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The copepod genus *Hatschekia* Poche, 1902 (Siphonostomatoida: Hatschekiidae) from triggerfishes (Pisces: Tetraodontiformes: Balistidae) from off the Ryukyu Islands, Japan, with descriptions of eleven new species

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Abstract

Eleven new species of the genus *Hatschekia* Poche, 1902 (Copepoda: Siphonostomatoida: Hatschekiidae) are described based on female specimens from triggerfishes (Tetraodontiformes: Balistidae) caught in coastal waters of the Ryukyu Islands, Japan. These include *Hatschekia hemicyclium* **n. sp.** on *Rhinecanthus rectangulus* (Bloch & Schneider), *R. aculeatus* (L.) and *R. verrucosus* (L.); *H. jonesi* **n. sp.** on *Sufflamen bursa* (Bloch & Schneider) and *S. fraenatum* (Latreille); *H. kabatai* **n. sp.** and *H. izenaensis* **n. sp.** on *Xanthichthys lineopunctatus* (Hollard); *H. churaumi* **n. sp.** on *Pseudobalistes flavimarginatus* (Rüppell); *H. zanpa* **n. sp.** and *H. fukurubi* **n. sp.** on *Balistapus undulatus* (Park); *H. mongarah* **n. sp.** on *Balistoides conspicillum* (Bloch & Schneider); *H. nakamurai* **n. sp.** on *Melichthys vidua* (Richardson); *H. mihkagan* **n. sp.** on *Odonus niger* (Rüppell); and *H. pseudobalistesi* **n. sp.** on *Pseudobalistes fuscus* (Bloch & Schneider). Ten of the 11 new species, with the exception of *H. fukurubi* **n. sp.**, share the intercoxal sclerites of legs 1 and 2 armed with 4 processes. This character differs from 87 of the known 97 species in *Hatschekia.* Of the 20 species with this character, the 10 new species are separated from each other mainly by the following morphological characters: the number of setal elements in the leg armature, on the antennule and the caudal ramus, the presence of posterior lobes on the trunk, the segmentation and form of the abdomen, and the length ratios of certain body parts.

Key words: parasitic Copepoda, new species, the Ryukyu Islands, triggerfishes

Introduction

The genus *Hatschekia* Poche, 1902 is one of the large genera of Copepoda parasitic on marine fishes. Since Jones (1985) recognized 68 species as valid, 29 new species have been described in this genus. Thus, the genus currently consists of 97 valid species which are found on the gills of nearly 140 actinopterigian fish species belonging to six orders: Anguilliformes, Beryciformes, Ophidiiformes, Perciformes, Pleuronectiformes and Tetraodontiformes (Pillai 1985; Castro & Baeza 1986; Villalba 1986; Jones & Cabral 1990; Kabata 1991; Ho & Kim 2001; Boxshall & Halsey 2004; Uyeno & Nagasawa 2009b, 2010a, 2010b). The taxonomic studies of the genus is insufficient because all of the species have featureless bodies, with a highly transformed trunk, bearing small, vestigial appendages, with males only rarely reported. Kabata (1991) suggested that the length and width of some body parts without appendages are useful for identification of species in the genus. Uyeno & Nagasawa (2009a) used some ratios of body parts and established the lengths of appendages as valuable characters for identification. They also used some distinctive morphological features (i.e., the parabasal papilla and rostral process) to identify the species. In this paper, 11 new species from triggerfishes are described.

Materials and Methods

Marine tetradontiform fishes were collected in various localities of the Ryukyu Islands, Japan, from 2005 to 2008. Copepods attached on the hosts' gills were carefully removed and preserved in 80% ethanol. Specimens were soaked in lactophenol for 10 to 12 h before dissection. Then, the appendages of the copepods were dissected and observed using the method of Humes & Gooding (1964). The drawings were made with the aid of a drawing tube. The terminology follows Huys & Boxshall (1991). Specimens were measured according to the method of Uyeno & Nagasawa (2009a), excluding the abdomen length and the abdomen width. In the present study, these two measurements are expressed as the urosome length (excluding the caudal ramus) and the urosome width, respectively. Measurements in micrometers are shown as ranges, with means and standard deviations in parentheses. The ratios of the lengths of various body parts and appendages are shown in Tables 1–2. Type specimens are deposited in the crustacean collection of the National Museum of Nature and Science, Tokyo (NSMT) and the University of the Ryukyus Museum, Fujukan (RUMF), Okinawa. The scientific names of fishes follow the list of Hayashi (2002) and Froese & Pauly (2010). In this study, the most intact specimens were designated as holotype, and then paratype specimens were chosen based on the following criteria: specimens are intact, represent meristic validities, and were collected from the type host species caught at sites as near as possible to the type locality.

TABLE 1. Ratios of body parts of females of *Hatschekia hemicyclium* **n. sp.**, *H. jonesi* **n. sp.**, *H. kabatai* **n. sp.**, *H. izenaensis* **n. sp.**, *H. churaumi* **n. sp.** and *H. zanpa* **n. sp.** The data are shown as the mean ± standard deviation.

	H. hemicyclium (n = 10)	*H. jonesi* (n = 12)	*H. kabatai* (n = 7)	*H. izenaensis* (n = 5)	*H. churaumi* (n = 8)	*H. zanpa* (n = 2)
CeL/BL	0.23 ± 0.03	0.22 ± 0.01	0.29 ± 0.01	0.16 ± 0.01	0.37 ± 0.02	0.31 ± 0.01
CeW/BL	0.27 ± 0.01	0.27 ± 0.02	0.36 ± 0.01	0.18 ± 0.01	0.42 ± 0.02	0.36 ± 0.03
TL/BL	0.79 ± 0.02	0.78 ± 0.01	0.75 ± 0.04	0.84 ± 0.01	0.67 ± 0.03	0.69 ± 0.01
TW/BL	0.23 ± 0.02	0.22 ± 0.03	0.30 ± 0.03	0.21 ± 0.02	0.30 ± 0	0.26 ± 0.01
UL/BL	0.04 ± 0.01	0.05 ± 0.01	0.04 ± 0.01	0.02 ± 0	0.05 ± 0.01	0.10 ± 0.01
UW/BL	0.09 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	0.08 ± 0.01	0.11 ± 0
CaL/BL	0.02 ± 0	0.02 ± 0	0.02 ± 0	0.01 ± 0	0.03 ± 0	0.05 ± 0
CaW/BL	0.01 ± 0	0.01 ± 0	0.01 ± 0	0.01 ± 0	0.02 ± 0	0.03 ± 0
CeW/CeL	1.21±0.05	1.20 ± 0.12	1.25 ± 0.03	1.15 ± 0.09	1.12 ± 0.03	1.15 ± 0.09
UL/UW	2.06 ± 0.31	1.70 ± 0.24	2.09 ± 0.27	2.76 ± 0.23	1.63 ± 0.37	1.10 ± 0.11
A1L/BL	0.15 ± 0.01	0.17 ± 0.01	0.24 ± 0.03	0.07 ± 0.01	0.23 ± 0.03	0.29 ± 0.03
A2L/BL	0.24 ± 0.03	0.18 ± 0.06	0.31 ± 0.03	0.11 ± 0.02	0.42 ± 0.02	0.34 ± 0.03
A2TL/A2ML	0.26 ± 0.04	0.28 ± 0.07	0.25 ± 0.05	0.26 ± 0.03	0.30 ± 0.06	0.26 ± 0.05
L1L/BL	0.09 ± 0.01	0.10 ± 0.01	0.12 ± 0.01	0.04 ± 0.01	0.13 ± 0.01	0.16 ± 0.01
L1ExL/L1EnL	1.74 ± 0.22	1.39 ± 0.13	1.56 ± 0.17	1.25 ± 0.15	1.43 ± 0.22	1.26 ± 0.13
L2 L/BL	0.09 ± 0.01	0.11 ± 0.01	0.13 ± 0.01	0.05 ± 0	0.12 ± 0	0.17 ± 0.01
L2ExL/L2EnL	1.39 ± 0.16	0.80 ± 0.08	0.89 ± 0.12	1.15 ± 0.15	1.26 ± 0.13	0.93 ± 0.04
A1L/A2L	0.64 ± 0.09	0.86 ± 0.14	0.77 ± 0.10	0.63 ± 0.09	0.55 ± 0.04	0.86 ± 0.11

Abbreviations: body length (BL), cephalothorax length (CeL), cephalothorax width (CeW), trunk length (TL), trunk width (TW), Urosome length excluding caudal ramus (UL), Urosome width(UW), caudal ramus length (CaL), and caudal ramus width (CaW), antennule length (A1L), antenna length (A2L), middle segment length of antenna (A2ML), terminal claw length of antenna* (A2TL), Leg 1 length (L1L), exopod length of leg 1 (L1ExL), endopod length of leg 1 (L1EnL), Leg 2 length (L2L), exopod length of leg 2 (L2ExL), and endopod length of leg 2 (L2EnL).
* This length was expressed as the "terminal segment length" in Uyeno & Nagasawa (2009a, 2009b).

Results

Order Siphonostomatoida Burmeister, 1835

Family Hatschekiidae Kabata, 1979

Genus *Hatschekia* Poche, 1902

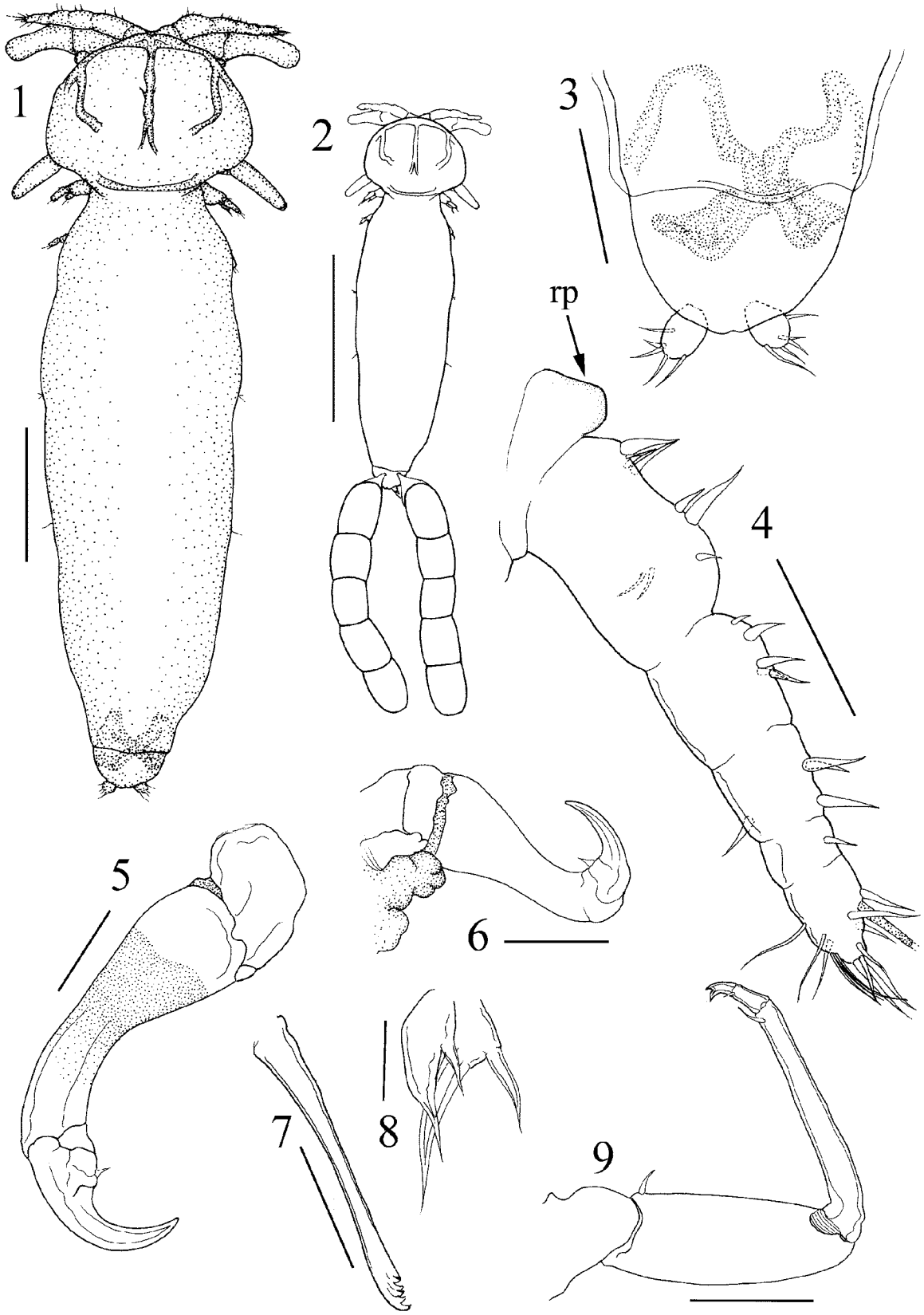
Hatschekia hemicyclium n. sp.

(Figs 1–15)

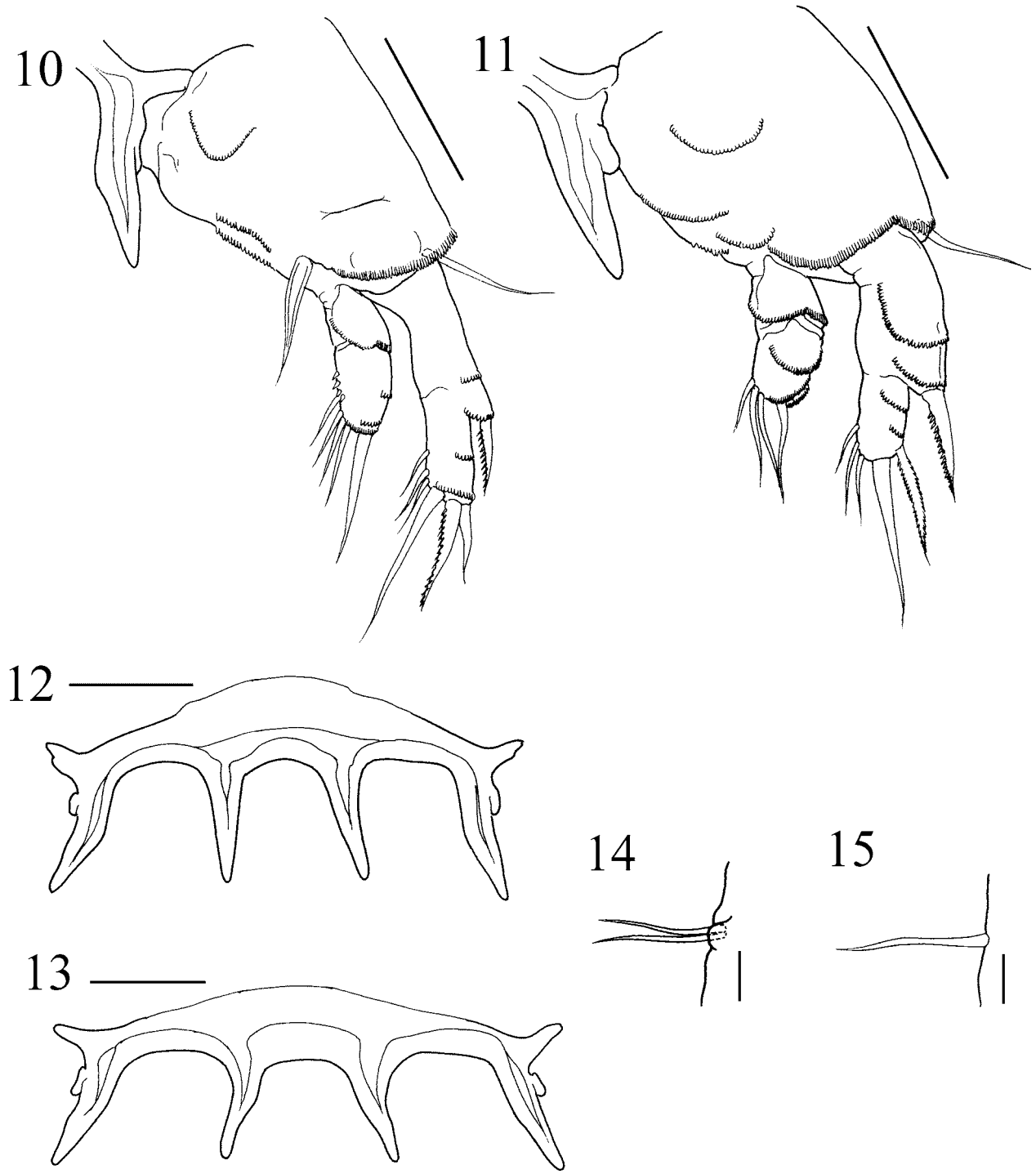
Type material. Holotype, female (NSMT–Cr 20898), ex *Rhinecanthus rectangulus* (Bloch & Schneider) (Tetraodontiformes: Balistidae), off Cape Maeda (26°26'N, 127°46'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 2 September 2005. Paratypes, 4 females (RUMF–ZC–00921), ex *R. rectangulus*, off Cape Maeda (26°26'N, 127°46'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 2 September 2005.

Other material examined. 3 females (NSMT–Cr 20899), ex *R. aculeatus* (L.), off Odo (26°5'N, 127°42'E), Okinawa-jima Island, the Ryukyu Islands, North Pacific Ocean, Japan, 1 September 2005; 2 females (NSMT–Cr 20900), ex *R. verrucosus* (L.), off Sunabe (26°19'N, 127°44'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 18 August 2006.

Description of female. Body (Figs 1–2) 1105–1344 (1242 ± 88) long, excluding caudal rami (n = 5). Cephalothorax semicircular, wider posteriorly, shorter than wide [232–294 (272 ± 25) × 301–356 (328 ± 20)],



FIGURES 1–9. *Hatschekia hemicyclium* **n. sp.**, female, holotype NSMT–Cr 20898. 1, habitus dorsal; 2, habitus dorsal with egg sacs; 3, posterior part of trunk, dorsal; 4, antennule, ventral, rp = rostrum process; 5, antenna, ventral; 6, antenna with parabasal papilla; 7, mandible; 8, maxillule; 9, maxilla. Scale bars: 1, 200μm; 2, 500μm; 3, 6, 70μm; 4–5, 9, 50μm; 7–8, 20μm.



FIGURES 10–15. *Hatschekia hemicyclium* **n. sp.**, female, holotype NSMT–Cr 20898. 10, leg 1, anterior view; 11, leg 2, anterior view; 12, intercoxal sclerite of leg 1, anterior view; 13, intercoxal sclerite of leg 2, anterior view; 14, leg 3; 15, leg 4. Scale bars: 10–13, 30μm; 14–15, 10μm.

widest near posterior end, bearing dorsal, M-shaped chitinous frame. Trunk elongated, elliptical, longer than wide [874–1080 (976 ± 76) × 270–316 (290 ± 19)], widest slightly anterior to middle. Urosome (Fig. 3) excluding caudal ramus rounded, shorter than wide [49–71 (56 ± 9) × 104–117 (111 ± 5)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 3) oval, length 25–31 (27 ± 3), width 17–20 (19 ± 1), bearing 5 naked setae.

Rostrum with 1 round process on posterolateral corners (Fig. 4). Antennule (Fig. 4) indistinctly 5-segmented, 166–202 (183 ± 15) long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 5) 3-

segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw bearing 1 basal seta and shallow groove near base; proximal segment length 58–89 (74 ± 13); middle segment length 141–184 (159 ± 20); terminal claw length 41–52 (46 ± 4); total length 241–316 (279 ± 33). Parabasal papilla (Fig. 6) aggregated, wrinkled, carrying apical process. Oral cone robust. Mandible (Fig. 7) slender, with 4 sharp apical teeth. Maxillule (Fig. 8) bilobate; both lobes armed with 2 tapering elements. Maxilla (Fig. 9) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 10–11) biramous, with exopods composed of 2 indistinct segments and 2–segmented endopods; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–0; 4

Leg 1 (Fig. 10) 104–112 (110 ± 3) long; protopod length 61–68 (64 ± 3); exopod length [43–48 (45 ± 2)] exceeding endopod length [21–28 (26 ± 3)]. Leg 2 (Fig. 11) length 103–107 (106 ± 2); protopod length 62–76 (70 ± 5); exopod length 31–42 (36 ± 4); endopod length 22–26 (25 ± 2). Protopods and rami of legs 1 and 2 ornamented with rows of blunt spinules on anterior surface.

Intercoxal sclerites of legs 1 and 2 (Figs 12–13) bearing 4 processes.

Leg 3 (Fig. 14) represented by 2 simple setae on small papilla at anterior mid-lateral surface of trunk. Leg 4 (Fig. 15) represented by 1 simple lateral seta on posterior ¾ of trunk.

Variability of measurement. The ”other material” specimens shares all important morphological characters with the type series. Measurement of their body parts and appendages was as follows: body length 1261–1383 (1309 ± 47), cephalothorax length 282–319 (304 ± 14), cephalothorax width 356–393 (369 ± 15), trunk length 969–1080 (1028 ± 40), trunk width 288–337 (305 ± 21), abdomen length 55–74 (59 ± 8), abdomen width 110–132 (121 ± 8), caudal ramus length 25–28 (25 ± 1), caudal ramus width 15–21 (18 ± 2), antennule length 193–215 (202 ± 9), antenna proximal segment length 72–98 (81 ± 10),antenna middle segment length 195–213 (204 ± 8), antenna terminal segment length 43–52 (47 ± 4), antenna total length 314–350 (332 ± 15), leg 1 length 109–130 (118 ± 8),leg 1 protopod length 66–78 (71 ± 5), leg 1 exopod length 43–52 (47 ± 4), leg 1 endopod length 25–33 (28 ± 3), leg 2 length 112–124 (117 ± 5), leg 2 protopod length 75–84 (79 ± 4), leg 2 exopod length 35–40 (38 ± 2), leg 2 endopod length 25–34 (29 ± 3).

