

## Records of Four Species of the Pylochelid Hermit Crab Genus *Trizacheles* Forest, 1987 (Crustacea: Decapoda: Anomura) from the Sagami Sea and Izu Islands, Central Japan, with Descriptions of Three New Species

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**Abstract** The present study reports on the “symmetrical” hermit crab genus *Trizacheles* Forest, 1987 (Paguroidea: Pylochelidae) collected in the Sagami Sea and Izu Islands, central Japan, during a continuous marine faunal survey of the Natural History Museum and Institute, Chiba. Four species were identified, of which three are new to science: *T. albatrossi* Forest, 1987, *T. albipes* sp. nov., *T. inermis* sp. nov., and *T. parvispina* sp. nov. The three new species are fully described and illustrated, and their affinities are discussed. Previous Japanese records referred to *T. spinosus* (Henderson, 1888) are not that taxon and have been found to actually represent three other species, *T. albatrossi*, *T. sakaii* Forest, 1987, and *Pomatocheles jeffreysii* (Miers, 1879). The present findings increase the number of species of *Trizacheles* known from Japanese waters to six and the number of species known from the world to 21. An identification key to the six Japanese species is provided.

**Key words:** *albatrossi*, *albipes*, *inermis*, *parvispina*, key.

The pylochelid genus *Trizacheles* Forest, 1987 is one of the genera of “symmetrical” hermit crabs, and was originally established to accommodate 17 species and one subspecies, all from in the Indo-West Pacific region (Forest, 1987). Since Forest (1987), four new species have been described (Forest and McLaughlin, 2000; McLaughlin and Lemaitre, 2008; 2009). Two taxa, *Trizacheles spinosus bathamae* Forest and de Saint Laurent, 1987 and *T. gracilis* Forest, 1987 were synonymized with *T. spinosus* (Henderson, 1888) and *T. boasi* Forest, 1987, respectively, by McLaughlin and Lemaitre (2009), who extensively reviewed the genus. Lemaitre *et al.* (2009) performed a cladistic analysis based on morphological characters in order to infer relationships among the taxa within Pylochelidae. Their analysis included 18 specific taxa recognized in *Trizacheles* and suggested that there were three major lineages in the genus, although their relationships were not fully resolved. Finally, McLaughlin and Lemaitre (2009) transferred *T. perplexus* Forest, 1987 to the new monotypic genus *Forestacheles* McLaughlin and Lemaitre, 2009. In total, 18 species are currently known in *Trizacheles* (McLaughlin *et al.*, 2010). The general geographical distribution of the genus is widespread in the Indo-West Pacific, but geographical

range of each species shows a tendency to restriction (Forest, 1987; McLaughlin and Lemaitre, 2009) (Table 1). In practice, *Trizacheles* is recognized by the carapace with a linea transversalis continuous, thus the shield completely separated from the posterior carapace, non-operculiform chelipeds, and the symmetrical telson not clearly divided into anterior and posterior articulating plates, with posterior lobes divided by deep median cleft, symmetrical.

From Japanese waters, the following three species have been reported: *T. albatrossi* Forest, 1987, *T. loquax* Forest, 1987, and *T. sakaii* Forest, 1987 (Forest, 1987; McLaughlin and Lemaitre, 2009). In earlier literature, *T. spinosus* had been reported in Japanese waters (Ortmann, 1892, as *Pylocheles*; Balss, 1913, as *Mixtopagurus*; Yokoya, 1933, as *Mixtopagurus*; Miyake, 1965, as *Pylocheles*; 1978, as *Pylocheles*; 1982, as *Pylocheles*), but Forest (1987) referred these records exclusively to *T. sakaii*.

The present study deals with a small collection made in the Sagami Sea and Izu Islands, central Japan, during 1996–2007 by the author aboard RV *Tansei-maru* of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and TRV *Shin'yo-maru* of the Tokyo University of Marine Science and

**Table 1.** Species of *Trizacheles* Forest, 1987 and their distribution. Source: McLaughlin et al. (2007); McLaughlin and Lemaitre (2009); present study.

Species	Distribution
<i>Trizacheles albatrossi</i> Forest, 1987	Japan; 95–150 m
<i>Trizacheles balssi</i> (Stebbing, 1914)	South Africa; 146–240 m
<i>Trizacheles boasi</i> Forest, 1987 = <i>Trizacheles gracilis</i> Forest, 1987	Indonesia, Philippines, Solomon Islands; 385–581 m
<i>Trizacheles brachyops</i> Forest and de Saint Laurent, 1987	New Zealand; 565–993 m
<i>Trizacheles brevicaulis</i> (Boas, 1926)	Indonesia, Taiwan; 268–438 m
<i>Trizacheles caledonicus</i> Forest, 1987	New Caledonia; 313–800 m
<i>Trizacheles hoenssonae</i> McLaughlin and Lemaitre, 2009	Comoro Islands, Réunion; 280–530 m
<i>Trizacheles laurentae</i> Forest, 187	Philippines, Solomon Islands; 487–592 m
<i>Trizacheles loquax</i> Forest, 1987	Japan; 300–460 m
<i>Trizacheles manningi</i> Forest, 1987	Philippines; 296 m
<i>Trizacheles mendanai</i> McLaughlin and Forest, 2009	Solomon Islands; 339 m
<i>Trizacheles moosai</i> Forest, 1987	Indonesia; 411 m
<i>Trizacheles mutus</i> Forest, 1987	South Africa; 240 m
<i>Trizacheles pilgrimi</i> Forest and McLaughlin, 2000	New Zealand, New Caledonia, Vanuatu, Tonga; 425–575 m
<i>Trizacheles pulcher</i> Forest, 1987	New Caledonia; 230–444 m
<i>Trizacheles sakaii</i> Forest, 1987	Japan, Taiwan; 100–613 m
<i>Trizacheles spinosus</i> (Henderson, 1888) = <i>Trizacheles spinosus bathamae</i> Forest and de Saint Laurent, 1987	Eastern Australia, New Zealand, New Caledonia; 205–650 m
<i>Trizacheles vaubanae</i> McLaughlin and Lemaitre, 2008	New Caledonia, Solomon Islands; 260–620 m
<i>Trizacheles albipes</i> sp. nov.	Japan; 187–261 m
<i>Trizacheles inermis</i> sp. nov.	Japan; 289–307 m
<i>Trizacheles parvispina</i> sp. nov.	Japan; 275–350 m

Technology. Material from Sagami Bay, used by Miyake (1978), has been reexamined in order to clarify the local fauna of the genus. In this study, four species, including three new species were discovered: *T. albatrossi* Forest, 1987, *T. albipes* sp. nov., *T. inermis* sp. nov., and *T. parvispina* sp. nov. The three new species are fully described and illustrated. The material referred to as *Pomatocheles spinosus* by Miyake (1978) has been found to consist of mixture of two species, *T. albatrossi* and *Pomatocheles jeffreysii* (Miers, 1879). Literature records of species of *Trizacheles* from Japanese waters are briefly reviewed.

### Material and Methods

The specimens examined are deposited in the following institutions: Institute of Marine Biology, National Taiwan Ocean University (NTOU); Muséum Zoologique, Strasbourg (MZS); Natural History Museum and Institute, Chiba (CBM); Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC); and the Showa Memorial Institute, Tsukuba Research Center, National Science Museum, Tsukuba (NSMT). General terminology follows McLaughlin *et al.* (2007) and McLaughlin and Lemaitre (2009). Shield length (sl), measured from the tip of the rostrum to the midpoint of the posterior margin of the shield, and/or

carapace length (cl), measured from the tip of the rostrum to the midpoint of the posterodorsal margin of the carapace, indicate specimen size.

For comparative purpose, the following material was examined.

*Trizacheles boasi* Forest, 1987. Balicasag Island, Bohol, Philippines, depth unknown, 1–5 March 2004, tangle net by local fisherman, 1 male (sl 7.3 mm), ZRC 2009.1128.

*Trizacheles loquax* Forest, 1987. Off Shionomisaki, Kii Peninsula, Japan, 300 m, October 1996, dredge, coll. S. Nagai, 1 male (sl 3.0 mm), 2 ovigerous females (sl 3.9, 5.3 mm), CBM-ZC 11357.

*Trizacheles manningi* Forest, 1987. PANGLAO 2004 Expedition, Bohol, Philippines, other data unknown, 1 female (sl 5.2 mm), ZRC 2009.1132.

*Trizacheles sakaii* Forest, 1987. Off Shionomisaki, Kii Peninsula, Japan, 250 m, 15 January 1990, dredge, coll. S. Nagai, 1 male (sl 4.7 mm), CBM-ZC 1084; same locality, 200 m, 19 December 1992, dredge, coll. S. Nagai, 1 ovigerous female (sl 5.1 mm), CBM-ZC 1182; same locality, 250 m, 22 March 1992, dredge, coll. S. Nagai, 1 female (sl 3.9 mm), CBM-ZC 1184; same locality, 300 m, October 1996, dredge, coll. S. Nagai, 1 male (sl 3.7 mm), 1 female (sl 4.0 mm), CBM-ZC 3561. TAIWAN 2000, stn DW 56, 24°29.8'N, 122°12.6'E, 438–539 m, 4 August 2000, 2 males (cl 4.3, 6.6 mm), 1 female (cl 4.2 mm), NTOU;

TAIWAN 2004, stn CP 269, 24°30.55'N, 122°05.78'E, 2 September 2004, 397–399 m, 2 ovigerous females (sl 4.9, 5.7 mm), NTOU.

### Taxonomic Account

Family **Pylochelidae** Spence Bate, 1888

Subfamily **Trizochelinae** Forest, 1987

Genus ***Trizacheles*** Forest, 1987

*Trizacheles* Forest, 1987: 155 (in part); Forest and McLaughlin, 2000: 40 (in part); Lemaitre *et al.*, 2009: 10 (in part); McLaughlin and Lemaitre, 2009: 170.

**Remarks.** Diagnostic characters differentiating *Trizacheles* and *Forestacheles* include the development of accessory tooth on the ischium of the third maxilliped (accessory tooth present in *Trizacheles* versus absent in *Forestacheles*) (McLaughlin and Lemaitre, 2009). One of the three new species described in this study, *Trizacheles inermis* sp. nov., does not possess an accessory tooth on the ischium of the third maxilliped. The generic assignment of *T. inermis* is based on the presence of an exopodal flagellum on the first maxilliped (versus absent in *Forestacheles*) and the telson being distinctly longer than wide and having a trace of lateral indentations (versus wider than long and without trace of lateral indentations in *Forestacheles*). In addition, in the holotype of *T. albipes* sp. nov., the left ischium of the third maxilliped has a distinct accessory tooth, whereas the right is devoid of it. During this study, the development of the accessory tooth on the third maxilliped was checked for some other congeneric species, *T. albatrossi*, *T. boasi*, *T. loquax*, *T. manningi*, and *T. sakaii*, and found that in these, the accessory tooth is always present on both sides. Presumably, the condition seen in *T. albipes* is aberrant.

***Trizacheles albatrossi*** Forest, 1987

(Figs. 1, 2)

*Pylocheles spinosus*: Ortmann, 1892: 274; Tarao, 1913: 391. Not *Pylocheles spinosus* Henderson, 1888.

*Mixtopagurus spinosus*: Balss, 1913: 34. Not *Mixtopagurus spinosus* (Henderson, 1888).

*Pomatocheles spinosus*: Miyake, 1965: 640 (in part), fig. 1065; 1978: 7 (in part), text-fig. 2. Not *Pomatocheles spinosus* (Henderson, 1888).

*Trizacheles albatrossi* Forest, 1987a: 174, fig. 51f, 54c,

55; 1987b: 215, fig. 2; Komai, 1999: 66; Lemaitre *et al.*, 2009: 5; McLaughlin and Lemaitre, 2009: 223; McLaughlin *et al.*, 2010: 41 (list).

*Trizacheles sakaii* Forest, 1987: 189 (in part).

