, merus thus fitting triangular spine of anterolateral margin of buccal cavern.

Thoracic sternites 4–7 (Fig. 13b) covered with rounded granules; granulation almost same as pterygostomial region. Sternal button of abdominal holding on anterior end of thoracic sternite 5 at lateral slope of thoracic cavity, button fitting proximolateral cup of somite 6. Penis coxal. Vulva on mesial end of thoracic suture 5/6, placed on somite 6, narrowed laterally, with distinct sternal cover on anterolateral corner (Fig. 17).

Chelipeds moderately long, subequal (Fig. 14). Merus slightly slender, shorter than chela, covered by rounded granules except for distoflexor part. Carpus sparsely covered with minute granules on upper surface, without knob from external margin. Palm with scattered, minute granules on outer, inner surfaces; fingers slender, gape absent when closed, with 7–9 almost equidistantly placed small teeth over distal three-quarters, much smaller teeth

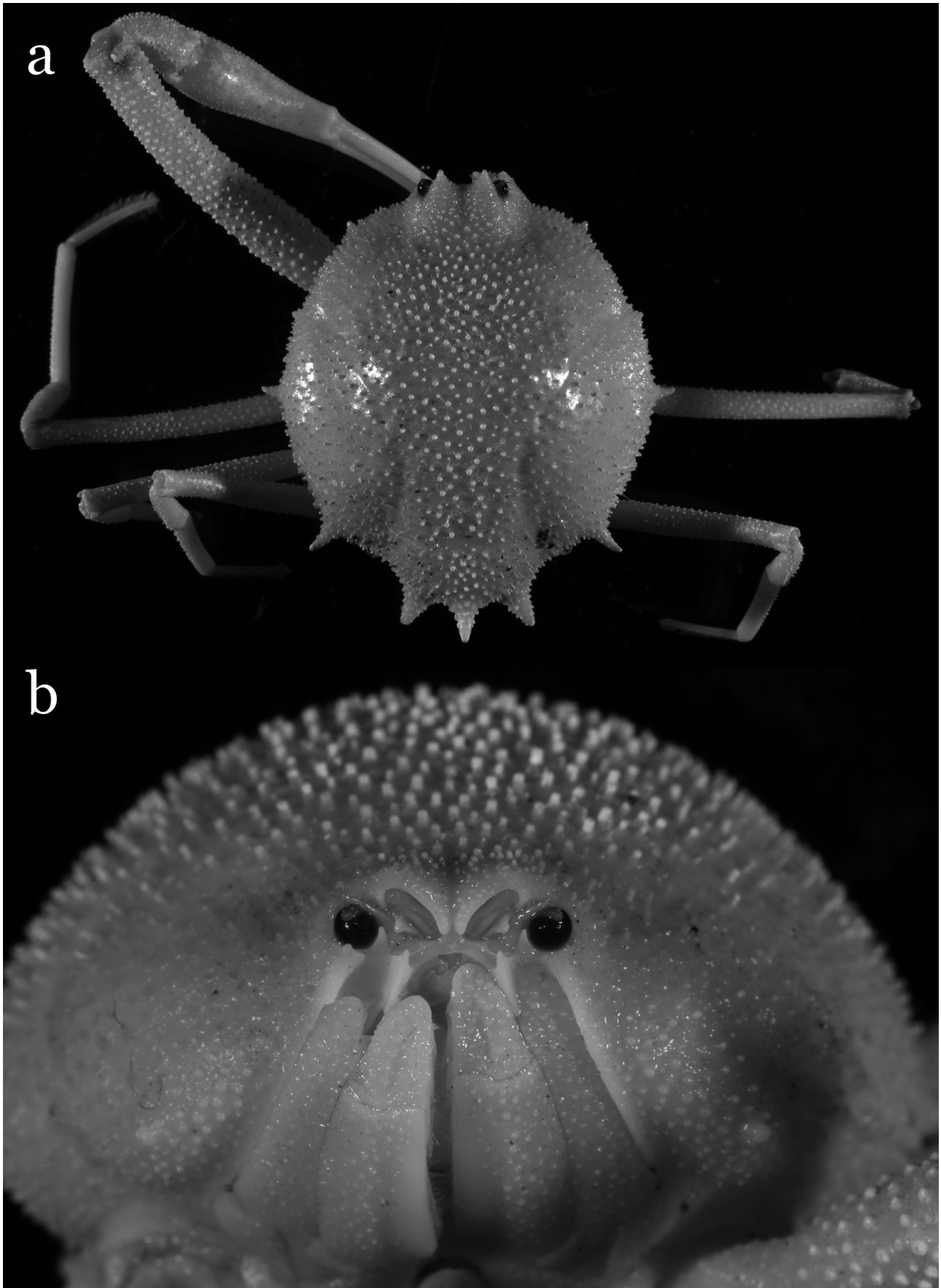


FIGURE 12. *Arcania elongata* Yokoya, 1933. NSMT-Cr 22338, male, 30.3 × 26.4 mm, Kochi, Japan; a, habitus; b, cephalothorax, frontal view.

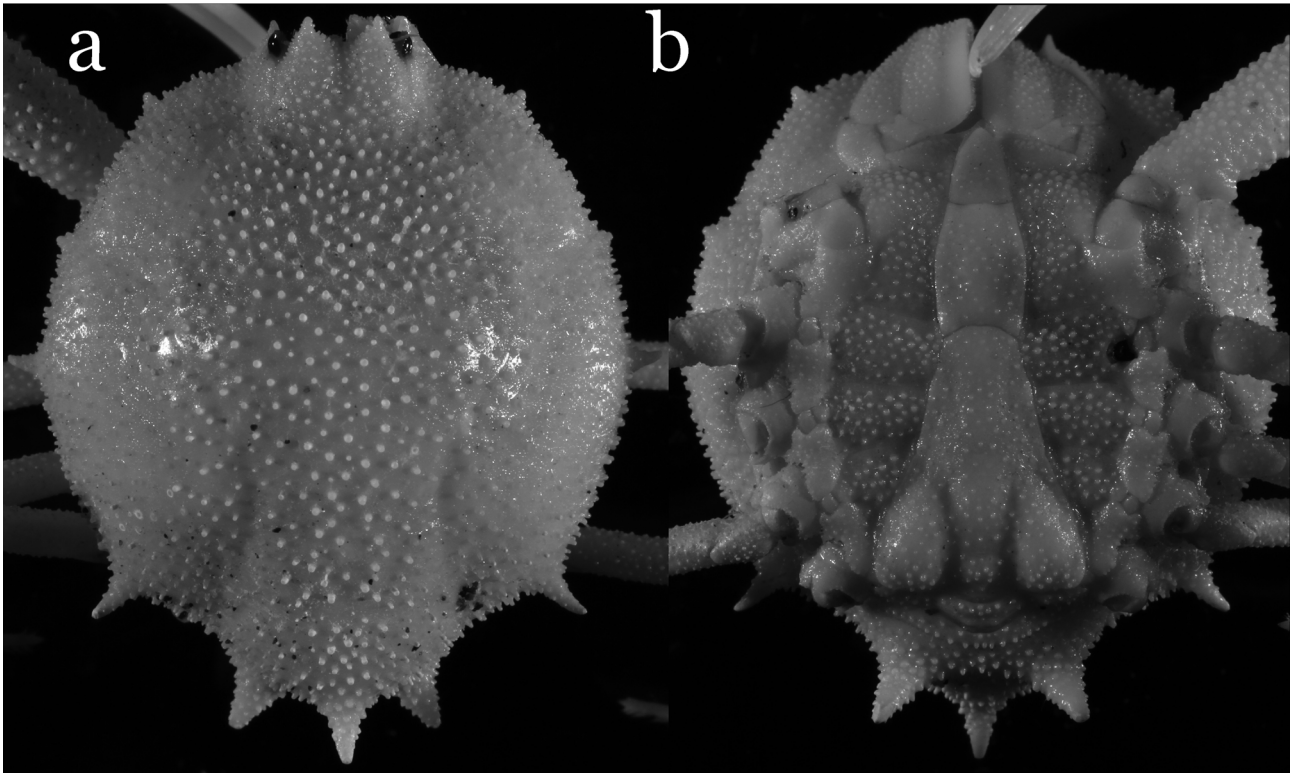


FIGURE 13. *Arcania elongata* Yokoya, 1933. NSMT-Cr 22338, male, 30.3 × 26.4 mm, Kochi, Japan; a, cephalothorax, dorsal view; b, cephalothorax, ventral view.

throughout. Ambulatory legs slender, merus longest of articles, covered with minute rounded granules. Carpus with granules on upper-outer, lower-outer margins. Propodus with same type of granules on outer, inner surfaces. Dactylus oblong in cross-section, low keel on lower surface, keel lined with setae laterally.

Abdomen (Fig. 13b) with sparse, rounded granules; somites 3–5 fused, with proximolateral protuberances on external surface, each protuberance not distinctly larger than central part between protuberances. Somite 6 with convex lateral margins. G1 (Figs. 15a–c, 16a–c) almost straight over proximal four-fifths; distal part curved laterally on distal fifth, further distal part curved anteriorly. Distal end hook-like, opening facing anteriorly. G2 (Fig. 15d) short, opening facing dorsally *in situ*.

Coloration. Dorsal surface of carapace and cheliped merus bright reddish.

Geographical distribution. Japan (Pacific coast: Sagami Bay, Mikawa Bay, Kushimoto, Tanabe Bay, Tosa [type locality]; Kyushu: Amakusa); Taiwan (Dasi; Penghu; Donggang); Coral Sea. (Sakai 1937; 1965; 1976; Galil 2001).

Remarks. Yokoya (1933) described *A. undecimspinoso* var. *elongata* from two females and one male collected from three different localities (Suruga Bay, between Kochi and Ashizuri-Misaki, and Kochi, all on Pacific coast of Japan). A search for the type specimens at the Kitakyushu Museum of Natural History & Human History with Dr. M. Shimomura was unsuccessful, and they are most probably lost.

There are good numbers of specimens that can be referable to *A. elongata* from Kochi, Pacific coast of Shikoku, Japan. *Arcania elongata* can be characterized by the ellipsoid carapace (Figs. 12a, 13a, 14), the proportionally shorter subhepatic and anterolateral spines (Figs. 12a, 13a, 14), the subdistally bent and gradually curved G1 (Figs. 15a–c, 16 a–c) and laterally narrowed vulva with a sternal cover arising from anteromesial corner (Fig. 17). The carapace contour agrees well with Yokoya's (1933: fig. 47) figure. Three out of four *Arcania* species (*A. undecimspinoso*, *A. cornigera* n. sp. and *A. elongata*) studied herein have been recorded from the type locality of *A. elongata*. It is also true that what Yokoya (1933) identified as *A. elongata* actually contained specimens of *A. cornigera* n. sp. (see **Remarks** of *A. cornigera* n. sp.).

The very large individuals (e.g. NTOU, ovig. female, 32.0 × 30.3 mm) tend to have a more rounded carapace contour.

