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Three new species of *Hatschekia* Poche, 1902 (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on boxfishes (Pisces: Tetraodontiformes: Aracanidae and Ostraciidae) in Japanese waters

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Abstract Three new species of *Hatschekia* Poche, 1902 are described from the gill filaments of three species of boxfishes captured off southern Japan: *H. pseudostracii* n. sp. on *Kentrocapros aculeatus* (Houttuyn) (Aracanidae); *H. bibullae* n. sp. on *Lactoria diaphana* (Bloch & Schneider) (Ostraciidae); and *H. kuroshioensis* n. sp. on *Tetrosomus concatenates* (Bloch) (Ostraciidae). Of the 93 currently valid species in the genus, these new species differ from the 87 species which lack four stout processes on the posterior margin of the intercoxal sclerites of legs 1 and 2. Those processes are present on the remaining six species and the three new species. Of these nine species, *H. pseudostracii* n. sp. is distinguished by having a T-shaped chitinous frame on the cephalothorax, the leg 1 exopod twice as long as the endopod and a small parabasal papilla. *H. bibullae* n. sp. can be differentiated by a combination of morphological features as follows: a well-developed, thumb-shaped parabasal papilla, the leg 1 exopod twice as long as the endopod and a trunk lacking posterior lobes. *H. kuroshioensis* n. sp. can be recognised by bearing a T-shaped chitinous frame on the cephalothorax, the leg 1 exopod is three times as long as the endopod and the trunk lacks posterior lobes.

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Introduction

The copepod genus *Hatschekia* Poche, 1902 belongs to the family Hatschekiidae Kabata, 1979. Although Kabata (1979) stated that this genus contained more than 80 species, Jones (1985) recognised 68 species as valid. The genus currently comprises 93 species (Pillai, 1985; Castro & Baeza, 1986; Villalba, 1986; Jones & Cabral, 1990; Kabata, 1991; Ho & Kim, 2001; Boxshall & Halsey, 2004; Uyeno & Nagasawa, 2009b). *Hatschekia* is a large group, occurring as gill parasites of various marine actinopterygian fishes of the orders Anguilliformes, Beryciformes, Ophidiiformes, Percifomes and Tetraodontiformes (see Boxshall & Halsey, 2004). Almost all species of the genus have a featureless body, such as the transformed trunk, and highly reduced appendages. Thus, species identification is often difficult. In this paper, three new species are described based on female specimens from three host species representing two boxfish families (Aracanidae and Ostraciidae) off southern Japan. Several peculiar characters (i.e. a parabasal papilla and a rostral process) are used to identify these three species.

Materials and methods

Boxfishes were collected using bottom trawl in temperate to tropical waters off southern Japan between 2006 and 2008. Parasitic copepods were carefully

removed from the hosts' gills and preserved in 80% ethanol. Fish specimens were also examined at the Faculty of Science, University of the Ryukyus (URM). Copepods were soaked in lactophenol for 2–3 h, dissected and examined using the wooden slide method of Humes & Gooding (1964). Drawings were made with the aid of a drawing tube. Morphological terminology follows Huys & Boxshall (1991). Specimens were measured according to the method of Uyeno & Nagasawa (2009a). Measurements in micrometres are shown as the range, with the mean and standard deviation in parentheses. The ratios of the lengths of various body parts and appendages are shown in Table 1. Type-specimens are deposited in the crustacean collection of the National Museum of Nature and Science, Tokyo (NSMT).

Table 1 Ratios of body parts of females of *Hatschekia pseudostracii* n. sp., *H. bibullae* n. sp. and *H. kuroshioensis* n. sp.

	H. pseudostracii n. sp. (n = 4)	*H. bibullae* n. sp. (n = 5)	*H. kuroshioensis* n. sp. (n = 10)
CeL/BL	0.39 ± 0.02	0.32 ± 0.02	0.34 ± 0.02
CeW/BL	0.37 ± 0.03	0.38 ± 0.02	0.43 ± 0.03
TL/BL	0.69 ± 0.02	0.75 ± 0.02	0.72 ± 0.02
TW/BL	0.42 ± 0.03	0.29 ± 0.02	0.28 ± 0.02
AbL/BL	0.03 ± 0.01	0.04 ± 0.01	0.05 ± 0.01
AbW/BL	0.08 ± 0.00	0.08 ± 0.00	0.08 ± 0.01
CaL/BL	0.04 ± 0.00	0.03 ± 0.00	0.03 ± 0.00
CaW/BL	0.02 ± 0.00	0.01 ± 0.00	0.02 ± 0.00
CeW/CeL	0.96 ± 0.04	1.27 ± 0.08	1.24 ± 0.06
AbW/AbL	2.44 ± 0.50	2.01 ± 0.34	1.68 ± 0.19
A1L/BL	0.23 ± 0.03	0.17 ± 0.01	0.20 ± 0.01
A2L/BL	0.42 ± 0.04	0.26 ± 0.03	0.32 ± 0.02
A2TL/A2ML	0.26 ± 0.05	0.31 ± 0.05	0.23 ± 0.02
L1L/BL	0.12 ± 0.01	0.11 ± 0.01	0.16 ± 0.01
L1ExL/L1EnL	2.08 ± 0.16	1.97 ± 0.26	3.12 ± 0.31
L2L/BL	0.12 ± 0.01	0.11 ± 0.01	0.13 ± 0.01
L2ExL/L2EnL	1.37 ± 0.12	1.50 ± 0.15	1.93 ± 0.17
A1L/A2L	0.54 ± 0.03	0.69 ± 0.05	0.62 ± 0.04

The data are shown as the mean ± standard deviation

Abbreviations: *BL* body length, *CeL* cephalothorax length, *CeW* cephalothorax width, *TL* trunk length, *TW* trunk width, *AbL* abdomen length, *AbW* abdomen width, *CaL* caudal ramus length, *CaW* caudal ramus width, *A1L* antennule length, *A2L* antenna length, *A2ML* middle segment length of antenna, *A2TL* terminal claw length of antenna*, *L1L* leg 1 length, *L1ExL* exopod length of leg 1, *L1EnL* endopod length of leg 1, *L2L* leg 2 length, *L2ExL* exopod length of leg 2, *L2EnL* endopod length of leg 2