**Material examined.** Sagami Bay, 50 fathoms (= 90 m), 1 male (cl 9.5 mm), 1881, MZS 386 (spirit); Sagami Bay, 3 km SW of Jogashima, Miura Peninsula, 95 m, 2 December 1961, 1 female (sl 3.2 mm, cl 5.7 mm), Miyake det. no. 440, NSMT-Cr R1937; same data, 1 male (sl 4.3 mm, cl 6.7 mm), Miyake det. no. 442, NSMT-Cr R1939; Sagami Bay, 5 km W of Jogashima, 110–150 m, 14 February 1963, 1 male (sl 4.6 mm, cl 7.0 mm), Miyake det. no. 499, NSMT-Cr R2077; Sagami Bay, 4 km WSW of Jogashima, 100 m, 28 January 1965, 1 female (sl 3.2 mm, cl 4.6 mm), Miyake det. no. 580, NSMT-Cr R2310; Sagami Bay, 3 km SSE of Jogashima, 90 m, 8 February 1968, 1 female (sl 2.8 mm, cl 4.2 mm), Miyake det. no. 633, NSMT-Cr R3552.

RV *Tansei-maru*, KT07-31 cruise, stn L-2-100, Sagami Sea, S of Jogashima, Miura Peninsula, 35°05.69'N, 139°35.50'E, 100–113 m, 25 November 2007, dredge, coll. T. Komai, 1 female (sl 3.7 mm, cl 4.1 mm), CBM-ZC 10373.

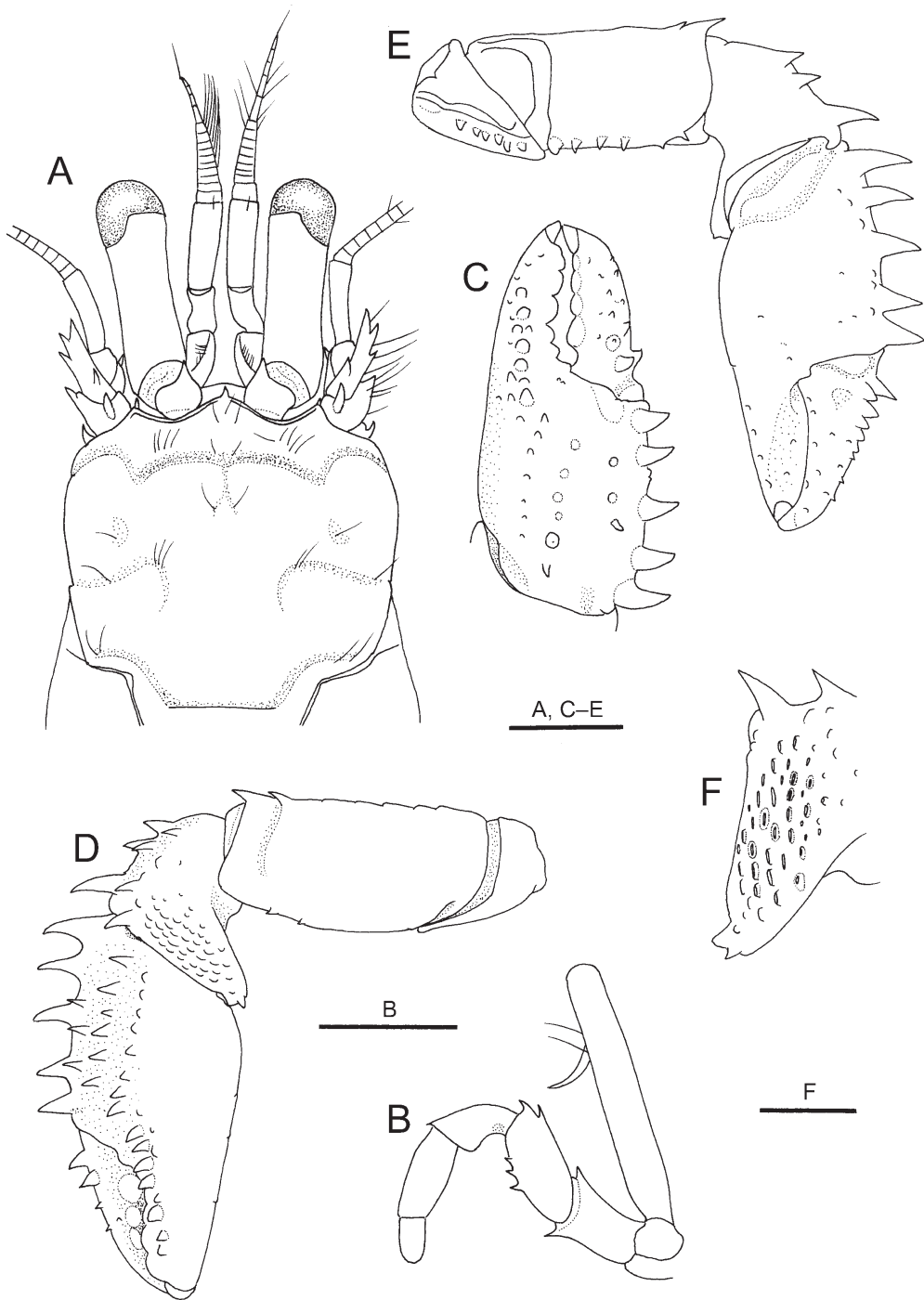
**Diagnosis.** Shield slightly wider than long (Fig. 1A). Corneal width 0.2–0.3 of length of ocular peduncle (Fig. 1A). Antennular peduncle reaching or slightly overreaching distal corneal margin (Fig. 1A). Merus of third maxilliped with 2 dorsodistal and 3 ventral spines, while carpus unarmed ventrodistally (Fig. 1B). Chelipeds subequal and similar, with stridulating rods or tubercles on lateral surface of each carpus (Fig. 1D, F), those on carpi short, scattered on lateral face (Fig. 1F); palms with longitudinal rows of spines on each outer surface (Fig. 1C, D). Propodi of second pereopods unarmed on dorsal margin or lateral surface (Fig. 2A, B); stridulatory apparatus on mesial surface of propodi and carpi consisting of some short, scattered rods restricted to proximal part (propodi) and single row of short to long rods, increasing in length distally (carpus) (Fig. 2B). Third pereopods with propodi unarmed on dorsodistal margin and carpi each only with dorsodistal spine (Fig. 2C).

**Coloration in life.** Whole body uniformly red (Miyake, 1978).

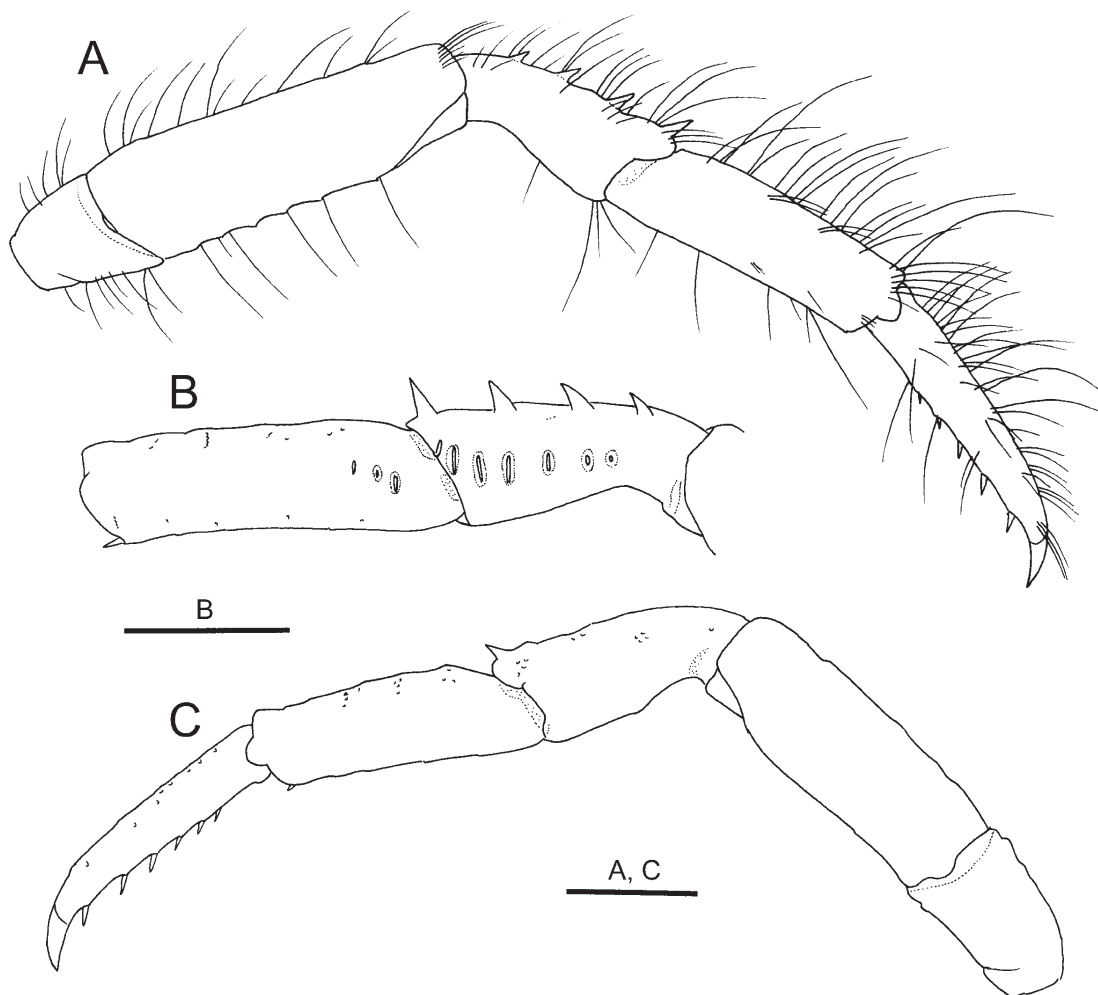
**Distribution.** Known only from Sagami Bay (off Jogashima) and Uruga Strait, central Japan; 95–150 m.

**Habitat.** Tubes of serpulid polychaetes, damaged tusk shells, gastropod shells (Miyake, 1978; this study).

**Remarks.** *Trizacheles albatrossi* was originally



**Fig. 1.** *Trizacheles albatrossi* Forest, 1987, male (sl 3.7 mm), Sagami Bay, off Jogashima, CBM-ZC 10373. A, shield and cephalic appendages, dorsal view; B, left third maxilliped, lateral view (setae omitted); C, left chela, outer view (setae omitted); D, left cheliped, lateral view (setae omitted); E, same, mesial view; same, F, lateral surface of carpus, showing details of stridulating apparatus. Scale bars: 2 mm for A, C–E; 1 mm for B; 0.5 mm for F.



**Fig. 2.** *Trizoecheles albatrossi* Forest, 1987, male (sl 3.7 mm), Sagami Bay, off Jogashima, CBM-ZC 10373. A, right second pereopod, lateral view; B, same, propodus and carpus, mesial view; C, left third pereopod, lateral view (setae omitted). Scale bars: 1 mm.

described on the basis of a molt collected from Sagami Bay (off Jogashima) (Forest, 1987). The present topotypic specimens agree well with the redescription by McLaughlin and Lemaitre (2009) in every diagnostic characters (see above “Diagnosis”).

Among the Japanese congeners, *T. sakaii* is most similar to *T. albatrossi*, particularly in the possession of longitudinal rows of prominent spines on the outer surfaces of chelae and the absence of a dorsal row of spines on the propodi of the second pereopods. The lack of a dorsodistal spine on the propodi of the second pereopods immediately distinguishes *T. albatrossi* from *T. sakaii*. Furthermore, the armature on the mesial surfaces of the propodi and carpi of the second pereopods is different between the two species: the

stridulatory rods or tubercles on the propodi are much fewer in *T. albatrossi* than in *T. sakaii* (10 or less versus more than 15); the carpi bear a single row of long stridulatory rods in *T. albatrossi*, instead of short rods or tubercles arranged in irregular two rows in *T. sakaii*.

Morphologically, *T. albatrossi* appears closest to *T. boasi*, but it can be distinguished from *T. boasi* by the proportionally smaller cornea (corneal width 0.2–0.3 of ocular peduncle length in *T. albatrossi* versus 0.4–0.5 in *T. boasi*) and the proportionally stouter propodi of the second pereopods, bearing low protuberances on the dorsal surface.

