THREE NEW SPECIES OF UPOGEBIIDAE (THALASSINIDEA) FROM IRIOMOTE ISLAND, RYUKYUS, JAPAN

BY

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ABSTRACT

Three new species of the genus *Upogebia* were recently collected in many specimens in the sandstone at the intertidal zone on Iriomote Island, Ryukyus, Japan. *Upogebia saigusai* sp. nov. is closely similar to *U. snelliusi* Ngoc-Ho, 1989; *U. iriomotensis* sp. nov. to *U. baweana* Tirmizi & Kazmi, 1979; and *U. spinidactylus* sp. nov. resembles *U. carinicauda* (Stimpson, 1860).

ZUSAMMENFASSUNG

Viele Exemplare dreier neuer Arten der Gattung *Upogebia* sind im Sandstein der Gezeitenzone von Iriomote Island, Ryukyu Inseln, Japan, gesammelt worden. Einander sehr ähnlich sind *Upogebia saigusai* sp. nov. und *U. snelliusi* Ngoc-Ho, 1989 sowie *U. iriomotensis* sp. nov. und *U. baweana* Tirmizi & Kazmi, 1979. *U. spinidactylus* sp. nov. hat Ähnlichkeit mit *U. carinicauda* (Stimpson, 1860).

INTRODUCTION

The investigations on the Ryukyus by Okayama University during the years 2003-2005, have yielded a lot of small specimens of Upogebiidae, including three new species, *U. saigusai*, *U. iriomotensis*, and *U. spinidactylus* spp. nov., all collected from the sandstones at the intertidal zone on Iriomote Island. Five species of *Upogebia*, i.e., *U. carinicauda* (Stimpson, 1860), *U. yokoyai* Makarov, 1938, *U. miyakei* Sakai, 1967, *U. sakaii* Ngoc-Ho, 1994, and *U. snelliusi* Ngoc-Ho, 1989 were already known from southwestern Japan, Amami-Oshima, the Okinawa

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Islands, Ishigaki-jima Island, and Iriomote Island (Sakai, 1968, 1982, 1995; Sakai & Mukai, 1991; Ngoc-Ho, 1994; Sakai & Takeda, 1995; Itani, 2004). *U. miyakei* is rare, and found in Japan only on Ishigaki Island and Iriomote Island (Sakai, 1982; Ngoc-Ho, 1994; Komai et al., 1999; Itani, 2004).

Abbreviations. — A1, A2, antennule and antenna, respectively; CL, carapace length, measured from rostral tip to posterior end of carapace; Mxp3, maxilliped 3; P1-5, pereiopods 1-5; TL, total length, measured from rostral tip to end of telson; RMNH, National Museum of Natural History, Leiden; SDO, Graduate School of Natural Science and Technology, Okayama University.

SYSTEMATIC PART

Upogebia saigusai sp. nov. (figs. 1-3)

Material examined. — Holotype: RMNH D 51729, female (TL/CL, 20.6/11.4 mm, missing P1, 3, 4, 5 on right side; P5 on left side), estuary of Mitara River, east coast of Iriomote Island, 24°22.5′N 123°44.6′E, 24.xi.2003, leg. M. Saigusa, H. Ikeda, and Y. Hirano.

Diagnosis. — Rostrum with two frontal teeth; infrarostral spine absent. Lateral ridge of gastric region projecting forward with rounded tooth. Anterolateral margin of carapace armed with six teeth. P1 subchelate; merus with sharp subterminal spine on dorsal margin, and with row of five small sharp spines in proximal half of ventral margin; palm oblong, armed with row of 12 sharp spines on dorsal margin, and with 16 scattered sharp spines on mesial surface; ventral margin bearing three strong sharp spines in its distal half, distally protruded forward to form sharp fixed finger. Telson broader than long; dorsal surface with concave posteromedian plate in posterior two-thirds, bordered by distinct transverse median carina.

Description of female holotype. — Small sized species (fig. 1). Rostrum (fig. 2A) convex on frontal margin, bearing two rounded frontal teeth at both

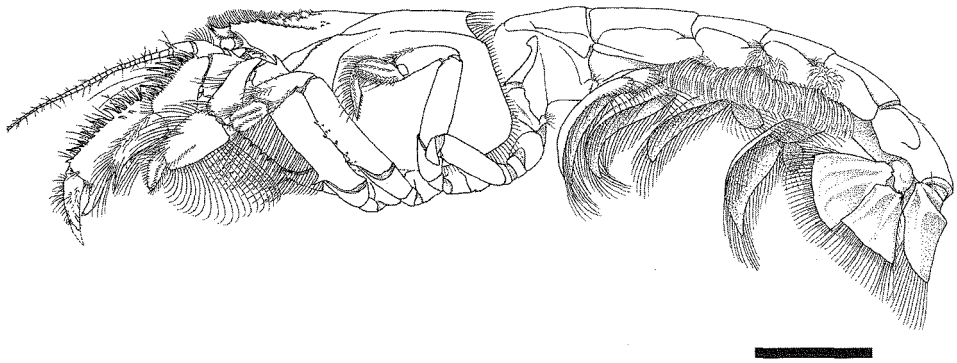

Fig. 1. *Upogebia saigusai* sp. nov., holotype female, RMNH D 51729 (TL = 20.6 mm), from estuary of Mitara River, Iriomote Island; lateral view. Scale, 5 mm.