Attachment site. Gill filaments.

Remarks. *Hatschekia hemicyclium* **n. sp.** shares 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species, namely *H. balistae* Nuñes-Ruivo, 1954; *H. bibullae* Uyeno & Nagasawa, 2009; *H. cylindrus* Uyeno & Nagasawa, 2009; *H. khahajya* Uyeno & Nagasawa, 2009; *H. kuroshioensis* Uyeno & Nagasawa, 2009; *H. lima* Uyeno & Nagasawa, 2009; *H. monacanthi* Yamaguti, 1939; *H. ostracii* Yamaguti, 1953; *H. pseudostracii* Uyeno & Nagasawa, 2009 and *H. sunaoi* Uyeno & Nagasawa, 2009. Of these species, 6 (i.e. *H. bibullae*, *H. cylindrus*, *H. khahajya*, *H. kuroshioensis*, *H. lima* and *H. monacanthi*) are differentiated from this new species by the number of leg elements. *Hatschekia pseudostracii* differs from the new species by having 10 setae on the proximal segment of the antennule. The setal elements of the antennule and legs 1-2 were inadequately described for *H. balistae* by Nuñes-Ruivo (1954) and it is thus difficult to compare the numbers of elements of these appendages between *H. balistae* and the new species. Nonetheless, *H. balistae* differs from the new species by having a distinct apex on the cephalothorax. *Hatschekia ostracii* is also distinguishable from the new species in bearing distinct posterior processes on the trunk while *H. sunaoi* differs from the new species by the following characteristics: the lack of a distinct parabasal papilla and the swollen base of leg 3.

Etymology. The specific name of the new species, *hemicyclium*, refers to its semicircle cephalothorax.

***Hatschekia jonesi* n. sp.**
(Figs 16–29)

Type material. Holotype, female (NSMT–Cr 20901), ex *Sufflamen bursa* (Bloch & Schneider) (Tetraodontiformes: Balistidae), off Cape Maeda (26°26'N, 127°46'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 2 September 2005. Paratypes: 6 females (NSMT–Cr 20902), ex *S. bursa*, off Cape Maeda (26°26'N, 127°46'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 2 September 2005.

Other material examined. 5 females (RUMF–ZC–00922), ex *S. fraenatum* (Latreille), off Chatan (26°19'N, 127°44'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 9 December 2005.

Description of female. Body (Fig. 16) 837–1034 (902 ± 61) long, excluding caudal rami (n = 12). Cephalothorax round, slightly shorter than wide [175–220 (195 ± 16) × 212–276 (236 ± 20)], with dorsal, M-shaped chitinous frame. Trunk rod-like, longer than wide [666–818 (711 ± 47) × 166–198 (182 ± 12)], widest in anterior ¼. Urosome (Fig. 17) excluding caudal ramus shorter than wide [34–49 (42 ± 5) × 58–80 (69 ± 7)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 17) slightly longer than wide [15–28 (20 ± 4) × 10–17 (13 ± 2)], bearing 5 naked setae.

Rostrum expanded anteriorly with 1 round process on each posterolateral corner (Fig. 18). Antennule (Fig. 18) indistinctly 5-segmented, 138–166 (146 ± 9) long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 19) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw bearing 1 basal seta; proximal segment length 41–50 (39 ± 16); middle segment length 101–135 (99 ± 42); terminal claw length 25–32 (24 ± 10); total length 169–210 (162 ± 67). Parabasal papilla (Fig. 20) well developed, wrinkled, extending to mid-lateral level of cephalothorax and visible from dorsal side. Oral cone robust. Mandible (Fig. 21) slender, with 4 sharp apical teeth. Maxillule (Fig. 22) bilobate; both lobes armed with 2 tapering elements; 2 elements on inner lobe swollen. Maxilla (Fig. 23) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 24–25) biramous, with exopods composed of 2 indistinct segments and 2–segmented endopods; leg armature formula as follows:

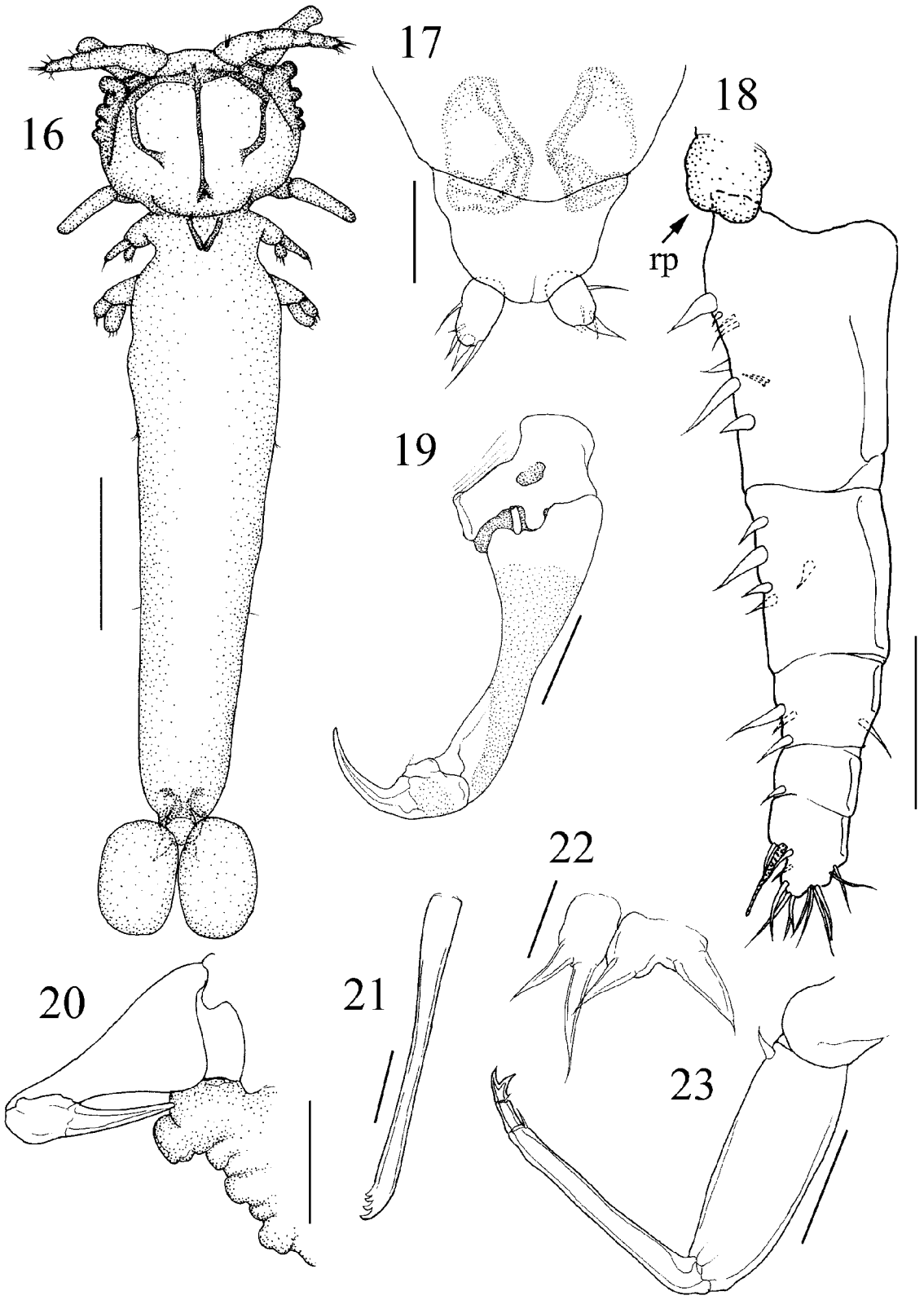
	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–0; 4

Leg 1 (Fig. 24) 87–105 (93 ± 6) long; protopod length 44–59 (50 ± 4); exopod length [39–46 (42 ± 2)] exceeding endopod length [24–36 (29 ± 3)]. Leg 2 (Fig. 25) length 94–114 (102 ± 7); protopod length 57–69 (64 ± 4); exopod length 35–45 (38 ± 3); endopod length 45–56 (51 ± 3). Both exopods and protopod of leg 2 ornamented with rows of blunt spinules on anterior surface. Endopod of leg 2 broad.

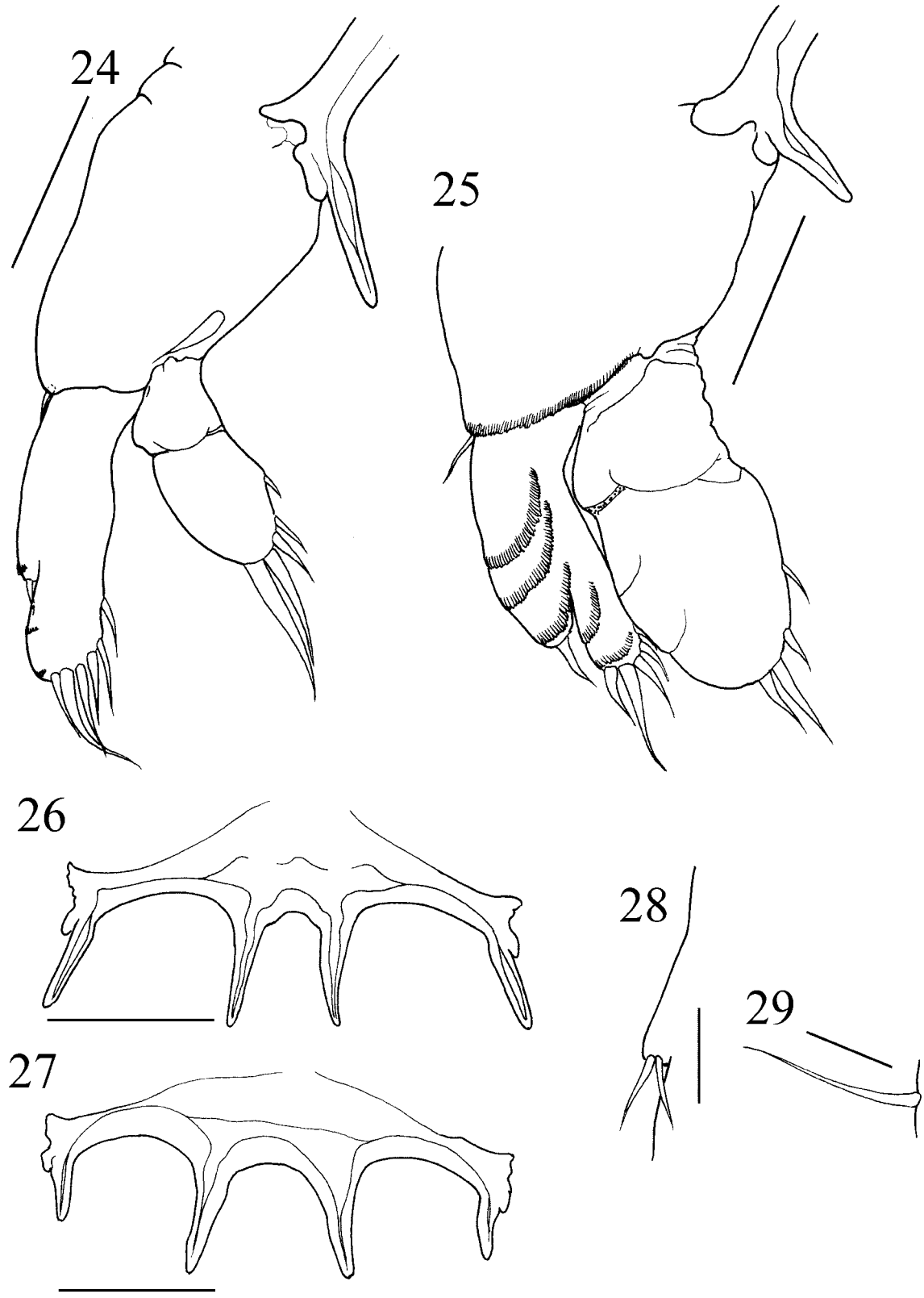
Intercoxal sclerites of legs 1 and 2 (Figs 26–27) bearing 4 processes.

Leg 3 (Fig. 28) represented by 2 simple setae on small conical process at anterior mid-lateral surface of trunk. Leg 4 (Fig. 29) represented by 1 simple lateral seta on posterior ¾ of trunk.

Variability of measurement. Specimens used as "other materials" did not show remarkable differences in meristic characters. Measurements of body parts and appendages as follows: body length 598–874 (779 ± 105), cephalothorax length 126–199 (180 ± 31), cephalothorax width 187–224 (210 ± 41), trunk length 472–690 (603 ± 80), trunk width 125–227 (199 ± 42), abdomen length 28–46 (38 ± 7), abdomen width 49–74 (65 ± 10), caudal ramus length 17–23 (20 ± 3), caudal ramus width 9–13 (12 ± 2), antennule length 110–160 (141 ± 20), antenna proximal segment length 28–44 (39± 7), antenna middle segment length 57–92 (80 ± 16), antenna terminal segment length 18–35 (26 ± 6), antenna total length 103–163 (145 ± 25), leg 1 length 58–84 (76 ± 11), leg 1 protopod length 34–52 (44 ± 8), leg 1 exopod length 24–38 (33 ± 5), leg 1 endopod length 18–29 (26 ± 4), leg 2 length 58–92 (80 ± 14), leg 2 protopod length 37–60 (53 ± 9), leg 2 exopod length 21–32 (27 ± 5), leg 2 endopod length 23–38 (31 ± 6).



FIGURES 16–23. *Hatschekia jonesi* **n. sp.**, female, holotype NSMT–Cr 20901. 16, habitus dorsal; 17, posterior part of trunk, dorsal; 18, antennule, ventral, rp = rostrum process (drawn from a paratype, NSMT–Cr 20902); 19, antenna, ventral. (drawn from a paratype, NSMT–Cr 20902); 20, antenna with parabasal papilla (drawn from a paratype, NSMT–Cr 20902); 21, mandible (drawn from a paratype, NSMT–Cr 20902); 22, maxillule; 23, maxilla. Scale bars: 16, 200μm; 17–19, 23, 40μm; 20, 22, 20μm; 21, 10μm.



FIGURES 24–29. *Hatschekia jonesi* **n. sp.**, female, holotype NSMT–Cr 20901. 24, leg 1, anterior view; 25, leg 2, anterior view; 26, intercoxal sclerite of leg 1, anterior view; 27, intercoxal sclerite of leg 2, anterior view; 28, leg 3, ventral; 29, leg 4, ventral. Scale bars: 24–27, 30μm; 28–29, 10μm.

Attachment site. Gill filaments.

Remarks. *Hatschekia jonesi* **n. sp.** also has 4 processes on the intercoxal sclerites of legs 1 and 2. These processes are shared with 10 species (see remarks for *H. hemicyclium*) and one new species, namely *H.*

hemicyclium **n. sp.** *Hatschekia jonesi* **n. sp.** is distinguishable from 7 species (*H. balistae, H. bibullae, H. cylindrus, H. khahajya, H. kuroshioensis, H. monacanthi* and *H. pseudostracii*) by having leg 3 located on a small conical process. Even though the base of leg 3 was not described for *H. balistae* it can be separated from the new species by the presence of an apex on the cephalothorax. *Hatschekia hemicyclium* **n. sp.** differs from the new species as follows: leg 2 with the exopod longer than the endopod, a considerably higher leg 2 exopod length/endopod length ratio [1.39 ± 0.16 vs. 0.80 ± 0.08 (U-test; $p<0.001$), Table 1], a smaller parabasal papilla, leg 3 represented by setae on a small papilla, and leg 2 with a broad endopod. *Hatschekia lima* is distinguishable from the new species by having 4 setae on the distal tip of the endopod of leg 1 and the maxillule with a highly sclerotized inner lobe while *H. sunaoi* is differentiated from the new species by having a distinctly higher antenna length/body length ratio [0.40 ± 0.03, vs. 0.18 ± 0.06 (U-test; $p<0.001$), Table 1, see also table 1 in Uyeno & Nagasawa 2009b] and by not having a well-developed parabasal papilla (Uyeno & Nagasawa 2009b).

Etymology. The specific name of the new species, *jonesi*, honors Dr. J. B. Jones who has greatly contributed to the taxonomy of the genus *Hatschekia*.

***Hatschekia kabatai* n. sp.**
(Figs 30–44)

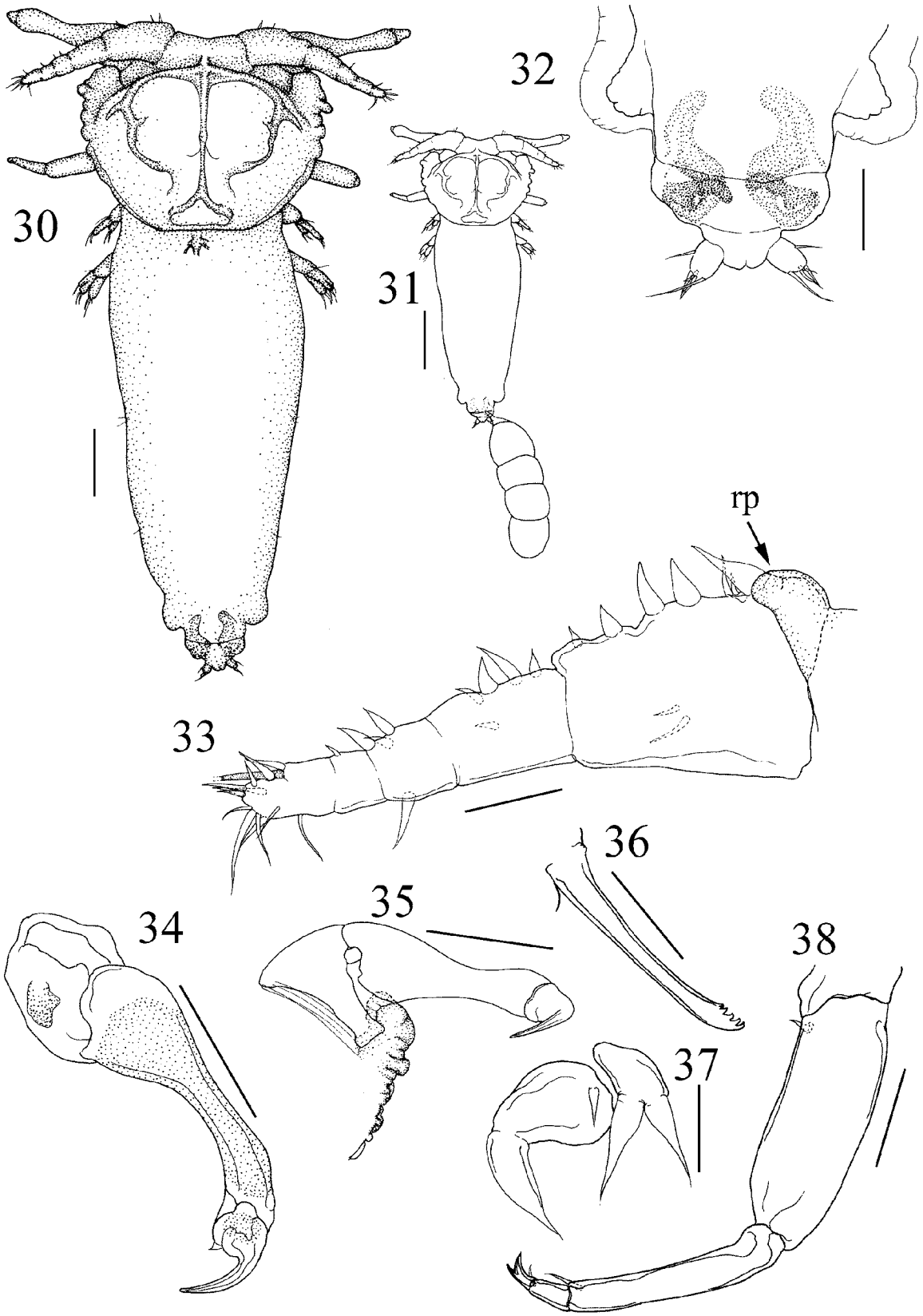
Type material. Holotype, female (NSMT–Cr 20903), ex *Xanthichthys lineopunctatus* (Hollard) (Tetraodontiformes: Balistidae), off Izena-jima Island (26°55'N, 127°54'E), the Ryukyu Islands, East China Sea, Japan, 10 April 2008. Paratypes: 3 females (NSMT–Cr 20904), ex *X. lineopunctatus*, off Izena-jima Island (26°55'N, 127°54'E), the Ryukyu Islands, East China Sea, Japan, 10 April 2008; 3 females (RUMF–ZC–00923), ex *X. lineopunctatus*, off Izena-jima Island (26°55'N, 127°54'E), the Ryukyu Islands, East China Sea, Japan, 10 April 2008.

Description of female. Body (Figs 30–31) 876–946 (912 ± 31) long, excluding caudal rami (n = 7). Cephalothorax ellipsoidal, slightly shorter than wide [252–285 (267 ± 10) ×313–360 (333 ± 17)], with dorsal, M-shaped chitinous frame with mid-line bifurcated at posterior end. Trunk bearing posterior lobes, longer than wide [639–772 (680 ± 46) × 233–331 (271 ± 34)], widest in anterior ¼. Urosome (Fig. 32) excluding caudal ramus shorter than wide [31–46 (37 ±) × 67–87 (76 ± 7)], with constriction in middle. Genital complex fused to abdomen without border. Caudal ramus (Fig. 32) slightly longer than wide [18–21 (20 ± 1) × 9–15 (13 ± 2)], bearing 5 naked setae.