Forest (1987) referred records of *Trizoecheles spinosus* from Japan (Ortmann, 1892, as *Pylocheles*;

**Table 2.** Re-identification of specimens referred to *Pomatocheles spinosus* (Henderson, 1888) by Miyake (1978).

Miyake (1978) det. no.	NSMT-Cr R	Re-identification	Locality	Date	No. individuals
351		<i>Pomatocheles jeffreysii</i>	WSW of Jogashima, 150-250 m	1960.01.03	1 ovig. female
428	1876	<i>Pomatocheles jeffreysii</i>	SW of Kamegi-sho, 190-230 m	1961.03.15	1 female
432	1880	<i>Pomatocheles jeffreysii</i>	SW of Kamegi-sho, 100 m	1961.03.17	4 specimens
440	1937	<i>Trizoecheles albatrossi</i>	SW of Jogashima, 95 m	1961.12.02	1 female
442	1939	<i>Trizoecheles albatrossi</i>	SW of Jogashima, 95 m	1961.12.02	1 male
491	2069	<i>Pomatocheles jeffreysii</i>	WSW of Jogashima, 200 m	1963.02.10	1 female
499	2077	<i>Trizoecheles albatrossi</i>	W of Jogashima, 110-150 m	1963.02.14	1 male
580	2310	<i>Trizoecheles albatrossi</i>	WSW of Jogashima, 100 m	1965.01.28	1 female
633	3552	<i>Trizoecheles albatrossi</i>	SSE of Jogashima, 90 m	1968.02.08	1 female
684	3719	<i>Pomatocheles jeffreysii</i>	WSW of Jogashima, 90-95 m	1971.03.13	1 female

Balss, 1913, as *Mixtopagurus*; Yokoya, 1933, as *Mixtopagurus*; Miyake, 1965, 1978, 1982, as *Pomatocheles*) exclusively to *T. sakaii*, although he did not examine any specimens reported by these authors. Miyake (1991) corrected his identification made in the first version of “Japanese Crustacean Decapods and Stomatopods in Color (I)” (Miyake, 1982) to *Trizoecheles sakaii*. Komai (1999) found that the specimen identified as *Pylocheles spinosus* by Ortmann (1892) actually represented *T. albatrossi*. During this study, I have reexamined a series of specimens from Sagami Bay, referred to *Pomatocheles spinosus* by Miyake (1978), and found that he confounded that taxon with *T. albatrossi* and *Pomatocheles jeffreysii* (Miers, 1879) (see Table 1). It is difficult to assume what species is actually represented by specimens used by Balss (1913; from Sagami Bay and Uruga Strait) and Yokoya (1933; from Sagami Bay and Suruga Bay), because six species of *Trizoecheles* are now known to occur in Sagami Bay and adjacent waters (Forest, 1987; this study). Miyake (1965; 1982) mentioned that the local geographical range of *Pomatocheles spinosus* included Sagami Bay and Tosa Bay, and Miyake (1991) identified his specimen from Tosa Bay with *T. sakaii*. Therefore, these records (Miyake, 1965; 1982) are partially referred to *T. albatrossi*.

Miyake (1978) reported that the carcinoecia of *T. albatrossi* (as *Pomatocheles spinosus*) included tusk shells. However, reexamination of his specimens has revealed that specimens used intact tusk shells are all *Pomatocheles jeffreysii*. Only a single specimen of *T. albatrossi* was associated with a damaged tusk shell.

***Trizoecheles albipes* sp. nov.**  
(Figs. 3–5)

**Material examined.** Holotype: male (sl 5.0 mm, cl 7.1 mm), RV *Tansei-maru*, KT07-31 cruise, stn L3-200, off Toshima Island, Izu Islands, 34°14.04'N,

139°18.37'E, 187–261 m, rock, 27 November 2007, chain bag dredge, CBM-ZC 11358.

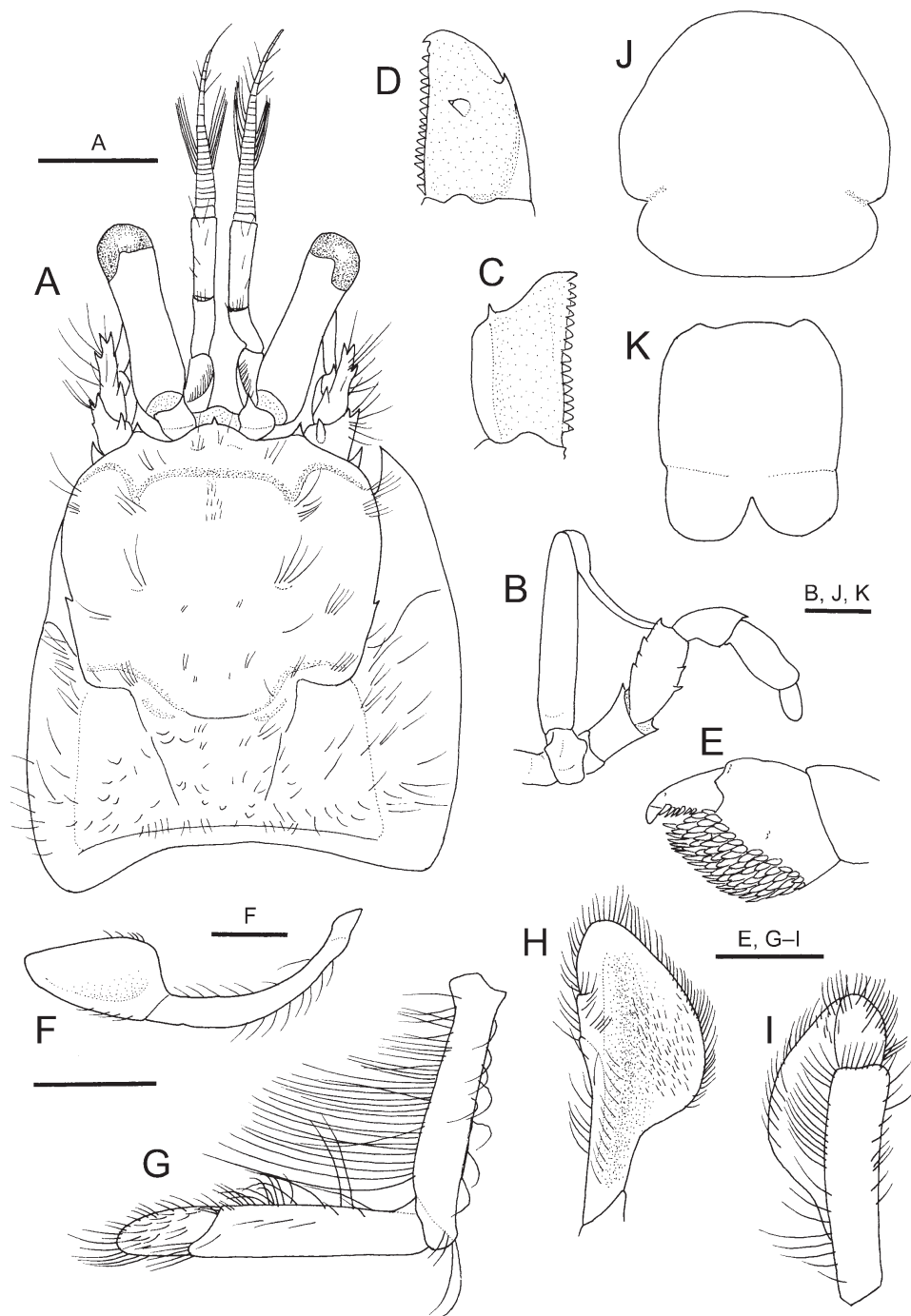
**Description.** Shield (Fig. 3A) slightly wider than long and distinctly longer than posterior carapace; dorsal surface with moderately long, deep transverse groove subrostrally; lateral margins each with small notch and spinule posterior to midlength; cervical groove clearly delineated laterally. Rostrum broadly triangular, with small marginal spine, slightly overreaching level of lateral projections. Lateral projections well developed, each with marginal, prominent spine. Posterior median plate trapezoidal, narrowed posteriorly, clearly delimited, moderately calcified; sulci cardiobranchialis apparent (Fig. 3A). Branchiostegite calcified in anterior to anterodorsal margin; dorsal margin unarmed, anterodorsal margin with 6 spinules.

Ocular peduncle (Fig. 3A) about 0.7 length of shield, slightly constricted at midlength, with uncalcified longitudinal suture extending from base of cornea to base of peduncle on lateral surface; cornea slightly inflated, width about 0.3 of peduncular length. Ocular acicle drawn out into acute spine, separated by basal width of one acicle.

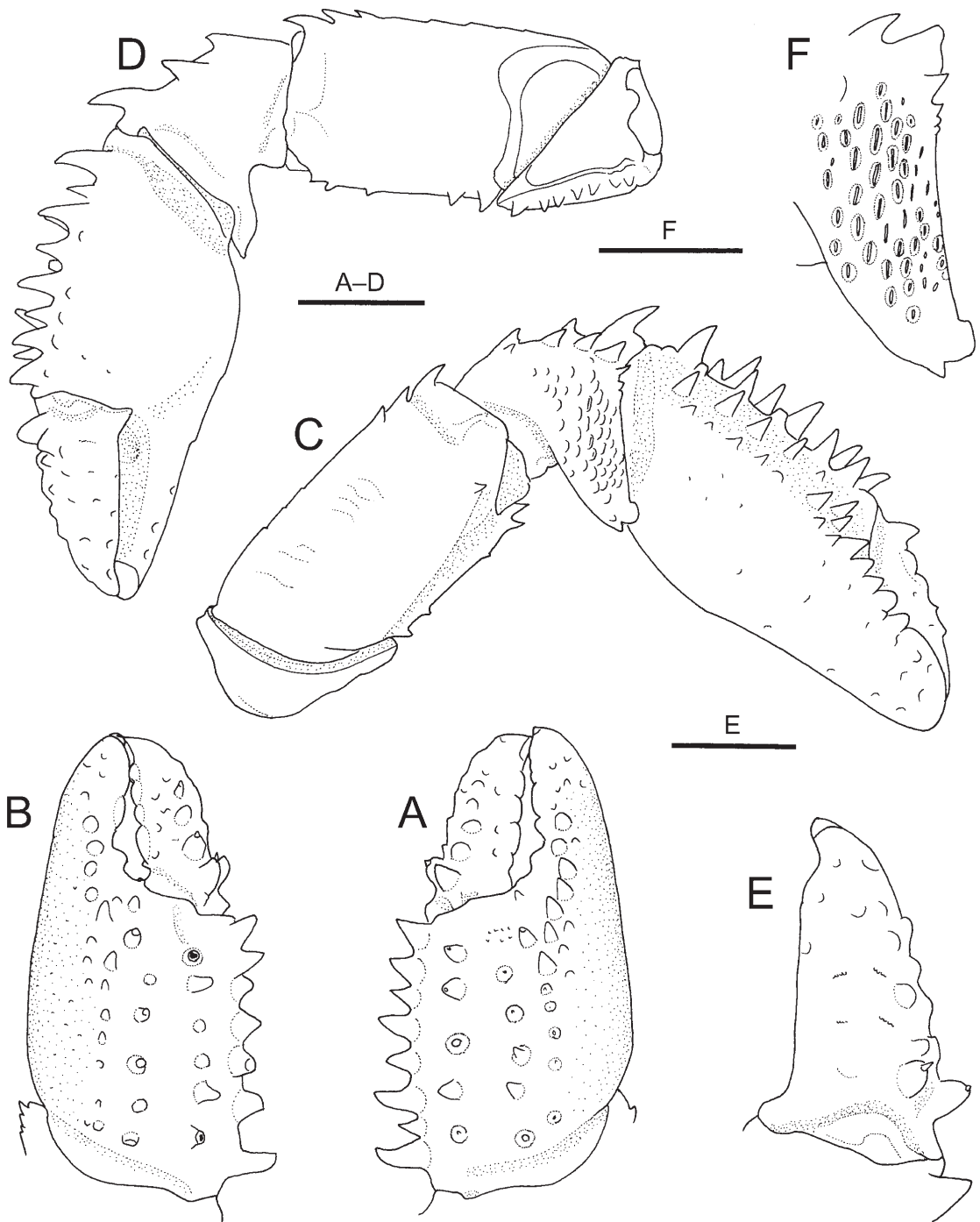
Antennular peduncle (Fig. 3A) moderately short, overreaching distal corneal margin by 0.1 length of ultimate segment. Ultimate segment slightly longer than penultimate segment. Basal segment with 1 prominent spinule on lateral surface of statocyst lobe and spinule on ventrodistal margin.