* This length was expressed as the "terminal segment length" in Uyeno & Nagasawa (2009a, b)

Family Hatschekiidae Kabata, 1979
Genus *Hatschekia* Poche, 1902

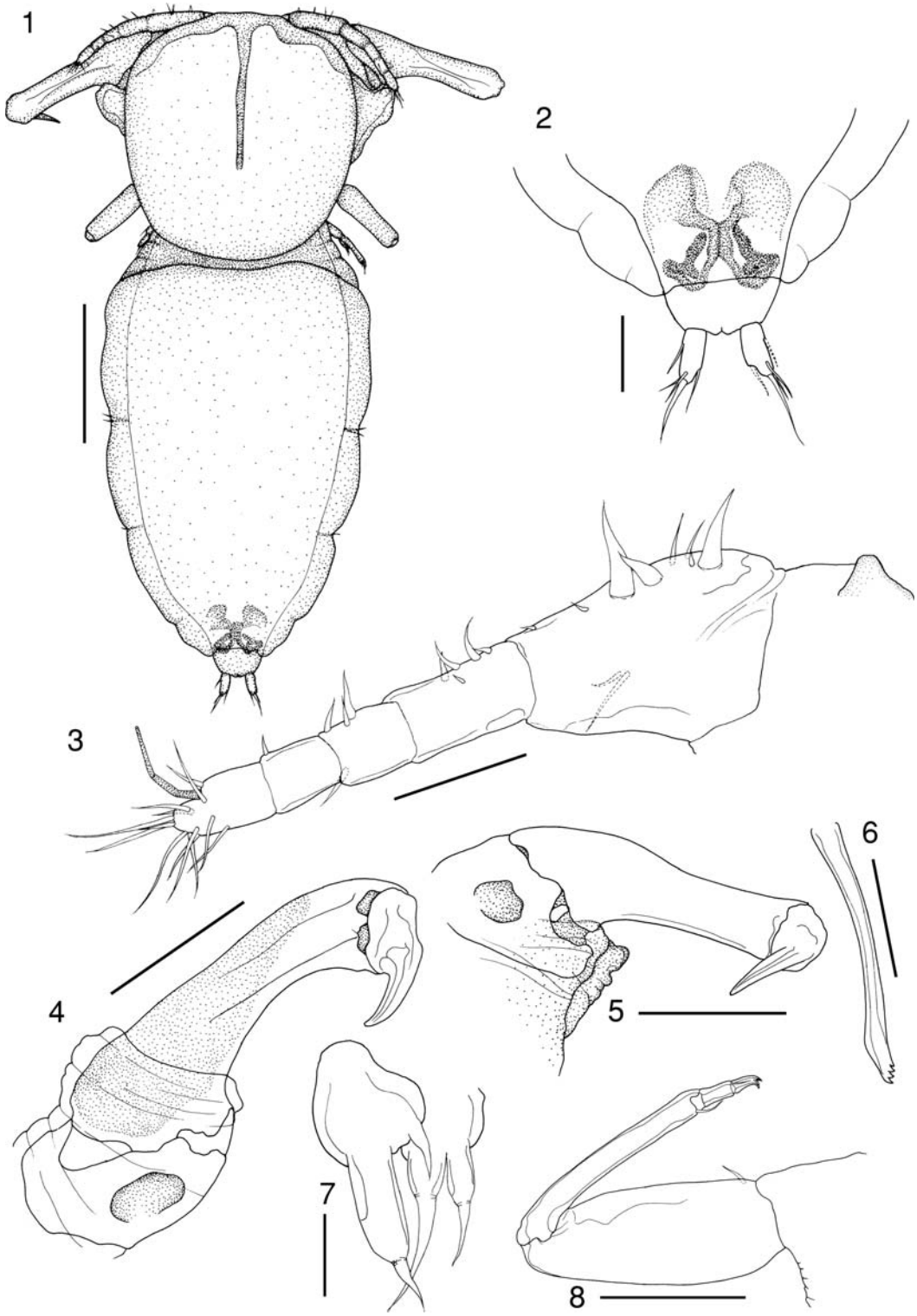
Hatschekia pseudostracii n. sp.

Type-host: *Kentrocapros aculeatus* (Houttuyn) (Tetraodontiformes: Aracanidae) (URM-P30739)
Additional hosts: *K. aculeatus* (URM-P25687); *K. aculeatus* (URM-P30740).
Type-locality: East China Sea, Japan (no information on latitude and longitude).
Attachment site: Gill filaments.
Type-material: Holotype female, NSMT-Cr 20855, 13 November 1993; 2 paratype females, NSMT-Cr 20856, 15 April 1991; 1 paratype female, NSMT-Cr 20857, 13 November 1993.
Etymology: The name of the new species refers to its morphological similarity to *H. ostracii* Yamaguti, 1953.