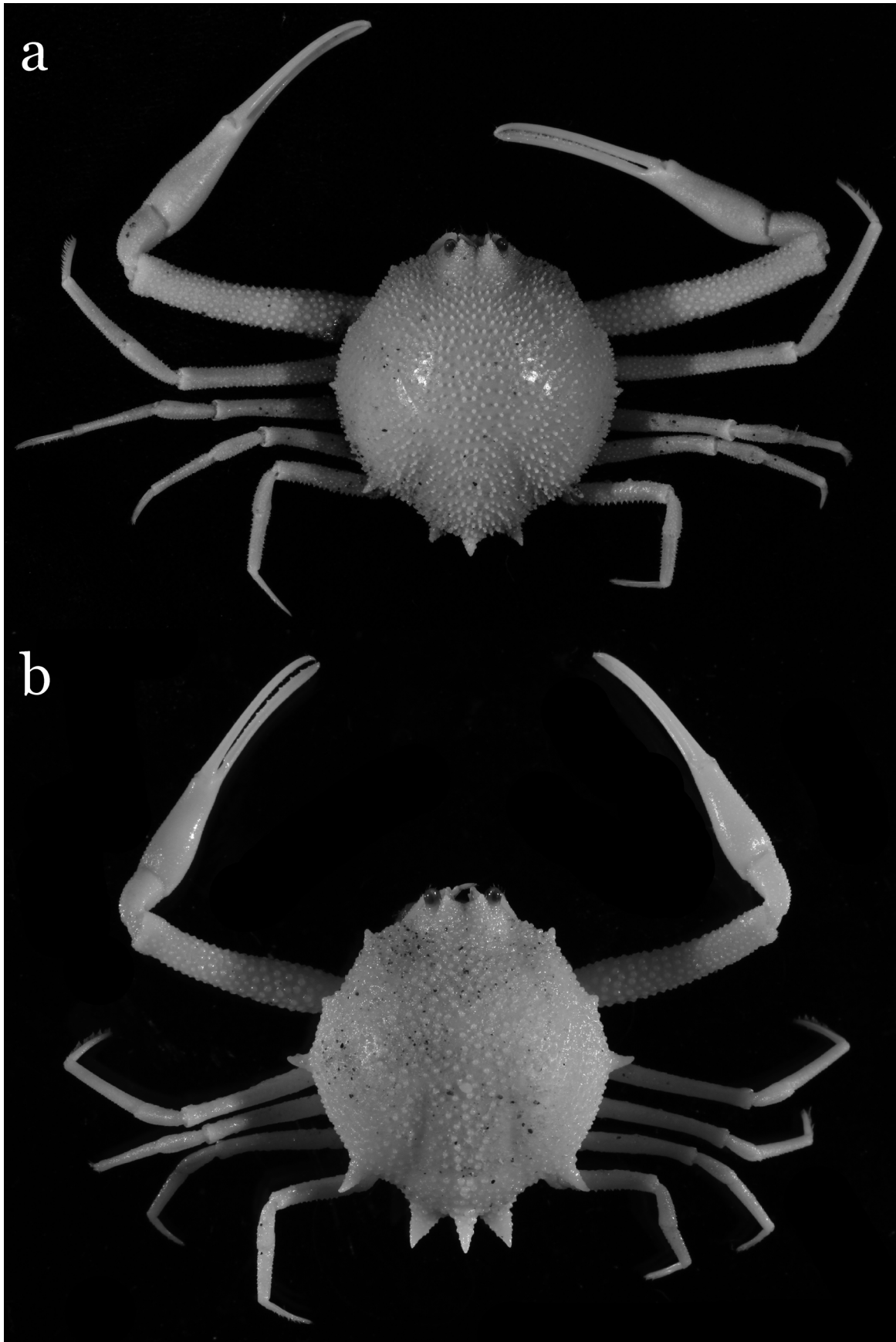


FIGURE 14. *Arcania elongata* Yokoya, 1933; a, ZRC 2005.0068, female, 29.3 × 25.5 mm, Amakusa, Kyushu, Japan; b, NSMT-Cr 5812, ovig. female, 18.7 × 17.7 mm, Wakayama, Japan.

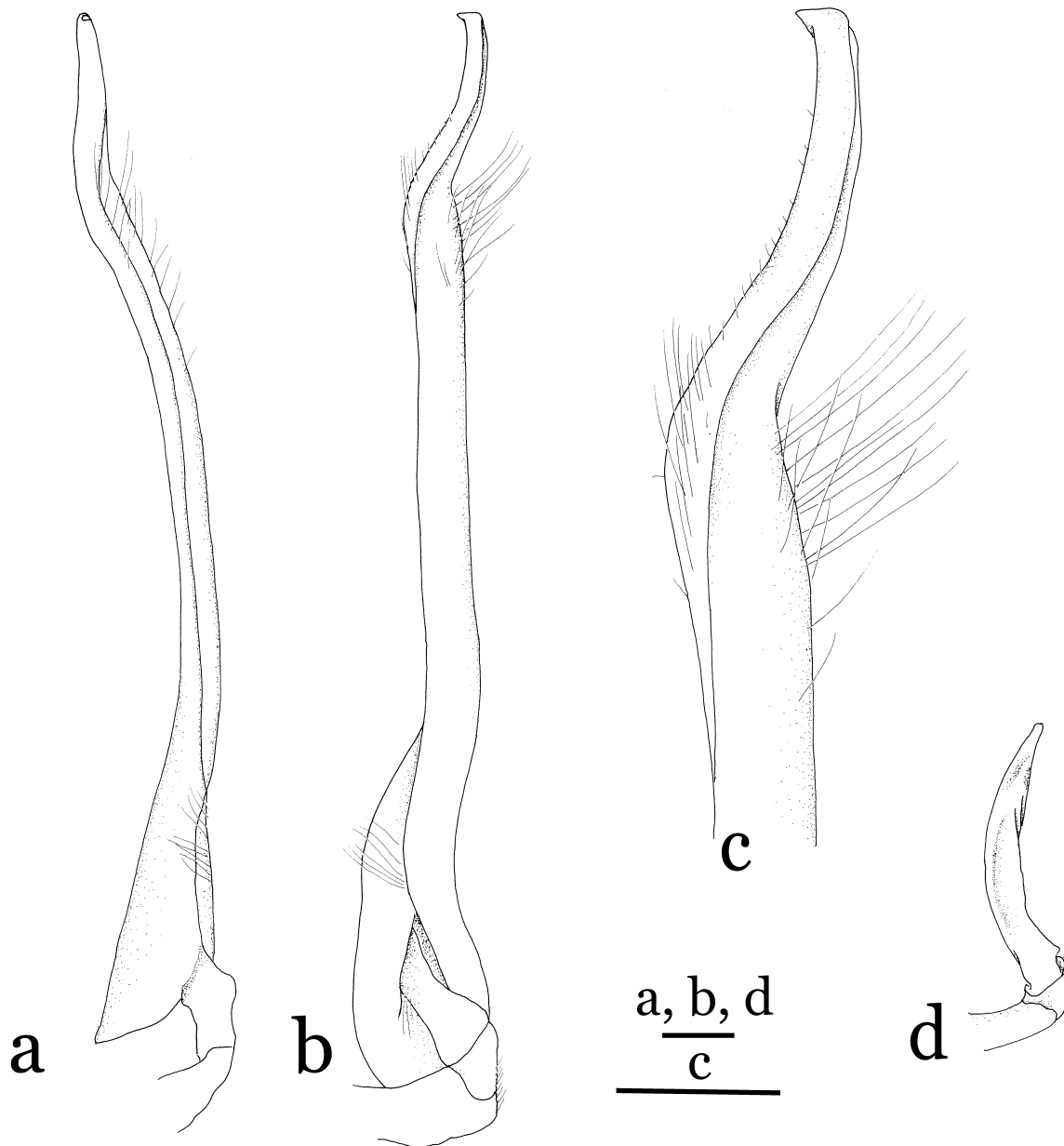


FIGURE 15. G1 and G2 of *Arcania elongata* Yokoya, 1933. NSMT-Cr 22338, male, 30.3 × 26.4 mm, Kochi, Japan; a, left G1, mesial view; b, left G1, ventral view; c, distal part of left G1, ventral view; d, left G2. Scales = 1 mm.

The drawing of the G1 of *A. elongata* by Dai *et al.* (1986: 67, fig. 34-1; locality not indicated), Dai & Yang (1991: fig. 34(1); locality not indicated) and Galil (2001a: 4D; MNHN B27450 from the Coral Sea) agree with the ventrolateral view of the G1 of the specimens examined during the present study, suggesting that they are conspecific.

Campbell (1971) recorded “*A. elongata*” from southern Queensland and noted that it was closer to *A. novemspinosa* than to Sakai’s (1937; 1965) *A. undecimspinosa*. Although Campbell (1971) listed a number of characters to differentiate “*A. elongata*” from *A. novemspinosa*, he mentioned that “*A. elongata*” “lacks prominent proximal spine on proximal margin of arm of cheliped”. Both *A. elongata* and *A. novemspinosa*, however, possess a small but distinct proximal spine on the posterior margin of the cheliped merus (Fig. 12b; RUMF-ZC-1910). The identity of “*A. elongata*” from southern Queensland needs to be re-assessed.

Romimohtarto (1967) identified material from the Arafura Sea as *A. undecimspinosa* and related it to *A. elongata* as well. Romimohtarto’s (1967: fig. 3) specimen, however, show subdistally curved but distally recurved G1. This condition is similar to that of *A. elongata*, but the G1 of *A. elongata* differs from the Arafura Sea species

by the presence of a hook-like structure at the distal end (Figs. 15b, c, 16b, c). The identification of the material from the Arafura Sea needs to be confirmed.