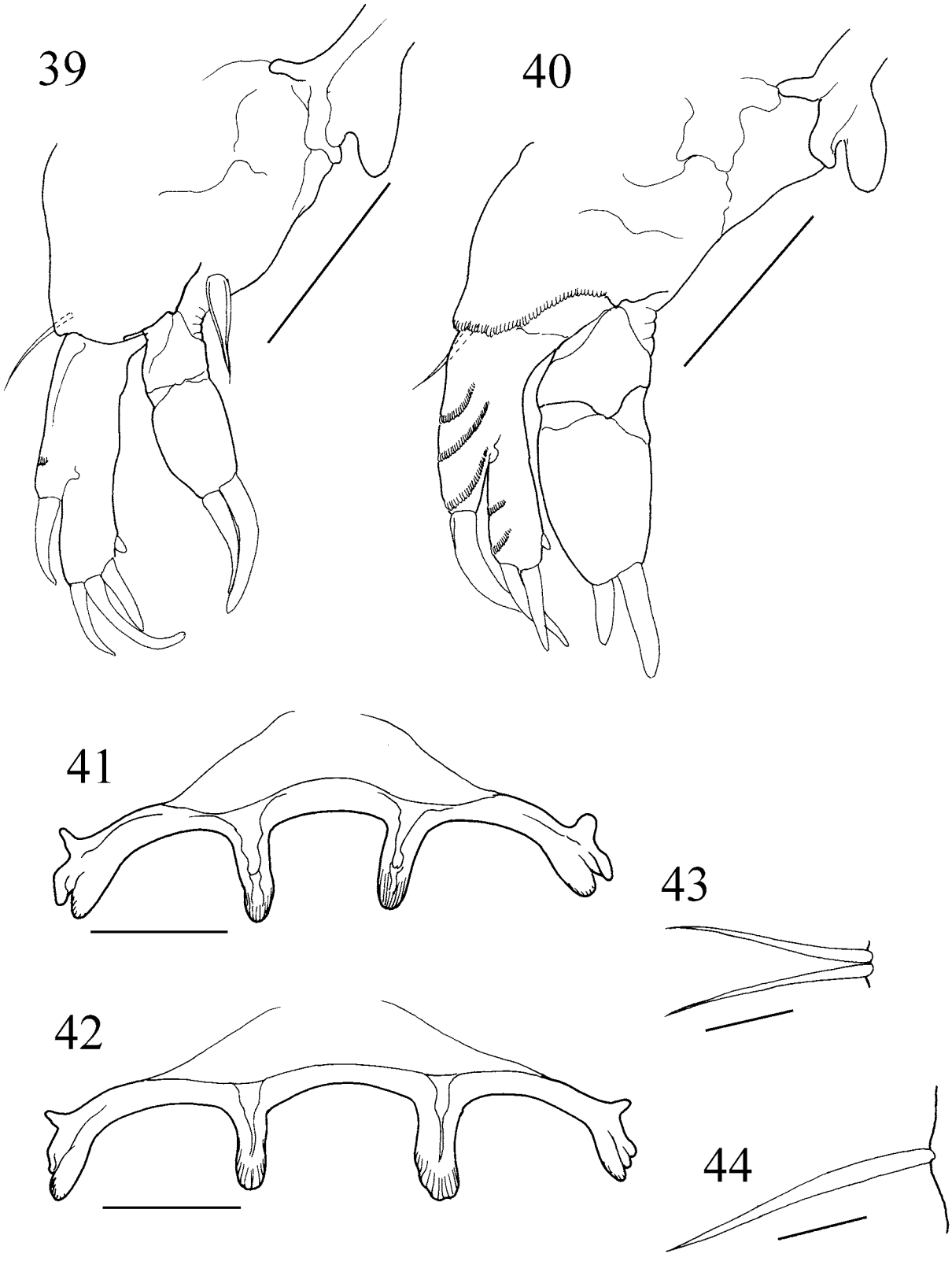
Rostrum expanded anterior to cephalothorax with 1 digitiform process on posterolateral corners (Fig. 33). Antennule (Fig. 33) indistinctly 5-segmented, 150–245 (220 ± 33) long; armature formula: 10, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 34) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with 1 basal seta; proximal segment length 67–83 (76 ± 5); middle segment length 144–201 (167 ± 18); terminal claw length 34–70 (42 ± 13); total length 258–345 (284 ± 29). Parabasal papilla (Fig. 35) well developed, wrinkled. Oral cone robust. Mandible (Fig. 36) slender, with 5 sharp apical teeth. Maxillule (Fig. 37) bilobate; both lobes armed with 2 tapering elements; inner lobe bearing swollen inner element. Maxilla (Fig. 38) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 39–40) biramous, with both exopods composed of 2 indistinct segments and 2–segmented endopods; both rami bearing blunt setae; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 4 (4–6)	0–0; 2 (2–3)
Leg 2	1–0	1–0; 3 (3–5)	0–0; 2 (2–3)



FIGURES 30–38. *Hatschekia kabatai* **n. sp.**, female, holotype NSMT–Cr 20903. 30, habitus dorsal; 31, habitus dorsal with egg sacs; 32, posterior part of trunk, dorsal; 33, antennule, ventral, rp = rostrum process; 34, antenna, ventral; 35, antenna with parabasal papilla (drawn from a paratype, NSMT–Cr 20904); 36, mandible; 37, maxillule; 38, maxilla. Scale bars: 30, 34–35, 100μm; 31, 200μm; 32–33, 38, 40μm; 36–37, 20μm.



FIGURES 39–44. *Hatschekia kabatai* **n. sp.**, female, holotype NSMT–Cr 20903. 39, leg 1, anterior view; 40, leg 2, anterior view; 41, intercoxal sclerite of leg 1, anterior view; 42, intercoxal sclerite of leg 2, anterior view; 43, leg 3; 44, leg 4. Scale bars: 39–42, 40μm; 43–44, 10μm.

Leg 1 (Fig. 39) 103–120 (112 ± 8) long; protopod length 52–71 (63 ± 7); exopod length 46–51 (49 ± 2); endopod length 26–38 (32 ± 4). Leg 2 (Fig. 40) length 106–139 (117 ± 11); protopod length 61–88 (70 ± 9); exopod length 37–54 (47 ± 6); endopod length 51–57 (53 ± 2). Both exopods and protopods of leg 2 ornamented with rows of blunt spinules on anterior surface.

Intercoxal sclerites of legs 1 and 2 (Figs 41–42) bear 2 short processes and 2 long, wrinkled processes .

Leg 3 (Fig. 43) represented by 2 simple setae originating on anterior mid-lateral surface of trunk. Leg 4 (Fig. 44) represented by 1 simple lateral seta on posterior ¾ of trunk.

Attachment site. Gill filaments.

Remarks. *Hatschekia kabatai* **n. sp.** also has 4 processes on the intercoxal sclerites of legs 1 and 2, a character shared with 10 species (see remarks of *H. hemicyclium*) and 2 new species, i.e. *H. hemicyclium* n. sp. and *H. jonesi* n. sp. The new species has blunt setae on legs 1 and 2 a character not share with the abovementioned 12 congeners which typically have acutely pointed setae. Furthermore, *H. balistae* differs from the new species by the presence of an apex on the cephalothorax. The 10 setae on the proximal segment of the antennule present in the new species . is shared with 3 species (i.e. *H. lima*, *H. pseudostracii* and *H. sunaoi*). Howeve, the new species can be distinguished from these congeners by the presence of posterior lobes on its trunk.

Etymology. The specific name of the new species, *kabatai*, is dedicated to Dr. Z. Kabata, an outstanding copepodologist who has made great advances in the systematics and phylogeny of the parasitic copepods.

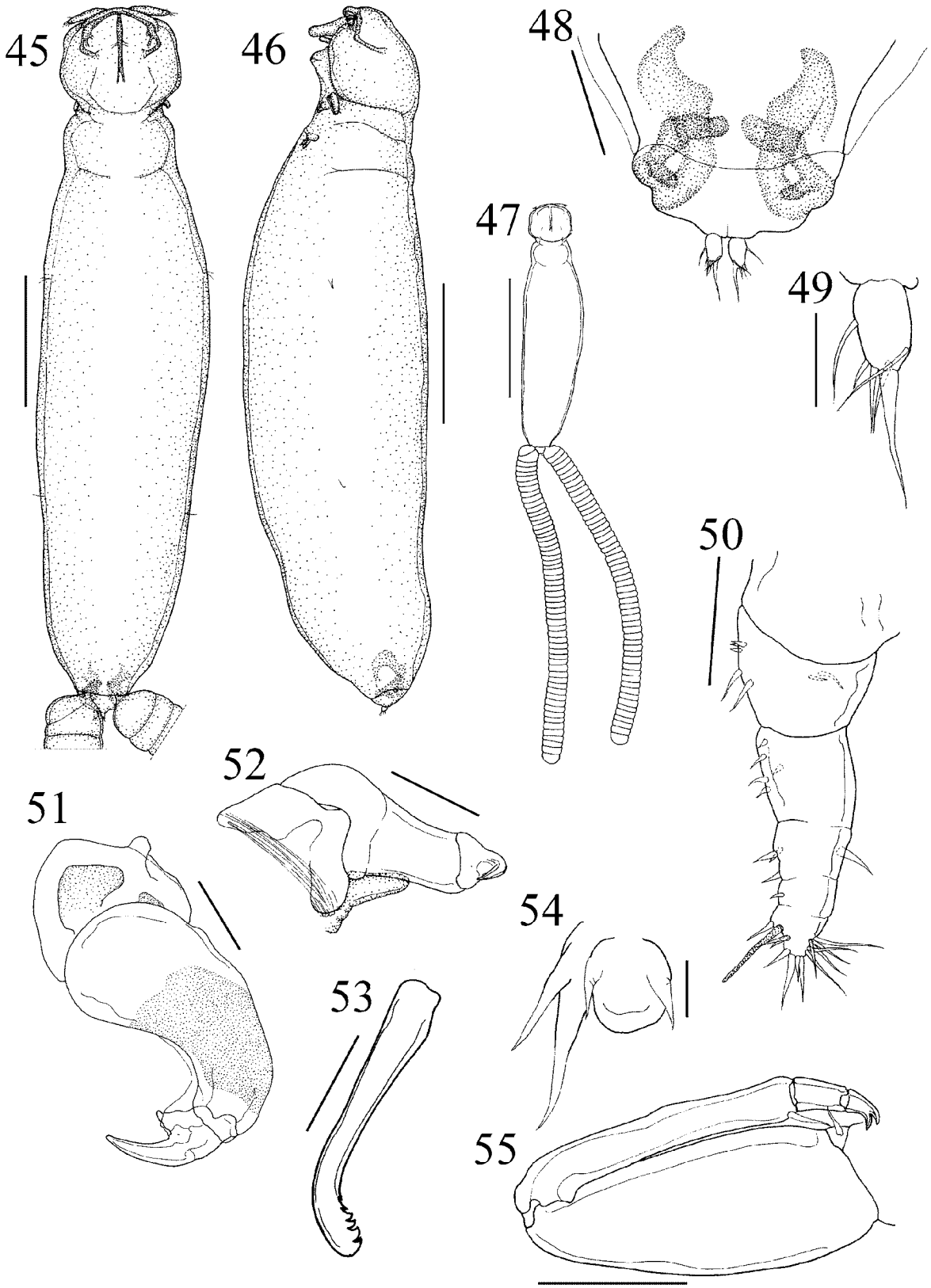
***Hatschekia izenaensis* n. sp.**
(Figs 45–61)

Type material. Holotype, female (NSMT–Cr 20905), ex *Xanthichthys lineopunctatus* (Hollard) (Tetraodontiformes: Balistidae), off Izena-jima Island (26°55'N, 127°54'E), the Ryukyu Islands, East China Sea, Japan, 10 April 2008. Paratypes: 2 females (NSMT–Cr 20906), ex *X. lineopunctatus*, off Izena-jima Island (26°55'N, 127°54'E), the Ryukyu Islands, East China Sea, Japan, 10 April 2008; 2 females (RUMF–ZC–00924), ex *X. lineopunctatus*, off Izena-jima Island (26°55'N, 127°54'E), the Ryukyu Islands, East China Sea, Japan, 10 April 2008.

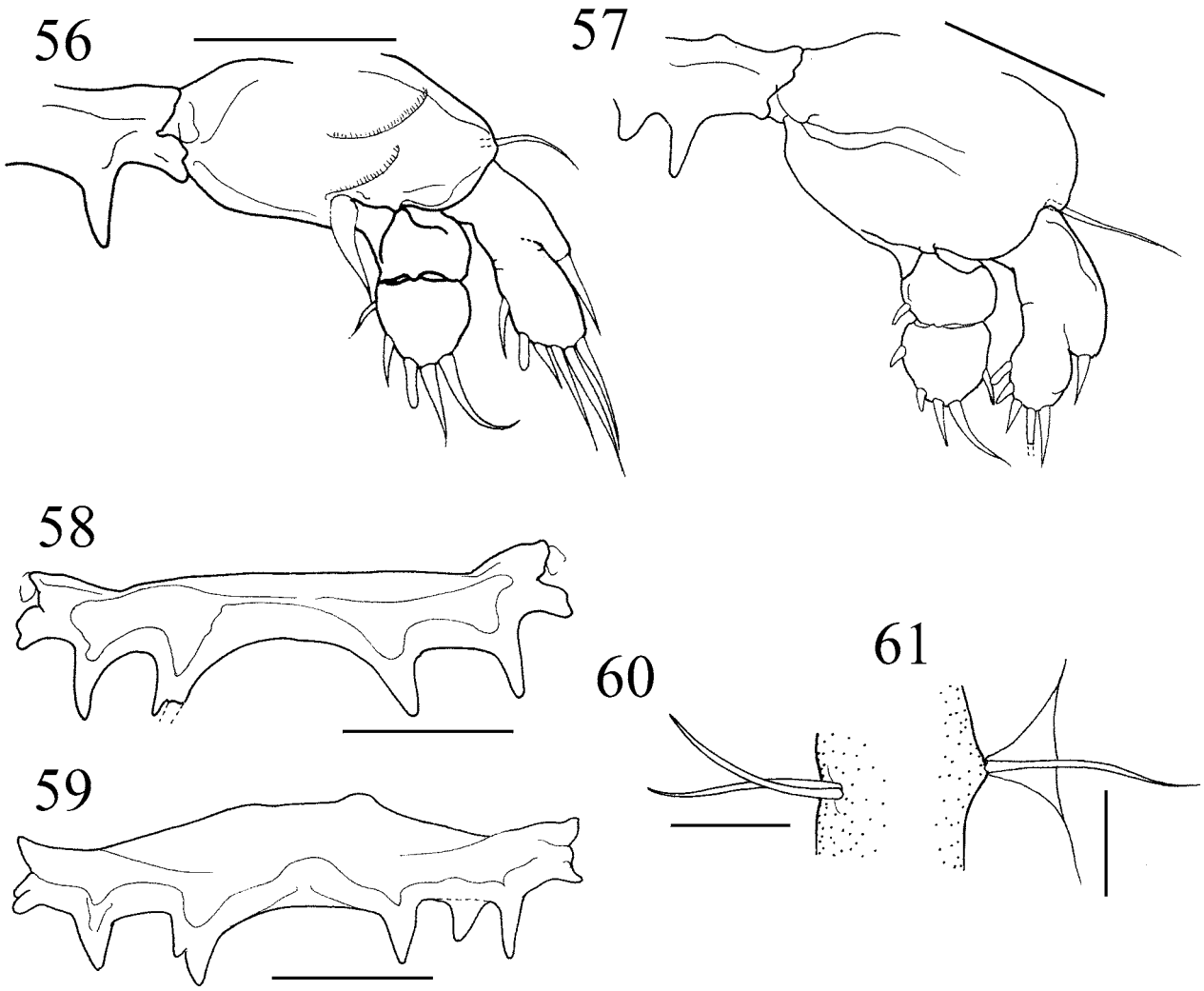
Description of female. Body (Figs 45–47) 1436–2145 (1748 ± 305) long, excluding caudal rami (n = 5). Cephalothorax hexagonal, fused to trunk, with distinct suture, slightly shorter than wide [252–323 (276 ± 29) × 273–369 (319 ± 41)], with dorsal, chitinous, trichotomous frame with mid-line extending beyond central point. Trunk sausage-shaped, longer than wide [1186–1829 (1463 ± 279) × 261–508 (364 ± 101)] with constriction in anterior 1/6. Urosome (Fig. 48) excluding caudal ramus shorter than wide [32–49 (38 ± 6) × 87–149 (107 ± 24)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 48–49) slightly longer than wide [20–23 (21 ± 1) × 11–13 (12 ± 1)], bearing 6 naked setae.

Rostrum without distinct anterior expansion. Antennule (Fig. 50) indistinctly 5-segmented, 110–129 (121 ± 7) long; armature formula: 7, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 51) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw bearing with robust, thick, basal process covered with thin membrane; proximal segment length 44–75 (51 ± 13); middle segment length 105–127 (112 ± 9); terminal claw length 24–33 (29 ± 4); total length 174–216 (192 ± 18). Parabasal papilla (Fig. 52) well developed, rod-like, half as long as middle segment of antenna. Oral cone robust. Mandible (Fig. 53) slender, with 6 sharp apical teeth. Maxillule (Fig. 54) bilobate; inner lobe carrying 2 small tapering elements; outer lobe with 1 large and 1 small tapering elements. Maxilla (Fig. 55) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment with 1 distal seta; terminal segment small, with bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 56–57) biramous, with both exopods composed of 2 indistinct segments and 2–segmented endopods; some setae on both rami blunt; leg armature formula as follows:



FIGURES 45–55. *Hatschekia izenaensis* **n. sp.**, female, holotype NSMT–Cr 20905. 45, habitus dorsal; 46, habitus lateral; 47, habitus dorsal with egg sacs; 48, posterior part of trunk, dorsal; 49, caudal ramus, dorsal; 50, antennule, ventral, rp = rostrum process; 51, antenna, ventral; 52, antenna with parabasal papilla (drawn from a paratype, NSMT–Cr 20906); 53, mandible; 54, maxillule; 55, maxilla. Scale bars: 45–46, 400μm; 47, 1000μm; 48, 80μm; 49, 53, 20μm; 50–51, 40μm; 52, 50μm; 54, 10μm; 55, 30μm.



FIGURES 56–61. *Hatschekia izenaensis* **n. sp.**, female, holotype NSMT–Cr 20905. 56, leg 1, anterior view; 57, leg 2, anterior view; 58, intercoxal sclerite of leg 1, anterior view; 59, intercoxal sclerite of leg 2, anterior view; 60, leg 3; 61, leg 4. Scale bars: 56–59, 30μm; 60–61, 10μm.

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–1; 5

Protopod of leg 1 ornamented with rows of blunt spinules on anterior surface. Leg 1 (Fig. 56) 67–82 (73 ± 6) long; protopod length 43–51 (47 ± 3); exopod length 22–31 (25 ± 3); endopod length 17–24 (20 ± 3). Leg 2 (Fig. 57) length 67–90 (80 ± 8); protopod length 46–55 (51 ± 4); exopod length 21–35 (28 ± 5); endopod length 22–26 (24 ± 2).

Intercoxal sclerite of legs 1 and 2 (Figs 58–59) bearing 4 processes plus some irregular processes ranging from 1 to 5 in number in different specimens.

Leg 3 (Fig. 60) represented by 2 simple setae originating on anterior ⅓ of trunk. Leg 4 (Fig. 61) represented by 1 simple lateral seta on posterior ¾ of trunk.

Attachment site. Gill filaments.

Remarks. *Hatschekia izenaensis* **n. sp.** shares the 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species (see remarks of *H. hemicyclium*) and 3 new species (i.e. *H. hemicyclium* **n. sp.**, *H. jonesi* **n. sp.** and *H. kabatai* **n. sp.**). The new species is easily separated from all these congeners by the presence of a variable number of irregular processes on the intercoxal sclerites and by the constriction of the trunk.

Etymology. The name of the new species refers to the type locality, Izena-jima Island.

***Hatschekia churaumi* n. sp.**
(Figs 62–75)

Type material. Holotype, female (NSMT–Cr 20907), ex *Pseudobalistes flavimarginatus* (Rüppell) (Tetraodontiformes: Balistidae), off Ishikawa Beach (26°25'N, 127°49'E), Okinawa-jima Island, the Ryukyu Islands, North Pacific Ocean, Japan, 1 September 2005. Paratypes: 2 females (NSMT–Cr 20908), ex *P. flavimarginatus*, off Ishikawa Beach (26°25'N, 127°49'E), Okinawa-jima Island, the Ryukyu Islands, North Pacific Ocean, Japan, 1 September 2005; 2 females (RUMF–ZC–00925), ex *P. flavimarginatus*, off Ishikawa Beach (26°25'N, 127°49'E), Okinawa-jima Island, the Ryukyu Islands, North Pacific Ocean, Japan, 1 September 2005.