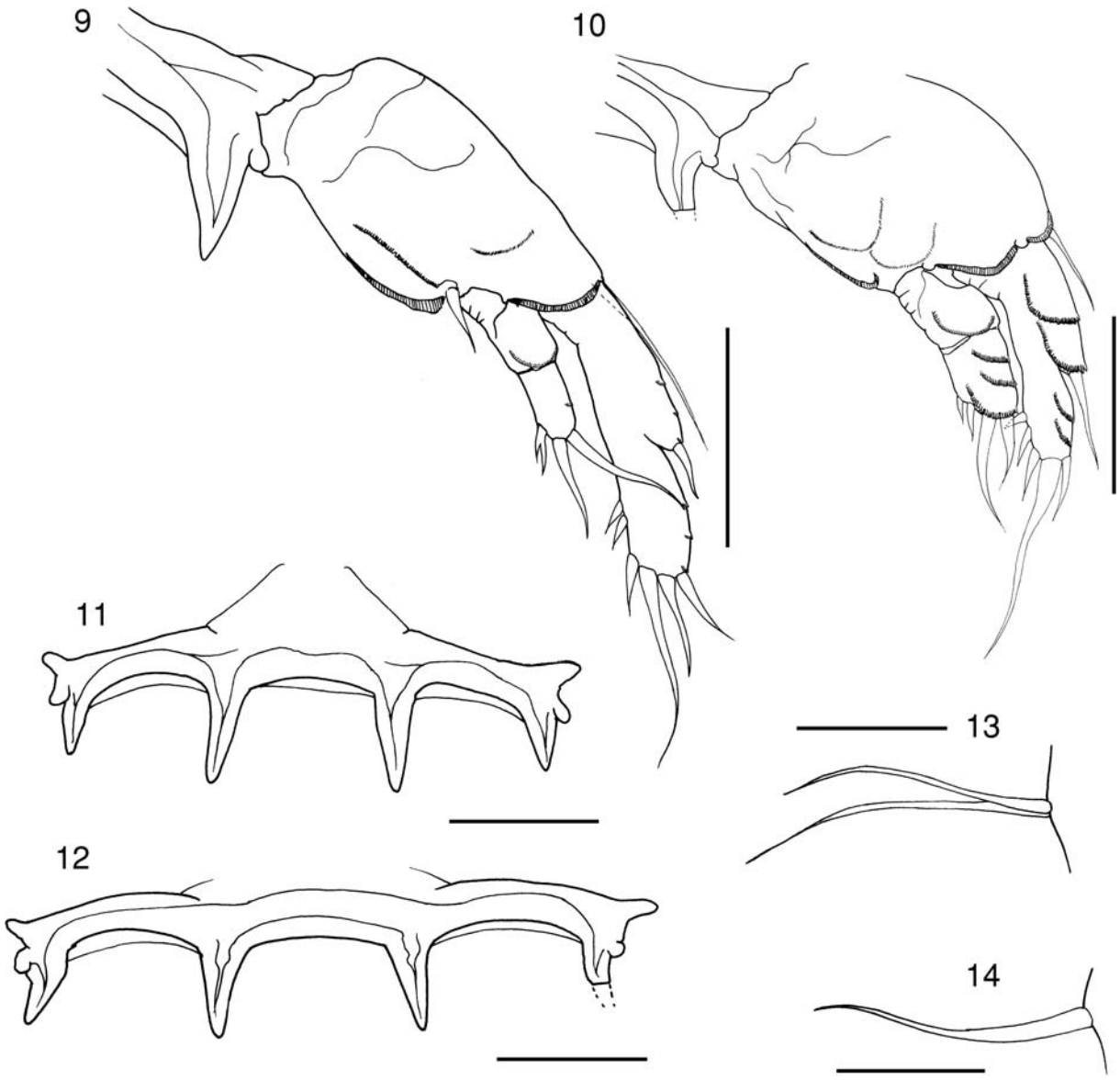
Description (Figs. 1–14)

Adult female

[Based on four specimens.] Body (Fig. 1) 870–968 (928 ± 44) long, excluding caudal rami. Cephalothorax almost round shape, but slightly longer than wide, 356–362 (359 ± 3) × 333–362 (354 ± 14), with dorsal, T-shaped chitinous frame. Trunk longer than wide, 578–664 (639 ± 41) × 356–432 (386 ± 34), without lobes. Abdomen (Fig. 2) wider than long, 23–42 (30 ± 8) × 67–72 (70 ± 2). Caudal ramus (Fig. 2) longer than wide, 32–35 (33 ± 1) × 15–16 (16 ± 0), bears five naked setae. Rostrum armed with one small round process (Fig. 3) on posterolateral corner. Antennule (Fig. 3) five-segmented, 189–225 (210 ± 23) long; armature formula: 10, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 4) three-segmented; proximal segment (coxa) without armature; middle segment (basis) ornamented with surface pits; terminal claw without armature; proximal segment length 100–113 (108 ± 5); middle segment length 194–248 (223 ± 22); terminal segment length 46–76 (58 ± 14); total length 349–416



Figs. 1–8 *Hatschekia pseudostracii* n. sp., female, holotype NSMT-Cr 20855. 1. Habitus dorsal; 2. posterior part of trunk, dorsal; 3. antennule, ventral; 4. antenna, ventral; 5. antenna and parabasal papilla (drawn from a paratype-Cr 20856), NSMT; 6. mandible; 7. maxillule; 8. maxilla, ventral. *Scale-bars*: 1, 200 μm; 2–3, 8, 50 μm; 4–5, 100 μm; 6, 30 μm; 7, 20 μm



Figs. 9–14 *Hatschekia pseudostracii* n. sp., female, holotype NSMT-Cr 20855. 9. Leg 1, ventral; 10. leg 2, ventral; 11. intercoxal sclerite of leg 1, ventral; 12. intercoxal sclerite of leg 2, ventral; 13. leg 3, ventral; 14. leg 4, ventral. *Scale-bars*: 9–10, 40 μm; 11–12, 50 μm; 13–14, 20 μm

(388 ± 29). Parabasal papilla (Fig. 5) slightly swollen. Oral cone robust. Mandible (Fig. 6) slender, with four sharp teeth. Maxillule (Fig. 7) bilobate; inner lobe weakly sclerotised, blunt, bearing two setae; outer lobe armed with two sharp, tapered processes. Maxilla (Fig. 8) four-segmented; proximal segment without armature; second segment rod-like, with one basal seta; third segment elongate, with one distal seta; terminal segment small, with one small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs. 9–10) biramous, with both exopods composed of two incompletely fused segments and two-segmented endopods; leg armature formula as follows (variation in armature on terminal segment of rami is represented by mode, followed by range in parentheses):

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

Leg 1 (Fig. 9) 104–124 (114 ± 9) long; protopod length 52–69 (59 ± 7); exopod length 52–60 (55 ± 4) exceeding endopod length of 23–29 (27 ± 2). Leg 2 (Fig. 10) 100–127 (112 ± 11) long; protopod length 59–77 (65 ± 8); exopod length 41–50 (47 ± 4); endopod length 32–39 (35 ± 3).

Protopods bears two rows of blunt spinules on distal tip and inner margin. Both rami ornamented with crescentic rows of fine spinules. Intercoxal sclerites of legs 1 (Fig. 11) and 2 (Fig. 12) ornamented with two short and two long processes. Leg 3 (Fig. 13) represented by two naked setae on anterior half of trunk. Leg 4 (Fig. 14) represented by one naked seta on posterior 2/3 of trunk.