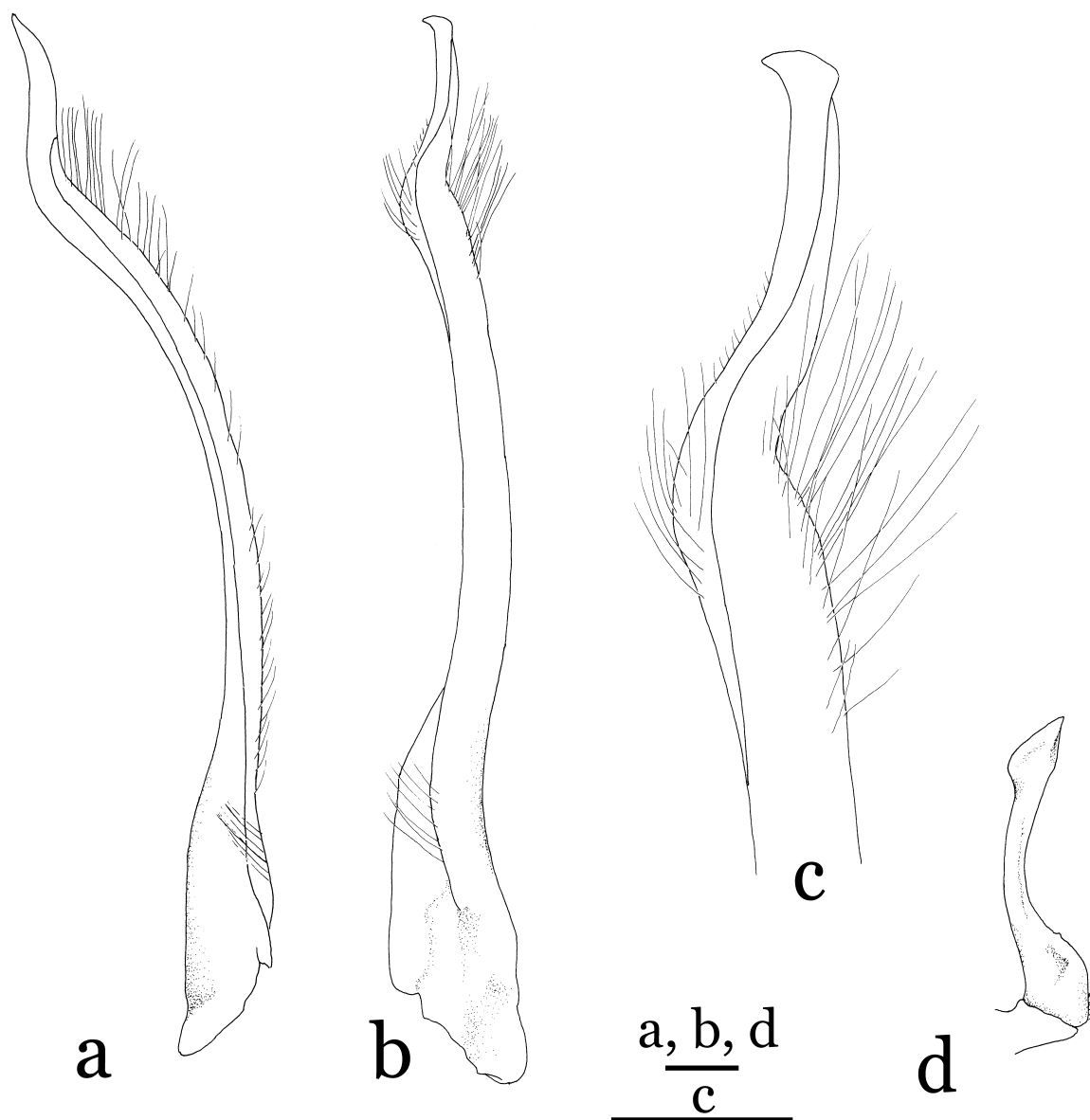


FIGURE 16. G1 and G2 of *Arcania elongata* Yokoya, 1933. NTOU B00104, male, 28.4 × 23.8 mm, Yilan, Taiwan; a, left G1, mesial view; b, left G1, ventral view; c, distal part of left G1, ventral view; d, left G2. Scales = 1 mm.

***Arcania tropicalis* n. sp.**

(Figs. 18–21)

Arcania elongata—Tan 1996: 1024 (part), fig. 2k–o.—Galil 2001: 176 (part).

Material examined. Holotype. NTOU B00111, 1 male, 27.6 × 23.3 mm, Kezailiao fishing port, Kaohsiung, Taiwan, coll. R. Yoshida, 17 July 2011.

Paratypes. *Taiwan*: NTOU B00113, 1 female, 32.5 × 29.6 mm, Dasi, coll. S.-H. Wu, 21 Aug. 1997.—NTOU B00112, 1 male, 23.7 × 21.0 mm, Dasi, coll. C.-W. Lin, 14 June 2002.—NTOU B00114, 1 ovig. female, 30.6 × 27.3 mm, Dasi, coll. J.-Z. Chang, 27 Sept. 2002.—ZRC 1997.0383, 1 female, 23.5 × 21.1 mm, Tachi, Ilan, coll. C.-C. Lin, from local commercial trawler, 20 Nov. 1987.—ZRC 1998.1202, 1 male, 26.1 × 22.0 mm, 1 female, 32.4 × 29.5 mm, Dasi, Ilan, coll. J.-C. Lim, 20 Nov. 1987.—ZRC 2013.0378, 2 females, 22.4 × 20.5, 22.7 × 21.1 mm,

Nangfangau, Ilan, coll. P.K.L. Ng, 18 Nov. 1997.—ZRC 2001.0041, 1 male, 23.7 × 22.6 mm, 1 female, 31.2 × 28.3 mm, Dasi, Ilan, coll. K.-X. Lee, 2000.—NMMBCD 4024, 1 female, 22.5 × 20.0 mm, 2 juveniles, 12.4 × 11.7, 17.4 × 16.3, Kezailiao fishing port, Kaohsiung, 25 Apr. 2013; NMMBCD 4010, 2 males, ca.23.9 × 21.8, 25.2 × 21.7 mm, 1 female, 21.9 × 19.8 mm, Kezailiao fishing port, Kaohsiung, 2 Sep. 2013.—RUMF-ZC-2722, 2 females, 24.4 × 22.7, 24.8 × 23.1 mm, Kezailiao fishing port, Kaohsiung, coll. R. Yoshida, 17 July 2011.

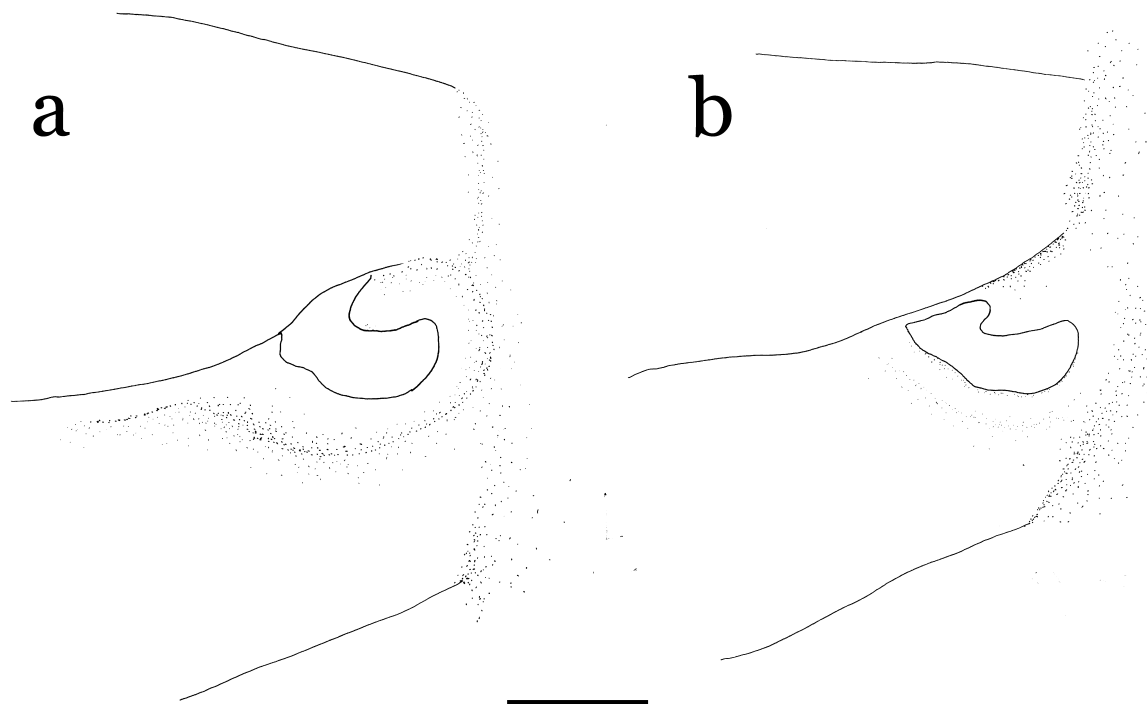


FIGURE 17. Right vulva of *Arcania elongata* Yokoya, 1933; a, NSMT-Cr 10041, female, 31.2 × 27.4 mm, Kochi, Japan; b, NSMT-Cr 22339, female, 31.3 × 29.5 mm, Kochi, Japan. Scale = 1 mm.

Other material. *China*: ZRC 1968.2.1.10, 1 male, 24.6 × 22.0 mm, Hong Kong, CSM T/267.—ZRC 1968.2.1.9, 1 male, 18.1 × 17.4 mm, 1 ovig. female, 25.4 × 23.7 mm, Hong Kong, Cr. 5/65, stn. 28, T/354.—ZRC 1968.2.1.11, 1 male, 24.9 × 21.3 mm, Hong Kong, Cr. 5/65, stn. 29, T/359.

Philippines: MNHN-IU-2013-13312, 1 ovig. female, 28.0 × 25.4 mm, Balicasag Island, Bohol, 50–500 m, tangle net, coll. local fishermen, 28 Nov. 2001.—MNHN-IU-2013-13313, 1 male, 23.9 × 21.9 mm, Balicasag Island, Bohol, coll. J. Arbasto, Feb. 2004.—NMCR 39104, 1 female, 26.0 × 23.4 mm, Balicasag Island, Bohol, 50–500 m, tangle net, coll. local fishermen, 28 Nov. 2001.—NMCR 39103, 1 male, 23.8 × 21.0 mm, Balicasag Island, Bohol, coll. J. Arbasto, Feb. 2004.—NSMT-Cr 15792, 3 males, 22.0 × 20.7–26.0 × 22.7 mm, 1 ovig. female, 26.1 × 23.7 mm, Balicasag Island, Bohol, tangle nets, coll. M. Takeda, M. Manuel-Santos & H. Komatsu, Feb, 2003.—RUMF-ZC-2357, 1 ovig. 24.9 × 22.1 mm, Balicasag Island, Bohol, 50–500 m, tangle net, coll. local fishermen, 28 Nov. 2001.—RUMF-ZC-02871, 1 male, 25.4 × 22.2 mm, dry, Balicasag Island, Bohol, 2014.—ZRC 2012.0505, 3 males, 17.9 × 17.2–25.4 × 22.0 mm, Balicasag Island, Bohol, 200–300 m, tangle net, coll. local fishermen, June 2002.—ZRC 2009.0267, 1 female, 20.3 × 18.7 mm, Aurora, Luzon, AURORA Expedition, stn. CP2763, 44m, 4 June 2007.—USNM 65346, sex unknown (badly damaged), Malavatuán, Verde Island Passage, Philippines Expedition stn. 5276, 13.8208, 120.2458, 18 fthms (ca. 33m), *Albatross*, Agassiz beam trawl, 12 ft (ca. 3.7m), with mud bag, 17 July 1908.—USNM 65427, 1 male, 28.1 × 24.8 mm, 1 female, 34.1 × 30.6 mm, San Fernando, SW of Luzon Island, 16.5100 120.1850, Philippines Expedition stn. 5442, *Albatross*, Agassiz beam trawl, 25 ft (ca. 7.6m), 10–11 May 1909. RUMF-ZC-2870, 1 male, 22.1 × 20.4 mm, dry, off Cavite, Mar. 2013.—NSMT-Cr 7499, 1 female, 29.2 × 27.7 mm, coll. H. Motoo;