Antennal peduncle (Fig. 3A) far falling short of corneal base. Fifth segment unarmed. Fourth segment with small spine at dorsodistal margin. Third segment with prominent spine at ventrodistal margin. Second segment with dorsolateral distal angle produced, terminating in bifid spine; lateral margin unarmed (right) or armed with minute spine (left); dorsomesial distal angle with prominent spine. First segment with prominent bifid spine on lateral surface distally; ventrodistal margin with 2 spinules. Antennal acicle



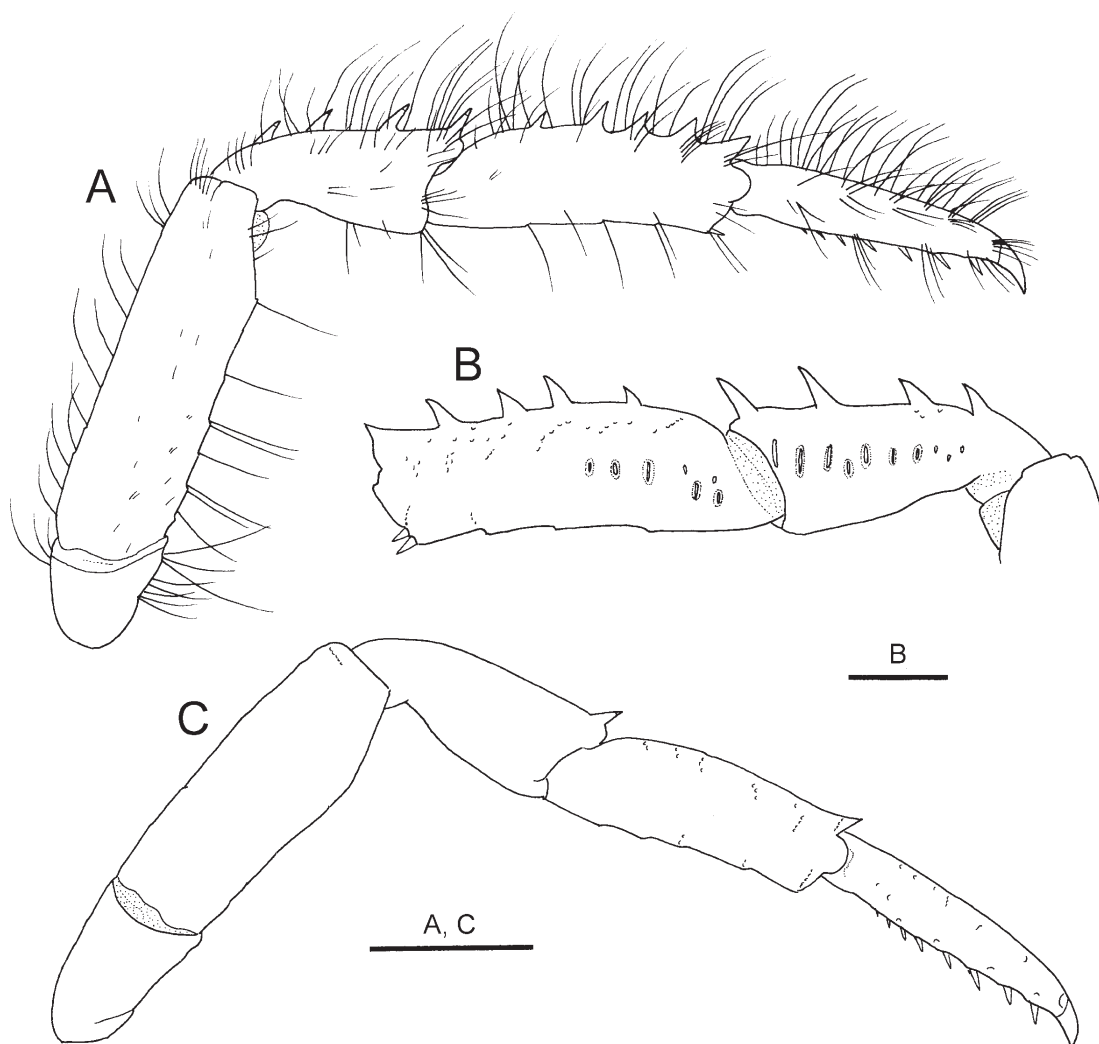


**Fig. 3.** *Trizocheles albipes* sp. nov., holotype, male (sl 5.0 mm), off Toshima, Izu Islands, CBM-ZC 11358. A, carapace and cephalic appendages, dorsal view; B, right third maxilliped, lateral view (setae omitted); C, ischium of left third maxilliped, ventral view (setae omitted); D, ischium of right third maxilliped, ventral view; E, dactylus and propodus of left fourth pereopod, lateral view (setae omitted); F, left first pleopod, lateral view; G, left second pleopod, lateral view; H, same, distal segment, inner view; I, same, outer view; J, sixth pleonal tergite, dorsal view (setae omitted); K, telson (setae omitted), dorsal view. Scale bars: 2 mm for A; 1 mm for B–D, G–J; 0.5 mm for F.



**Fig. 4.** *Trizocheles albipes* sp. nov., holotype, male (sl 5.0 mm), off Toshima, Izu Islands, CBM-ZC 11358. A, right chela, outer view; B, left chela, outer view; C, right cheliped, lateral view; D, same, mesial view; E, dactylus of right chela, mesial view; F, lateral surface of carpus of right cheliped, showing details of stridulating apparatus. Setae omitted. Scale bars: 2 mm for A–D; 1 mm for E, F.





**Fig. 5.** *Trizoecheles albipes* sp. nov., holotype, male (sl 5.0 mm), off Toshima, Izu Islands, CBM-ZC 11358. A, right second pereopod, lateral view; B, same, propodus and carpus, mesial view (setae omitted); C, right third pereopod, lateral view (setae omitted). Scale bars: 1 mm.

nearly reaching midlength of ocular peduncle, terminating in bifid spine, mesial margin with 1 spine proximally, lateral margin with 1 spine in distal half. Antennal flagellum with 3 or 4 long distal setae every 2 articles.

Third maxilliped (Fig. 3B) moderately slender. Basis with 2 or 3 minute denticles on mesial margin. Ischium with well developed crista dentata, accessory tooth present only on left (Fig. 3C, D); dorsodistal and ventrodistal angle each with spinule. Merus with 1 distal and 3 smaller spines on dorsal margin, and 2 small spines in distal half of ventral margin. Carpus with dorsodistal spine, ventrodistal margin unarmed. Exopod unarmed.

Chelipeds (Fig. 4A–D) subequal and symmetrical, with propodal-carpal rotation approximately  $45^\circ$ ; narrow proximal hiatus between dactylus and fixed finger. Dactylus distinctly shorter than palm, surfaces with tufts of stiff setae; outer surface mesially with row of 4 prominent spines decreasing in size distally (left) or with 1 prominent spine and 4 low, eroded tubercles (right); mesial surface with 1 prominent proximal spine and 3 low tubercles adjacent to dorsal margin (Fig. 4E); cutting edge with row of low, rounded calcareous teeth, terminating in large corneous claw. Fixed finger with row of moderately strong calcareous teeth, terminating in large corneous claw. Palm about 1.5 times longer than carpus; dorsomesial

margin with row of 7 (left) or 8 (right) prominent large spines, dorsal surface convex, with numerous, scattered short to long stiff setae, and 3 irregular longitudinal rows of smaller spines or tubercles of various sizes, spines in lateralmost row smaller than those in other rows, extending onto fixed finger, increasing in size but reducing in acuteness distally; lateral surface nearly perpendicular, with some scattered granules proximally and scattered tufts of short stiff setae; mesial and ventral surfaces smooth, unarmed, with sparse short setae. Carpus subtrapezoidal; dorsomesial margin 3 prominent spines increasing in size distally; dorsal surface with tufts of short to long setae and oblique row of 4 smaller spines; lateral surface with numerous, scattered short to long stridulatory ridges or rods, ventrodistal angle with 1 or 2 minute denticles; mesial and ventral surfaces smooth, each with subdistal row of short setae. Merus trigonal in cross section, with shallow transverse groove along distal margin; dorsal margin with 1 or 2 subterminal spines and row of sparse setae; dorsodistal margin with 1 prominent spine; lateral surface smooth, with sparse short setae, ventrolateral margin with 1 small spine subdistally; mesial surface also smooth, with few short setae, ventromesial margin with 2 small distal and 2 small proximal spines; ventral surface nearly flat, almost naked, with 1 minute denticle near mesial margin at distal 0.3. Ischium with row of prominent spines on ventromesial margin.

Second and third pereopods (Fig. 5A, C) slightly overreaching chelipeds, dissimilar in armature. Dactyli 1.1 times longer than propodi; dorsal and ventral margins with tufts of long stiff setae; lateral and mesial faces with few tufts of stiff setae; ventral margins each with 8 corneous spines (proximalmost one minute). Propodi about 3.0 times longer than wide; dorsal margins each with 4 or 5 large spines (including dorsodistal spine) (second) or with only dorsodistal spine (third), and with row of tufts of long stiff setae; lateral surfaces unarmed; mesial surfaces each with main series of 5 stridulating rods in various length arranged in single longitudinal row in proximal half (and 1 or 2 additional minute stridulatory rods dorsal to proximal rods of main series) (second; Fig. 5B) or unarmed (third); ventral surfaces with sparse tufts of long setae and with 2 corneous spinule on ventrodistal margin mesially. Carpi each with dorsal row of 4 prominent long spines (second) or only small dorsodistal spine (third), and tufts of long stiff setae on dorsal and lateral surfaces; mesial surfaces each with series of 7 stridulating rods (increasing in length distally) and 3 minute tubercles arranged in a single

longitudinal row (second; Fig. 5B) or unarmed (third). Meri unarmed except for ventral margins of second bearing sparse minute denticles; dorsal margin with sparse tufts of long setae. Ischia also unarmed.

Fourth pereopods semichelate; each with propodal rasp consisting of several rows of long corneous scales (Fig. 3E). Fifth pereopods weakly chelate; propodal rasp well developed.

Male first pleopod (Fig. 3F) with distal segment subtriangular in lateral view, tapering to narrow distal margin. Male second pleopod as figured (Fig. 3G–I).

Pleon with first tergite moderately well calcified; second to fifth tergites not calcified, pleura weakly calcified. Sixth tergite (Fig. 3J) subcircular, with deep lateral incisions at posterior 0.3; terminal margin nearly straight, unarmed. All tergites and telson with dense covering of short setae. Uropods symmetrical; protopods produced posteriorly, each with prominent spine. Telson (Fig. 3K) 1.2 times longer than wide, with faint lateral indentations at posterior 0.3; posterior lobes separated by deep median cleft, terminal margins rounded, unarmed but with fringe of long setae.

*Coloration in life.* Body generally orange; shield with scattered small white spots; posteromedian plate of carapace with dark red spot anteromedially. Ocular peduncles generally orange, darker proximally; corneas gray. Antennular peduncles dark orange; dorsal flagellum pinkish. Antennal peduncles generally orange, tips of spines whitish. Chelipeds generally orange, fingers of chelae whitish; spines on palms and stridulatory ridges or tubercles on carpi white; lateral surfaces of meri with slight iridescent sheen. Ambulatory legs white in dactyli to distal halves of meri, proximal halves of meri orange.

*Distribution.* Known only from the type locality, off Toshima Island, Izu Islands, at depths of 187–261 m.

*Remarks.* *Trizacheles albipes* sp. nov. is strikingly similar to *T. hoensonae* McLaughlin and Lemaitre, 2009, known only from Comoros and Réunion in the western Indian Ocean, in the propodi of the second pereopods devoid of armature on the lateral surfaces, but with a single row of large spines on dorsal surface, and the propodi of the third pereopods each armed with only a small dorsodistal spine. Nevertheless, there are some minor but possibly significant differences between the two taxa (cf. Forest, 1987, as *T. balssi*; McLaughlin and Lemaitre, 2009), though paucity of the material prevents a full assessment of the range of variation. The second pereopods are proportionately more robust in *T. albipes* than in *T. hoensonae* (for example, the propodus is about 3.0 times longer than wide in *T. albipes* versus about 4.3 times in *T.*

*hoenisonae*). The dactyli of ambulatory legs are proportionately longer in *T. albipes* than in *T. hoenisonae* (1.1 times longer than propodi in *T. albipes* versus 0.5–0.7 in *T. hoenisonae*). The merus of the third pereopod is unarmed on the dorsodistal margin in *T. albipes*, but it is armed with a dorsodistal spinule in *T. hoenisonae*. The telson is proportionately shorter in *T. albipes* than in *T. hoenisonae* (1.2 times longer than wide versus 1.5 times). Furthermore, the presently available data suggests that species of *Trizacheles* have narrowly restricted geographical ranges. Actually, no species of this genus widely ranging from the western Pacific to the western Indian Ocean are known. This may support the differentiation between *T. hoenisonae* and the present new taxon.