Remarks

Hatschekia currently contains 93 valid species, which are divided into two groups in terms of the presence or absence of processes on the posterior margin of the intercoxal sclerites of legs 1 and 2; 87 species lack these processes, but the remaining six species (see below) have them. *H. pseudostracii* n. sp. and the other two species described below as new (i.e. *H. bibullae* n. sp. and *H. kuroshioensis* n. sp.) have four stout processes which easily distinguish them from 87 of their congeners. This distinct character is shared with eight species, of which six are previously known species, i.e. *H. balistae* Nuñes-Ruivo, 1954, *H. lima* Uyeno & Nagasawa, 2009, *H. cylindrus* Uyeno & Nagasawa, 2009, *H. monacanthi* Yamaguti, 1939, *H. ostracii* Yamaguti, 1953 and *H. sunaoi* Uyeno & Nagasawa, 2009. *H. pseudostracii* n. sp. differs from four of these species, *H. balistae*, *H. lima*, *H. cylindrus* and *H. sunaoi,* by having a T-shaped chitinous frame on the dorsal surface of the cephalothorax. *H. monacanthi* also bears a T-shaped chitinous frame, but its posterior end forms a complete ring (there is no such structure in *H. pseudostracii*). This new species is distinguishable from *H. ostracii* by the exopod of leg 1 being twice as long as the endopod (exopod length/endopod length ratio of leg 1 = 2.08 ± 0.16; Table 1). The ratio of both lengths in *H. ostracii* is considerably higher (3.24 ± 0.36; Uyeno & Nagasawa, 2009a), and this difference is statistically significant (U-test, $P < 0.01$). Furthermore, posterior lobes on the trunk are present in *H. ostracii* but absent in *H. pseudostracii*. The new species also differs from *H. ostracii* in that the latter has a well-developed, thumb-shaped parabasal papilla and an ovoid rostral process (Uyeno & Nagasawa, 2009a). Our finding of *H. pseudostracii* n. sp. represents the first record of a species of *Hatschekia* from an aracanid fish.

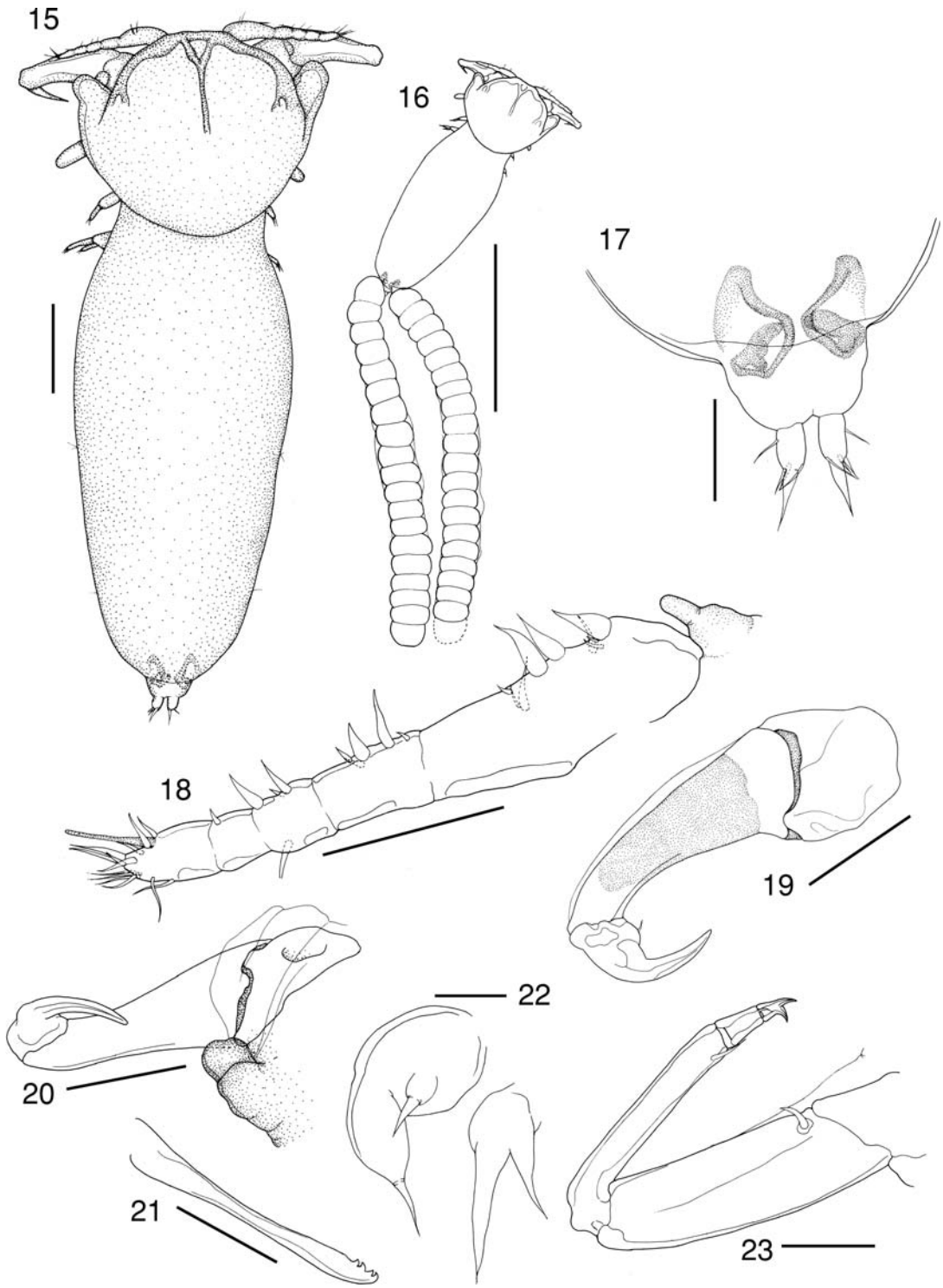
Hatschekia bibullae n. sp.

Type-host: *Lactoria diaphana* (Bloch & Schneider) (Tetraodontiformes: Ostraciidae).
Type-locality: Off Tosasaga, Kuroshio, Kochi, North Pacific Ocean, Japan (33°3′N, 133°8′E).
Attachment site: Gill filaments.
Type-material: Holotype female, NSMT-Cr 20858, 7 August 2008; 4 paratype females, NSMT-Cr 20859, 7 August 2008.
Etymology: The name of the new species refers to the presence of parabasal papillae on the lateral sides of the cephalothorax, which look like two bosses.