Vanuatu: SANTO 2006: ZRC 2009.0613, 1 male, 25.9 × 22.9 mm, NE Aore Island, Aimbue Bay, tangle net, stn. EP04, 89–109 m, 12 Sep. 2006.—ZRC 2009.0571, 1 male, 17.9 × 16.3 mm, S Tutuba Island, stn. AT51, 153–166 m, coll. 30 Sept. 2006.—ZRC 2009.0482, 1 female, 26.6 × 26.0 mm, Scorff Passage, stn. AT88, 87–115 m, 15°31.9'S 167°15.0E, 12 Oct. 2006.—ZRC 2013.0379, 1 female, 20.9 × 18.7 mm, Second Channel, stn. AT84,

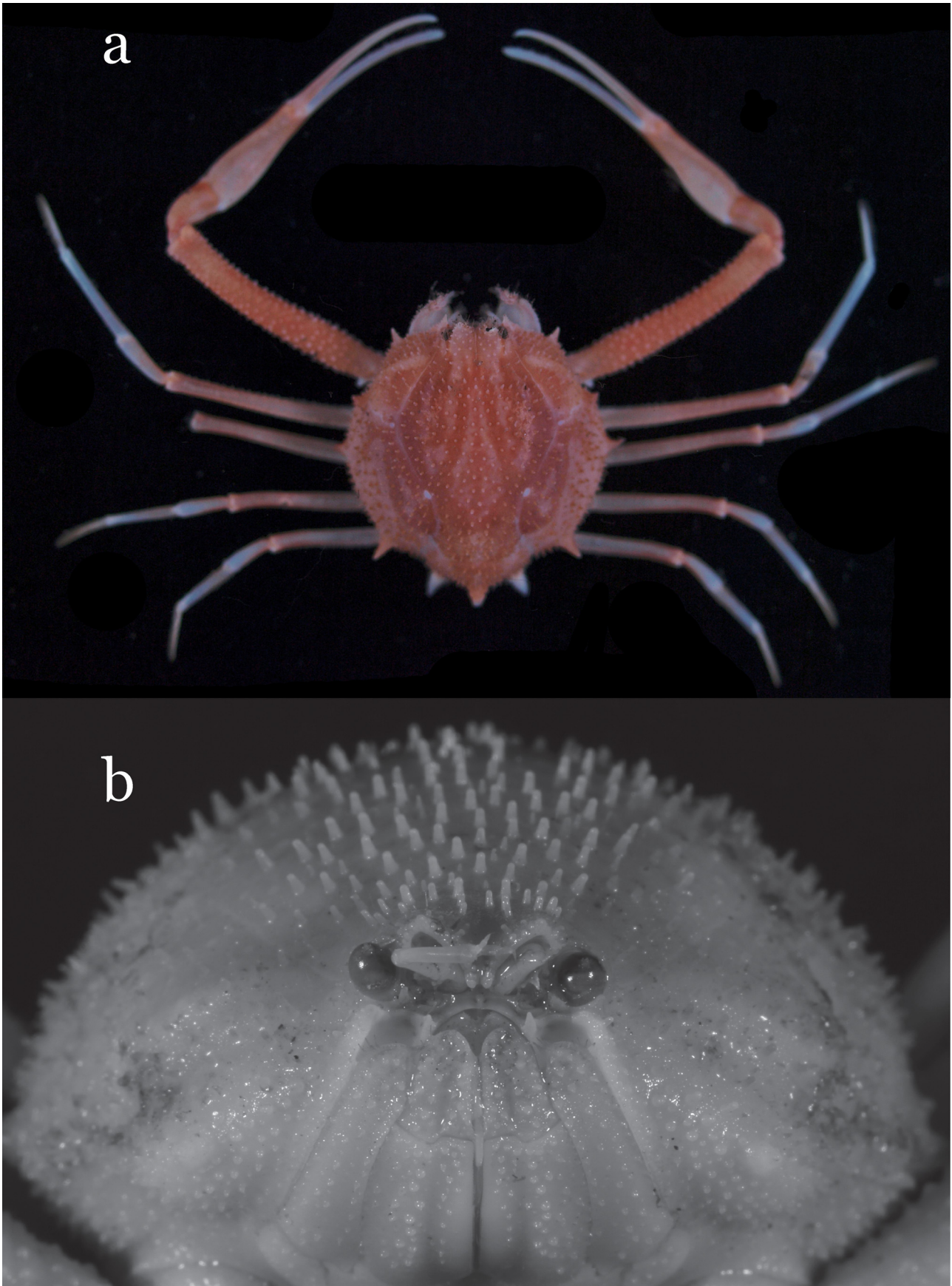


FIGURE 18. *Arcania tropicalis* n. sp. Holotype. NTOU B00111, male, 27.6 × 23.3 mm, Kaohsiung, Taiwan; a, habitus, with live coloration (photographed by R. Yoshida); b, cephalothorax, anterior view.

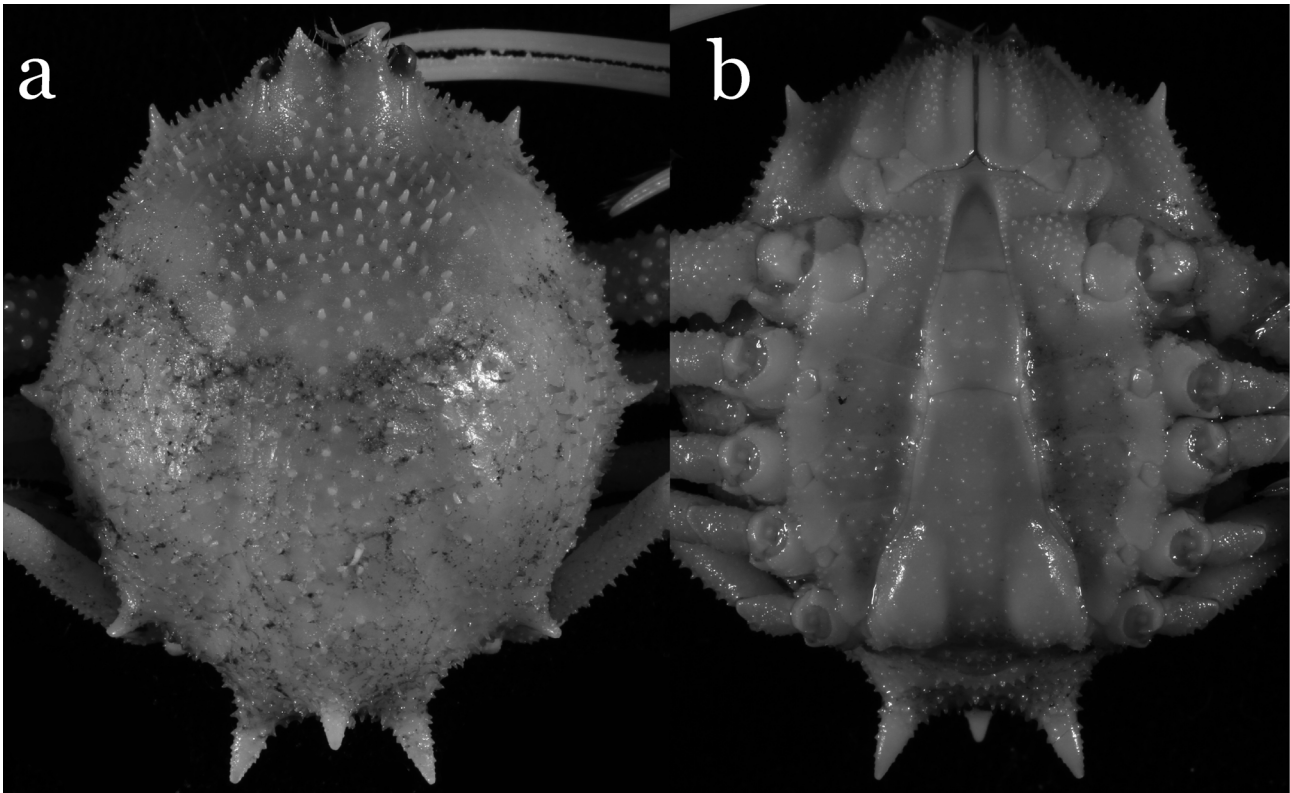


FIGURE 19. *Arcania tropicalis* n. sp. Holotype. NTOU B00111, male, 27.6 × 23.3 mm, Kaohsiung, Taiwan; a, cephalothorax, dorsal view; b, cephalothorax, ventral view.

71–104 m, 12 Oct. 2006.—ZRC 2009.0617, 1 male, 26.7 × 24.5 mm, 1 juvenile, 13.4 × 12.4 mm, NE Urilapa Island, stn. AT 119, 87–120 m, 19 Oct. 2006.—MNHN-IU-2013-13311, 1 male, 24.1 × 22.5 mm, ENE Tutuba Island, stn. AT48, 330–341 m, 15°33.8'N 167°18.9'E, 30 Sept. 2006.

Description. Carapace roundly elliptical, dorsal surface densely, uniformly covered with columnar granules (Figs. 18, 19a); pterygostomial, subhepatic regions evenly covered with rounded granules (Figs. 18b, 19b). Front divided into 2 blunt triangular lobes by blunt triangular gap, lobes weakly produced anteriorly, tip not acute (Figs. 18a, 19a). Carapace with subhepatic, anterolateral, lateral, posterolateral, posterior, intestinal spines. Anterolateral spines smallest, more distinct in small individuals, followed in size by subhepatic-lateral, posterolateral-intestinal, posterior spines; posterior spines with dorsoventrally compressed, wide bases; distal end of intestinal spines not reaching those of posterior spines. Branchiocardiac to branchiogastric grooves distinct, epibranchial, cardiointestinal grooves present in large individuals. Antennular fossae oblique, basal antennular segment with acutely triangular lobe on distoposterior margin, long setum on subdistal part of posterior surface. Mesial end of infraorbital margin forming sharp triangular spine. Anteromesial corner of pterygostomial region, anterolateral margin of buccal cavern forming laterally compressed triangular, sharp spines, these spines fitting closed exopod of mxp3; distance between spines large due to blunt exopod of mxp3.

Eyes fitting within orbit, only corneal part slightly exposed.

Mxp3 (Figs. 18b, 19b) sparsely covered with rounded granules; merus length about two-fifths of ischium; ischium, merus each with longitudinal groove on mesial third, half; female merus with longitudinal row of setae along longitudinal groove. Exopod narrowed at level of proximal half of merus, gap between narrowed part of exopod, merus thus fitting triangular spine of anterolateral margin of buccal cavern.