**Etymology.** From the combination of the Latin *albus* (= white) and *pes* (= leg), in reference to the white distal segments of ambulatory legs of this new species. Used as a noun in apposition.

***Trizacheles inermis* sp. nov.**

(Figs. 6–9)

**Material examined.** Holotype: male (sl 4.6 mm, cl 6.6 mm), TRV *Shin'yo-maru*, 2002 cruise, stn 29, SW of Izu-oshima Island, Izu Islands, 34°40.21'N, 139°18.62'E, 289–307 m, volcanic pebbles, 24 October 2002, dredge, coll. T. Komai, CBM-ZC 11359.

**Description.** Shield (Fig. 6A) slightly wider than long, and distinctly longer than posterior carapace; dorsal surface with moderately long, deep transverse groove subrostrally; lateral margins each with faint notch posterior to midlength; cervical groove clearly delineated laterally. Rostrum broadly triangular, with prominent marginal spine, overreaching level of lateral projections. Lateral projections well developed, each with marginal, prominent spine. Posterior median plate poorly delimited (Fig. 6A), weakly calcified; sulci cardiobranchialis not apparent. Branchiostegite calcified only on anterior margin; dorsal margin unarmed, anterior margin with few spinules.

Ocular peduncle (Fig. 6A) about 0.6 length of shield, slightly constricted at midlength, with uncalcified longitudinal suture extending from base of cornea to midlength on lateral surface; cornea slightly inflated, width 0.34 of peduncular length. Ocular acicle drawn out into acute spine, separated by basal width of one acicle.

Antennular peduncle (Fig. 6A) moderately short, overreaching distal corneal margin by 0.5 length of ultimate segment. Ultimate segment slightly longer

than penultimate segment. Basal segment with spinule on lateral surface of statocyst lobe and smaller spinule on ventrodistal margin.

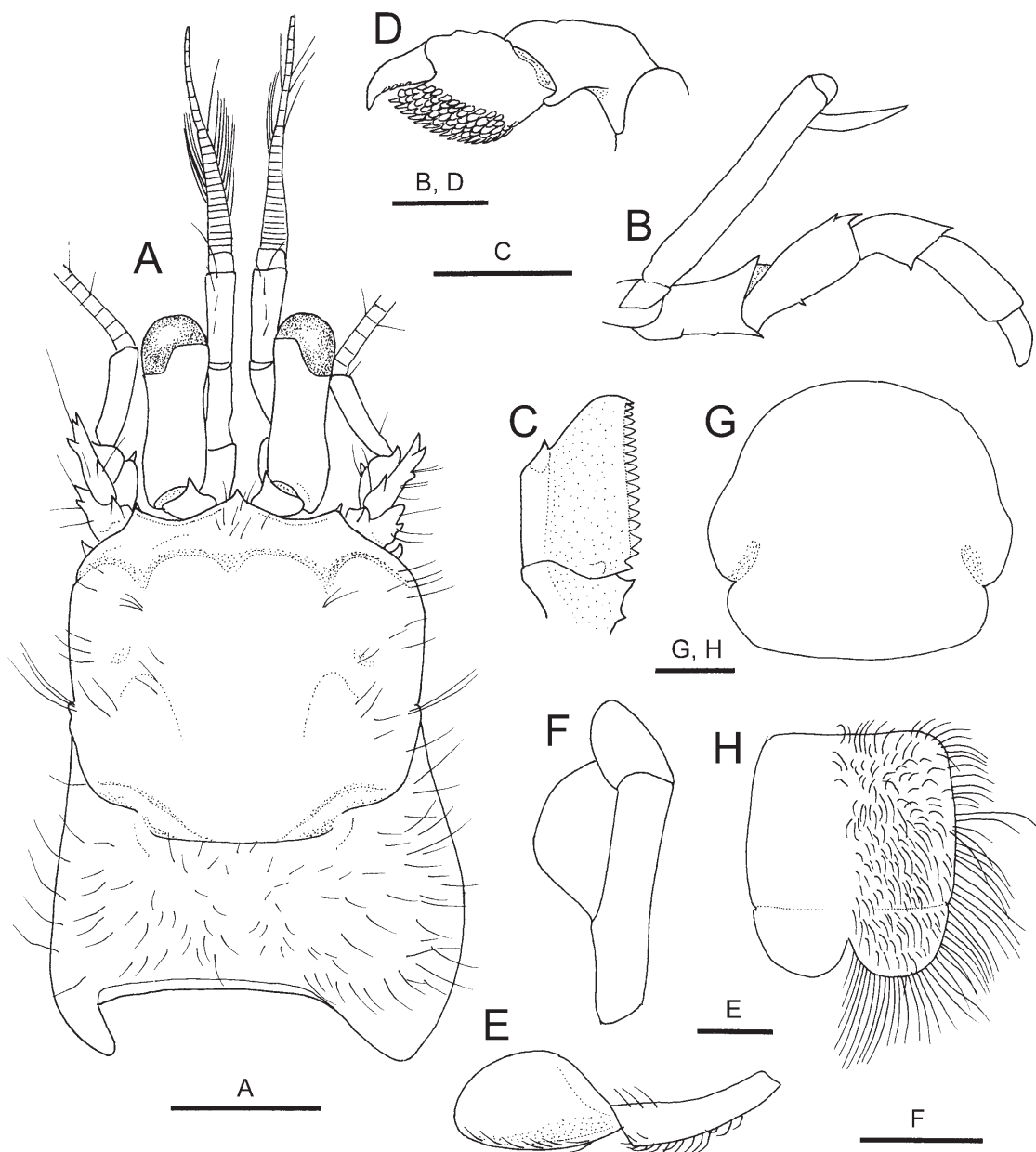
Antennal peduncle (Fig. 6A) slightly overreaching corneal base. Fifth segment unarmed. Fourth segment with small spine at dorsodistal margin. Third segment with prominent spine at ventrodistal margin. Second segment with dorsolateral distal angle produced, terminating in spine; lateral margin with 1 small spine; dorsomesial distal angle with prominent spine. First segment with prominent spine on lateral surface distally; ventrodistal margin with few small spines. Antennal acicle short, not reaching midlength of ocular peduncle, terminating in simple or bifid spine, mesial margin with 1 spine proximally, lateral margin with 2 spines in distal half. Antennal flagellum with 4 or 5 short to long distal setae every 2 articles.

Third maxilliped (Fig. 6B) moderately slender. Basis with 2 minute corneous-tipped denticles on mesial margin (Fig. 6C). Ischium with well developed crista dentata, but no accessory tooth (Fig. 6C) and also with 1 dorsodistal and 1 ventrodistal spines. Merus with 1 distal and 1 smaller subdistal spines, and 1 minute ventral spine slightly proximal to midlength. Carpus with 1 dorsodistal and 1 ventrodistal spines. Exopod unarmed.

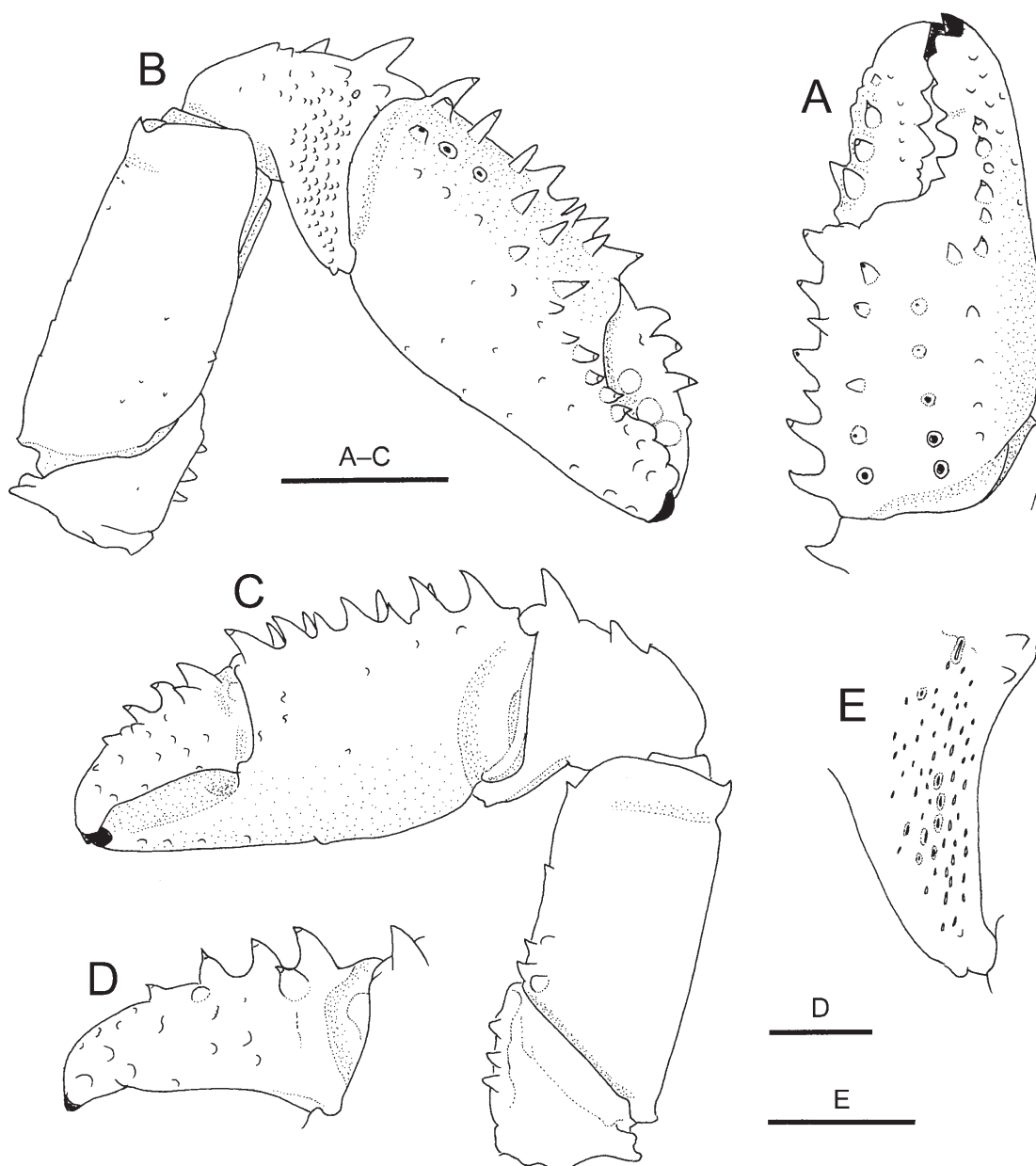
Only right cheliped preserved (Fig. 7A–C); propodal-carpal rotation approximately 30°; narrow hiatus between dactylus and fixed finger. Dactylus slightly shorter than palm; surfaces with tufts of short to long stiff setae, setae on outer surface particularly long; dorsal surface mesially with row of 4 prominent spines decreasing in size distally; mesial surface with 1 small proximal spine adjacent to dorsal margin and 1 smaller tubercle at midlength (Fig. 7D); cutting edge with row of prominent, roundly triangular calcareous teeth, terminating in large corneous claw. Fixed finger with tufts of stiff setae on surfaces; cutting edge with row of large, roundly triangular calcareous teeth, terminating in large corneous claw. Palm about 1.5 times longer than carpus; dorsomesial margin with row of 7 prominent large spines; dorsal surface slightly convex, with numerous scattered short setae, sparse tufts of longish setae, and 3 irregular longitudinal rows of spines or tubercles of various sizes, lateralmost row extending onto fixed finger, increasing in size and acuteness distally; mesial and ventral surfaces smooth, unarmed. Carpus subtrapezoidal; dorsomesial margin with 3 prominent spines increasing in size distally; dorsal surface with tufts of stiff long setae and 3 obsolescent tubercles; lateral surface with covering of minute stridulatory ridges or rods, ventrodistal angle

with 1 minute tubercle; mesial and ventral surfaces smooth. Merus subtriangular in cross section; dorsal margin almost smooth, bearing sparse setae, dorsodistal margin with 1 small spine; lateral surface

smooth, ventrolateral margin with 1 minute tubercle proximal to midlength; mesial surface with few setae and small proximoventral tubercle, ventromesial margin with row of 4 spinules (proximal 2 spinules



**Fig. 6.** *Trizacheles inermis* sp. nov., holotype, male (sl 4.6 mm), off Izu-ohshima Island, Izu Islands, CBM-ZC 11359. A, carapace and cephalic appendages, dorsal view; B, right third maxilliped, lateral view (setae omitted); C, ischium of right third maxilliped, ventral view (setae omitted); D, dactylus, propodus and carpus of left fourth pereopod, lateral view (setae omitted); E, left first pleopod, lateral view; F, distal segment of left second pleopod, outer view; G, sixth pleonal tergite, dorsal view (setae omitted); H, telson (setae omitted on left side), dorsal view. Scale bars: 2 mm for A; 1 mm for B–D, F–H; 0.5 mm for E.