Description of female. Body (Fig. 62) 644–738 (700 ± 39) long, excluding caudal rami (n = 5). Cephalothorax blunt sub-triangular, slightly shorter than wide [242–273 (261 ± 12) × 270–299 (292 ± 13)], widest in anterior ⅓, with dorsal, Y-shaped chitinous frame with mid-line ending as short horizontal bar immediately before triangular depression connecting posteriormost slit, bearing two small setae in small dorsal pits. Trunk tapering posteriorly, longer than wide [433–523 (470 ± 41) × 190–223 (208 ± 14)], widest near anterior end. Urosome (Fig. 63) excluding caudal ramus shorter than wide [27–43 (35 ± 6) × 41–62 (56 ± 9)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 63) slightly longer than wide [18–23 (20 ± 2) × 11–15 (13 ± 1)], bearing 5 naked setae.

Rostrum with 1 digitiform process at each posterolateral corner (Fig. 64). Antennule (Fig. 64) indistinctly 5-segmented, 144–184 (162 ± 15) long; armature formula: 10, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 65) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw without armature; proximal segment length 77–88 (82 ± 5); middle segment length 143–172 (162 ± 11); terminal claw length 34–57 (48 ± 9); total length 273–312 (293 ± 15). Parabasal papilla (Fig. 66) developed, digitiform. Oral cone robust. Mandible (Fig. 67) slender, with 3 sharp apical teeth. Maxillule (Fig. 68) bilobate; both lobes armed with 2 tapering elements. Maxilla (Fig. 69) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

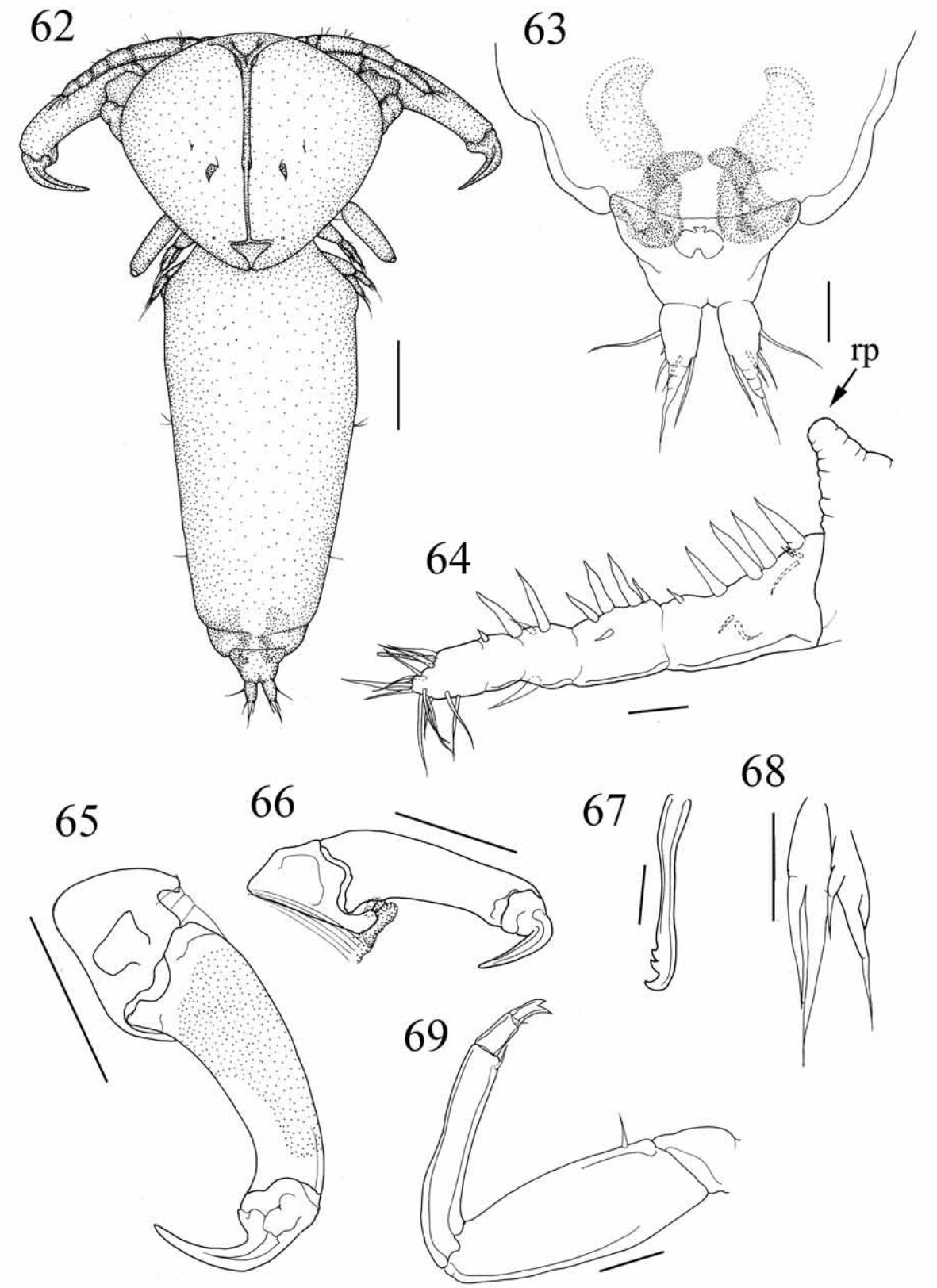
Legs 1 and 2 (Figs 70–71) biramous, with both exopods composed of 2 indistinct segments and 2–segmented endopods; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 3	0–0; 2
Leg 2	1–0	1–0; 2 (1–2)	0–1; 2

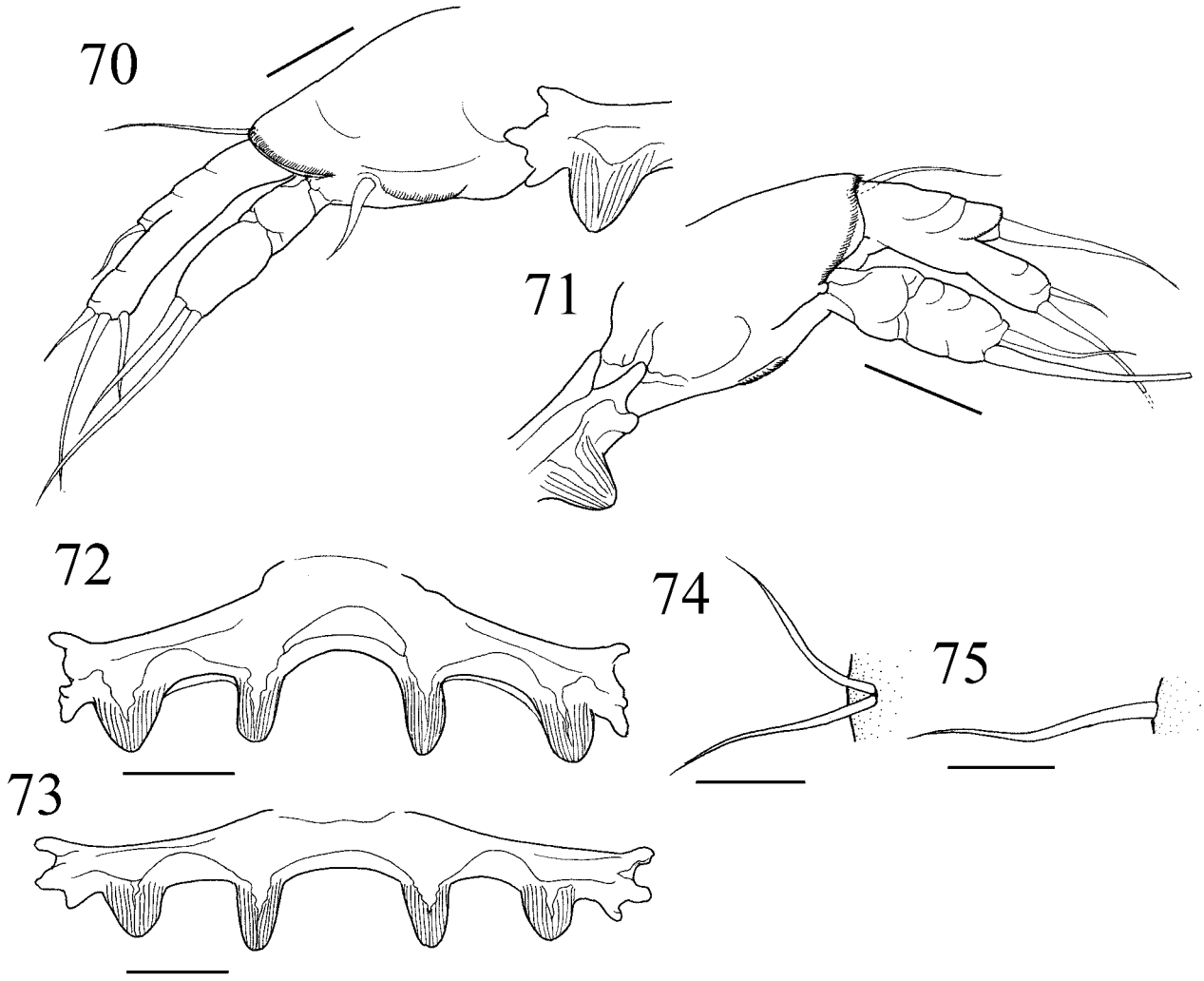
Protopods of legs 1 and 2 ornamented with rows of blunt spinules on anterior surface. Both rami of legs 1 and 2 carrying semicircular wrinkles (it is uncertain whether these wrinkles are spinulate or membranous). Leg 1 (Fig. 70) 81–105 (88 ± 10) long; protopod length 42–59 (49 ± 7); exopod length 35–46 (40 ± 4); endopod length 23–35 (28 ± 4). Leg 2 (Fig. 71) length 79–89 (82 ± 4); protopod length 44–53 (50 ± 3); exopod length 29–36 (33 ± 3); endopod length 23–29 (26 ± 3).

Intercoxal sclerites of legs 1 and 2 (Figs 72–73) bearing 4 spatulate, wrinkled processes.

Leg 3 (Fig. 74) represented by 2 simple setae originating on mid-lateral surface of trunk. Leg 4 (Fig. 75) represented by 1 simple lateral seta on posterior ¾ of trunk.



FIGURES 62–69. *Hatschekia churaumi* **n. sp.**, female, holotype NSMT–Cr 20907. 62, habitus dorsal; 63, posterior part of trunk, dorsal; 64, antennule, ventral, rp = rostrum process; 65, antenna, ventral; 66, antenna with parabasal papilla; 67, mandible; 68, maxillule; 69, maxilla. Scale bars: 62, 65–66, 100µm; 63–64, 68–69, 20µm; 67, 10µm.



FIGURES 70–75. *Hatschekia churaumi* **n. sp.**, female, holotype NSMT–Cr 20907. 70, leg 1, anterior view; 71, leg 2, anterior view; 72, intercoxal sclerite of leg 1, anterior view; 73, intercoxal sclerite of leg 2, anterior view; 74, leg 3; 75, leg 4. Scale bars: 70–73, 20μm; 74–75, 10μm.

Attachment site. Gill filaments.

Remarks. *Hatschekia churaumi* **n. sp.** shares the presence of 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species (see remarks of *H. hemicyclium*) and 4 new species (i.e. *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.** and *H. kabatai* **n. sp.**). The new species lacks the distinct apex on the cephalothorax present in *H. balistae* and differs from *H. bibullae*, *H. cylindrus*, *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.**, *H. kabatai* **n. sp.**, *H. khahajya*, *H. kuroshioensis*, *H. monacanthi* and *H. ostracii* in having 10 setae on the proximal segment of the antennule and in the spatulate shape of the 4 processes on the intercoxal sclerites of legs 1 and 2. *Hatschekia lima* and *H. sunaoi* both have 10 setae on the proximal segment of the antennule but differ from the new species in having 4 pointed, non-spatulate processes on the intercoxal sclerites of legs 1 and 2. In addition, the new species can also be separated from these two species by having 2 setae on the endopods of legs 1 and 2, instead of 4–5.

Etymology. The specific name of the new species, *churaumi*, is a dialect of Okinawa, referring to the beautiful ocean around the Ryukyu Islands.

***Hatschekia zanpa* n. sp.**
(Figs 76–90)

Type material. Holotype, female (NSMT–Cr 20909), ex *Balistapus undulatus* (Park) (Tetraodontiformes: Balistidae), off Cape Zanpa (26°26'N, 127°42'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 7 April 2007. Paratypes: 1 female (RUMF–ZC–00926), ex *B. undulatus*, off Cape Zanpa (26°26'N, 127°42'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 7 April 2007; 6 females (NSMT–Cr 20910), ex *B. undulatus*, off Chatan (26°19'N, 127°44'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 19 July 2007.

Description of female. Body (Fig. 76) 485–546 (516 ± 19) long, excluding caudal rami (n = 8). Cephalothorax round, slightly shorter than wide [152–180 (161 ± 9) × 169–209 (186 ± 13)], widest in middle, with dorsal, T-shaped chitinous frame and 2 additional independent, short frames; bearing irregular protrusions on lateral margins. Trunk elongated, longer than wide [334–374 (354 ± 13) × 126–145 (134 ± 7)], ornamented with scale-like structures (Fig. 77). Genital complex distinctly separated from abdomen (Fig. 78). Urosome excluding caudal ramus as long as wide [43–58 (51 ± 5) × 53–58 (51 ± 5)]. Caudal ramus (Fig. 78) slightly longer than wide [21–30 (25 ± 3) ×13–17 (15 ± 1)], bearing 5 naked setae.

Rostrum with 1 digitiform process at each posterolateral corner (Fig. 79). Antennule (Fig. 79) indistinctly 5-segmented, 129–174 (148 ±13) long; armature formula: 10, 5, 4, 1, 13 + 1 aesthetasc; some setae blunt, papilliform; proximal segment with small knobs. Antenna (Fig. 80) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with small seta near base; proximal segment length 31–59 (43 ± 8); middle segment length 86–122 (108 ±14); terminal claw length 22–43 (28 ± 7); total length 153–187 (174 ± 14). Parabasal papilla (Fig. 81) digitiform. Oral cone robust. Mandible (Fig. 82) slender, with 3 sharp apical teeth. Maxillule (Fig. 83) bilobate; inner rod-like lobe elongated, chitinized; both lobes armed with 2 tapering elements. Maxilla (Fig. 84) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 85–86) biramous, with both exopods composed of 2 indistinct segments and 2–segmented endopods; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 4
Leg 2	1–0	1–0; 5	0–0; 4

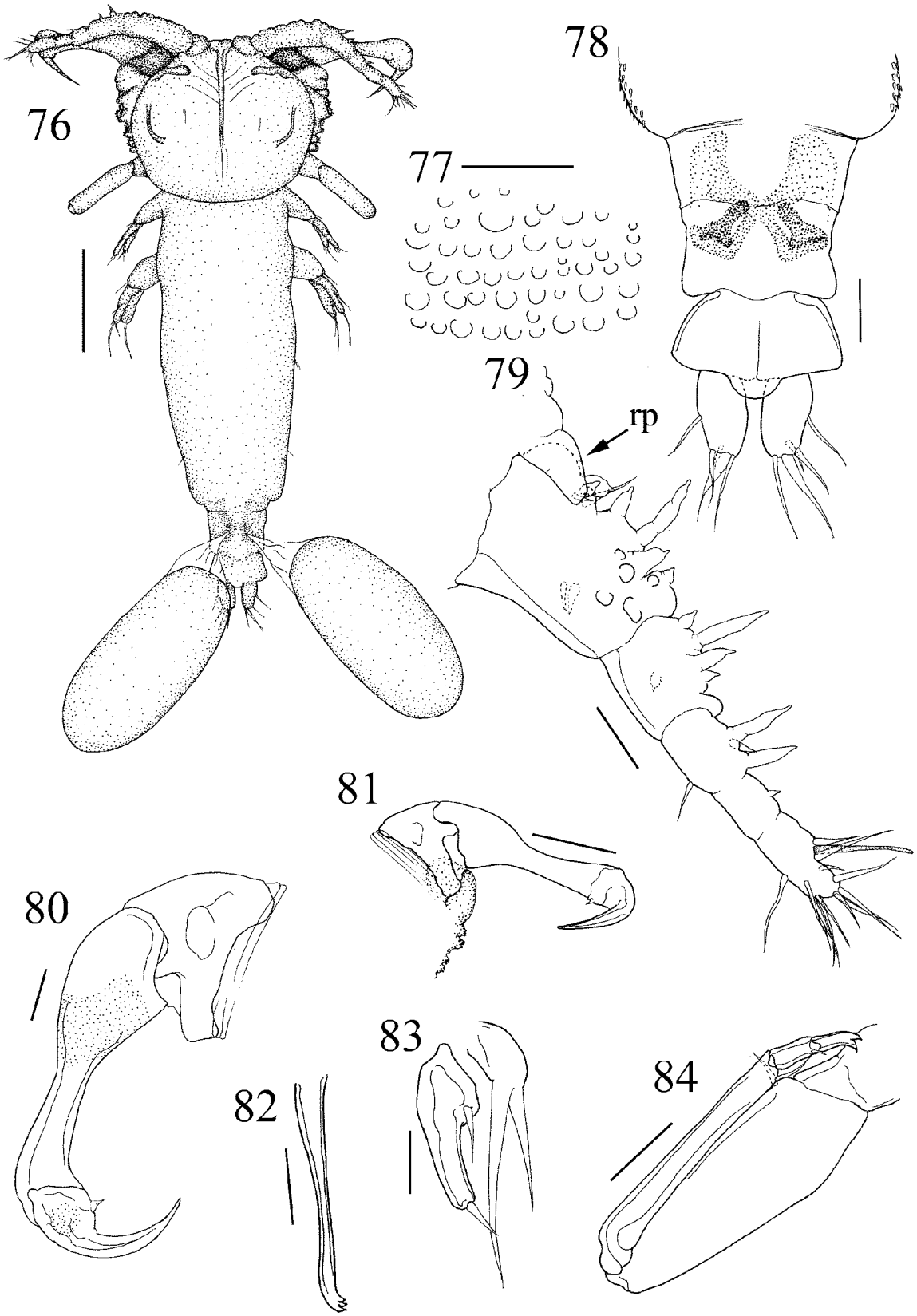
Leg 1 (Fig. 85) 71–93 (81 ± 8) long; protopod length 38–52 (45 ± 5); exopod length 32–45 (36 ± 4); endopod length 26–31 (29 ± 2). Leg 2 (Fig. 86) length 73–95 (86 ± 8); protopod length 40–57 (49 ± 6); exopod length 33–38 (36 ± 2); endopod length 37–41 (39 ± 1). Protopods and rami of legs 1 and 2 respectively ornamented on anterior surfaces with rows of blunt spinules and semicircular surface wrinkles (it is uncertain whether these wrinkles are spinulate or membranous). Intercoxal sclerites of legs 1 and 2 (Figs 87–88) bearing 2 long and 2 short processes.

Leg 3 (Fig. 89) represented by 2 simple setae on conical process at mid-lateral surface of trunk. Leg 4 (Fig. 90) represented by 1 simple lateral seta on posterior ¾ of trunk.

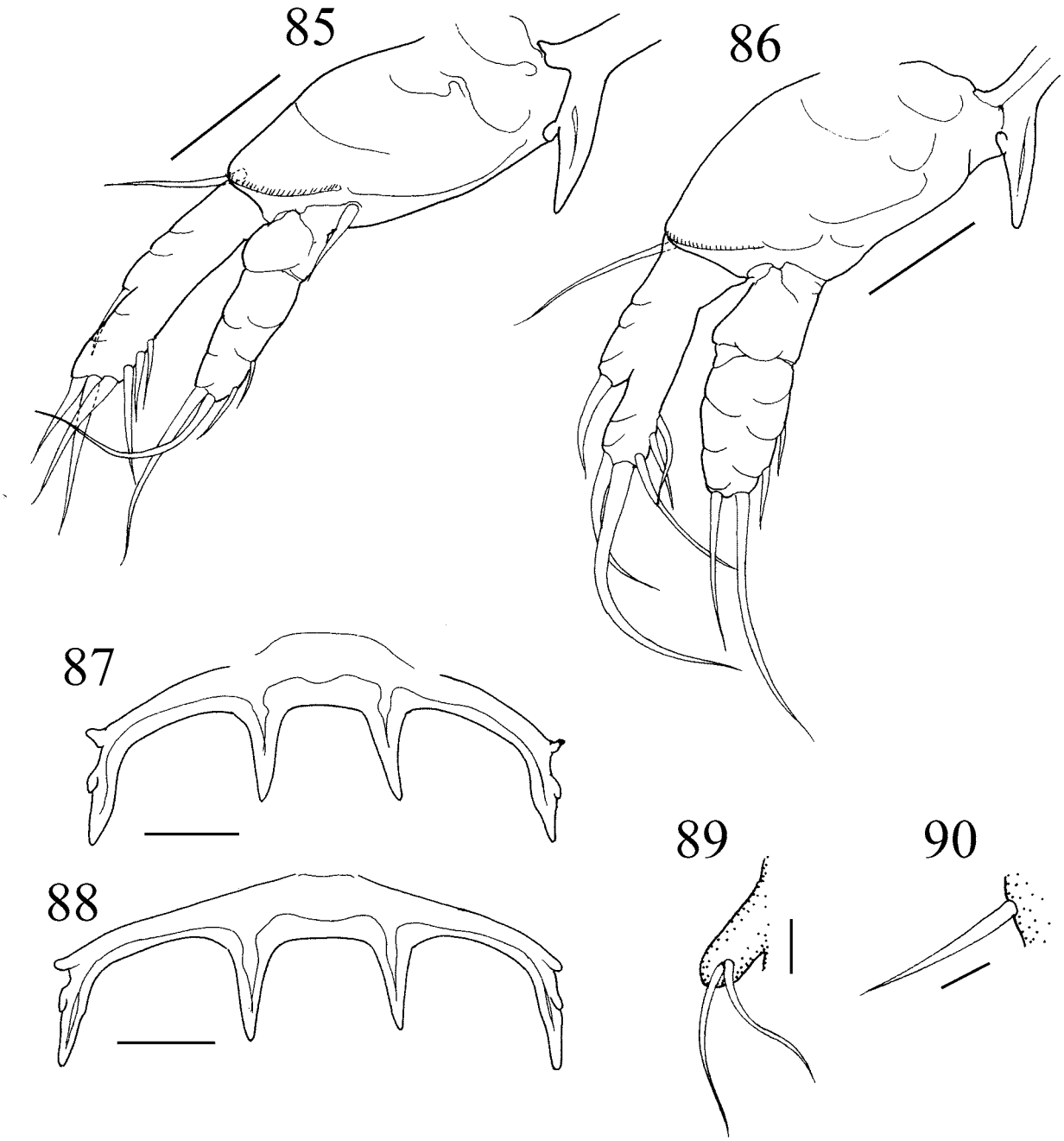
Attachment site. Gill filaments.