Male thoracic sternites 4–7 covered with rounded granules (Fig. 19b); granulation about equal to pterygostomial region. Sternal button of abdominal holding on anterior end of thoracic sternite 5 at lateral slope of thoracic cavity, button fitting proximolateral cup of somite 6. Penis coxal. Vulva on mesial end of thoracic suture 5/6 on somite 6; mesial end of vulva converged, sternal cover on sublateral part of anterior margin (Fig. 21).

Cheliped moderately long, subequal (Fig. 18a). Merus shorter than chela, entirely covered with rounded, conical granules. Carpus, palm covered with minute granules, granules sparser on lower surfaces of carpus, absent

in lower surface of palm. Fingers slender, without gape when closed, with 10–16 small teeth with much smaller teeth throughout. Ambulatory legs slender, merus longest of articles, merus to propodus covered with minute conical granules, sparser to absent from lower surfaces. Dactylus with low keels on mid-lines of mesial, lateral surfaces, keel on lateral surface flanked by rows of setae.

Abdomen (Fig. 19b) granular with rounded granules; somites 3–5 fused, with proximolateral protuberances well swollen, each protuberance higher, slightly wider than central part between protuberances. Lateral margins of somite 6 slightly convex. G1 (Fig. 20a–d) strongly curved dorsally, distal part weakly recurved anteriorly; distal end with complex flaps fringing opening. G2 (Fig. 20e) short, opening facing dorsally *in situ*.

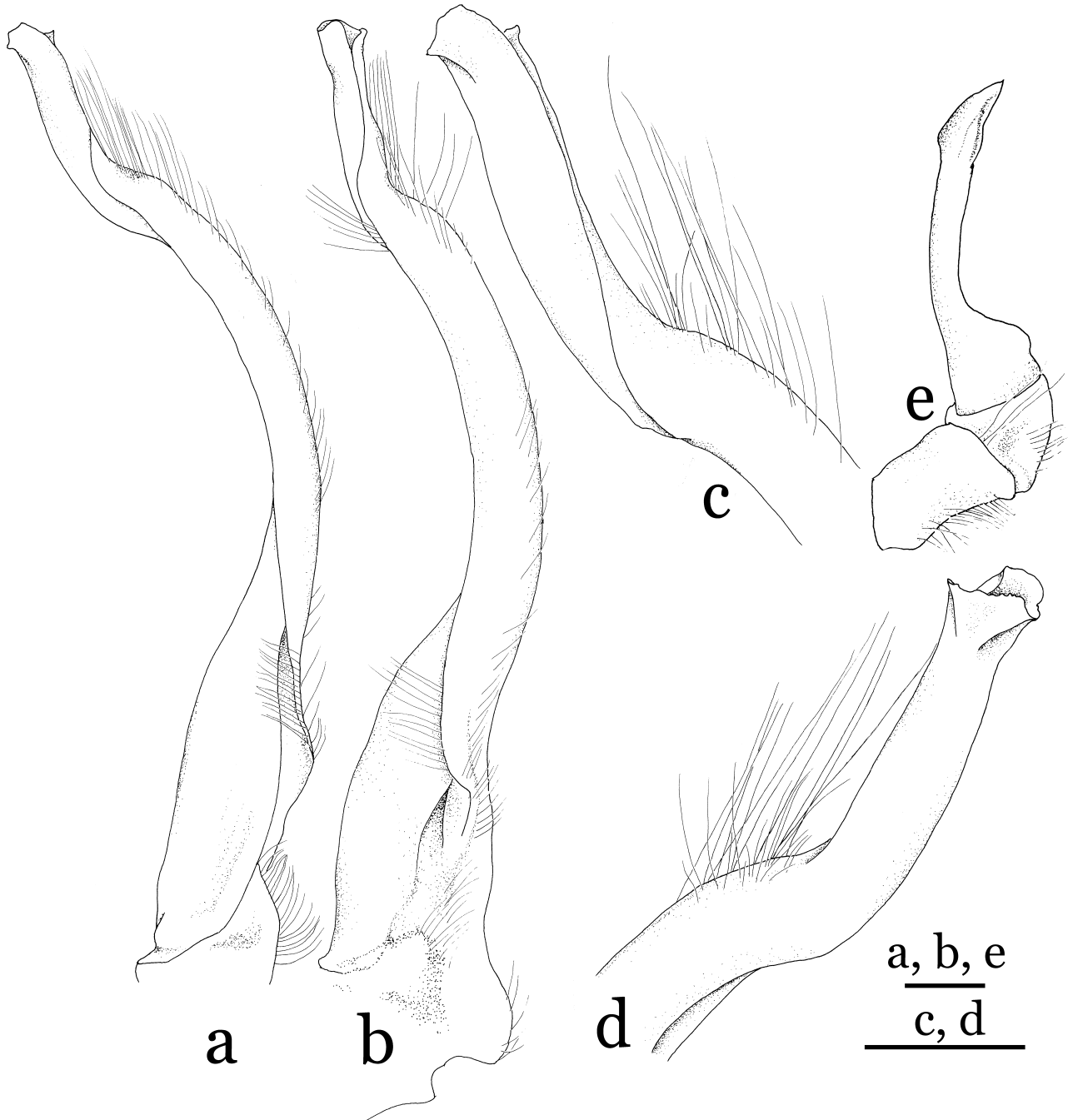


FIGURE 20. G1 and G2 of *Arcania tropicalis* n. sp. Holotype. NTOU B00111, male, 27.6 × 23.3 mm, Kaohsiung, Taiwan; a, left G1, mesial view; b, left G1, ventral view; c, distal part of left G1, mesial view; d, distal part of left G1, lateral view; e, left G2. Scales = 1 mm.



FIGURE 21. Right vulva of *Arcania tropicalis* n. sp. NTOU (NTOU B00113), male, 32.5 × 29.6 mm, Yilan, Taiwan. Scale = 1 mm.

Coloration. Body and cheliped merus reddish dorsally, with pink lines on the gastric and hepatic regions. Branchial regions near posterolateral margins lighter in color (Fig. 18a).

Geographical distribution. Taiwan (Kezailiao; Dasi; Tashi; Toucheng; Nangfangau); China (Hong Kong); Philippines (Aurora; Bohol; Verde Island Passage; Samar Sea); Vanuatu.

Etymology. The species name is derived from the Latin *tropicalis* alluding its geographical distribution.

Remarks. *Arcania tropicalis* n. sp. is morphologically closest to *A. elongata*, but the new species can be easily distinguished from the latter by its strongly bent G1 (gradually curved dorsally in *A. elongata*), and the shape of the vulvae, being converged mesially, with a sternal cover on the sublateral part of anterior margin in the new species (Fig. 21 vs. fig. 17; see Table 1).

Tan (1996) studied material from the U.S. Fisheries Steamer *Albatross* and recorded *A. elongata* from 4 stations. Re-examination of these specimens revealed that three out of four lots of the specimens from the Philippines (USNM 1192285, stn. 5210; USNM 65346, stn. 5276; USNM 65427, stn. 5442) are *A. tropicalis* n. sp. (see Tan 1996: fig. 2k–o). The remaining male specimen from Hong Kong (Tan 1996: fig. 1(B); USNM 1192284, stn. 5309) has conspicuously long posterolateral and intestinal spines, but the condition of the G1 is similar to that of *A. elongata*. It is thus possible that this belongs to an undescribed species.

Morphometric analysis

Variations between sexes in the body width and cheliped merus length were analyzed by ANCOVA. Slopes of

regression lines of the body width against the postfrontal carapace length are significantly different in *A. cornigera n. sp.* ($p = 0.018$) and *A. elongata* ($p = 0.038$) (Table 2), indicating that these species show different morphometric trends between the sexes. The body width in both sexes in *A. undecimspinosa* show no differences, whereas that of *A. tropicalis n. sp.* is significantly larger in females than in males (Table 2, Figure 22a, b). Slopes of regression lines of cheliped merus against postfrontal carapace length are significantly different in *A. undecimspinosa* ($p < 0.001$) and *A. cornigera n. sp.* ($p = 0.022$) (Table 2, Figure 22c, d), indicating that these species have different morphometric trends between the sexes. The cheliped merus in both sexes in *A. tropicalis n. sp.* show no differences, whereas that of *A. elongata* is significantly longer in males than in females (Table 2, Figure 22c, d).

Differences of the body width and cheliped merus lengths between species were also analyzed by sex. Slopes of regression lines of male body width ($p = 0.01$) as well as male and female cheliped merus length (male, $p < 0.001$; female, $p = 0.003$) are significantly different, indicating that these characters show different morphometric trends between species (Table 2, Figure 22a, c, d). The female body width of *A. elongata* is significantly larger than those of *A. cornigera n. sp.* and *A. undecimspinosa*, and female *A. tropicalis n. sp.* has significantly larger body width than that of *A. cornigera n. sp.* (Table 2, Figure 22b).