**Fig. 7.** *Trizoecheles inermis* sp. nov., holotype, male (sl 4.6 mm), off Izu-ohshima Island, Izu Islands, CBM-ZC 11359. A, right chela, outer view; B, right cheliped, lateral view; C, same, mesial view; D, dactylus of right chela, mesial view; E, lateral surface of carpus of right cheliped, showing details of stridulating apparatus. Setae omitted. Scale bars: 2 mm for A–C; 1 mm for D, E.

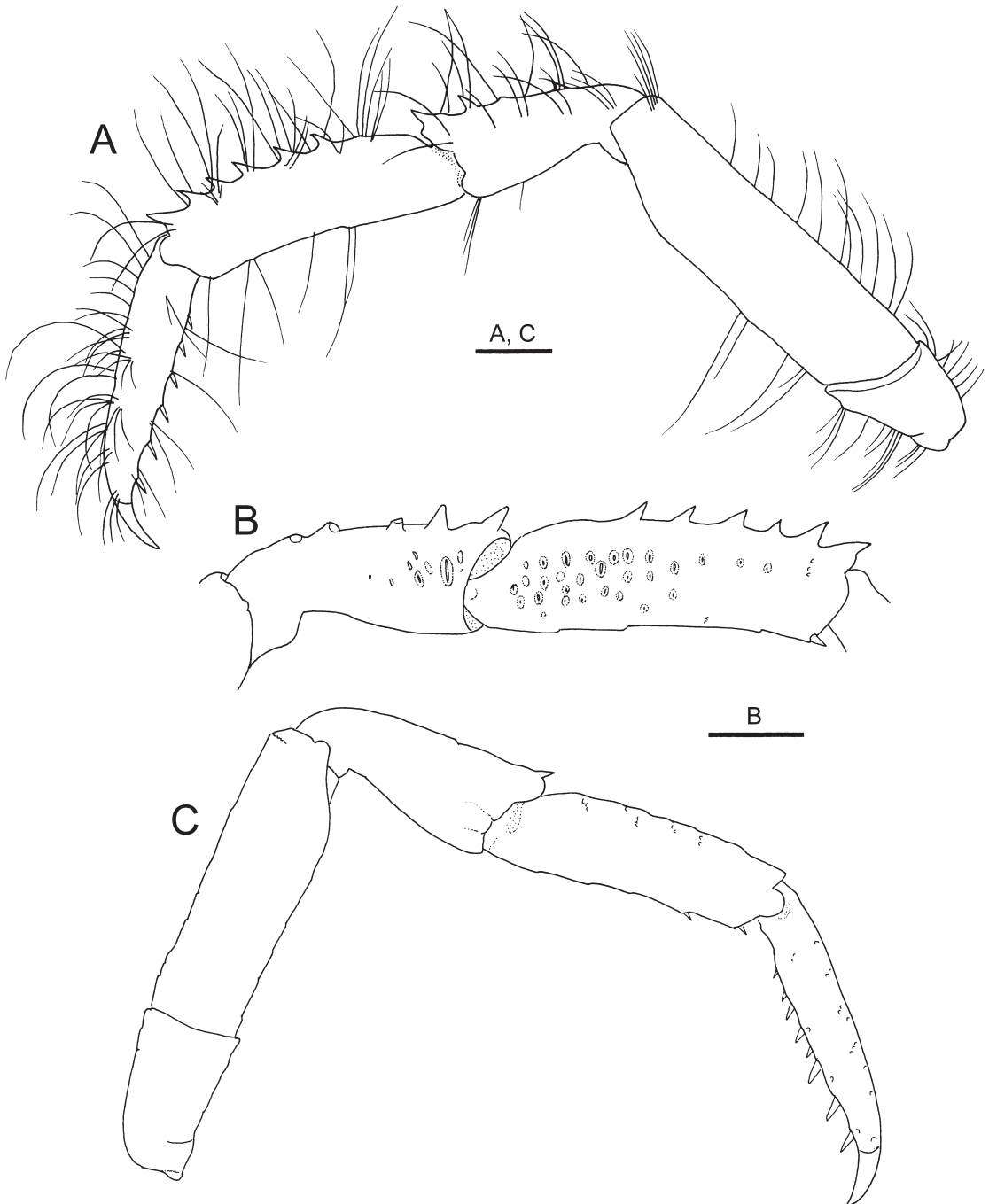
closely set). Ischium with row of prominent spines on ventromesial margin.

Second and third pereopods (Fig. 8A, C) slightly overreaching chelipeds, dissimilar in armature. Dactyli subequal in length to propodi; dorsal and ventral margins with tufts of long stiff setae; lateral and mesial faces with few tufts of stiff setae; ventral margins each

with 6–8 corneous spines. Propodi longer than carpi; dorsal margins each with 6 large spines (including dorsodistal spine) (second) or unarmed (third), and with row of tufts of long stiff setae; lateral surfaces unarmed; mesial surfaces each with numerous minute stridulatory ridges or tubercles scattered in proximal half (second; Fig. 8B) or unarmed (third); ventral

surfaces with sparse tufts of long setae and with corneous spinule at ventrodistal margin. Carpi each with dorsal row of 5 prominent spines (second) or only

small dorsodistal spine (third), and with tufts of long stiff setae on dorsal and lateral surfaces; mesial surfaces each with scattered stridulatory ridges or



**Fig. 8.** *Trizacheles inermis* sp. nov., holotype, male (sl 4.6 mm), off Izu-ohshima Island, Izu Islands, CBM-ZC 11359. A, left second pereopod, lateral view; B, same, propodus and carpus, mesial view (setae omitted); C, right third pereopod, lateral view (setae omitted). Scale bars: 1 mm.



tubercles in distal half (second; Fig. 8B) or unarmed (third). Meri unarmed; dorsal margins with sparse long setae. Ischia also unarmed.

Fourth pereopods semichelate; each with propodal rasp consisting of several rows of corneous scales (Fig. 6D). Fifth pereopods weakly chelate; propodal rasp well developed.

Male first pleopod (Fig. 6E) with distal segment subsemicircular in lateral view, 1.7 times longer than wide. Distal segment of male second pleopod as figured (Fig. 6F).

Pleon with first tergite moderately well calcified; second to fifth tergites weakly calcified, pleura faintly delineated. Sixth tergite (Fig. 6G) subcircular, with deep lateral incisions at posterior 0.3; terminal margin slightly convex, unarmed. All tergites and telson with dense covering of short setae. Uropods symmetrical; protopods produced posteriorly, each with prominent spine. Telson (Fig. 6H) with faint lateral indentations at posterior 0.3; posterior lobes separated by deep median cleft, terminal margins rounded, unarmed but with fringe of long setae.

*Coloration in life.* Not known.

*Distribution.* Known only from the type locality, SW of Izu-oshima Island, at depths of 289–307 m.

*Habitat.* The single known specimen was found in a cavity of a fragment of dead farraeid sponge.

*Remarks.* Only a single male specimen is available for this new species. Nevertheless, as noted above, *Trizacheles inermis* sp. nov. appears distinctive in the genus in the lack of an accessory tooth on each ischium of the third maxilliped. In this regard, this new species is similar to *Forestacheles perplexus*, but the presence of an exopodal flagellum on the first maxilliped and the structure of the telson clearly place the present new species in *Trizacheles*. Other diagnostic characters suggest a close relationship of this new species to *T. albipes* sp. nov. and *T. hoensonae*. These include: carpi of chelipeds provided with stridulating rods or tubercles on lateral surfaces; propodi of second pereopods devoid of armature on lateral surface, but with a single row of prominent spines on dorsal surface; and propodi of third pereopods without dorsal row of spines. In addition to the lack of accessory tooth on the third maxilliped, the possession of a spine on the ventrodistal margin of the carpus of the third maxilliped might be characteristic to the present new species, though armature of the third maxilliped is not fully documented for other congeneric species. No other species examined in this study have such a spine on the carpus of the third maxilliped. Furthermore, *T. inermis* differs from both

*T. albipes* and *T. hoensonae* in the structure of the stridulating apparatus on the mesial face of the propodi of the second pereopods. In *T. inermis*, the stridulating apparatus is composed of minute tubercles or rods scattered in the proximal half, whereas it mainly consists of a single row of long rods in *T. albipes* and *T. hoensonae*. The proportionately longer dactyli of the ambulatory legs further distinguishes *T. inermis* from *T. hoensonae*. The stridulating rods and tubercles are much smaller in *T. inermis* than in *T. albipes* (cf. Fig. 7E and Fig. 4F).

*Etymology.* From the Latin *inermis* (= unarmed), in reference to the lack of an accessory tooth on the ischium of the third maxilliped.

***Trizacheles parvispina* sp. nov.**  
(Figs. 9–11)

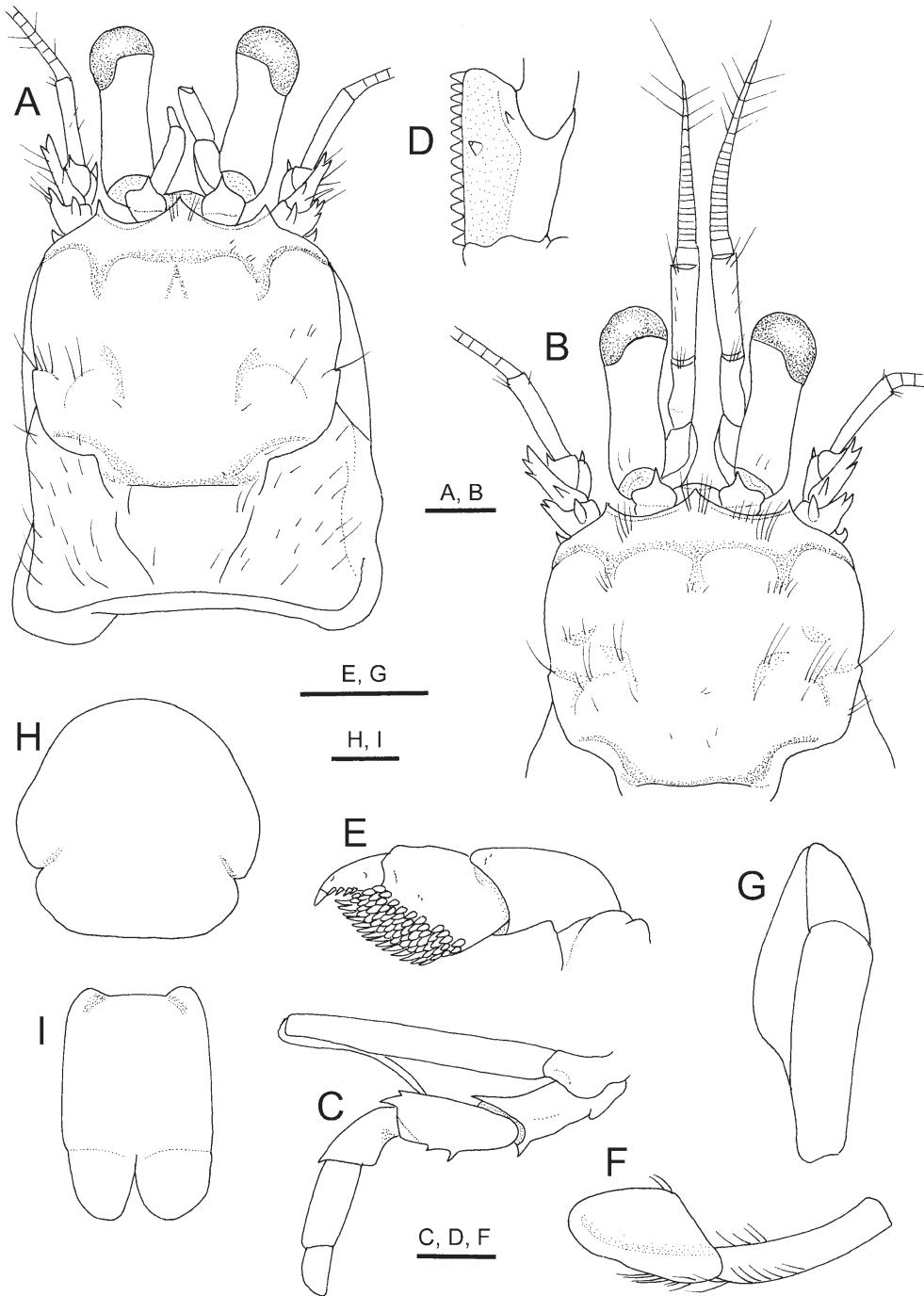
*Material examined.* Holotype: ovigerous female (sl 4.1 mm, cl 5.8 mm), TRV *Shin'yo-maru*, 1996 cruise, stn 6, Hyotan-se Bank, Izu Islands, 34°20.75'N, 139°20.00'E, 275–350 m, steep slope of rocky bottom, 22 October 1996, dredge, coll. T. Komai, CBM-ZC 7212.