Remarks. *Hatschekia zanpa* **n. sp.** shares the 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species (see remarks of *H. hemicyclium*) and 5 new species (*H. churaumi* **n. sp.**, *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.** and *H. kabatai* **n. sp.**). However, the new species is easily distinguished from them by having a genital complex distinctly separated from the abdomen, whereas all the others lack a border between the genital complex and abdomen.

Etymology. The name of the new species refers to the type locality, Cape Zanpa.



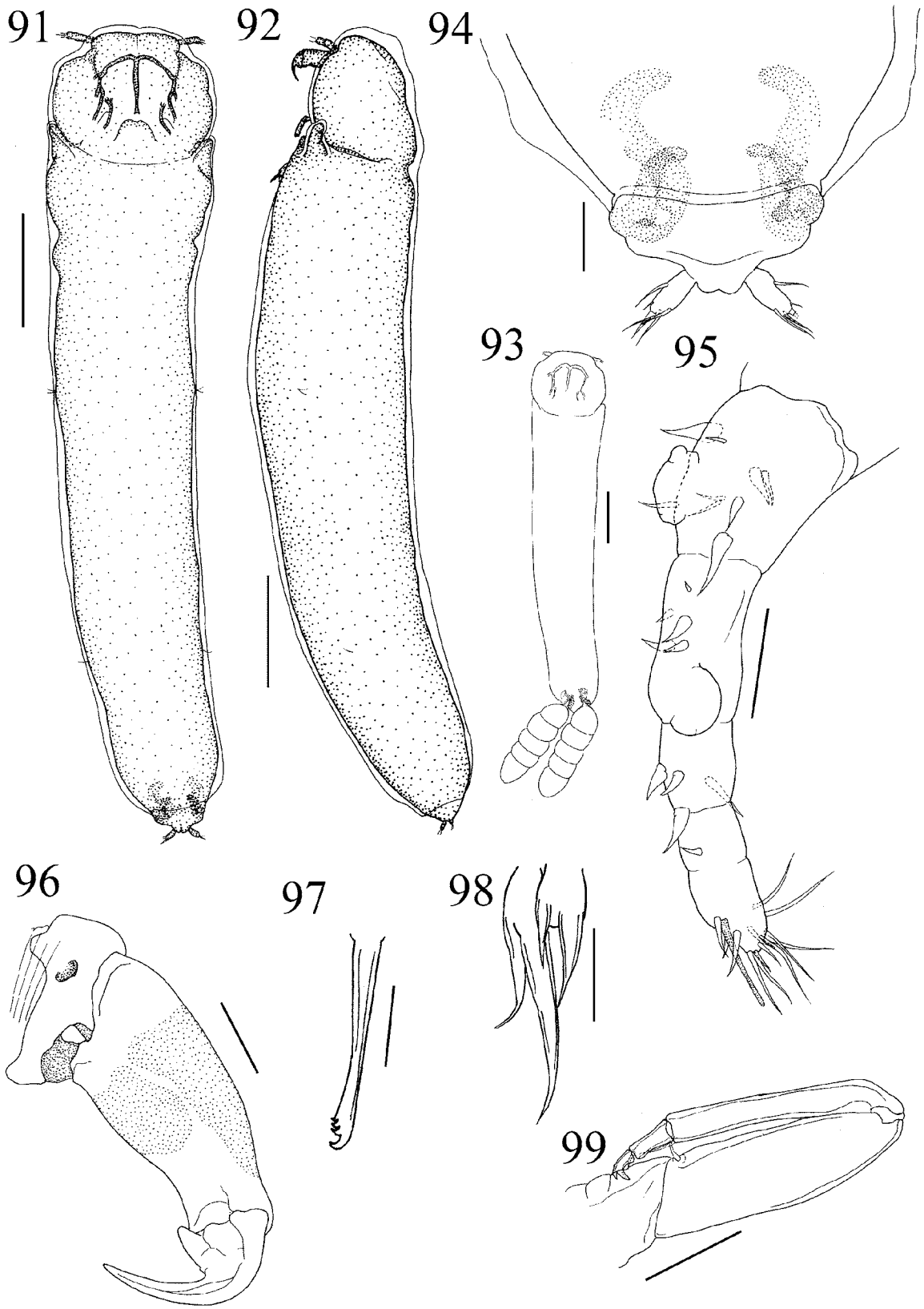
FIGURES 76–84. *Hatschekia zanpa* **n. sp.**, female, holotype NSMT–Cr 20909. 76, habitus dorsal; 77, surface of trunk; 78, posterior part of trunk, dorsal; 79, antennule, ventral, rp = rostrum process; 80, antenna, ventral; 81, antenna with parabasal papilla (drawn from a paratype, NSMT–Cr 20910); 82, mandible; 83, maxillule; 84, maxilla. Scale bars: 76, 100μm; 77–80, 84, 20μm; 81, 50μm; 82–83, 10μm.



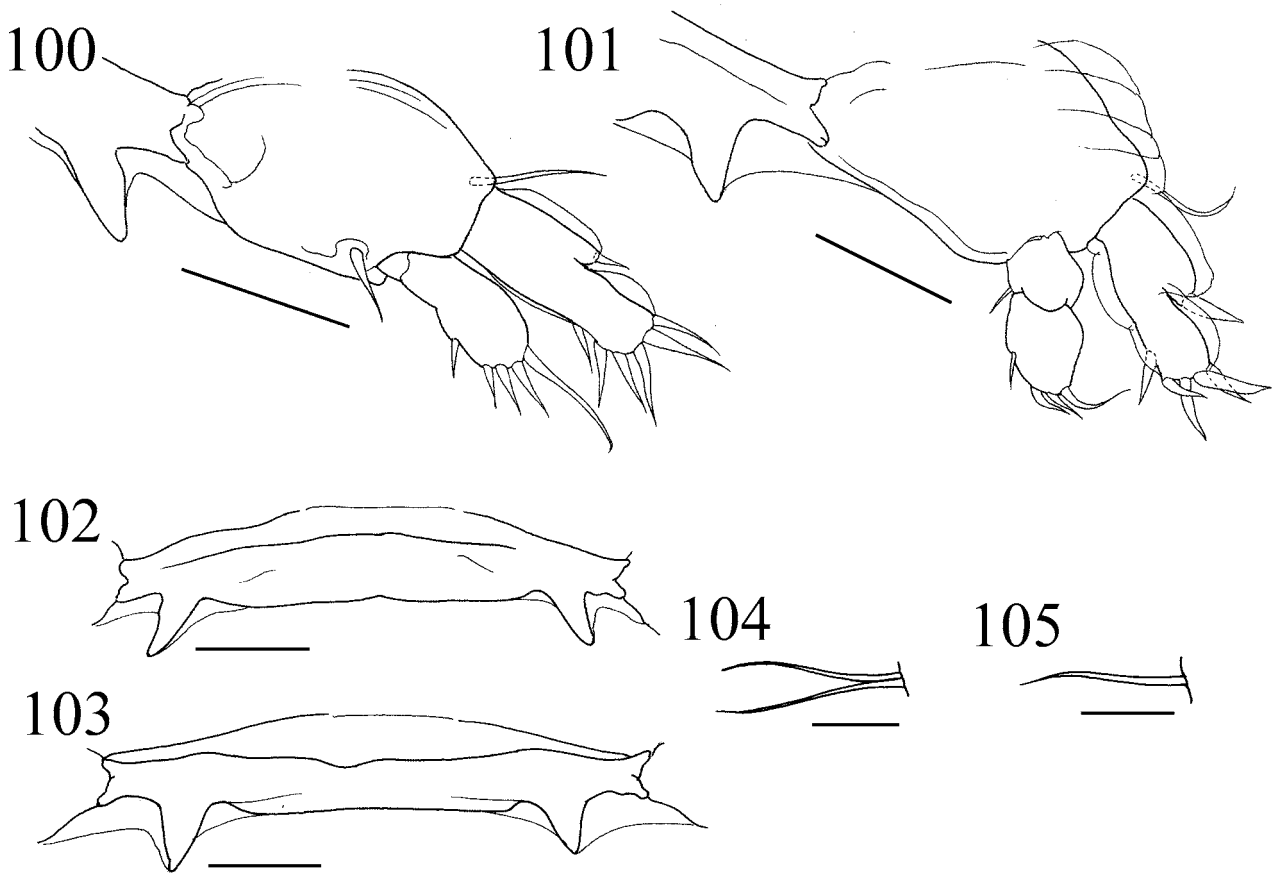
FIGURES 85–90. *Hatschekia zanpa* **n. sp.**, female, holotype NSMT–Cr 20909. 85, leg 1, anterior view; 86, leg 2, anterior view; 87, intercoxal sclerite of leg 1, anterior view; 88, intercoxal sclerite of leg 2, anterior view; 89, leg 3; 90, leg 4. Scale bars: 85–88, 20μm; 89–90, 5μm.

***Hatschekia fukurubi* n. sp.**
(Figs 91–105)

Type material. Holotype, female (NSMT–Cr 20911), ex *Balistapus undulatus* (Park) (Tetraodontiformes: Balistidae), off Cape Zanpa (26°26'N, 127°42'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 7 April 2007. Paratype: 1 female (RUMF–ZC–00927), ex *B. undulatus*, off Cape Zanpa (26°26'N, 127°42'E), Okinawa-jima Island, the Ryukyu Islands, East China Sea, Japan, 7 April 2007.



FIGURES 91–99. *Hatschekia fukurubi* **n. sp.**, female, holotype NSMT–Cr 20911. 91, habitus dorsal; 92, habitus lateral; 93, habitus dorsal with egg sacs; 94, posterior part of trunk, dorsal; 95, antennule, ventral, rp = rostrum process; 96, antenna, ventral; 97, mandible; 98, maxillule; 99, maxilla. Scale bars: 91–93, 200μm; 94, 30μm; 95–96, 99, 20μm; 97–98, 10μm.



FIGURES 100–105. *Hatschekia fukurubi* **n. sp.**, female, holotype NSMT–Cr 20911. 100, leg 1, anterior view; 101, leg 2, anterior view; 102, intercoxal sclerite of leg 1, anterior view; 103, intercoxal sclerite of leg 2, anterior view; 104, leg 3; 105, leg 4. Scale bars: 100–103, 20μm; 104–105, 10μm.

Description of female. Body (Figs 91–93) 1270–1400 (1335 ± 92) long, excluding caudal rami (n = 2). Cephalothorax nearly round with 2 protrusions on frontal margin, shorter than wide [221–240 (230 ± 14) × 270–291 (280 ± 15)], with dorsal, chitinous. trichotomous frame with lateral ends branched, plus a pair of short, independent outward-curved frames. Trunk sausage-shaped, longer than wide [1117–1167 (1142 ± 36) × 267–291 (279 ±17)] bearing 2 anterior processes. Urosome (Fig. 94) excluding caudal ramus shorter than wide [26–36 (31 ± 7) × 77–91 (84 ± 10)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 94) slightly longer than wide [17–22 (20 ± 3) ×8–10 (9 ± 1)], bearing 6 naked setae.

Rostrum not expanded anteriorly. Antennule (Fig. 95) indistinctly 5-segmented, 101–110 (106 ± 7) long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc; knobs settled on proximal and second segments. Antenna (Fig. 96) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with thick, basal processes; proximal segment length 23–25 (24 ± 1); middle segment length 55–76 (65 ± 14); terminal claw length 21–23 (22 ± 2); total length 103–119 (111 ± 12). Parabasal papilla not observed. Oral cone robust. Mandible (Fig. 97) slender, with 4 sharp apical teeth. Maxillule (Fig. 98) bilobate; both lobes armed with 2 tapering elements. Maxilla (Fig. 99) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 100–101) biramous; leg 1 with exopod composed of 2 incompletely fused segments and 1-segmented endopod; leg 2 with 2 indistinct exopod segments and 2-segmented endopod; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–1; 4

Leg 1 (Fig. 100) 44–61 (53 ± 13) long; protopod length 14–28 (21 ± 10); exopod length 15–24 (20 ± 6); endopod length 18 (18 ± 0). Leg 2 (Fig. 101) length 69–73 (71 ± 3); protopod length 45–47 (46 ± 1); exopod length 24–26 (25 ± 2); endopod length 21–29 (25 ± 6).

Intercoxal sclerites of legs 1 and 2 (Figs 102–103) bearing 2 processes.

Leg 3 (Fig. 104) represented by 2 simple setae originating on mid-lateral surface of trunk. Leg 4 (Fig. 105) represented by 1 simple lateral seta on posterior ¾ of trunk.

Attachment site. Gill filaments.

Remarks. Of 108 species in *Hatschekia*, 23 species have processes on the intercoxal sclerites of legs 1 and 2. *Hatschekia fukurubi* **n. sp.**, *H. oblonga* Wilson, 1913 and *H. quadrabdominalis* Yü, 1933 all have two processes on the intercoxal sclerites,. However, the new species distinctly differs from the other two congeners by having anterior processes on the trunk.

Etymology. The specific name of the new species, *fukurubi*, is a local name of the type host, *Balistapus undulatus*, in Okinawa.

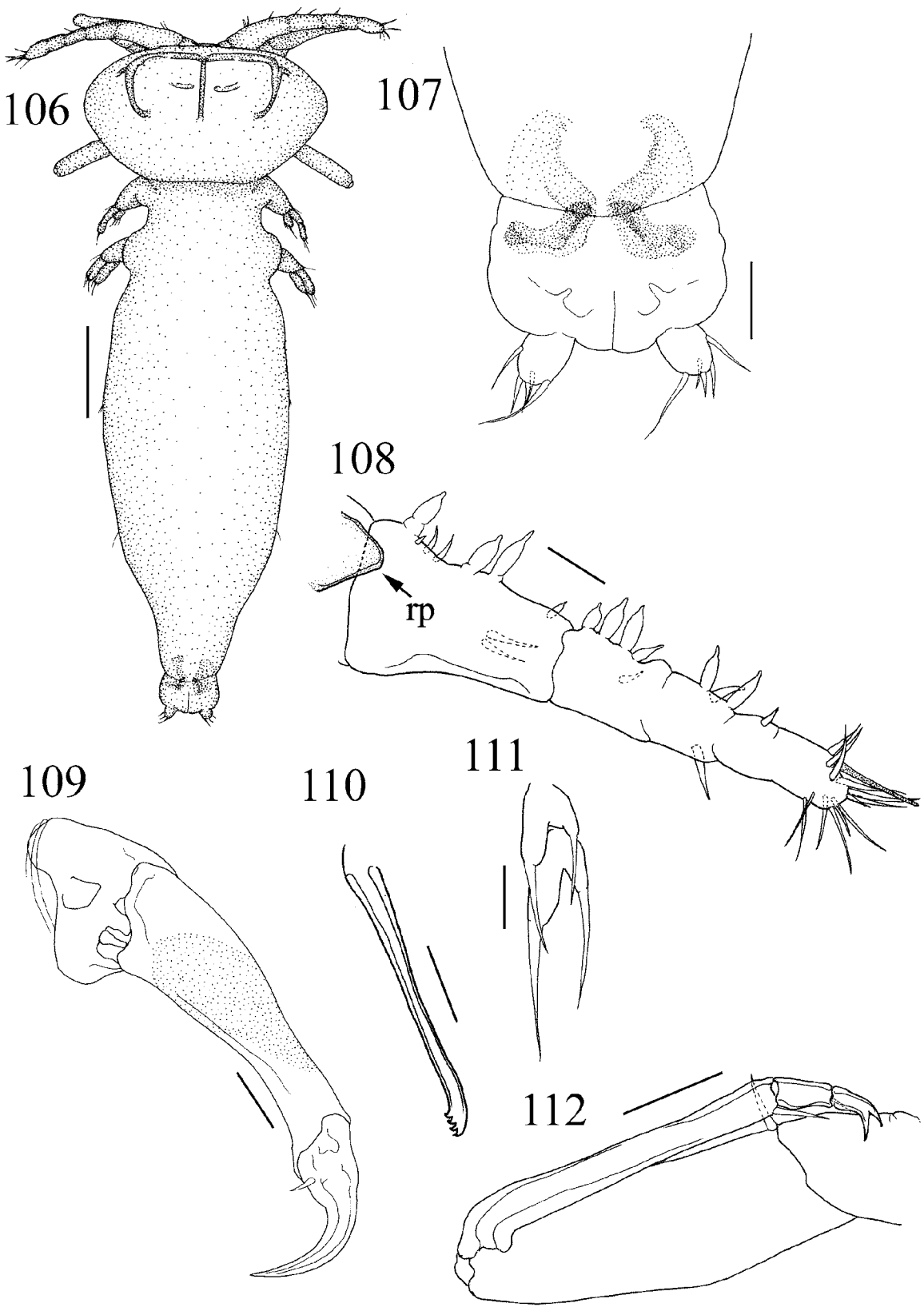
***Hatschekia mongarah* n. sp.**
(Figs 106–118)

Type material. Holotype, female (NSMT–Cr 20912), ex *Balistoides conspicillum* (Bloch & Schneider) (Tetraodontiformes: Balistidae), off Zamami-jima Island (26°13'N, 127°17'E), the Ryukyu Islands, East China Sea, Japan, 27 May 2006. Paratypes: 4 females (NSMT–Cr 20913), ex *B. conspicillum*, off Yonaguni-jima Island (24°26'N, 123°1'E), the Ryukyu Islands, East China Sea, Japan, 8 July 2007; 3 females (RUMF–ZC–00928) ex *B. conspicillum*, off Yonaguni-jima Island (24°26'N, 123°1'E), the Ryukyu Islands, East China Sea, Japan, 8 July 2007.

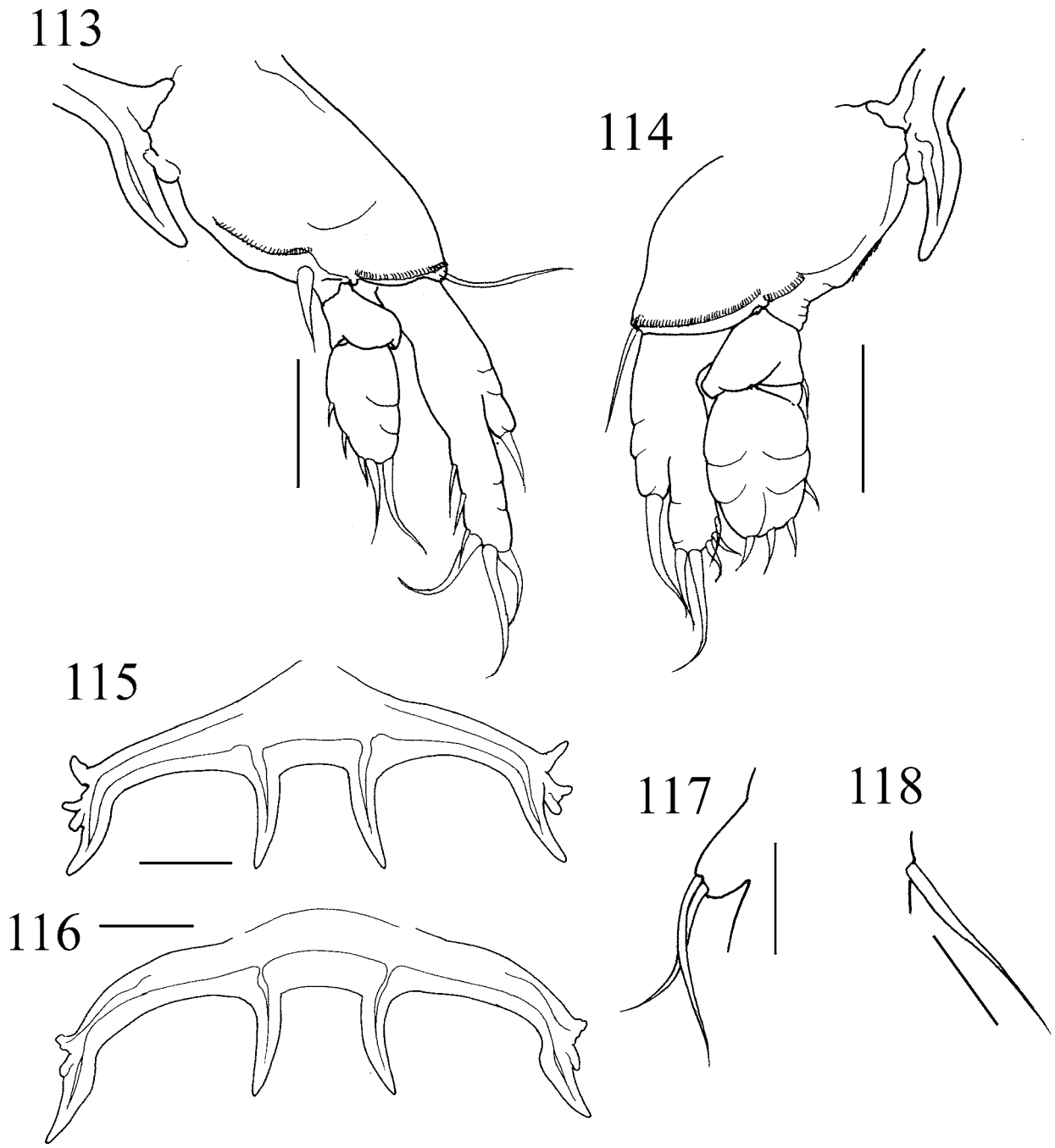
Description of female. Body (Fig. 106) 723–853 (800 ± 43) long, excluding caudal rami (n = 8). Cephalothorax oval with flat anterior and posterior margins, shorter than wide [140–190 (165 ± 16) × 265–307 (289 ± 16)], widest in anterior ⅓, with dorsal, M-shaped chitinous frame. Trunk fusiform, tapering posterior, longer than wide [575–672 (631 ± 33) × 202–248 (221 ± 14)] with protrusion near base of leg 2. Urosome (Fig. 107) excluding caudal ramus shorter than wide [35–55 (41 ± 6) × 61–75 (70 ± 4)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 107) slightly longer than wide [15–26 (21 ± 3) ×12–13 (12 ± 1)], bearing 5 naked setae.