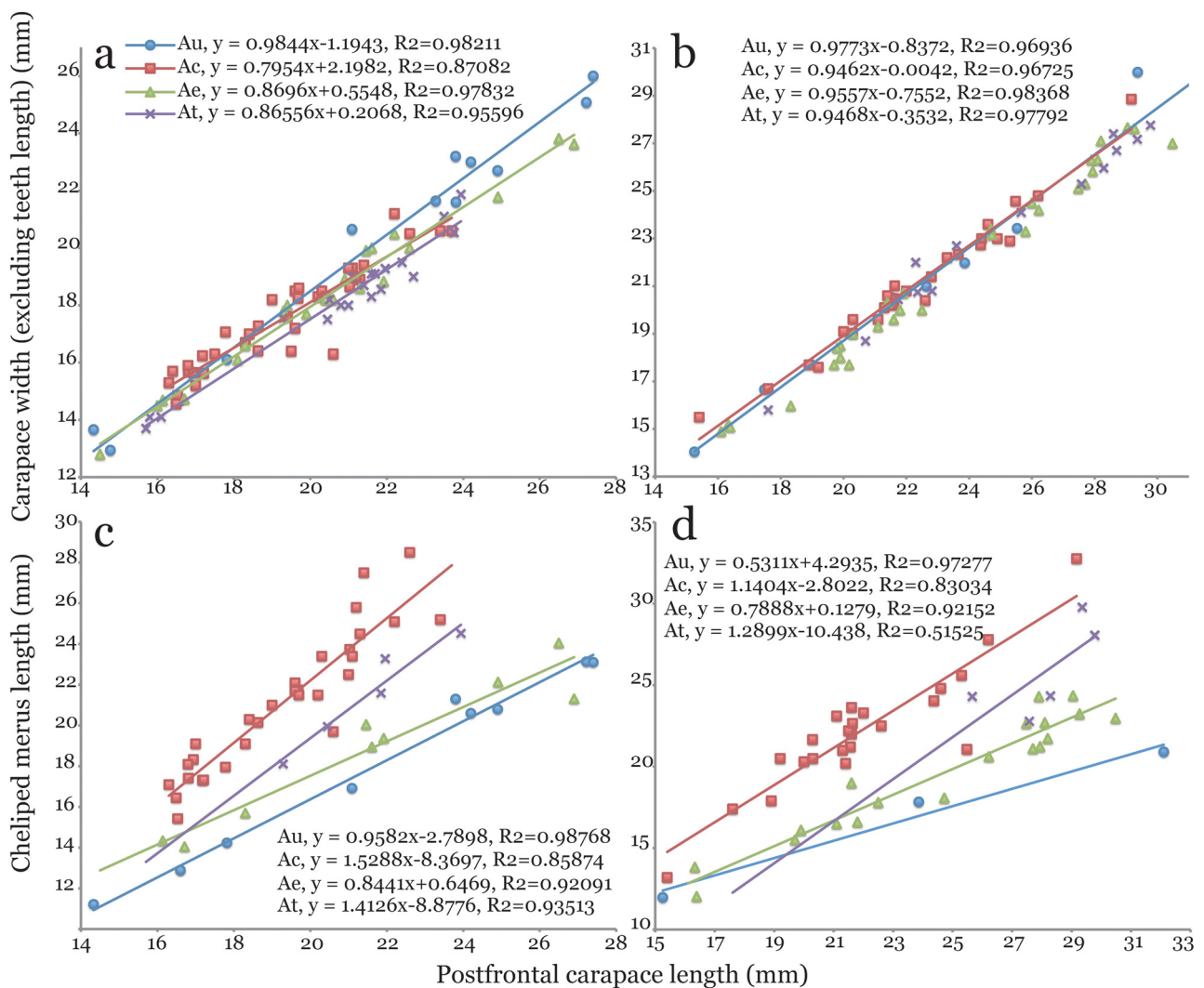


FIGURE 22. Relationships between body width (length excluding teeth) and cheliped merus length against postfrontal carapace length of four *Arcania* species; a, male body width; b, female body width; c, male cheliped merus; d, female cheliped merus. Ac, *A. cornigera n. sp.*; Ae, *A. elongata* Yokoya, 1933; At, *A. tropicalis n. sp.*; Au, *A. undecimspinosa* De Haan, 1841.

TABLE 2. Result of ANCOVA and multiple comparisons for body width (BW) and cheliped merus length between sexes of each species and between species of each sex.

Postfrontal carapace length (PCL) is used as an independent variable. Ac, *A. cornigera* n. sp.; Ae, *A. elongata* Yokoya, 1933; At, *A. tropicalis* n. sp.; Au, *A. undecimspinosa* De Haan, 1841.

	ANCOVA		Multiple comparison	Number of examined specimens
	F	P		
PCL-BW by sex				
<i>A. undecimspinosa</i>	1.5608973	0.2284627	Male=female	13 males, 8 females
<i>A. cornigera</i>	5.93661129	0.01776354		37 males, 28 females
<i>A. elongata</i>	4.55763587	0.03801598		21 males, 30 females
<i>A. tropicalis</i>	1.8080854	0.1888172	Male<female	21 males, 14 females
PCL-merus by sex				
<i>A. undecimspinosa</i>	39.70141	0.000140833		10 males, 3 females
<i>A. cornigera</i>	5.61215069	0.02182202		30 males, 23 females
<i>A. elongata</i>	0.2572615	0.6166369	Male>female	10 males, 19 females
<i>A. tropicalis</i>	0.02802349	0.87255327	Male=female	5 males, 5 females
PCL-BW by species				
Male	3.9894344	0.01046461		Au, 13; Ac, 37; Ae, 22; At, 20
Female	0.1275924	0.9434417	Ac ¹ , Au ^{1,2} , At ^{2,3} , Ae ³	Au, 7; Ac, 28; Ae, 30; At, 14
PCL-merus by species				
Male	9.4	0.0000587		Au, 10; Ac, 30; Ae, 10; At, 5
Female	5.402519531	0.003096736		Au, 3; Ac, 23; Ae, 19; At, 5

Acknowledgements

Thanks are due to R. Yoshida (University of the Ryukyus) who provided specimens that made the author realize the need of this investigation. I thank T.-Y. Chan (NTOU), K. van Dorp (The Nauralis, Leiden), K. Hirashima (WMNH), W. Kim and J. Jung (Seoul National University), H. Komatsu (National Museum of Nature and Science, Tokyo), S.-K. Lee (Korea Institute of Ocean Science & Technology), R. Lemaitre, K. Reed and other staff at the Smithsonian Institution (Washington, D.C.), C.-W. Lin (NMMB), M. Lowe (The Natural History Museum, London), H.-K. Mok (National Sun Yat-Sen University, Kaohsiung, Taiwan), P.K.L. Ng (National University of Singapore) and M. Shimomura (KMNH) for their help in accessing specimens. I also thank P. Castro (California State Polytechnic University) and B. Galil (Israel Oceanographic and Limnological Research) for their detailed review.

Some of the specimens studied were collected during three expeditions (PANGLAO 2004, PANGLAO 2005 and AURORA 2007) organized by the Muséum national d'Histoire naturelle (Paris), University of San Carlos (Cebu, Philippines), National Museum of the Philippines (Manila), Philippines Bureau of Fisheries Research (Manila), Raffles Museum of Biodiversity Research, National University of Singapore, and National Taiwan Ocean University. Some of the specimens of the new species were collected during the SANTO 2006 expedition to Vanuatu organized by MNHN together with Pro Natura International (PNI), Institut de Recherche pour le Développement (IRD) and the Vanuatu Department of Fisheries, with funding support from the TOTAL Foundation and Sloan Foundation.

References

- Alcock, A. (1896) Materials for a carcinological fauna of India. No. 2. The Brachyura Oxystomata. *Journal of the Asiatic Society of Bengal*, 65 (2), 134–296, pls. 6–8.
- Balss, H. (1922) Ostasiatische Decapoden. III. Die Dromiaceen, Oxystomen und Parthenopiden. *Archiv für Naturgeschichte*, 88A (3), 104–140.
- Bell, T. (1855a) Horae carcinologicae, or notices of Crustacea. I. A monograph of the Leucosiadae. *Annals and Magazine of Natural History*, 16, 361–367.
- Bell, T. (1855b) Horae carcinologicae, or notices of Crustacea. I. A monograph of the Leucosiadae, with observations on the relations, structure, habits and distribution of the family; a revision of the generic characters; and descriptions of new genera and species. *Transactions of the Linnean Society*, 21, 277–314, pls. 30–34.
<http://dx.doi.org/10.1111/j.1096-3642.1852.tb00464.x>
- Bell, T. (1855c) Catalogue of Crustacea in the collections of the British Museum. Part I. Leucosiadae. Printed by order of the Trustees [by Taylor and Francis], London, 1–24 pp.
- Campbell, B.M. (1971) New records and new species of crabs (Crustacea: Brachyura) trawled off southern Queensland: Dromiacea, Homolidea, Gymnopleura, Corystoidea, and Oxystomata). *Memoirs of the Queensland Museum*, 16 (1), 27–48, pls. 2, 3.
- Campbell, B.M. & Stephenson, W. (1970) The sublittoral Brachyura (Crustacea: Decapoda) of Moreton Bay. *Memoirs of the Queensland Museum*, 15 (4), 235–302, pl. 22.
- Chang, C.-M. (1963) A check list of Taiwan crabs with descriptions of 19 new records. Department of Biology, College of Science, Tunghai University, *Biological Bulletin*, 5 (2), 95–118.
- Dai, A. & Yang, S. (1991) *Crabs of the China Sea*. China Ocean Press, Beijing and Springer-Verlag, Berlin, Heidelberg, New York, Tokyo, 21+608 pp.+74 pls.
- Dai, A.-Y., Yang, S.-L., Song, Y.-Z. & Chen, G.-X. (1986) *Crabs of Chinese Seas*. China Ocean Press, Beijing, xvii + 642 pp., 74 pls. [in Chinese]
- Davie, P.J.F. & Short, J.W. (1989) Deepwater Brachyura (Crustacea: Decapoda) from southern Queensland, Australia with description of four new species. *Memoirs of the Queensland Museum*, 27 (2), 157–187.
- Estampador, E.P. (1937) A check list of Philippine crustacean decapods. *Philippine Journal of Science*, 62, 465–559.
- Fransen, C.H.J.M., Holthuis, L.B. & Adema, J.P.H.M. (1997) Type-catalogue of the decapod Crustacea in the collections of the Nationaal Natuurhistorisch Museum, with appendices of pre-1900 collectors and material. *Zoologische Verhandelingen*, 311, i–xvi, 1–344.
- Fujii, T. & Naruse, T. (2013) First record of *Arcania novemspinosa* (Crustacea: Decapoda: Leucosiidae) from Okinawa Island, Japan. *Fauna Ryukyuna*, 3, 1–6. [in Japanese]
- Fukuda, Y. (1978) Preliminary notes on recently obtained larvae of brachyuran Crustacea of the sea around the Aitsu Marine Biological Station. *Calanus*, 6, 10–16. [in Japanese with English summary]
- Galil, B.S. (2001) A revision of the genus *Arcania* Leach, 1817 (Crustacea: Decapoda: Leucosioidea). *Zoologische Mededelingen*, 75, 169–205.
- Gurjanova, E.F. & Chang, H.P. (1972) Bottom communities of the Tonking Gulf. The fauna of the Tonking Gulf and conditions of life in it. In: Bychovskii, B.E. (Ed.), *Explorations of the fauna of the seas X (XVIII)*. Leningrad, Zoological Institute, Academy of Sciences of the USSR, pp. 147–169. [in Russian]
- Haan, W. de (1833–1849) Crustacea. In: Siebold, P.F. (Ed), *Fauna Japonica sive Descriptio Animalium, quae in Itinere per Japoniam, Jussu et Auspiciis Superiorum, Qui Summum in India Batava Imperium Tenent, Suscepto, Annis 1823–1830 Collegit, Notis, Observationibus et Adumbrationibus Illustravit, (Crustacea)*. Lugduni-Batavorum, Leiden, xvii+xxxii+ix-xvi+243 pp. + pls. A–J, L–Q, 1–55, circ. table 2.
- Hamano, T., Furukawa, T., Fukumoto, N. & Matsuura, S. (1985) The benthic megalofaunal community in Hakata Bay, Japan. *Report of Fishery Research Laboratory, Kyushu University*, 7, 1–26. [in Japanese with English summary and figure legends]
- Haswell, W.A. (1880) Contributions to a monograph of Australian Leucosiidae. *Proceedings of the Linnean Society of New South Wales*, 4 (1), 44–60, pls. 5, 6.
- Haswell, W.A. (1882) *Catalogue of the Australian Stalk- and Sessile-Eyed Crustacea*. Australian Museum, Sydney, 327 pp + 4 pls.
- Hill, D.S. (1982) The Leucosiidae (Crustacea: Decapoda) of Hong Kong. In: Morton, B. & Tseng, C.K. (Eds.), *Proceedings of the First International Marine Biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China*. Hong Kong, Hong Kong University Press, pp. 195–205.
- Henderson, J.R. (1893) A contribution to Indian carcinology. *Transactions of the Linnean Society of London, Series 2 Zoology*, 5 (10), 325–458, pls 36–40.
- Herklots, J.A. (1861) Symbolae carcinologicae. Etudes sur la classe des Crustacés. I. Catalogue des Crustacés qui ont servi de base au système carcinologique de M.W. de Haan, rédigé d'après la collection du Musée des Pays-Bas et les Crustacés de la faune du Japon. *Tijdschrift voor Entomologie*, 4, 116–156.
- Holthuis, L.B. & Sakai, T. (1970) *Ph. F. von Siebold and Fauna Japonica: A history of early Japanese zoology*. Academic Press of Japan, Tokyo, 323 pp + 38 color plates + 1 map.