Paratypes: 2 male (sl 2.7, 4.2 mm, cl 3.8, 5.9 mm), 1 female (sl 2.3 mm, cl 3.4 mm), same data as holotype, CBM-ZC 11360.

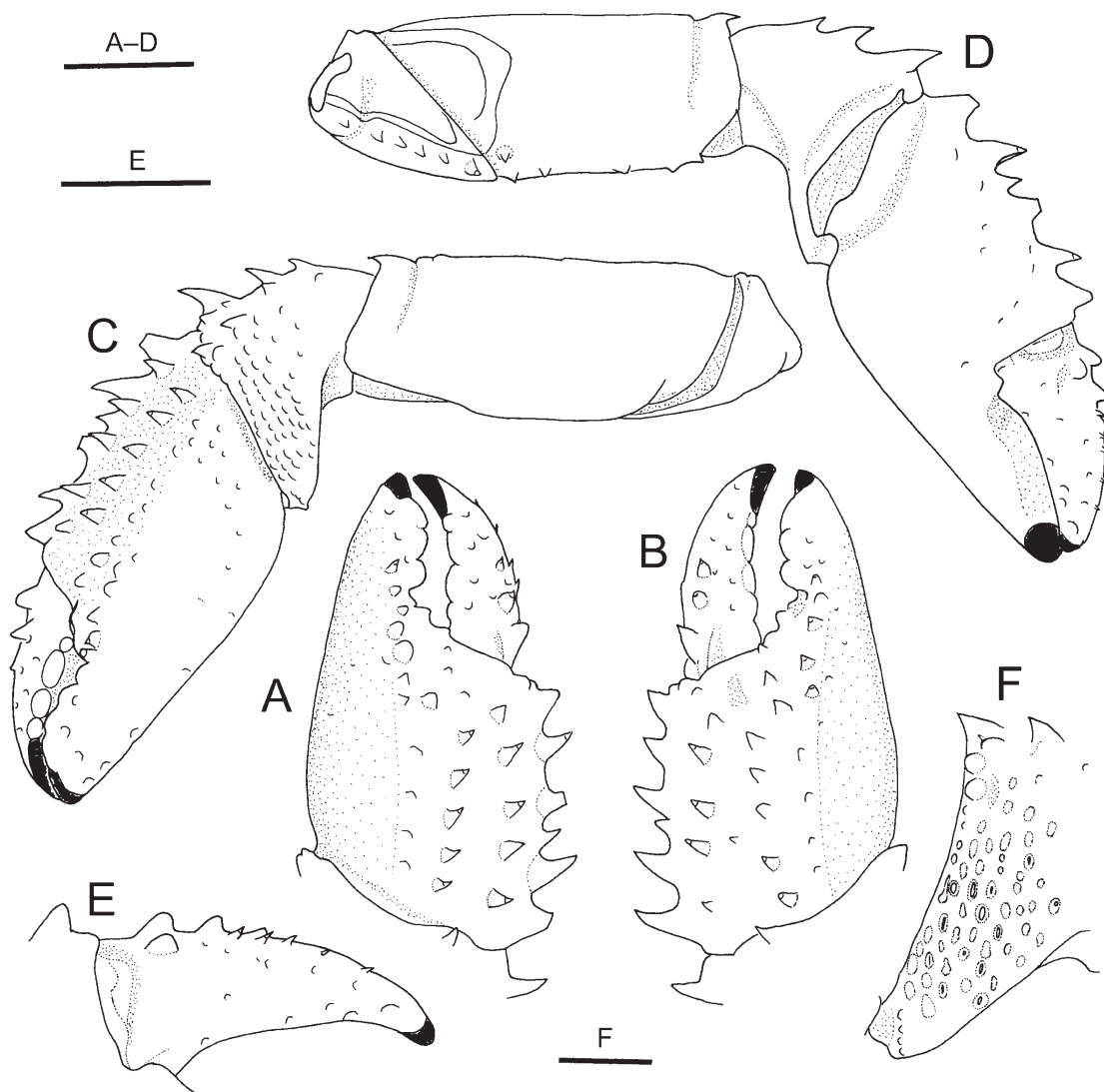
*Description.* Shield (Fig. 9A, B) distinctly wider than long and distinctly longer than posterior carapace; dorsal surface with moderately long, deep transverse groove subrostrally; lateral margins each with faint notch posterior to midlength; cervical groove clearly delineated laterally. Rostrum broadly triangular, with small marginal spine, reaching or slightly overreaching level of lateral projections. Lateral projections well developed, each with prominent marginal spine. Posterior median plate trapezoidal, narrowed posteriorly, clearly delimited, moderately calcified (Fig. 9A); sulci cardiobranchialis apparent. Branchiostegite calcified in anterior to anterodorsal margin; dorsal margin unarmed, anterior margin with 1–3 spinules.

Ocular peduncle (Fig. 9A, B) about 0.6 length of shield, slightly constricted at midlength, with broad uncalcified longitudinal suture on lateral surface, extending from base of cornea to proximal 0.3; cornea slightly inflated, width about 0.4 of peduncular length. Ocular acicle drawn out into acute spine, separated by basal width of one acicle.

Antennular peduncle (Fig. 9B) moderately short, overreaching distal corneal margin by half length of ultimate segment. Ultimate segment slightly longer



**Fig. 9.** *Trizacheles parvispina* sp. nov. A, C–E, H, I, holotype, ovigerous female (sl 4.1 mm), Hyotan-se Bank, Izu Islands, CBM-ZC 7212; B, F, G, paratype, male (sl. 4.2 mm), same locality, CBM-ZC 11360. A, carapace and cephalic appendages, dorsal view (right antennule damaged, left antennule in process of regeneration); B, shield and cephalic appendages, dorsal view; C, left third maxilliped, lateral view; D, same, ischium, ventral view; E, dactylus, propodus and carpus of left fourth pereopod, lateral view; F, left first pleopod, lateral view; G, distal segment of left second pleopod, outer view; H, sixth pleonal tergite, dorsal view (setae omitted); I, telson, dorsal view (setae omitted). Scale bars: 1 mm for A–C, E, G–I; 0.5 mm for D, F.



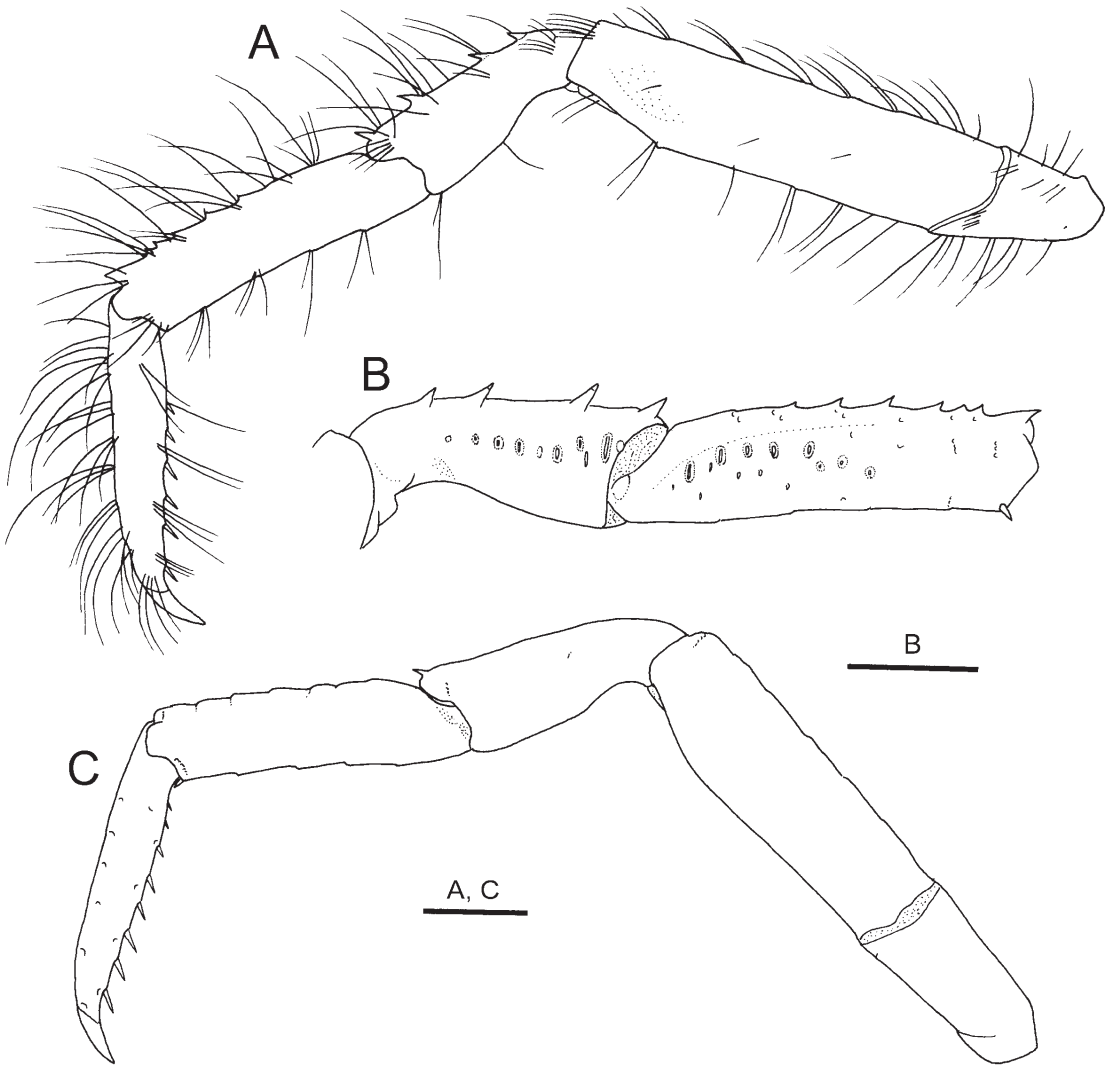
**Fig. 10.** *Trizocheles parvispina* sp. nov., holotype, ovigerous female (sl 4.1 mm), Hyotan-se Bank, Izu Islands, CBM-ZC 7212. A, left chela, outer view; B, right chela, outer view; C, left cheliped, lateral view; D, same, mesial view; E, same, dactylus, mesial view; F, outer surface of carpus of left cheliped. Setae omitted. Scale bars: 1 mm for A–E; 0.5 mm for F.

than penultimate segment. Basal segment with 1 spinule on lateral surface of statocyst lobe and spinule on ventrodiscal margin.

Antennal peduncle (Fig. 9A, B) slightly overreaching corneal base. Fifth segment unarmed. Fourth segment with small spine at dorsodistal margin. Third segment with small spine on ventrodiscal margin. Second segment with dorsodistal lateral angle produced, terminating in bifid spine, with or without 1 additional spinule on lateral margin; dorsomesial distal angle with prominent spine. First segment with bifid

spinule on lateral surface distally; ventrodiscal margin with 2 spinules. Antennal acicle short, reaching nearly midlength of ocular peduncle, terminating in bifid spine, mesial margin with 1 spine proximally, lateral margin with or without 1 spine in distal half. Antennal flagellum with 3–5 long distal setae every 2 articles.

Third maxilliped (Fig. 9C) moderately slender. Basis with 2 or 3 minute denticles on mesial margin. Ischium with well developed crista dentata, 1 accessory tooth present on either side (Fig. 9D); dorsodistal and ventrodiscal angle each with spinule.