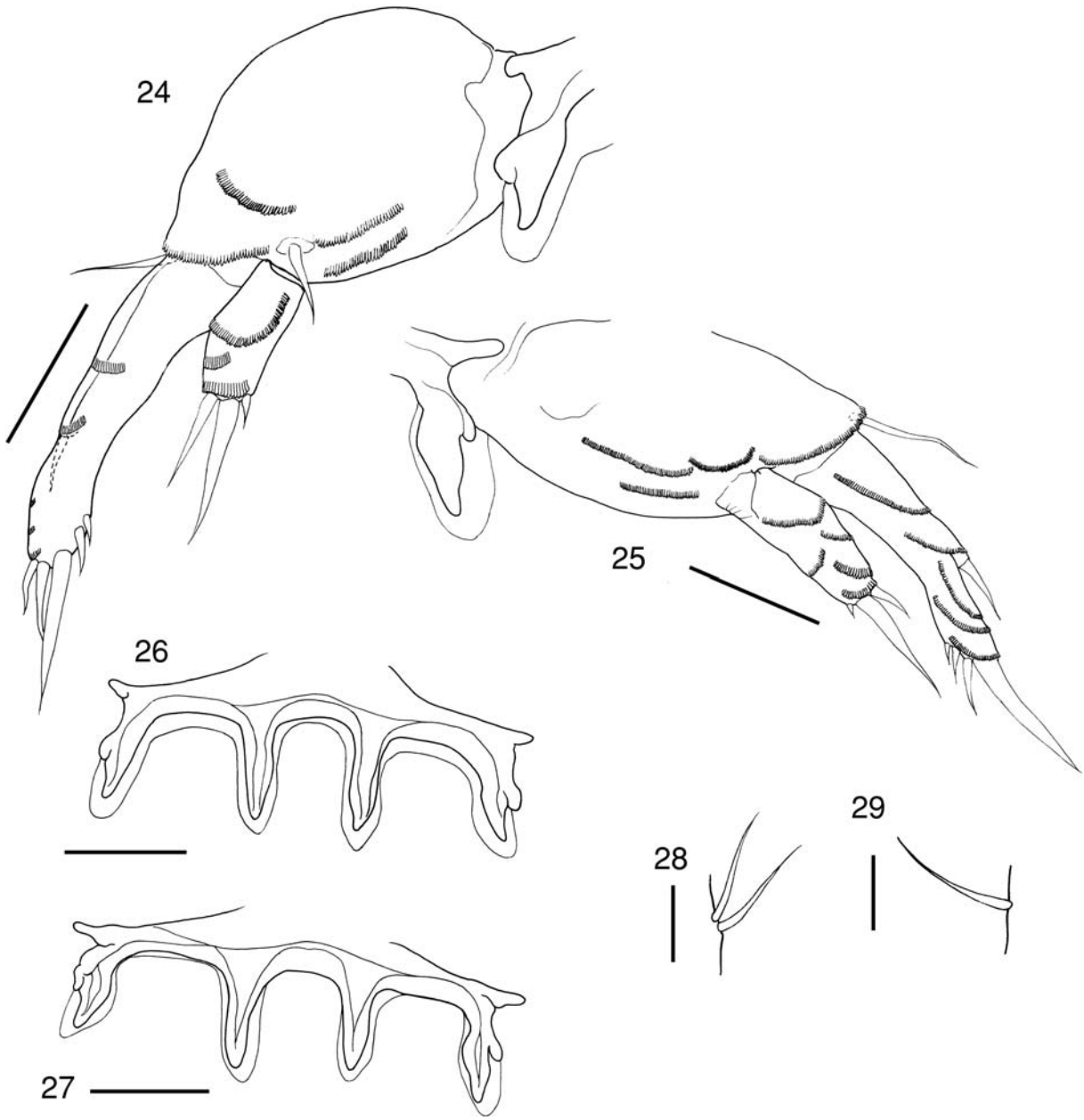
Description (Figs. 15–29)

Adult female

[Based on five specimens.] Body (Figs. 15–16) 1,178–1,485 (1,372 ± 119) long, excluding caudal rami. Cephalothorax ellipsoid, shorter than wide, 368–458 (415 ± 34) × 483–572 (525 ± 35), with dorsal, trichotomous, chitinous frame. Trunk longer than wide, 863–1,131 (1,031 ± 109) × 314–484 (406 ± 64). Abdomen (Fig. 17) shorter than wide, 41–70 (53 ± 11) × 95–111 (104 ± 7). Caudal ramus (Fig. 17) slightly longer than wide, 31–43 (37 ± 4) × 17–23 (20 ± 2), bears five naked setae. Rostrum armed with single digitiform process (Fig. 18) on posterolateral corner. Antennule (Fig. 18) five-segmented, 215–265 (239 ± 19) long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 19) three-segmented; proximal segment (coxa) fused to basement; middle segment (basis) ornamented with surface pits; terminal claw with an element; proximal segment length 74–93 (82 ± 9); middle segment



Figs. 15–23 *Hatschekia bibullae* n. sp., female, holotype NSMT-Cr 20858. 15. Habitus, dorsal; 16. habitus with egg sacs, dorsal; 17. posterior part of trunk, dorsal; 18. antennule, ventral; 19. antenna, ventral; 20. antenna and parabasal papilla; 21. mandible; 22. maxillule; 23. maxilla, ventral. *Scale-bars*: 15, 200 μm; 16, 1,000 μm; 17–18, 80 μm; 19, 23, 40 μm; 20, 100 μm; 21, 30 μm; 22, 20 μm