- Huang, L. (1989) Oxystomata. In: Wei, C. & Chen, Y. (Eds.), *Fauna of Zhejiang. Crustacea*. Zhejiang Science and Technology Publishing House, Hangzhou, pp. 294–324. [in Chinese]
- Huang, Z. (1994). *Marine species and their distributions in China's seas*. China Ocean Press, Beijing, 764+144 pp. [in Chinese]
- Ihle, J.E.W. (1918) Die Decapoda Brachyura der Siboga-Expedition. III. Oxystomata: Calappidae, Leucosiidae, Raninidae. *Siboga Expéditie*, 39n (b2), 159–322.
- Ives, J.E. (1891) Echinoderms and arthropods from Japan. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 43, 210–223, pls. 7–12.
- Jones, D.S. (1990) Annotated checklist of marine decapod Crustacea from Shark Bay, Western Australia. In: Berry, P.B., Bradshaw, S.D. & Wilson, B.R. (Eds.), *Research in Shark Bay. Report of the France-Australe Bicentenary Expedition Committee*. Western Australian Museum, Perth, pp. 169–208.
- Kamita, T. (1936) Crabs from the coast of Korea Strait. *Journal of Chosen Natural History Society*, 21, 30–35. [in Japanese]
- Kamita, T. (1941a) On the distribution of Brachyuran Crustacea in Korea. *Zoological Magazine*, 53, 232–244. [in Japanese with English Summary]
- Kamita, T. (1941b) *Studies of the Decapod Crustaceans of Chosen. Pt. I. Crabs*. The Fisheries Society of Chosen, Keijo, 2 pls.+2+2+14+289, 1 map.
- Kensley, B. (1978) Decapod crustaceans collected in southern African waters by the Th. Mortensen Java-South Africa Expedition (Crustacea, Decapoda). *Steenstrupia*, 4, 249–261.
- Kensley, B. (1981) On the zoogeography of Southern African decapod Crustacea, with a distributional checklist of the species. *Smithsonian Contributions to Zoology*, 338, 1–64.
<http://dx.doi.org/10.5479/si.00810282.338>
- Kim, H.S. (1970) A checklist of the Anomura and Brachyura (Crustacea, Decapoda) of Korea. *Seoul University Journal, Biology and Agriculture*, Series B, 21, 1–34.
- Lichtenstein, K.M.H. (1816) Die Gattung *Leucosia*: als Probe einer neuer Bearbeitung der Krabben und Krebse. *Magasin der Gesellschaft Naturforschender Freunde zu Berlin*, 7 (2), 135–144.
- Marumura, M. & Kosaka, A. (2003) *Catalogue of brachyuran and anomuran crabs collection donated by the late Mr. Seiji Nagai to the Wakayama Prefectural Museum of Natural History*. Wakayama Prefectural Museum of Natural History, Wakayama, 74 pp.
- Miers, E.J. (1877) Notes upon the Oxystomatous Crustacea. *Transactions of the Linnean Society of London*, Series 2, 1 (5), 235–249, pls. 38–40.
- Miers, E.J. (1879) On a collection of Crustacea made by Capt. H.C. St. John, R.N., in the Korean and Japanese Seas. Part I. Podophthalmia. With an appendix by Capt. H. C. St. John. *Proceedings of the Scientific Meetings of the Zoological Society of London*, 1879, 18–61.
- Miers, E.J. (1884) Crustacea (Brachyura). In: Report on the Zoological Collections made in the Indo-Pacific Ocean during the voyage of H.M.S. 'Alert' 1881–1882. Part II. *The collections from the Western Indian Ocean*, 8 (2), 513–575, pls. 46–52. [British Museum (Natural History), London]
- Miyake, S. (1961a) Decapod Crustacea. Fauna and Flora of the sea around the Amakusa Marine Biological Laboratory, Kyushu University. *The Amakusa Marine Biological Laboratory, Kyushu University*, 2, i–iv, 1–30. [in Japanese]
- Miyake, S. (1961b) A list of the decapod Crustacea of the sea of Ariaké, Kyushu. *Records of Oceanographic Works in Japan*, Special Number 5, 165–178.
- Miyake, S. (1983) *Japanese Crustacean Decapods and Stomatopods in Color. Vol. II Brachyura (Crabs)*. Hoikusha, Osaka, 277 pp. [in Japanese]
- Miyake, S., Sakai, K., Nishikawa, S. (1962) A fauna-list of the decapod Crustacea from the coasts washed by the Tsushima warm current. *Records of Oceanographic Works in Japan*, Special Number 6, 121–131.
- Muraoka, K. (1998) Catalogue of the Brachyuran and Anomuran Crabs donated by Prof. Dr. Tune Sakai to the Kanagawa Prefectural Museum. *Catalogue of the Collection in the Kanagawa Prefectural Museum of Natural History*, 11, 5–67, pls. 1–16. [in Japanese]
- Ng, P.K.L. & Huang, J.-F. (1997) Unrecorded crabs (Crustacea: Decapoda: Brachyura) from Taiwan and Tungsha Islands, with description of a new genus and species of Xanthidae. *Zoological Studies*, 36 (4), 261–276.
- Ortmann, A. (1892) Die Decapoden-Krebse des Strassburger Museums, mit bedonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen. V Theil. Die Abtheilungen Hippidea, Dromiidea und Oxystomata. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Thiere*, 6, 532–588, pl. 26.
- Parisi, B. (1914) I Decapodi giapponesi del Museo di Milano. I. Oxystomata. *Atti della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale in Milano*, 53, 282–312, pls. 11–13.
- Park, T.K. (1964) On the crabs in the Eastern Sea of Korea. *Korea Journal of Zoology*, 7, 15–18. [in Korean with English summary and figure caption]
- Rathbun, M.J. (1902) Japanese stalk-eyed crustaceans. *Proceedings of the United States National Museum*, 26 (1307), 23–55.
<http://dx.doi.org/10.5479/si.00963801.26-1307.23>
- Rathbun, M.J. (1910) The Danish Expedition to Siam 1899–1900. V. Brachyura. *Konelige Danske Videnskabernes Selskat, Naturvidenskabelige Matematiske Afhandlinger*, 5 (4), 301–368, pls. 1–2, 1 map.

- Romimohtarto, K. (1967) The oxystomatous crabs of the Baruna Expedition. *Marine Research in Indonesia*, 8, 1–27, pls. 1–3.
- Sakai, K. (2004) *Crabs of Japan*. ETI Information Services Ltd. [CD-ROM]
- Sakai, T. (1934) Brachyura from the coast of Kyusyu, Japan. *Science Reports of the Tokyo Bynrika Daigaku, section B*, 1 (25), 281–330, pls. 17–18.
- Sakai, T. (1935) Simoda fukin suisan dobutsu mokuroku [A list of marine animals around Shimoda area]. *Tokyo Bunrika Daigaku Shimoda Rinkai Jikkensyo Seibutsu Hokoku, Daiippo (Biological Report of Simoda Marine Biological Station, Tokyo University of Literature and Science)*, 1, 23–89. [in Japanese]
- Sakai, T. (1937) Studies on the crabs of Japan. II. Oxystomata. *Science Reports of the Tokyo Bunrika Daigaku, Section B, Supplement No. 2, 3*, 67–192, pls. 10–19.
- Sakai, T. (1965) *The crabs of Sagami Bay collected by His Majesty the Emperor of Japan*. Maruzen, Tokyo, 206 pp. + 100 pls. + 92 pp., in Japanese + 32 pp. of bibliography and index pp.
- Sakai, T. (1976) *Crabs of Japan and the Adjacent Seas. Vol. 1–3*. Kodansha, Tokyo, English text, xxix + 773 pp.; plates volume, 16 pp., 251 pls.; Japanese text, 461 pp.
- Sankarankutty, C. (1962) On Decapoda Brachyura from the Andaman and Nicobar Islands. 3. Families: Calappidae, Leucosiidae, Parthenopidae, Majidae, and Gecarcinidae. *Journal of the Marine Biological Association of India*, 4 (1), 151–164.
- Serène, R. (1937) Inventaire des invertébrés marins de l'Indochine : première liste. *Institut océanographique de l'Indochine*, Saigon, 30, 3–83.
- Serène, R. (1968) Prodomus for a check list of the non-planctonic marine fauna of Southeast Asia. *Singapore National Academy of Science, Special Publication 1*, 1–122.
- Serène, R. & Vadon, C. (1981) Crustacés Décapodes: Brachyours Liste préliminaire, description de formes nouvelles et remarques taxonomiques. In: *Résultats des Campagnes MUSORSTOM. I—Philippines (18–28 Mars 1976). Mémoires ORSTOM. Vol. 91*. Éditions de l'Office de la Recherche Scientifique et Technique d'Outre-Mer, Paris, pp. 117–140, pls. 1–4.
- Shen, C.J. (1931) The crabs of Hong Kong. Part I. *The Hong Kong Naturalist*, 2, 92–110, pls. 4–10.
- Shen, C.J. (1937a) On some account of the crabs of North China. *Bulletin of the Fan Memorial Institute of Biology (Zoology)*, 7 (5), 167–185.
- Shen, C.J. (1937b) Second addition to the fauna of brachyuran Crustacea of North China, with a check list of the species recorded in this particular region. *Contributions from the Institute of Zoology, National Academy of Peiping*, 3, 277–312.
- Shen, C.J. (1940a) The brachyuran fauna of Hong Kong. *Journal of the Hong Kong Fisheries Research Society*, 1 (2), 211–242.
- Shen, C.J. (1940b) On the collection of Crabs of South China. *Bulletin of the Fan Memorial Institute of Biology (Zoology)*, 10 (2), 69–104.
- Suzuki, S. (1979) *Marine invertebrates in Yamagata Prefecture*. Tamakibi-kai, Yamagata, 370 pp. + 29 pls. [in Japanese]
- Takeda, M. (1979) Systematic and biogeographic notes on the crabs obtained by dredging at the sea around Cape Shionomisaki, Kii Peninsula. *Memoirs of the National Science Museum*, 12, 151–157. [in Japanese]
- Takeda, M. (1982) Biogeographical notes on the crabs obtained by dredging off the southeast coast of the Izu Peninsula, Central Japan. *Bulletin of the Biogeographical Society of Japan*, 37(4), 15–21. [in Japanese]
- Takeda, M. (1983) Brachyura. In: Utinomi, H. (Ed.), *Gakken illustrated nature encyclopedia. The aquatic lower animals of Japan*. Gakken, Tokyo, pp. 1–342. [in Japanese]
- Takeda, M. & Miyake, S. (1970) Crabs from the East China Sea. IV. Gymnopleura, Dromiacea and Oxystomata. *Journal of the Faculty of Agriculture, Kyushu University*, 16 (3), 193–236, pl. 1.
- Takeda, M., Furuta, S., Miyana, T., Tamura, A. & Wada, T. (2011) Crabs from the southwestern Sea of Japan along Tottori Prefecture and its vicinity, Japan. *Bulletin of the Tottori Prefectural Museum*, 48, 29–94. [in Japanese with English abstract]
- Tan, C.G.S. (1996) Leucosiidae of the *Albatross* expedition to the Philippines, 1907–1910 (Crustacea: Brachyura: Decapoda). *Journal of Natural History*, 30, 1021–1058.
<http://dx.doi.org/10.1080/00222939600770551>
- Tirmizi, N.M. & Kazmi, Q.B. (1988) Crustacea: Brachyura (Dromiacea, Archaeobrachyura, Oxystomata, Oxyrhyncha). *Marine Fauna of Pakistan*, 4, i–viii, 2 unnumbered color plates, 1–244, 1 unnumbered plate.
- Walker, A.O. (1887) Notes on a collection of Crustacea from Singapore. *Journal of the Linnean Society of London, Zoology*, 20, 107–117, pls. 6–9.
- Yamaguchi, T. (1993) Ph. F. von Siebold and Natural History of Japan, Crustacea. Carcinological Society of Japan, Hakodate, viii + 732 pp. + 24 pls.
- Yamaguchi, T. & Baba, K. (1993) Crustacean specimens collected in Japan by Ph. F. von Siebold and H Bürger and held by the Nationaal Natuurhistorisch Museum in Leiden and other museums. In: Yamaguchi, T. (Ed.), *Ph. F. von Siebold and Natural History of Japan, Crustacea*. The Carcinological Society of Japan, Tokyo, pp. 145–570. [in Japanese with English summary and figure caption]
- Yamaguchi, T. & Baba, K. (2003) Crustacean specimens collected in Japan by Ph. F. von Siebold and H. Bürger and held by the Nationaal Natuurhistorisch Museum in Leiden and other museums (revised edition). *Calanus, Special Number*, 4, 1–340 [in Japanese and English summary and list of specimens]
- Yamaguchi, T., Takeda, M. & Tokudome, K. (1976) A list of crabs collected in the vicinity of the Aitsu Marine Biological