**Fig. 11.** *Trizacheles parvispina* sp. nov., holotype, ovigerous female (sl 4.1 mm), Hyotan-se Bank, Izu Islands, CBM-ZC 7212. A, left second pereopod, lateral view; B, same, propodus and carpus, mesial view (setae omitted); C, left third pereopod, lateral view (setae omitted). Scale bars: 1 mm.

Merus with 1 distal and 1 smaller subterminal spines on dorsal margin, and 2 small spines in distal half of ventral margin. Carpus with dorsodistal spine, ventrodistal margin unarmed. Exopod unarmed.

Chelipeds (Fig. 10A–D) subequal and symmetrical, with propodal–carpal rotation approximately 30°; narrow proximal hiatus between dactylus and fixed finger. Dactylus slightly shorter than palm, surfaces with tufts of stiff setae; dorsal surface mesially with row of 3 spines decreasing in size distally; mesial surface with 1 small proximal tubercle and 4 or 5 minute corneous spinules adjacent to dorsal margin (Fig. 10E); cutting edge with row of low, rounded

calcareous teeth, terminating in large corneous claw. Fixed finger with tufts of stiff setae on surfaces; cutting edge with row of rounded calcareous teeth and deep proximal notch, terminating in large corneous claw. Palm 1.5–1.8 times longer than carpus; dorsomesial margin with row of 5 or 6 prominent spines; dorsal surface convex, with relatively few, scattered short to long stiff setae, and 2 longitudinal rows of smaller spines and dorsolateral row of tubercles or spines extending onto fixed finger and increasing in size distally (tubercles or spines on palm very small, sometimes obsolescent); lateral surface nearly perpendicular, smooth, with few setae; mesial

and ventral surfaces smooth, unarmed, with sparse short setae. Carpus subtrapezoidal; dorsomesial margin 3 prominent spines increasing in size distally; dorsal surface with tufts of short to long setae and oblique row of 3 smaller spines or tubercles; lateral surface with numerous, scattered short stridulatory ridges or tubercles (Fig. 10F), ventrodistal angle with 1 or 2 minute denticles; mesial and ventral surfaces smooth, with few short setae. Merus trigonal in cross section, with shallow transverse groove along distal margin; dorsal margin with row of tiny protuberances over entire length and sparse setae; dorsodistal margin with 1 small spine; lateral surface smooth, with sparse short setae, ventrolateral margin unarmed; mesial surface also smooth, with 1 small spine proximoventrally, ventromesial margin with 3 distal spinules and 2 proximal spinules; ventral surface nearly flat, almost naked. Ischium with row of small spines on ventromesial margin.

Second and third pereopods (Fig. 11A, C) slightly overreaching chelipeds, dissimilar in armature. Dactyli 1.1–1.2 times longer than propodi; dorsal and ventral margins with tufts of long stiff setae; lateral and mesial faces with few tufts of stiff setae; ventral margins each with 7 or 8 corneous spines. Propodi about 3.1–3.6 times longer than wide; dorsal margins each with small dorsodistal spine and row of 5–7 tiny corneous-tipped spines decreasing in size proximally (second) or unarmed (third), and with row of tufts of long stiff setae; lateral surfaces unarmed; mesial surfaces each with main series of more than 10 small stridulating tubercles or short rods arranged in two irregular longitudinal rows in proximal 0.7 (second; Fig. 11B) or unarmed (third); ventral margins with sparse tufts of long setae and occasionally with 1 subterminal corneous spinule, ventrodistal margins each with 1 corneous spinule mesially. Carpi each with dorsal row of 4 or 5 small spines (second) or only small dorsodistal spine (third), and tufts of long stiff setae on dorsal and lateral surfaces; mesial surfaces each with series of 8–10 stridulating rods arranged in a single or double longitudinal row and increasing in length distally (second; Fig. 11B) or unarmed (third). Meri unarmed except for ventral margins of second bearing sparse minute denticles; dorsal margin with sparse tufts of long setae. Ischia also unarmed.

Fourth pereopods (Fig. 9E) semichelate; each with propodal rasp consisting of several rows of long corneous scales. Fifth pereopods weakly chelate; propodal rasp well developed.

Male first pleopod (Fig. 9F) with distal segment roundly subtriangular in lateral view, tapering to

moderately broad, rounded distal margin. Distal segment of male second pleopod as figured (Fig. 9G).

Pleon with tergites moderately calcified generally, anterior part of first tergite strongly calcified. Sixth tergite (Fig. 9H) subcircular, with deep lateral incisions at posterior 0.3; terminal margin nearly straight, unarmed. All tergites and telson with moderately dense covering of short setae. Uropods symmetrical; protopods produced posteriorly, each with prominent spine. Telson (Fig. 9I) with faint lateral indentations at posterior 0.3; posterior lobes separated by deep median cleft, terminal margins rounded, unarmed but with fringe of long setae.

Five large eggs carried by ovigerous female holotype, measuring about 2.1 x 2.5 mm.

*Coloration in life.* Not known.

*Distribution.* Known only from the type locality, Hyotan-se Bank, Izu Islands, at depths of 275–350 m.

*Remarks.* Of the four specimens available to study, the smallest female has no spinules on the dorsal margins of the propodi of the second pereopods. It is possible that the development of those spinules is size-related.

The armature on the dorsal surfaces of the propodi of the second pereopods in this new species appears unique within the genus, as it consists of tiny spines decreasing in size proximally. In nine congeneric species [*T. albipes* sp. nov., *T. hoenonae*, *T. inermis* sp. nov., *T. longicaulis* (Boas, 1926), *T. pilgrimi* Forest and McLaughlin, 2000, *T. pulcher* Forest, 1987, *T. spinosus*, *T. mutus* Forest, 1987, and *T. vaubanae* McLaughlin and Lemaitre, 2008], the armature consists of a single or double row of large spines; in the remaining 10 congeneric species [*T. albatrossi*, *T. boasi* Forest, 1987, *T. brachyops* Forest & de Saint Laurent, 1987, *T. brevicaulis* (Boas, 1926), *T. caledonicus* Forest, 1987, *T. laurentae* Forest, 1987, *T. loquax*, *T. manningi* Forest, 1987, *T. moosai* Forest, 1987, and *T. sakaii*], there is no row of spines or spinules on the dorsal surfaces of the propodi of the second pereopods, except for a dorsodistal spine or low protuberances present in some species. Characters of the second pereopods remain unknown for *T. balssi* (Stebbing, 1914) (McLaughlin & Lemaitre, 2009). Nevertheless, *T. balssi* appears characteristic in having markedly dissimilar chelipeds (McLaughlin and Lemaitre, 2009).

The combination of the following features characterizes *T. parvispina*: ocular peduncles moderately stout, corneal width about 0.4 of peduncular length; antennular peduncle overreaching distal corneal margin by about half-length of ultimate

segment; dactyli of chelipeds each with row of corneous spinules on mesial surface adjacent to dorsal margin; palms of chelipeds with rows of prominent spines on outer (dorsal) surfaces; carpi of chelipeds with numerous stridulatory tubercles or rods on lateral surface; dorsal margins of meri of chelipeds almost smooth; dactyli of ambulatory legs slightly longer than propodi, unarmed dorsally; propodi of second pereopods each with dorsodistal spine and short stridulatory rods or tubercles arranged in irregular two rows on mesial surfaces; carpi with single or double row of short stridulatory rods on mesial surfaces; dorsal spines on carpi of second pereopods relatively weak; and propodi and carpi of third pereopods unarmed.

The holotype carried five eggs, of which one larva prematurely hatched. The larva is very similar to those of *T. spinosus* and *T. vaubani* described by McLaughlin and Lemaitre (2008), particularly in the development of appendages.

**Etymology.** From the combination of the Latin *parvus* (= tiny) and *spina* (spine), referring to the tiny spines on the propodi of the second pereopods. Used as a noun in apposition.

### Concluding Remarks

The regional fauna of hermit crabs in Sagami Bay and adjacent waters is fairly well documented by a monographic work by Miyake (1978) and many subsequent revisionary and faunal studies (e.g., Komai, 2001; 2009; Komai and Takeda, 2004; 2006; Okuno and Arima, 2004; 2006; Okuno *et al.*, 2006). In fact, all the three previously described Japanese species of *Trizacheles* have been recorded from Sagami Bay by Forest (1987). The discovery herein of the three new species from this narrow area in Japan is therefore surprising. The available data suggests that *T. albatrossi* inhabits in shallowest zone among the six local species, occurring at depths of 95–150 m. The other four species usually occur at depths greater than 200 m, although *T. sakaii* possibly extends to shallower depth of 100 m (Forest, 1987). Our knowledge on the geographical distribution of these species is still limited. At present, four species, *T. albatrossi*, *T. albipes* sp. nov., *T. inermis* sp. nov., and *T. parvispina* sp. nov. are known only from respective type locality and/or nearby area. *Trizacheles sakaii*, of which the type locality is Tosa Bay, Shikoku, southwestern Japan, extends southward to Taiwan (McLaughlin *et al.*, 2007). The specimens of *T. loquax* from Kii Peninsula, here examined for comparison,

represent the first record of this species outside Sagami Bay.

As mentioned before, geographical distributions of species of *Trizacheles* are generally limited to narrow areas (McLaughlin and Lemaitre, 2009). McLaughlin and Lemaitre (2008) described prematurely hatched larvae of two species of *Trizacheles*, *T. spinosus* and *T. vaubanae*. The larvae are lecithotropic and exhibit marked advanced development. In the present material, the female holotype of *T. parvispina* has four very large eggs and one prematurely hatched larva. It is suspected that dispersal ability of the larvae of species of this genus limited. In marine decapod crustaceans, species having advanced or highly abbreviated larval development tend to show more or less localized distribution (e.g., Komai, 2004; Komai & Ahyong, 2011), species of *Trizacheles* may be another such example.

### Key to Japanese species of *Trizacheles*

1. Propodi of second pereopods each with dorsal row of prominent spines or tiny spines ..... 2
1. Propodi of second pereopods without dorsal row of spines or spinules (dorsodistal spine may be present) ..... 4
2. Propodi of second pereopods each with row of tiny spines (corneous-tipped) on dorsal margin; ..... *T. parvispina* sp. nov.
2. Propodi of second pereopods each with row of large spines on dorsal margin; ..... 3
3. Carpus of third maxilliped without ventrodistal spine; mesial faces of propodi of second pereopods with long stridulatory rods arranged in single main row ..... *T. albipes* sp. nov.
3. Carpus of third maxilliped with ventrodistal spine; mesial faces of propodi of second pereopods with scattered short stridulatory rods or tubercles ..... *T. inermis* sp. nov.
4. Propodi of second pereopods each with dorsodistal spine ..... *T. sakaii*
4. Propodi of second pereopods each without dorsodistal spine ..... 5
5. Palms of chelae with dorsal surfaces only with single proximal spine except for spines or tubercles on dorsolateral margin..... *T. loquax*
5. Palms of chelae with dorsal surfaces with longitudinal rows of prominent spines ..... *T. albatrossi*

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相模灘および伊豆諸島海域で採集された  
トガリツノガイヤドカリ属  
(甲殻亜門：十脚目：異尾下目：カルシ  
ヤドカリ科) 4種の記録

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1996～2007年にかけて相模灘および伊豆諸島海域で実施された深海生物相調査で採集されたトガリツノガイヤドカリ属 *Trizacheles* Forest, 1987の標本を検討したところ、以下の3新種を含む4種が発見された：*T. albatrossi* Forest, 1987 (新称：アルバトロストガリツノガイヤドカリ)；*T. albipes* sp. nov. (新称：アシジロトガリツノガイヤドカリ)；*T. inermis* sp. nov. (新称：ハナシトガリツノガイヤドカリ)；*T. parvispina* sp. nov. (新称：ハザマトガリツノガイヤドカリ)。さらに、日本周辺海域からの *Trizacheles spinosus* (Henderson, 1888)の既往の記録を再検討し、いずれも他種に同定されることを確認した。相模灘～伊豆諸島海域には本研究で記録された4種に加え、日本周辺海域から記録のある他の既知種2種 *T. loquax* Forest, 1987 (新称：トゲナシトガリツノガイヤドカリ) および *T. sakaii* Forest, 1987 (ツノガイヤドカリ) も記録されており、本海域における種多様性の高さを反映するものとなっている。本邦に産する6種の検索表を与えた。