Rostrum with 1 lobe-like process at each posterolateral corner (Fig. 108). Antennule (Fig. 108) indistinctly 5-segmented, 161–190 (179 ± 10) long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc; some setae blunt, papilliform. Antenna (Fig. 109) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with basal seta; proximal segment length 33–57 (43 ± 8); middle segment length 74–108 (95 ± 11); terminal claw length 23–44 (31 ± 6); total length 146–187 (169 ± 16). Parabasal papilla not observed. Oral cone robust. Mandible (Fig. 110) slender, with 4 sharp apical teeth. Maxillule (Fig. 111) bilobate; both lobes armed with 2 tapering elements. Maxilla (Fig. 112) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 113–114) biramous; both legs with exopod composed of 2 indistinct segments and 2-segmented endopod; leg armature formula as follows:



FIGURES 106–112. *Hatschekia mongarah* **n. sp.**, female, holotype NSMT–Cr 20912. 106; habitus dorsal; 107, posterior part of trunk, dorsal; 108, antennule, ventral, rp = rostrum process; 109, antenna, ventral; 110, mandible; 111, maxillule; 112, maxilla. Scale bars: 106, 100μm; 107–109, 112, 20μm; 110–111, 10μm.



FIGURES 113–118. *Hatschekia mongarah* **n. sp.**, female, holotype NSMT–Cr 20912. 113, leg 1, anterior view; 114, leg 2, anterior view; 115, intercoxal sclerite of leg 1, anterior view; 116, intercoxal sclerite of leg 2, anterior view; 117, leg 3; 118, leg 4. Scale bars: 113–116, 20μm; 117–118, 10μm.

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–1 (0–1); 4

Leg 1 (Fig. 113) 92–107 (97 ± 5) long; protopod length 51–57 (53 ± 2); exopod length 38–50 (43 ± 3); endopod length 21–34 (27 ± 4). Leg 2 (Fig. 114) length 73–103 (91 ± 9); protopod length 44–63 (55 ± 6); exopod length 29–40 (35 ± 4); endopod length 31–43 (36 ± 5). Protopods of legs 1 and 2 ornamented with

rows of blunt spinules on anterior surface. Both rami of legs 1 and 2 ornamented with semicircular membranes.

Intercoxal sclerites of legs 1 and 2 (Figs 115–116) bearing 2 long and 2 short processes.

Leg 3 (Fig. 117) represented by 2 simple setae on conical process at mid-lateral surface of trunk. Leg 4 (Fig. 118) represented by 1 simple lateral seta on posterior ¾ of trunk.

Attachment site. Gill filaments.

TABLE 2. Ratios of body parts of females of *Hatschekia fukurubi* **n. sp.**, *H. mongarah* **n. sp.**, *H. nakamurai* **n. sp.**, *H. mihkagan* **n. sp.** and *H. pseudobalistesi* **n. sp.** The data are shown as the mean ± standard deviation.

	H. fukurubi (n = 2)	*H. mongarah* (n = 8)	*H. nakamurai* (n = 6)	*H. mihkagan* (n = 12)	*H. pseudobalistesi* (n = 11)
CeL/BL	0.17 ± 0	0.21 ± 0.01	0.21 ± 0.02	0.18 ± 0.01	0.24 ± 0.01
CeW/BL	0.21 ± 0	0.36 ± 0.01	0.24 ± 0.02	0.23 ± 0.02	0.29 ± 0.01
TL/BL	0.86 ± 0.03	0.79 ± 0.03	0.80 ± 0.02	0.83 ± 0.01	0.77 ± 0.01
TW/BL	0.21 ± 0	0.28 ± 0.01	0.23 ± 0.02	0.26 ± 0.03	0.22 ± 0.01
UL/BL	0.02 ± 0	0.05 ± 0.01	0.06 ± 0.01	0.03 ± 0.01	0.06 ± 0.01
UW/BL	0.06 ± 0	0.09 ± 0	0.07 ± 0.01	0.05 ± 0.01	0.06 ± 0.01
CaL/BL	0.01 ± 0	0.03 ± 0	0.03 ± 0	0.02 ± 0	0.02 ± 0
CaW/BL	0.01 ± 0	0.02 ± 0	0.02 ± 0	0.01 ± 0	0.01 ± 0
CeW/CeL	1.22±0.01	1.76 ± 0.09	1.16 ± 0.08	1.29 ± 0.08	1.21 ± 0.08
UL/UW	2.76 ± 0.31	1.72 ± 0.15	1.40 ± 0.24	1.84 ± 0.36	1.06 ± 0.08
A1L/BL	0.08 ± 0.01	0.22 ± 0.01	0.18 ± 0.01	0.08 ± 0.01	0.21± 0.02
A2L/BL	0.08 ± 0	0.21 ± 0.02	0.21 ± 0.02	0.10 ± 0.01	0.32 ± 0.03
A2TL/A2ML	0.34 ± 0.10	0.34 ± 0.10	0.37 ± 0.07	0.35 ± 0.04	0.35 ± 0.04
L1L/BL	0.04 ± 0.01	0.12 ± 0.01	0.09 ± 0.01	0.06 ± 0.01	0.11 ± 0.01
L1ExL/L1EnL	1.11 ± 0.34	1.59 ± 0.17	1.40 ± 0.12	1.28 ± 0.14	2.15 ± 0.27
L2 L/BL	0.05 ± 0	0.11 ± 0.01	0.11 ± 0.01	0.07 ± 0.01	0.11 ± 0.01
L2ExL/L2EnL	1.04 ± 0.32	0.98 ± 0.09	0.92 ± 0.04	1.09 ± 0.08	1.16 ± 0.11
A1L/A2L	0.96 ± 0.16	1.07 ± 0.12	0.86 ± 0.05	0.85 ± 0.08	0.66 ± 0.09

Abbreviations: body length (BL), cephalothorax length (CeL), cephalothorax width (CeW), trunk length (TL), trunk width (TW), Urosome length excluding caudal ramus(UL), Urosome width (UW), caudal ramus length (CaL), and caudal ramus width (CaW), antennule length (A1L), antenna length (A2L), middle segment length of antenna (A2ML), terminal claw length of antenna* (A2TL), Leg 1 length (L1L), exopod length of leg 1 (L1ExL), endopod length of leg 1 (L1EnL), Leg 2 length (L2L), exopod length of leg 2 (L2ExL), and endopod length of leg 2 (L2EnL).
* This length was expressed as the "terminal segment length" in Uyeno & Nagasawa (2009a, 2009b).

Remarks. *Hatschekia mongarah* **n. sp.** shares the possession of 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species (see remarks of *H. hemicyclium*) and 6 new species (i.e *H. churaumi* **n. sp.**, *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.**, *H. kabatai* **n. sp.** and *H. zanpa* **n. sp.**). In the new species, the location of leg 3 on a conical process is a character state which is shared with *H. jonesi* **n. sp.**, *H. lima*, *H. sunaoi* and *H. zanpa* **n. sp.** Due to the inadequate original description (Nuñes-Ruivo, 1954), it is unclear whether leg 3 of *H. balistae* is located on a conical process. Nevertheless, *H. balistae* can be distinguished from the new species by having a distinct apex on the cephalothorax. *H. jonesi* **n. sp.** is characterized by a well-developed parabasal papilla and the variable protrusions extending the mid-lateral line of the cephalothorax, whereas the new species lacks both these characters. *H. lima* differs from the new species by having the maxillule with a highly chitinized, inner lobe and an apex on the cephalothorax. *H. sunaoi* is distinguished from the new species in having a higher antenna length/body length ratio [0.40 ± 0.03 vs. 0.21 ± 0.02 (U-test; $p<0.001$), Table 2, see also table 1 in Uyeno & Nagasawa 2009b] and a lower antenna

length/antennule length ratio [0.66 ± 0.03 vs. 1.07 ± 0.12 (U-test; $p<0.001$), Table 2, see also table 1 in Uyeno & Nagasawa 2009b]. *H. zanpa* **n. sp.** is characterized by the presence of lateral protrusions on the cephalothorax, a well-developed parabasal papilla and having the proximal segment of the antenna ornamented with small knobs. None of these characters are exhibited by the new species.

Etymology. The specific name of the new species, *mongarah*, is a Japanese vernacular name of the type host, *Balistoides conspicillum*.

***Hatschekia nakamurai* n. sp.**
(Figs 119–132)

Type material. Holotype, female (NSMT–Cr 20914), ex *Melichthys vidua* (Richardson) (Tetraodontiformes: Balistidae), off Sesoko-jima Island (26°38'N, 127°51'E), the Ryukyu Islands, East China Sea, Japan, 21 May 2005. Paratypes: 1 female (RUMF–ZC–00929), ex *M. vidua*, off Sesoko-jima Island (26°38'N, 127°51'E), the Ryukyu Islands, East China Sea, Japan, 21 May 2005; 4 females (NSMT–Cr 20915), ex *M. vidua*, off Minna-jima Island (26°38'N, 127°48'E), the Ryukyu Islands, East China Sea, Japan, 25 July 2007.

Description of female. Body (Fig. 119) 926–1174 (1008 ±91) long, excluding caudal rami (n = 6). Cephalothorax hexagonal, shorter than wide [196–212 (206 ± 7) × 221–255 (240 ± 13)], widest in posterior ⅔, with dorsal, pentangular chitinous frame with mid-line ending immediately before triangular depression. Trunk narrowing posteriorly, curved slightly, longer than wide [721–995 (808 ± 99) × 204–276 (234 ± 24)]. Urosome (Fig. 120) excluding caudal ramus shorter than wide [34–70 (55 ± 13) × 58–84 (75 ± 10)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 120) ovoid, slightly longer than wide [21–31 (26 ± 3) ×13–22 (17 ± 3)], bearing 5 naked setae.

Rostrum expanded anteriorly on cephalothorax with 1 round process at each posterolateral corner (Fig. 121). Antennule (Fig. 121) indistinctly 5-segmented, 174–185 (180 ± 5) long; armature formula: 10, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 122) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with a basal seta; proximal segment length 48–73 (57 ± 9); middle segment length 103–126 (112 ± 9); terminal claw length 32–49 (41 ± 7); total length 195–225 (210 ± 12). Parabasal papilla (Fig. 123) digitiform, wrinkled. Oral cone robust. Mandible (Fig. 124) slender, with 4 sharp apical teeth. Maxillule (Fig. 125) bilobate; inner lobe highly sclerotized; both lobes armed with 2 tapering elements. Maxilla (Fig. 126) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 127–128) biramous; both legs with exopod composed of 2 indistinct segments and 2-segmented endopod; leg armature formula as follows:

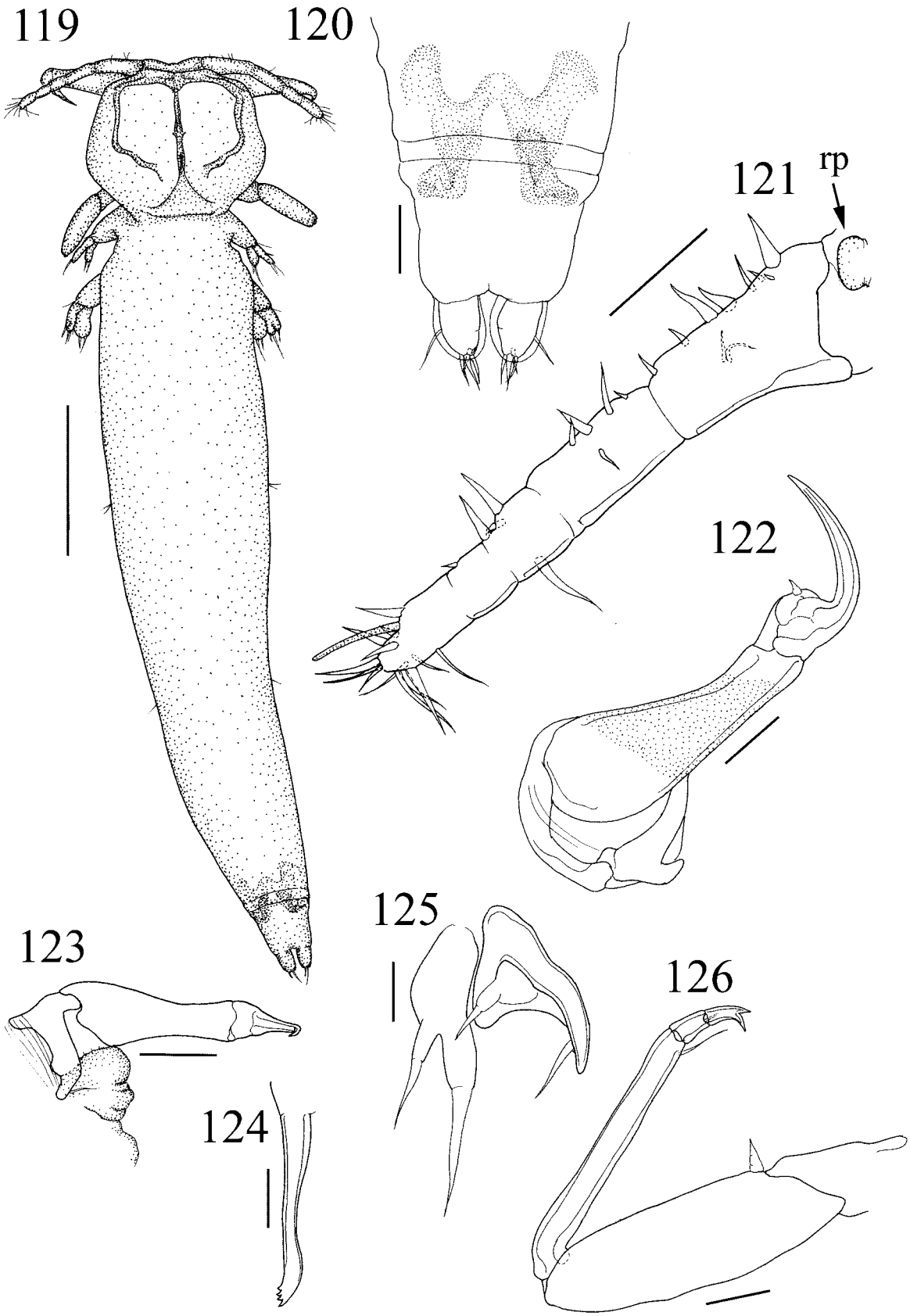
	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–0; 3 (3–4)

Leg 1 (Fig. 127) 81–102 (94 ± 8) long; protopod length 40–56 (50 ± 6); exopod length 38–51 (44 ± 5); endopod length 28–37 (32 ± 3). Leg 2 (Fig. 128) length 90–117 (106 ± 10); protopod length 55–72 (64 ± 6); exopod length 35–46 (43 ± 4); endopod length 38–50 (46 ± 5). Protopods of legs 1 and 2 ornamented with rows of blunt spinules on anterior surface. Both rami of legs 1 and 2 ornamented with semicircular membranes.

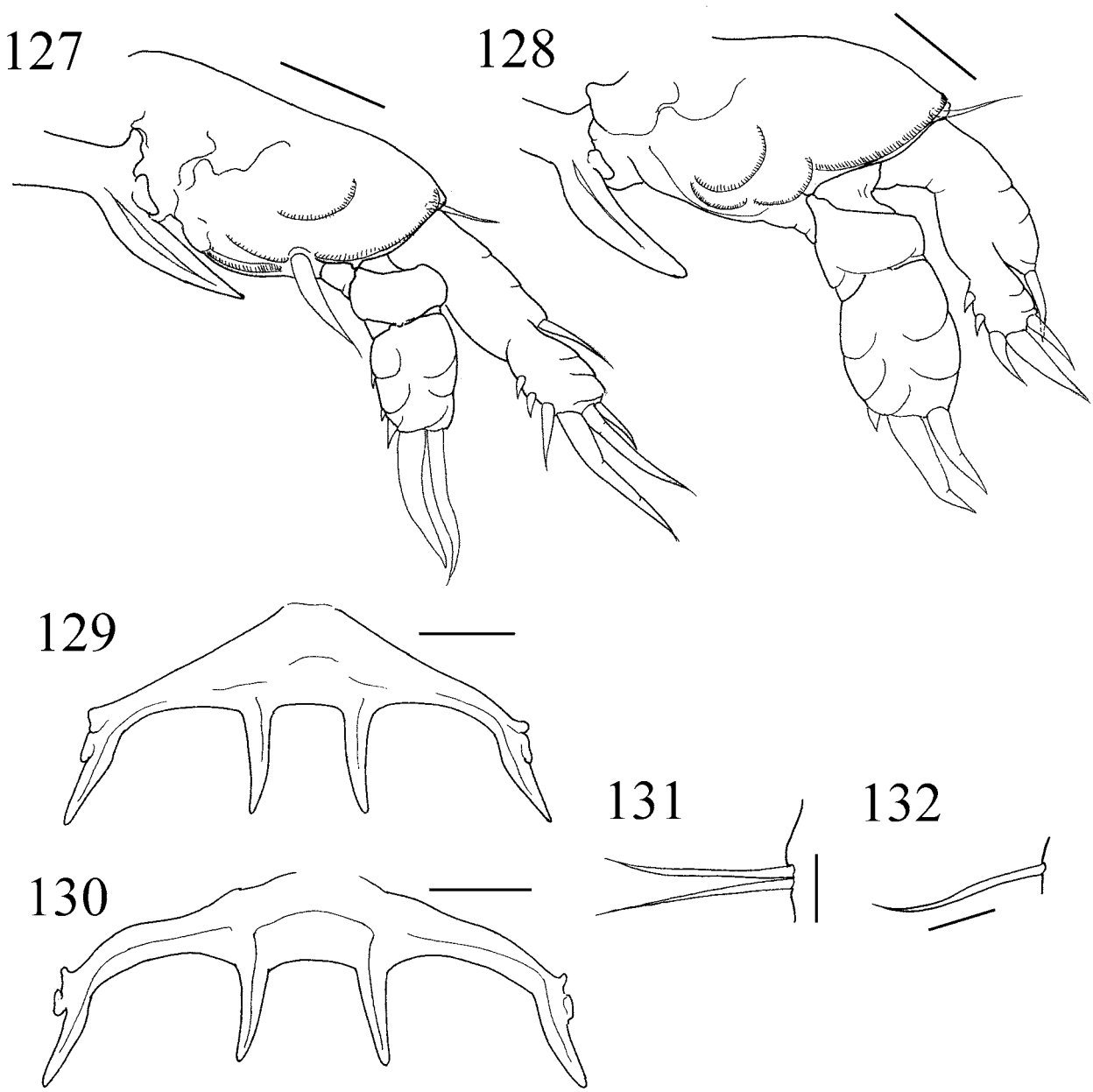
Intercoxal sclerites of legs 1 and 2 (Figs 129–130) bearing 4 similar processes.

Leg 3 (Fig. 131) represented by 2 simple setae originating on anterior ⅓ of trunk. Leg 4 (Fig. 132) represented by 1 simple lateral seta on posterior ⅔ of trunk.

Attachment site. Gill filaments.



FIGURES 119–126. *Hatschekia nakamurai* **n. sp.**, female, holotype NSMT–Cr 20914. 119, habitus dorsal; 120, posterior part of trunk, dorsal; 121, antennule, ventral, rp = rostrum process; 122, antenna, ventral; 123, antenna with parabasal papilla (drawn from a paratype, NSMT–Cr 20915); 124, mandible; 125, maxillule; 126, maxilla. Scale bars: 119, 200μm; 120, 122, 30μm; 121, 40μm; 123, 50μm; 124–125, 10μm; 126, 20μm.



FIGURES 127–132. *Hatschekia nakamurai* **n. sp.**, female, holotype NSMT–Cr 20914. 127, leg 1, anterior view; 128, leg 2, anterior view; 129, intercoxal sclerite of leg 1, anterior view; 130, intercoxal sclerite of leg 2, anterior view; 131, leg 3; 132, leg 4. Scale bars: 127–128, 20μm; 129–130, 30μm; 131–132, 10μm.