- Station and a preliminary report on the cheliped asymmetry of the crabs. *Calanus*, 5, 31–46. [in Japanese]
- Yokoya, Y. (1933) On the distribution of decapod crustaceans inhabiting the continental shelf around Japan, chiefly based upon materials collected by s.s. Sôyô-Marû during the years 1923–1930. *Journal of the College of Agriculture, Tokyo Imperial University*, 12 (1), 1–226.
- Zarenkov, N.A. (1969) Crabs of the family Leucosiidae (subfamilies Ebalinae and Iliinae) collected in tropical waters of Indian and Pacific Oceans. *Nauchnye Doklady Vysshei Shkoly, Biologicheskie Nauki, SSSR*, 12 (10), 16–26. [in Russian]
- Zarenkov, N.A. (1994) Crabs from seamounts of the western part of the Indian Ocean. In: Kuznetsov, A.P. & Mironov, A.N. (Eds.), *Bottom fauna of seamounts. Transactions of the P.P. Shirshov Institute of Oceanology*. Russian Academy of Sciences, Nauka, Moscow, pp. 97–125. [in Russian]

APPENDIX 1. References that cited *A. undecimspinosa* s.l.

References that cited *A. undecimspinosa* s.s.

(Identifications were confirmed by the present study based on their descriptions and figures. Note that the literature may still include non-*A. undecimspinosa* s.s.)

- De Haan 1841: 135, pl. 33, fig. 8 [Nagasaki]
- Bell 1855a: 367 [citing De Haan 1841]
- Bell 1855b: 309 [citing De Haan 1841]
- Bell 1855c: 21 [citing De Haan 1841]
- Herklots 1861: 28 [citing De Haan 1841]
- Ives 1891: 216 [citing De Haan 1841]
- Shen 1931: 107, pl. 10, fig. 1 [Fukien; Kwangtung]
- Sakai 1937: 123, fig. 15a, pl. 14, fig. 2 [Shimoda; Tokyo; Sagami; Ise; Kii; Tosa; Nagasaki]
- Kamita 1941b: 40, fig. 13 [Kore Peninsula (Busan Bay, Jinhae, Masan & Tongyeong in Gyeongsangnam-do; Yeosu, Jeollanam-do; Chinnampo, Pyongan-nando)]
- Holthuis & Sakai 1970: 119, pl. 11, fig. 2 [Nagasaki]
- Sakai 1976: 91, pl. 28, fig. 1 [Oga Peninsula; Tokyo Bay; Sagami Bay; Izu Peninsula; Mikawa Bay; Shima Peninsula; Kii Peninsula; Tosa Bay; Nagasaki]
- Miyake 1983: 60, pl. 20, fig. 6 [Kii-Tanabe]
- Dai *et al.*, 1986: 66, 33(1), pl. 8, fig. 1 [examined material not listed]
- Dai & Yang 1991: 73, fig. 33(1), pl. 8, fig. 1 [examined material not listed]
- Yamaguchi, 1993: pl. 21(c) [Japan]
- Yamaguchi & Baba 1993: 318, fig. 101 [Nagasaki]
- Huang 1989: 305, fig. 267 [Hangzhou]
- Yamaguchi & Baba 2003: 33 [Nagasaki]
- Takeda *et al.* 2011: 37, fig. 9 (26) [Tottori; Sea of Japan side of Hyogo]

References that cited both *A. undecimspinosa* s.s. and other species as “*A. undecimspinosa*”

- Sakai 1965: 40, text-fig. 6a, pl. 16, fig. 3 [Hiramon, near Enoshima; off Kameki Reef] *Anterior part of the cephalothorax in text-fig. 6a is probably of *A. cornigera* n. sp. The habitus (pl. 16, fig. 3) is probably of *A. undecimspinosa* s.s.
- Galil 2001a: 197, figs. 3D, 7D [Japan; Loyalty Islands; Australia; China; Taiwan; Philippines; South Africa] *At least figures (figs. 3D, 7D) and many records are of *A. undecimspinosa* s.s.

References that cited “*Arcania undecimspinosa*” but the identity was not confirmed by the present study

- Miers 1884: 548 [Seychelles]
- Walker 1887: 111 [Singapore (list)]
- Ortmann 1892: 577 [Tokyo Bay; Kagoshima; citing other records as well]
- Henderson 1893: 404 [Gulf of Martahan]
- Alcock 1896: 266 [India (the Andamans and from the Madras side of Palk Straits)] *Different carapace shape (longitudinally ovoid).
- Rathbun 1902: 30 [Kii, Nagasaki, Hizen]
- Rathbun 1910: 314 [Koh Kam, Thailand (list)]
- Parisi 1914: 296 [“Cina merid”; Yokohama; Sagami Bay]
- Ihle 1918 [Sulu; Seychelle]
- Balss 1922: 132 [Misaki; Haidashi; Okinose; Tomo, Tomonoku, Bingo]
- Yokoya 1933: 132 [Suruga Bay; Omae-zaki; Owase; Goto; Saisyu-to; Kyogasaki] *But at least the specimens from Kyogasaki, Goto and Saisyuto are *A. cornigera* n. sp. (see **Remarks** for *A. undecimspinosa*)
- Sakai 1934: 288 [Nagasaki]
- Sakai 1935: 64 [Shimoda]
- Kamita 1936: 30 [Busan, Korea (list)]

Estampador 1937: 514 [citing Ihle, 1918]
 Serène 1937: 77 [list]
 Shen 1937a: 172 [no new locality].
 Shen 1937b: 284 [Kiaochow Bay]
 Shen 1940a: 215 [Hong Kong]
 Shen 1940b: 78 [Amoy; Tsimei; Liuwutien (list)]
 Kamita 1941a: 235 [Korea Strait (list)]
 Miyake 1961a: 14 [Amakusa (list)]
 Miyake 1961b: 170 [Ariake (list)]
 Miyake *et al.* 1962: 126 [Amakusa, Sea of Ariake, Tsuyazaki, Tottori, Toyama (list)]
 Sankarankutty 1962: 155 [Aberdeen Bay]
 Chang 1963: 96 [Pescadores (list)]
 Park 1964: 16 [Korea (Kampo; Guryongpo; Yeongilman) (list)]
 Romimohtarto 1967: 11, pl. 2(B) [Arafura Sea]
 Serène 1968 [(list)]
 Zarenkov 1969: 23 [Gulf of Tonkin (list)]
 Kim 1970: 10 [Korea (Bangpo, Anmyon-do I.; Bangjugpo, Dolsan-do I.; Jinhae; Hacundae, Pusan) (list)]
 Takeda & Miyake 1970: 223 [East China Sea]
 Campbell 1971: 41 [off Cape Moreton, S Queensland (list)]
 Gurjanova & Chang 1972: 162, table 3 [Tonking Gulf]
 Yamaguchi *et al.* (1976: 34) [Aitsu, Amakusa (list)]
 Fukuda 1978: 10, 11 [Aitsu, Ariake].
 Kensley 1978: 250 [off Durban, South Africa (list)]
 Suzuki 1979: 306 [Yamagata (list)]
 Takeda 1979: 153 [Shionomisaki]
 Kensley 1981: 38 [Southern Africa (list)]
 Serène & Vadon 1981: 118 [Philippines (Manila Bay; N & NW Lubang Island; S Mariveles, Bataan)]
 Takeda 1982: 18 [Izu Peninsula]
 Takeda 1983: 122, 252. [No locality indicated] *Probably *A. undecimspinosa* s.s., but photo is not clear.
 Hamano *et al.* 1985: 21 [Hakata Bay (list)]
 Davie & Short 1989: 173 [Coral Sea]
 Jones 1990: 188 [Shark Bay, Rottneest Island (list)]
 Huang 1994: [Guangdong; Hainan; Fujian; Taiwan (list)]
 Zarenkov 1994: 111, fig. 8Ж [Agalega Islands]
 Tan 1996: 102 [Philippines (citing Chen 1989; list)]
 Muraoka 1998: 18 [Aichi; Kochi (list)]

References that cited “*Arcania undecimspinosa*” but confirmed representing different species

Romimohtarto 1967: 11, pl. 2(B) [Arafura Sea]—*A.* sp. 1
 Tirmizi & Kazmi 1988: 76, fig. 22 [Karachi]—*A.* sp. 2
 Marumura & Kosaka 2003: 27 [Kushimoto]—*A. cornigera* n. sp.