Figs. 24–29 *Hatschekia bibullae* n. sp., female, holotype NSMT-Cr 20858. 24. Leg 1, ventral; 25. leg 2, ventral; 26. intercoxal sclerite of leg 1, ventral; 27. intercoxal sclerite of leg 2, ventral; 28. leg 3, ventral; 29. leg 4, ventral. *Scale-bars*: 24–25, 40 μm; 26–27, 50 μm; 28–29, 20 μm

length 175–225 (204 ± 20); terminal segment length 52–76 (62 ± 10); total length 303–380 (348 ± 29). Parabasal papilla (Fig. 20) thumb-shaped, directed ventrally. Oral cone robust. Mandible (Fig. 21) slender, with four sharp teeth. Maxillule (Fig. 22) bilobate; inner lobe swollen, round, armed with two elements; outer lobes armed with two tapering sharp processes. Maxilla (Fig. 23) four-segmented; proximal segment without armature; second segment rod-like, with one basal seta; third segment elongate, with

one distal seta; terminal segment small with one small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs. 24–25) biramous, with both exopods composed of two incompletely fused segments and unsegmented endopods; leg armature formula as follows:

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

Leg 1 (Fig. 24) 116–182 (153 ± 25) long; protopod length 65–99 (87 ± 13); exopod length 51–83 (67 ± 12), exceeding endopod length of 32–36 (34 ± 2). Leg 2 (Fig. 25) 130–197 (154 ± 26) long; protopod length 75–120 (95 ± 17); exopod length 51–77 (60 ± 10); endopod length 33–48 (40 ± 6).

Protopods and both rami bear crescentic rows of blunt spinules. Endopods of both legs consisting of two incompletely fused segments. Intercoxal sclerites of legs 1 (Fig. 26) and 2 (Fig. 27) bear two short and two long processes, ornamented with thin, well-developed edge along posterior margin. Leg 3 (Fig. 28) represented by two naked setae at mid-length of trunk. Leg 4 (Fig. 29) represented by one naked seta on posterior 3/4 of trunk.

Remarks

Like *H. pseudostracii* n. sp., *H. bibullae* n. sp. has four processes on the posterior margin of the intercoxal sclerites of legs 1 and 2. As indicated above, this character is commonly found in seven of its congeners, *H. ballistae*, *H. lima*, *H. cylindrus*, *H. monacanthi*, *H. ostracii*, *H. pseudostracii* n. sp. and *H. sunaoi*. *H. ballistae* is readily differentiated from *H. bibullae* n. sp. by having a pointed apex on the cephalothrorax. The new species differs from five of the above species by having a thumb-shaped parabasal papilla: *H. lima* and *H. sunaoi* have an indistinct papilla; *H. cylindrus* has a long, rod-like papilla; *H. pseudostracii* n. sp. has a small papilla; and *H. monacanthi* has a pedunculate, wrinkled papilla. The new species is distinguished from *H. ostracii* by having a trunk without posterior lobes (versus with lobes in the latter), a maxillule with a swollen inner lobe (versus with an elongate sclerotised lobe) and a digitiform rostral process (versus an ovoid process). The ratio of leg 1 exopod/endopod length is statistically (U-test, $P < 0.01$) different between the two species, i.e. 1.97 ± 0.26 in *H. bibullae* n. sp. (see Table 1) vs. 3.24 ± 0.36 in *H. ostracii* (see Uyeno & Nagasawa, 2009a).

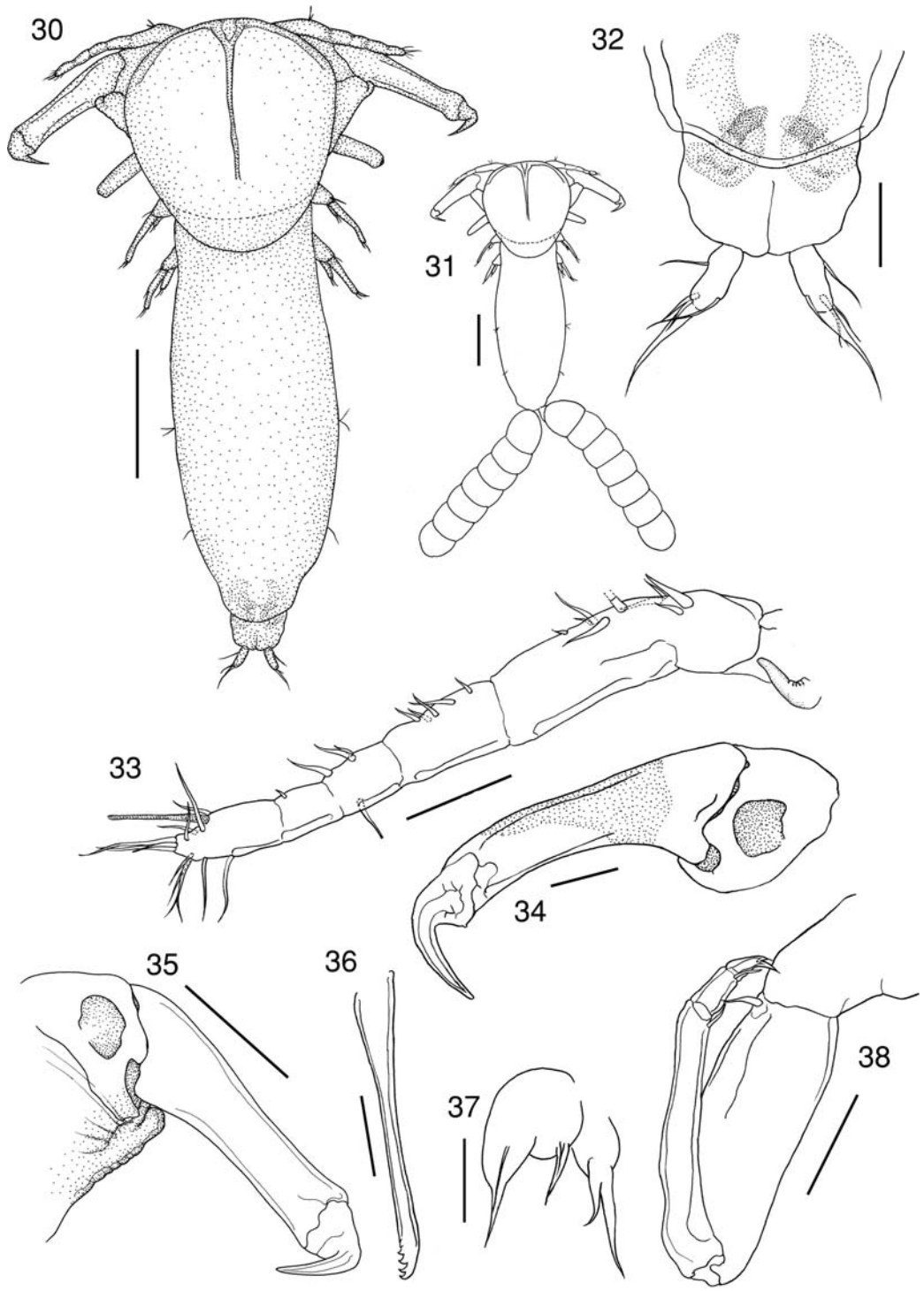
Hatschekia kuroshioensis n. sp.