Remarks. *H. nakamurai* **n. sp.** shares the 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species (see remarks of *H. hemicyclium*) and 7 new species (i.e. *H. churaumi* **n. sp.**, *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.**, *H. kabatai* **n. sp.**, *H. mongarah* **n. sp.** and *H. zanpa* **n. sp.**). *Hatschekia balistae* possesses an apex on the cephalothorax not present in the new species. Additionally, the new species bears 10 setae on the proximal segment of the antennule, a character shared with *H. churaumi* **n. sp.**, *H. kabatai* **n. sp.**, *H. lima*, *H. pseudostracii*, *H. sunaoi* and *H. zanpa* **n. sp.** and the new species has a maxillule with a highly chitinized inner lobe, which is also present on *H. lima* and *H. zanpa* **n. sp.** These species, however, differ from the new species by having leg 3 situated on a conical process.

Etymology. The specific name, *nakamurai*, is dedicated to Mr. Shigeo Nakamura, a technical officer at the Sesoko Station, Tropical Biosphere Research Center, University of the Ryukyus, who assisted with collecting the specimens.

***Hatschekia mihkagan* n. sp.**
(Figs 133–147)

Type material. Holotype, female (NSMT–Cr 20916), ex *Odonus niger* (Rüppell) (Tetraodontiformes: Balistidae), off Sesoko-jima Island (26°37'N, 127°52'E), the Ryukyu Islands, East China Sea, Japan, 16 August 2006. Paratypes: 8 females (NSMT–Cr 20917), ex *O. niger*, off Sesoko-jima Island (26°37'N, 127°52'E), the Ryukyu Islands, East China Sea, Japan, 16 August 2006; 3 females (RUMF–ZC–00930), ex *O. niger*, off Sesoko-jima Island (26°37'N, 127°52'E), the Ryukyu Islands, East China Sea, Japan, 16 August 2006

Description of female. Body (Figs 133–134) 966–1261 (1113 ± 90) long, excluding caudal rami (n = 12). Cephalothorax ovoid with 2 lobes on frontal margin, indistinctly separated from trunk, shorter than wide [187–222 (200 ± 10) × 232–300 (257 ± 16)], with dorsal, double ring shaped, chitinous frame. Trunk fusiform, longer than wide [780–1064 (919 ± 88) × 235–336 (284 ± 28)] with posterior knobs. Urosome (Fig. 135) excluding caudal ramus shorter than wide [18–42 (33 ± 7) × 45–68 (59 ± 7)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 135) slightly longer than wide [12–21 (18 ± 2) × 8–12 (9 ± 1)], bearing 6 naked setae.

Rostrum with 1 round process at each posterolateral corner (Fig. 136). Antennule (Fig. 136) indistinctly 5-segmented, 87–104 (94 ± 6) long; armature formula: 8, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 137) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with basal accessory element; proximal segment length 22–29 (26 ± 2); middle segment length 55–71 (64 ± 6); terminal claw length 18–25 (22 ± 2); total length 97–120 (112 ± 7). Parabasal papilla (Fig. 138) rod-like, as long as middle segment of antenna. Oral cone robust. Mandible (Fig. 139) slender, with 4 sharp apical teeth. Maxillule (Fig. 140) bilobate; both lobes armed with 2 tapering elements; elements on inner lobe shorter than on outer lobe. Maxilla (Fig. 141) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 142–143) biramous; both legs with exopod composed of 2 indistinct segments and 2-segmented endopod; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 5
Leg 2	1–0	1–0; 5	0–1; 4

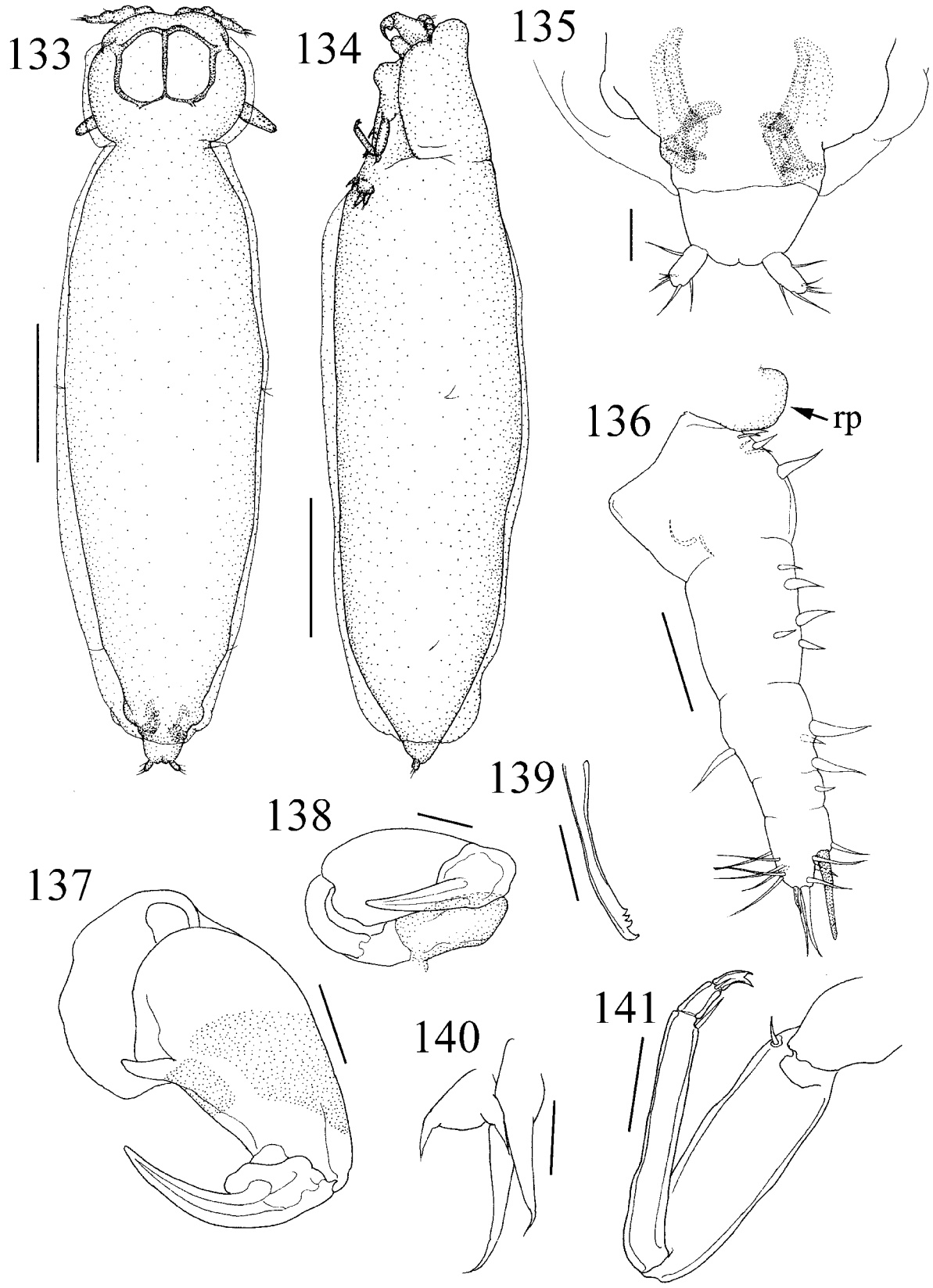
Leg 1 (Fig. 142) 58–64 (61 ± 2) long; protopod length 33–40 (36 ± 2); exopod length 18–29 (25 ± 3); endopod length 15–22 (20 ± 2). Leg 2 (Fig. 143) length 67–78 (72 ± 3); protopod length 36–46 (42 ± 3); exopod length 25–33 (30 ± 2); endopod length 24–31 (28 ± 2). Protopods of legs 1 and 2 ornamented with rows of blunt spinules on anterior surface. Both rami of legs 1 and 2 ornamented with semicircular membranes and fine rows of spinules.

Intercoxal sclerites of legs 1 and 2 (Figs 144–145) bearing 4 similar processes.

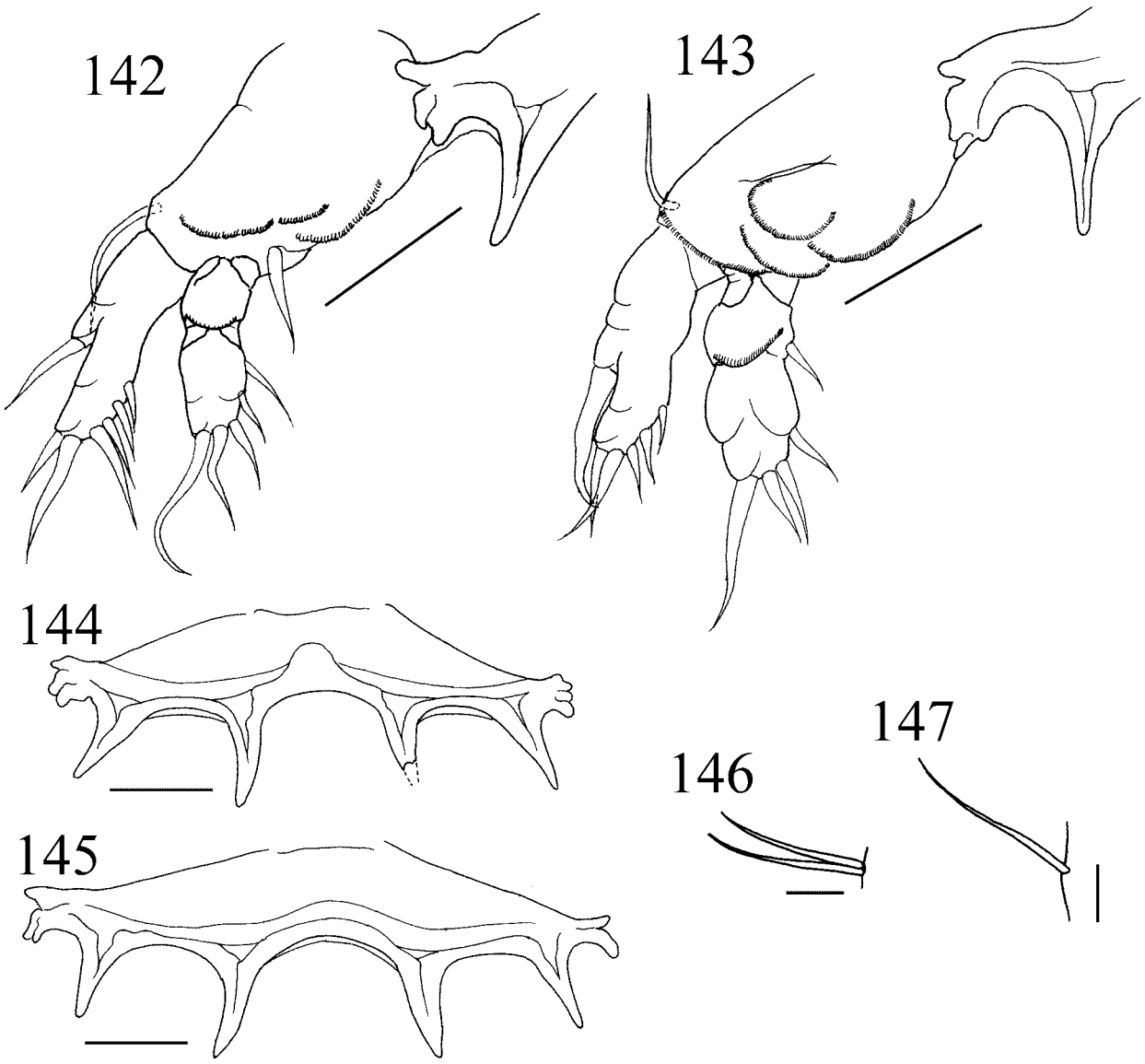
Leg 3 (Fig. 146) represented by 2 simple setae originating on mid-lateral line of surface of trunk. Leg 4 (Fig. 147) represented by 1 simple lateral seta on posterior ⅝ of trunk.

Attachment site. Gill filaments.

Remarks. *Hatschekia mihkagan* **n. sp.** share the possession of 4 processes on the intercoxal sclerites of legs 1 and 2 with 10 species (see remarks of *H. hemicyclium*) and 8 new species (i. e. *H. churaumi* **n. sp.**, *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.**, *H. kabatai* **n. sp.**, *H. mongarah* **n. sp.**, *H. nakamurai* **n. sp.**and *H. zanpa* **n. sp.**). Of these 18 species *H. cylindrus* and *H. izenaensis* **n. sp.** share a single seta on the endopod of leg 2 and the caudal ramus with 6 setae with the new species. Even though *H. cylindrus* resembles the new species, *H. mihkagan* **n. sp.** it differs from it in having a fusiform trunk (rather than a sausage-shaped trunk) with posterior knobs although the knobs are often very small and indistinct. Additionally, the new



FIGURES 133–141. *Hatschekia mihkagan* **n. sp.**, female, holotype NSMT–Cr 20916. 133, habitus dorsal; 134, habitus lateral; 135, posterior part of trunk, dorsal; 136, antennule, ventral, rp = rostrum process; 137, antenna, ventral; 138, antenna with parabasal papilla (drawn from a paratype, NSMT–Cr 20917); 139, mandible; 140, maxillule; 141, maxilla. Scale bars: 133–134, 200μm; 135–138, 141, 20μm; 139–140, 10μm.



FIGURES 142–147. *Hatschekia mihkagan* **n. sp.**, female, holotype NSMT–Cr 20916. 142, leg 1, anterior view; 143, leg 2, anterior view; 144, intercoxal sclerite of leg 1, anterior view; 145, intercoxal sclerite of leg 2, anterior view; 146, leg 3; 147, leg 4. Scale bars: 142–145, 20μm; 146–147, 10μm.

species has and a higher cephalothorax/body length ratio [0.18 ± 0.01 vs. 0.15 ± 0.01 (U-test; $p<0.001$), Table 1, see also table 1 in Uyeno & Nagasawa 2009b]. *Hatschekia izenaensis* **n. sp.** is easily distinguishable from the new species by having a trichotomous chitinous frame on the dorsal surface of the cephalothorax (instead of a double ring shaped frame), by the trunk having a constriction and by the presence of additional processes on the intercoxal sclerites of legs 1 and 2. It is uncertain in the original description of *H. balistae* (Nuñes-Ruivo 1954), whether a single seta is present on the first segment of the endopod of leg 2 as in the new species, but *H. balistae* differs from the new species by having a distinct apex on the cephalothorax.

Etymology. The new species name, *mihkagan*, refers to the similarity between the traditional swimming glasses in Okinawa and the chitinous frame on the cephalothorax of the new species.

***Hatschekia pseudobalistesi* n. sp.**
(Figs 148–161)

Type material. Holotype, female (NSMT–Cr 20918), ex *Pseudobalistes fuscus* (Bloch & Schneider) (Tetraodontiformes: Balistidae), off Henza-jima Island (26°21'N, 127°59'E), Kin Bay, the Ryukyu Islands, North Pacific Ocean, Japan, 6 December 2007. Paratypes: 7 females (NSMT–Cr 20919), ex *P. fuscus*, off Henza-jima Island (26°21'N, 127°59'E), Kin Bay, the Ryukyu Islands, North Pacific Ocean, Japan, 6 December 2007; 3 females (RUMF–ZC–00931), ex *P. fuscus*, off Henza-jima Island (26°21'N, 127°59'E), Kin Bay, the Ryukyu Islands, North Pacific Ocean, Japan, 6 December 2007.

Description of female. Body (Fig. 148) 770–850 (817 ± 28) long, excluding caudal rami (n = 11). Cephalothorax pentangular with apex, shorter than wide [181–206 (196 ± 8) × 218–248 (237 ± 10)], widest in anterior ⅓, with dorsal, hexagonal chitinous frame. Trunk longer than wide [586–660 (626 ± 29) × 156–199 (183 ± 13)] with posterior knobs. Urosome (Fig. 149) excluding caudal ramus slightly shorter than wide [43–61 (49 ± 5) × 46–71 (52 ± 7)]. Genital complex fused to abdomen without border. Caudal ramus (Fig. 149) slightly longer than wide [12–23 (19 ± 3) × 8–12 (10 ± 1)] with 5 naked setae; base inserted in depression in abdomen.

Rostrum with 1 digitiform process at each posterolateral corner (Fig. 150). Antennule (Fig. 150) indistinctly 5-segmented, 147–209 (172 ± 18) long; armature formula: 8, 5, 4, 1, 13 + 1 aesthetasc; proximal segment bearing pointed process on distal posterior margin. Antenna (Fig. 151) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw with basal seta; proximal segment length 66–86 (75 ± 8); middle segment length 107–153 (139 ± 12); terminal claw length 43–55 (49 ± 4); total length 222–291 (262 ± 19). Parabasal papilla (Fig. 152) bilobate. Oral cone robust. Mandible (Fig. 153) slender, with 6 sharp apical teeth. Maxillule (Fig. 154) bilobate; inner lobe weakly sclerotized, blunt rod-like; both lobes armed with 2 tapering elements. Maxilla (Fig. 155) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 156–157) biramous; both legs with exopod composed of 2 indistinct segments and 2-segmented endopod; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 3	0–0; 2
Leg 2	1–0	1–0; 2	0–1; 2

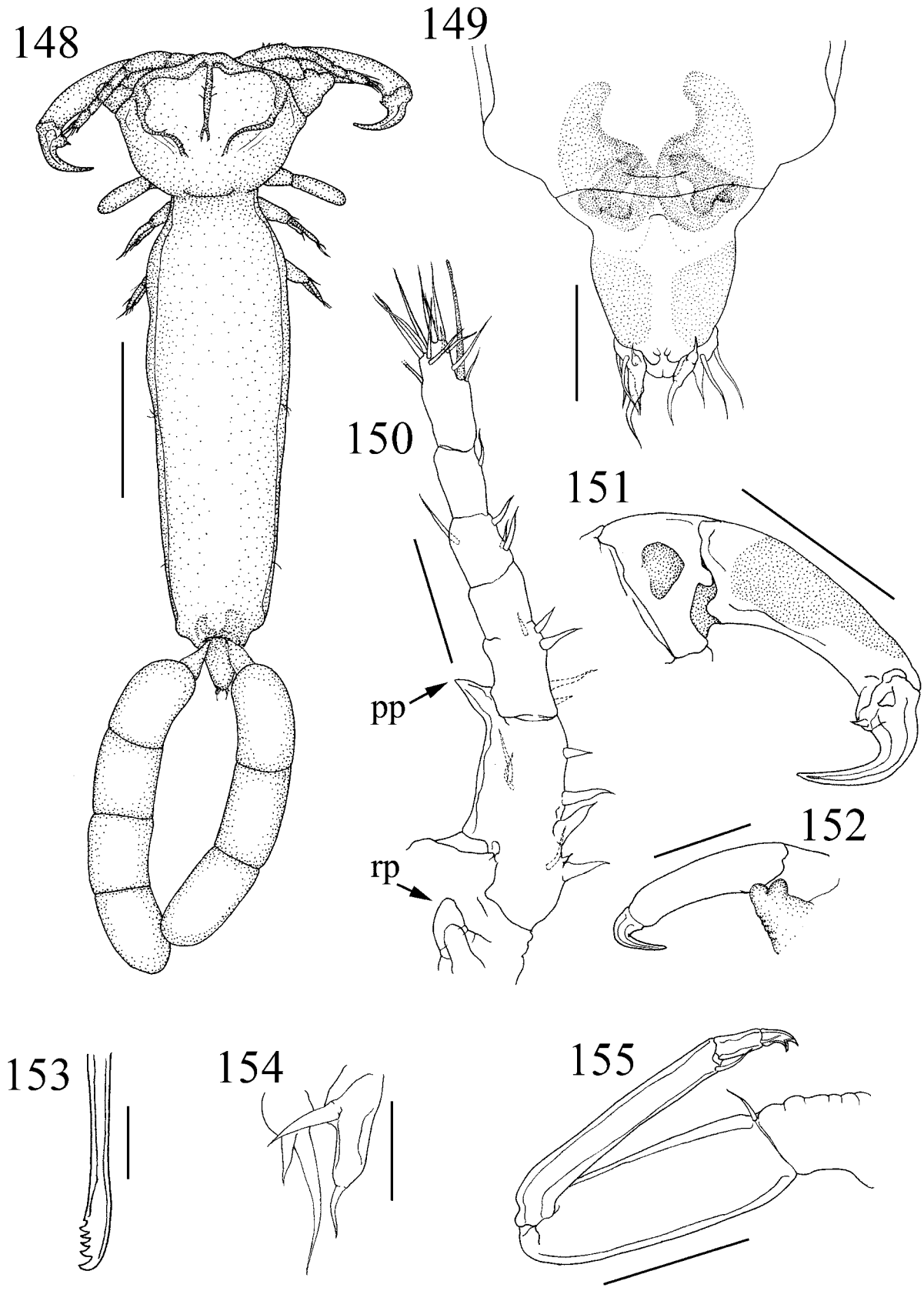
Leg 1 (Fig. 156) 74–100 (91 ± 8) long; protopod length 34–52 (45 ± 5); exopod length 40–51 (46 ± 4); endopod length 18–26 (21 ± 3). Leg 2 (Fig. 157) length 87–102 (94 ± 5); protopod length 48–60 (53 ± 4); exopod length 37–44 (41 ± 2); endopod length 29–41 (35 ± 4). Protopods and rami of legs 1 and 2 ornamented with semicircular membranes.

Intercoxal sclerites of legs 1 and 2 (Figs 158–159) bearing 4 similar processes.