Type-host: *Tetrosomus concatenates* (Bloch) (Tetraodontiformes: Ostraciidae).
Type-locality: Off Tosasaga, Kuroshio, Kochi, North Pacific Ocean, Japan (33°3′N, 133°8′E).
Attachment site: Gill filaments.
Type-material: Holotype female, NSMT-Cr 20860, 11 May 2006; 7 paratype females, NSMT-Cr 20861, 11 May 2006.
Etymology: The name of the new species refers to the type-locality.

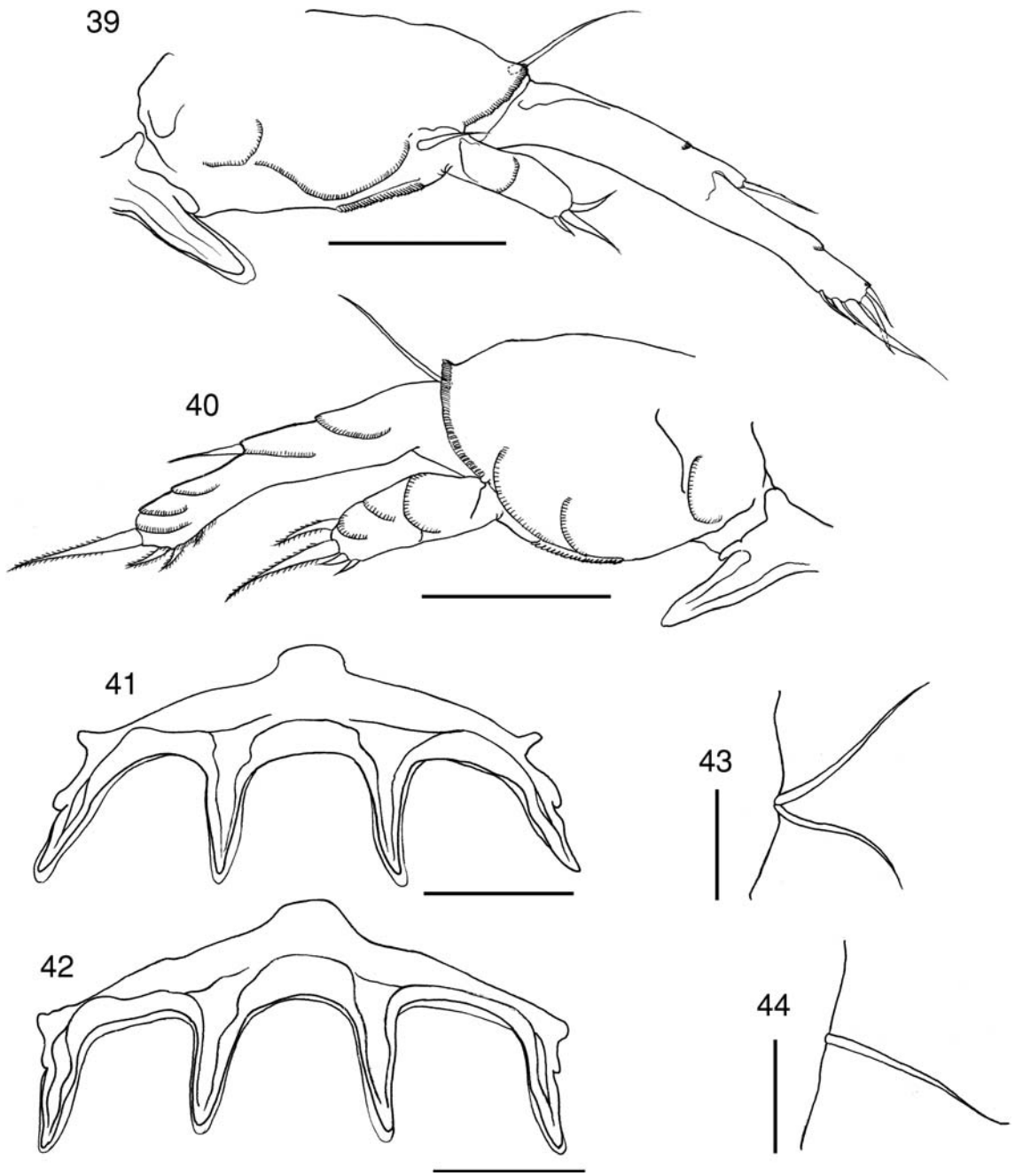
Description (Figs. 30–44)

Adult female

[Based on eight specimens.] Body (Figs. 30–31) 1,003–1,200 (1,116 ± 84) long, excluding caudal rami. Cephalothorax ellipsoid, slightly shorter than wide, 356–397 (383 ± 15) × 438–505 (473 ± 29), with dorsal, T-shaped, chitinous frame. Trunk longer than wide, 695–876 (804 ± 72) × 265–363 (317 ± 38). Abdomen (Fig. 32) wider than long, 44–67 (57 ± 8) × 86–105 (94 ± 7). Caudal ramus (Fig. 32) slightly longer than wide, 32–46 (36 ± 5) × 16–19 (17 ± 1), bears five naked setae. Rostrum armed with single fine digitiform process (Fig. 33) on posterolateral corner. Antennule (Fig. 33) five-segmented, 198–240 (224 ± 13) long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 34) three-segmented; proximal segment (coxa) without armature; middle segment (basis) ornamented with surface pits; terminal claw without armature; proximal segment length 92–110 (101 ± 6); middle segment length 189–244 (211 ± 18); terminal segment length 44–56 (49 ± 4); total length 335–402 (361 ± 22). Parabasal papilla (Fig. 35) slightly swollen. Oral cone robust. Mandible (Fig. 36) slender, with 4 sharp teeth. Maxillule



Figs. 30–38 *Hatschekia kuroshioensis* n. sp., female, holotype NSMT-Cr 20860. 30. Habitus dorsal; 31. habitus with egg-sacs, dorsal; 32. posterior part of trunk, dorsal; 33. antennule, ventral; 34. antenna, ventral; 35. antenna and parabasal papilla (drawn from a paratype-Cr 20861); 36. mandible, ventral; 37. maxillule, ventral; 38. maxilla, ventral. *Scale-bars*: 30–31, 200 μm; 32–33, 38, 40 μm; 34, 50 μm; 35, 100 μm; 36–37, 20 μm



Figs. 39–44 *Hatschekia kuroshioensis* n. sp., female, holotype NSMT-Cr 20860. 39. Leg 1, ventral; 40. leg 2, ventral; 41. intercoxal sclerite of leg 1, ventral; 42. intercoxal sclerite of leg 2, ventral; 43. leg 3, ventral; 44. leg 4, ventral. *Scale-bars*: 39–40, 40 μm; 41–42, 50 μm; 43–44, 20 μm

(Fig. 37) bilobate; inner lobe swollen, armed with two sharp, tapered processes; outer lobe ornamented with two attenuate processes. Maxilla (Fig. 38) four-segmented; proximal segment without armature; second segment rod-like with one basal seta; third segment elongate, with one distal seta; terminal segment small, with one small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs. 39–40) biramous, with both exopods composed of two incompletely fused segments and endopods with indistinct segmentation; leg armature formula as follows:

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

Leg 1 (Fig. 39) 160–186 (176 ± 9) long; protopod length 75–95 (87 ± 8); exopod length 85–96 (89 ± 5), exceeding endopod length of 25–37 (29 ± 4). Leg 2 (Fig. 40) 137–154 (146 ± 7) long; protopod length 66–84 (76 ± 6); exopod length 62–78 (70 ± 5); endopod length 33–40 (37 ± 2).

Protopods and both rami bear crescentic ornamentation consisting of fine, blunt spinules. Intercoxal sclerites of legs 1 (Fig. 41) and 2 (Fig. 42) bear two short and two long processes and are ornamented by thin edge along posterior margin. Leg 3 (Fig. 43) represented by two naked setae inserted at about middle of trunk. Leg 4 (Fig. 44) represented by one naked seta on posterior 3/4 of trunk.

Remarks

Hatschekia kuroshioensis n. sp. shares the intercoxal sclerites of legs 1 and 2 with four processes with eight species, *H. balistae*, *H. bibullae* n. sp., *H. lima*, *H. cylindrus*, *H. monacanthi*, *H. ostracii*, *H. pseudostracii* n. sp. and *H. sunaoi*. This new species differs from *H. balistae*, *H. bibullae* n. sp., *H. lima*, *H. cylindrus* and *H. sunaoi* by having a cephalothorax with a T-shaped chitinous frame. *H. monacanthi* bears a T-shaped frame with a complete ring at the posterior end and is thus distinguishable from *H. kuroshioensis*. *H. ostracii* is easily discriminated from *H. kuroshioensis* by three distinct features: a trunk with posterior lobes; a well-developed, thumb-shaped parabasal papilla; and a rostrum with an ovoid process. *H. pseudostracii* can be readily separated from *H. kuroshioensis* by having the following three characteristics: a rostrum with a small round process (instead of a comparatively long sausage-shaped process); leg 1 exopod nearly twice as long as the endopod [the exopod length/endopod length ratio are 2.08 ± 0.16 vs. 3.12 ± 0.31 (U-test, $P < 0.01$); Table 1]; and a maxillule with a swollen, rounded inner lobe.

Discussion

Ninety-three species of *Hatschekia* have previously been accepted as valid, and three new species are described in this paper. Of these 96 species, only 12 have been described from tetraodontiform fishes throughout the world's oceans (Wilson, 1913; Yamaguti, 1939, 1953; Pearse, 1948; Nuñes-Ruivo, 1954; Pillai, 1968; Hewitt, 1969; Jones, 1985; Uyeno & Nagasawa, 2009a, b). *H. ostracii* is the only species which has been described from boxfishes of the family Ostraciidae, and no species have been recorded from fishes of the family Aracanidae. The Ostraciidae and Aracanidae contain 15 species and 12 species, respectively, which are widely distributed in temperate to tropical waters (Uyeno & Sakamoto, 1999). In this paper, three species of boxfishes were examined, and each species was found to harbour one new species of *Hatschekia*. Although a few species are utilised in Japan, the commercial importance of boxfishes remains very low in many countries and regions, and it is thus quite difficult to obtain sufficient material of the fishes for parasitological research. This means that much remains unknown regarding about their parasite fauna, including copepods, and more studies on this group are needed.

Twenty-four species of *Hatschekia* are known from marine fishes in Japanese waters (Yamaguti, 1939, 1953, 1963; Shiino, 1957a, b; Yamaguti & Yamasu, 1959; Jones, 1985; Uyeno & Nagasawa, 2009a, b). The three new species described in this paper bring this total to 27.

In this study, the leg 1 exopod length/endopod length ratio was used as a diagnostic between the new species and their congeners. This ratio was previously used by Uyeno & Nagasawa (2009a) to differentiate two morphologically similar species, *H. monacanthi* and *H. ostracii*. In future studies, it will be useful to examine and use the ratios between various body parts and their appendages for identifying more species of *Hatschekia*. In addition, Uyeno & Nagasawa (2009a) have suggested that both the parabasal papilla and the rostral process can be used for the identification of species of this genus. In this study, we confirmed the usefulness of these characters. So far, the description of the parabasal papilla is available for only a limited number of species (e.g. Kabata, 1979, 1991; Schram & Aspholm, 1997; Uyeno & Nagasawa, 2009a, b) and the presence of a rostral process is known for only

seven species (Uyeno & Nagasawa, 2009a, b). Nevertheless, these morphological features have potential as valuable diagnostic characters for identifying species of *Hatschekia*.

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