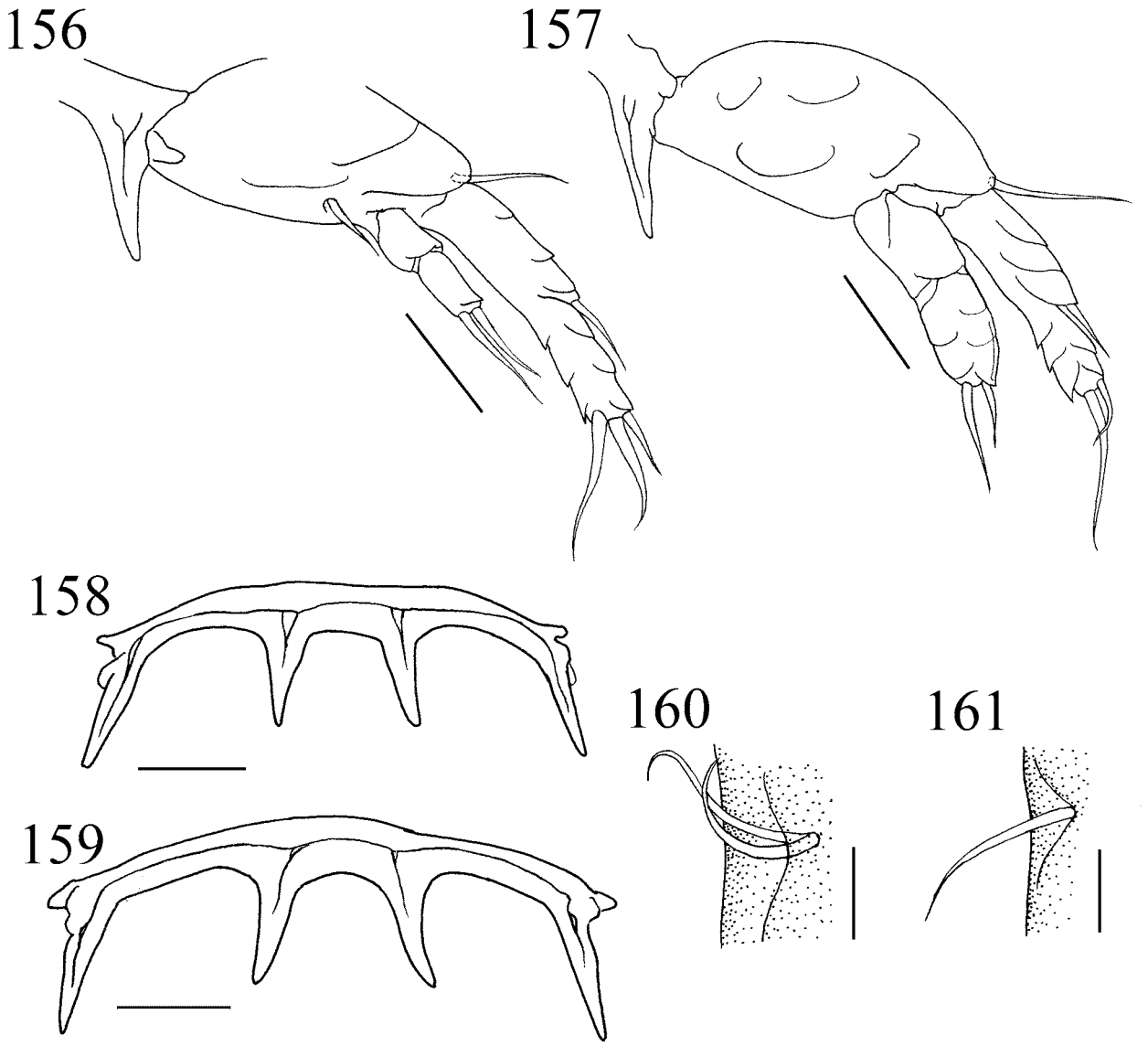
Leg 3 (Fig. 160) represented by 2 simple setae originating on mid-lateral line of surface of trunk. Leg 4 (Fig. 161) represented by 1 simple lateral seta on posterior ¾ of trunk.

Attachment site. Gill filaments.

Remarks. *Hatschekia pseudobalistesi* **n. sp.** has 4 processes on the intercoxal sclerite of legs 1 and 2. In the genus *Hatschekia*, this character is shared with 10 species (see remarks of *H. hemicyclium*) and 9 new species (*H. churaumi* **n. sp.**, *H. hemicyclium* **n. sp.**, *H. izenaensis* **n. sp.**, *H. jonesi* **n. sp.**, *H. kabatai* **n. sp.**, *H. mihkagan* **n. sp.**, *H. mongarah* **n. sp.**, *H. nakamurai* **n. sp.** and *H. zanpa* **n. sp.**). The new species can be differentiated from these species by having an unusual caudal ramus inserted in a depression in the abdomen. It also has a unique antennule with a pointed process on the distal posterior edge of the proximal segment, which is not found in 18 of these species, except for *H. ballistae*. In the original description of *H. balistae* (Nuñes-Ruivo 1954, fig. 11b), the antennule was illustrated with an element on the posterior surface of the



FIGURES 148–155. *Hatschekia pseudobalistesi* **n. sp.**, female, holotype NSMT–Cr 20918. 148, habitus dorsal; 149, posterior part of trunk, dorsal; 150, antennule, ventral, rp = rostrum process, pp = pointed process; 151, antenna, ventral; 152, antenna with parabasal papilla; 153, mandible. 154, maxillule. 155, maxilla. Scale bars: 148, 200μm; 149–150, 155, 40μm; 151–152, 100μm; 153, 10μm; 154, 20μm.



FIGURES 156–161. *Hatschekia pseudobalistesi* **n. sp.**, female, holotype NSMT–Cr 20918. 156, leg 1, anterior view; 157, leg 2, anterior view; 158, intercoxal sclerite of leg 1, anterior view; 159, intercoxal sclerite of leg 2, anterior view; 160, leg 3; 161, leg 4. Scale bars: 156–157, 40μm; 158–159, 50μm; 160–161, 10μm.

proximal segment. However, *Hatschekia* spp. usually have no such an element so it appears that the element reported by Nuñes-Ruivo (1954) is a process. The new species also shares the presence of an apex on the cephalothorax, and has the same number of setal elements on legs 1 and 2 as *H. balistae*, but differs from it in the trunk width being shorter than the cephalothorax width.

Etymology. The specific name of the new species, *pseudobalistesi*, refers to the scientific name of the type fish, *Pseudobalistes fuscus*.

Discussion

A total of 108 species are reported in the genus *Hatschekia*, including the 11 new species described in this paper. Of these 108 species, 27 are known from tetraodontiform fishes in the world oceans (Jones 1985; Uyeno & Nagasawa 2009a, 2009b, 2010a, 2010b). The family Balistidae is among tetraodontiform fishes and comprises about 40 species (Nelson 2006). However, only two or three balistid fishes are known to carry four

Hatschekia spp. (*H. balistae*, *H. cylindrus*, *H. lima* and *H. sunaoi*) (Nuñes-Ruivo 1954; Kabata 1991; Uyeno & Nagasawa 2009b). In this paper, 11 new species of *Hatschekia* are described from 12 species of balistid fishes. The number of species of *Hatschekia* infecting balistid fishes now reaches 14 in total. Of these 14 species, 11 species exhibit high host specificity (Table 3).The remaining three species have been found on more than one host species, but in all cases these hosts are related species within the same genera.

TABLE 3. Known hosts of *Hatschekia* spp. from triggerfishes.

Hatschekia	Host	Reference
H. cylindlus	*Abalistes filamentosus* Matsuura & Yoshino	Uyeno & Nagasawa, 2009b
H. lima	*Abalistes filamentosus* Matsuura & Yoshino	Uyeno & Nagasawa, 2009b
H. sunaoi	*Abalistes filamentosus* Matsuura & Yoshino	Uyeno & Nagasawa, 2009b
H. mongarah n. sp	*Balistoides conspicillum* (Bloch & Schneider)	Present study
H. zanpa n. sp	*Balistapus undulatus* (Park)	Present study
H. fukurubi n. sp	*Balistapus undulatus* (Park)	Present study
H. balistae	*Balistes capriscas* Gmelin	Nuñes-Ruivo, 1954
	Balistidae gen. sp.	Kabata, 1991
H. nakamurai n. sp	*Melichthys vidua* (Richardson)	Present study
H. mihkagan n. sp	*Odonus niger* (Rüppell)	Present study
H. churaumi n. sp	*Pseudobalistes flavimarginatus* (Rüppell)	Present study
H. pseudobalistesi n. sp	*Pseudobalistes fuscus* (Bloch & Schneider)	Present study
H. hemicyclium n. sp	*Rhinecanthus rectangulus* (Bloch & Schneider)	Present study
	Rhinecanthus aculeatus (L.)	Present study
	Rhinecanthus verrucosus (L.)	Present study
H. jonesi n. sp	*Sufflamen bursa* (Bloch & Schneider)	Present study
	Sufflamen fraenatum (Latreille)	Present study
H. kabatai n. sp	*Xanthichthys lineopunctatus* (Hollard)	Present study
H. izenaensis n. sp	*Xanthichthys lineopunctatus* (Hollard)	Present study

Of the 14 species occurring on balistid fishes, 13 (93%) species possess unique intercoxal sclerites, bearing 4 processes, on legs 1 and 2. This character is shared with *H. bibullae*, *H. khahajya*, *H. kuroshioensis*, *H. monacanthi*, *H. ostracii* and *H. pseudostracii* that are parasites of fishes of the tetraodontiform families Ostraciidae and Monacanthidae. This implies that these six species and those infecting balistids are closely related and co-speciated with their hosts, because this character is not known for the remaining species in the genus.

Currently, interrelationships of tetraodontiform families have been estimated through various studies, which have commonly suggested that the two families Balistidae and Monacanthidae are closely related to each other (e.g. Winterbottom 1974; Tyler & Sorbini 1996; Santini & Tyler 2003; Holcroft 2005; Alfaro *et al*. 2007; Yamanoue *et al*. 2008). However, there is discrepancy in the results of these studies in term of the relationship among the family Ostraciidae and the previous two families, since comparative research based on osteology, myology and morphology has indicated that the Ostraciidae is the sister-group of the two families (Winterbottom 1974; Winterbottom & Tyler 1983; Klassen 1995; Tyler & Sorbini 1996; Santini & Tyler 2003), while molecular analyses with nuclear DNA and mitochondrial DNA have shown totally different results (Holcroft 2005; Alfaro *et al*. 2007; Yamanoue *et al*. 2008). Our observations with the morphological characters of *Hatschekia* spp. may support the results of the comparative studies (Winterbottom 1974; Winterbottom & Tyler 1983; Klassen 1995; Tyler & Sorbini 1996; Santini & Tyler

2003), because the species from the three tetraodontiform families (Balistidae, Ostraciidae and Monacanthidae) commonly possess unique intercoxal sclerites bearing 4 processes on legs 1 and 2.

Hatschekia spp. usually have 6 setae on the caudal ramus (Hewitt 1969; Ho & Dojiri 1978; Kabata 1979, 1991; Ho & Kim 2001), however, 23 (85%) of the 27 species of *Hatschekia* far been described from tetraodontiform fishes possess only 5 setae on the caudal ramus, which indicates that this number of setae is a distinctive character shared among the species parasitizing this fish host group.

During this study, two *Hatschekia* spp. were found on a single host specimen twice. Both *H. kabatai* **n. sp.** and *H. izenaensis* **n. sp.** were found to infect a single *Xanthichthys lineopunctatus.* Similarly, *H. zanpa* **n. sp.** and *H. fukurubi* **n. sp.** infected a single *Balistapus undulatus*. In our previous study, three species of *Hatschekia* (*H. cylindrus, H. lima* and *H. sunaoi*) were taken from a single *Abalistes filamentosus* Matsuura & Yoshino (Uyeno & Nagasawa 2009b). *Hatschekia plectropomi* Ho & Dojiri, 1978 is known to show site preference on the gills of its marine fish host *Plectropomus leopardus* Lacepède in Australian waters (Scott-Holland *et al*. 2006). In order to examine site preferences and competition the microhabitats of two or three *Hatschekia* species on the gills of a single host fish should be examined.

Cephalothorax width/length ratio, antennule length/antenna length ratio and leg 1 exopod length/endopod length ratio were used in our previous studies to distinguish morphologically similar species (Uyeno & Nagasawa 2009a, 2009b, 2010a). Additionally to those, the ratios of lengths to widths of the following body parts and appendages were also used to differentiate the new species from their congeners in the current study: leg 2 exopod length/endopod length ratio, antenna length/body length ratio, antenna length/antennule length ratio, and cephalothorax length/body length ratio. As proposed by Uyeno & Nagasawa (2009a), it is recommendable to include the ratios of body parts and appendages in future descriptions of *Hatschekia* species.

In most previous studies, the dorsal chitinous frame on the cephalothorax was poorly described. Based on this study and our earlier studies (Uyeno & Nagasawa 2009a, 2009b, 2010a, 2010b), it is obvious that the frame often shows a unique shape that is useful in species diagnosis, for example: *H. monacanthi* and *H. khahajya* have a mid-line with a complete ring at the posterior end, *H. cylindrus* and *H. mihkagan* **n. sp.** both bear a double ring shaped frame, and *H. rotundigenitalis* Yamaguti, 1939 has a circular frame. We, therefore also recommend that the shape of the chitinous frame is described in future descriptions of species of the genus.

Thirty-three species of *Hatschekia* are known to occur on marine fishes in the North Pacific Ocean. Of these, 28 species are found in Japanese waters (Yamaguti 1939, 1953, 1954, 1963; Shiino 1957a, 1957b; Yamaguti & Yamasu 1959; Jones 1985; Uyeno & Nagasawa 2009a, 2009b, 2010a, 2010b). With the description of 11 new species in this paper there are now at least 39 species of the genus distributed around Japan and 44 in the North Pacific Ocean.

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References

Alfaro, M.E., Santini, F. & Brock, C.D. (2007) Do reefs drive diversification in marine teleosts? Evidence from the pufferfishes and their allies (order Tetraodontiformes). *Evolution*, 61, 2104–2126.

Boxshall, G.A. & Halsey, S.H. (2004) *An Introduction to Copepod Diversity.* The Ray Society, London, 966 pp.
Castro, R. & Baeza, H. (1986) Two new species of *Hatschekia* Poche, 1902 (Copepoda, Hatschekiidae) parasitic on two inshore fishes from Antofagasta, Chile. *Journal of Natural History*, 20, 439–444.
Froese, R. & Pauly, D. (Eds.) (2010) FishBase. World Wide Web electronic publication. Available from http://www.fishbase.org/ (accessed 15 March 2010).
Hayashi, M. (2002a) Balistidae. *In*: Nakabo T. (Ed.), *Fishes of Japan with Pictorial Keys to the Species, English Edition.* Tokai University Press, Tokyo, pp. 1396–1402.
Hewitt, G.C. (1969) Two new species of *Hatschekia* (Copepoda, Dichelesthiidae) from New Zealand waters. *New Zealand Journal of Marine and Freshwater Research*, 3, 159–168.
Ho, J.-S. & Dojiri, M. (1978) A new species of *Hatschekia* (Copepoda: Dichelesthiidae) parasitic on leopard coral trout in the Great Barrier Reef, Australia. *Journal of Parasitology*, 64, 727–730.
Ho, J.-S. & Kim, I.-H. (2001) New species of *Hatschekia* Poche, 1902 (Copepoda: Hatschekiidae) parasitic on marine fishes of Kuwait. *Systematic Parasitology*, 49, 73–79.
Holcroft, N.I. (2005) A molecular analysis of the interrelationships of tetraodontiform fishes (Acanthomorpha: Tetraodontiformes). *Molecular Phylogenetics and Evolution*, 34, 525–544.
Humes, A.G. & Gooding, R.U. (1964) A method for studying the external anatomy of copepods. *Crustaceana*, 6, 238–240.
Huys, R. & Boxshall, G.A. (1991) *Copepod Evolution*. The Ray Society, London, 468 pp.
Jones, J.B. (1985) A revision of *Hatschekia* Poche, 1902 (Copepoda: Hatschekiidae), parasitic on marine fishes. *New Zealand Journal of Zoology*,12, 213–271.
Jones, J.B. & Cabral, P. (1990) New species of *Hatschekia* (Copepoda: Siphonostomatoida) from the gills of South Pacific fishes. *Journal of the Royal Society of New Zealand*, 20, 221–232.
Kabata, Z. (1979) *Parasitic Copepoda of British Fishes*. The Ray Society, London, 468 pp.
Kabata, Z. (1991) Copepoda parasitic on Australian fishes, XIII: family Hatschekiidae. *Journal of Natural History*, 25, 91–121.
Klassen, G.J. (1995) Phylogeny and biogeography of the Ostraciinae (Tetraodontiformes: Ostraciidae). *Bulletin of Marine Science*, 1995, 57, 393–411.
Nelson, J.S. (2006) *Fishes of the World*. *Fourth Edition*. John Wiley & Sons Inc., New York, 601 pp.
Nuñes-Ruivo, L.P. (1954) Parasites de poissons de mer ouest–Africains récoltés par M.J. Cadenat. III. Copépodes (2°note). Genres *Prohatschekia* n. gen. et *Hatschekia* Poche. *Bulletin de l' Institute francais d'Afrique Noire*, 16A, 479–505.
Pillai, N.K. (1985) *The Fauna of India*. *Copepod Parasites of Marine Fishes*. Zoological Survey of India, Calcutta, 900 pp.
Santini, F. & Tyler, J.C. (2003) A phylogeny of the families of fossil and extant tetraodontiform fishes (Acanthomorpha, Tetraodontiformes), Upper Cretaceous to recent. *Zoological Journal of the Linnean Society*, 139, 565–617.
Scott-Holland, T.B., Bennet, S.M. & Bennet, M.B. (2006) Distribution of an asymmetrical copepod, *Hatschekia plectropomi*, on the gills of *Plectropomus leopardus*. *Journal of Fish Biology*, 68, 222–235.
Shiino, S.M. (1957a) Copepods parasitic on Japanese fishes. 15. Eudactylinidae and Dichelesthiidae. *Reports of the Faculty of Fisheries, Prefectural University of Mie*, 2, 392–410.
Shiino, S.M. (1957b) On a new species of *Hatschekia* (Crustacea Copepoda) from *Halichoeres poecilopterus* (T. & S.). *Journal of the Faculty of Science, Hokkaido University, Series 6, Zoology*, 13, 105–108.
Tyler, J.C. & Sorbini, L. (1996) New superfamily and three new families of tetraodontiform fishes from the Upper Cretaceous: the earliest and most morphologically primitive plectognaths. *Smithsonian Contributions to Paleobiology*, 82, 1–59.
Uyeno, D. & Nagasawa, K. (2009a) Redescription of four species of *Hatschekia* (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on tetraodontiform fishes from Japan. *Zootaxa*, 2110, 1–21.
Uyeno, D. & Nagasawa, K. (2009b) Three new species of *Hatschekia* (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on *Abalistes filamentosus* (Pisces: Tetraodontiformes: Balistidae) from Okinawa, Japan. *Systematic Parasitology*, 74, 225–237.
Uyeno, D. & Nagasawa, K. (2010a) Three new species of *Hatschekia* (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on boxfishes (Pisces: Tetraodontiformes: Aracanidae and Ostraciidae) from Japan. *Systematic Parasitology*, 75, 147–158.
Uyeno, D. & Nagasawa, K. (2010b) A new species of parasitic copepod of the genus *Hatschekia* Poche, 1902 (Siphonostomatoida: Hatschekiidae) from filefishes (Pisces: Tetraodontiformes: Monacanthidae) from off Okinawa, Japan. *Systematic Parasitology*, 76, 53–58.
Villalba, C. (1986) Contribution al conocimiento del genero *Hatschekia* Poche, 1902 en Chile (Copepoda: Hatschekiidae). *Boletin de la Sociedad de Biologia de Concepcion, Chile*, 56, 155–170.
Winterbottom, R. (1974) The familial phylogeny of the Tetraodontiformes (Acanthopterygii: Pisces) as evidenced by

their comparative myology. *Smithsonian Contributions to Zoology*, 155, 1–201.
Winterbottom, R. & Tyler, J.C. (1983) Phylogenetic relationships of aracanin genera of boxfishes (Ostraciidae: Tetraodontiformes). *Copeia*, 4, 902–917.
Yamaguti, S. (1939) Parasitic copepods from fishes of Japan. Part 5. Caligoida, III. *Volume Jubilare pro Professore Sadao Yoshida*, 2, 443–487, pls. 14–33.
Yamaguti, S. (1953) Parasitic copepods from fishes of Japan. Part 7. Cyclopoida, III and Caligoida, IV. *Publications of the Seto Marine Biological Laboratory*, 3, 221–231, pls. 13–17.
Yamaguti, S. (1954) Parasitic copepods from fishes of Celebes and Borneo. *Publications of the Seto Marine Biological Laboratory*, 3, 375–398.
Yamaguti, S. (1963) *Parasitic Copepoda and Branchiura of Fishes*. John Wiley & Sons Inc., New York, 1104 pp.
Yamaguti, S. & Yamasu, T. (1959) Parasitic copepods from fishes of Japan with description of 26 new species and remarks on two known species. *Biological Journal of Okayama University*, 5, 89–165.
Yamanoue, Y., Miya, M., Matsuura, K., Katoh, M., Sakai, H. & Nishida, M. (2008) A new perspective on phylogeny and evolution of tetraodontiform fishes (Pisces: Acanthopterygii) based on whole mitochondrial genome sequences: Basal ecological diversification?. *BMC Evolutionary Biology*, 8, 212.