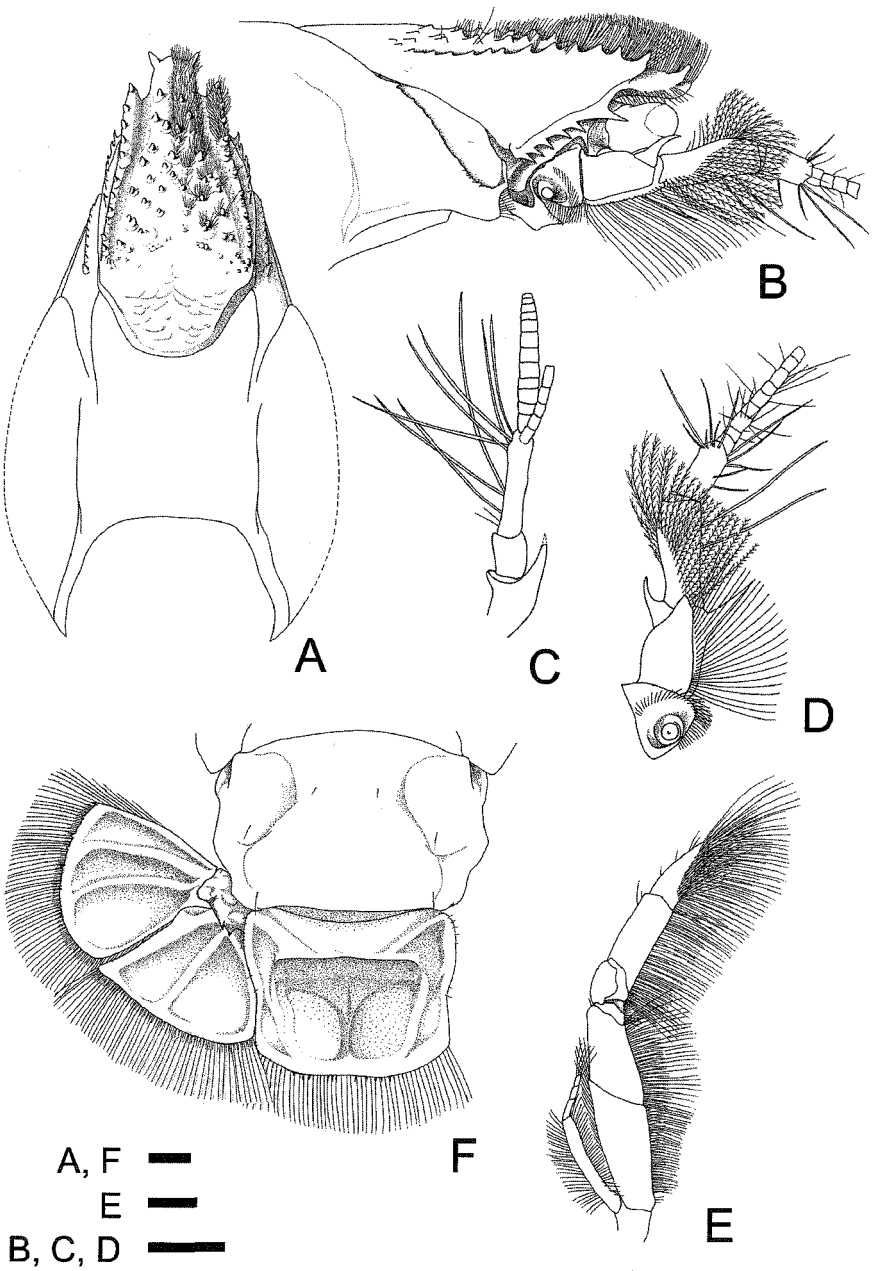

Fig. 2. *Upogebia saigusai* sp. nov. A-F, holotype female, RMNH D 51729 (TL = 20.6 mm), from estuary of Mitara River, Iriomote Island. A, carapace, dorsal view; B, carapace, lateral view; C, A1; D, A2; E, Mxp3; F, telson and uropod: telson viewed from anterior in posterior direction, hence dorsomedian carina figured in posterior position. Scale, 1 mm.

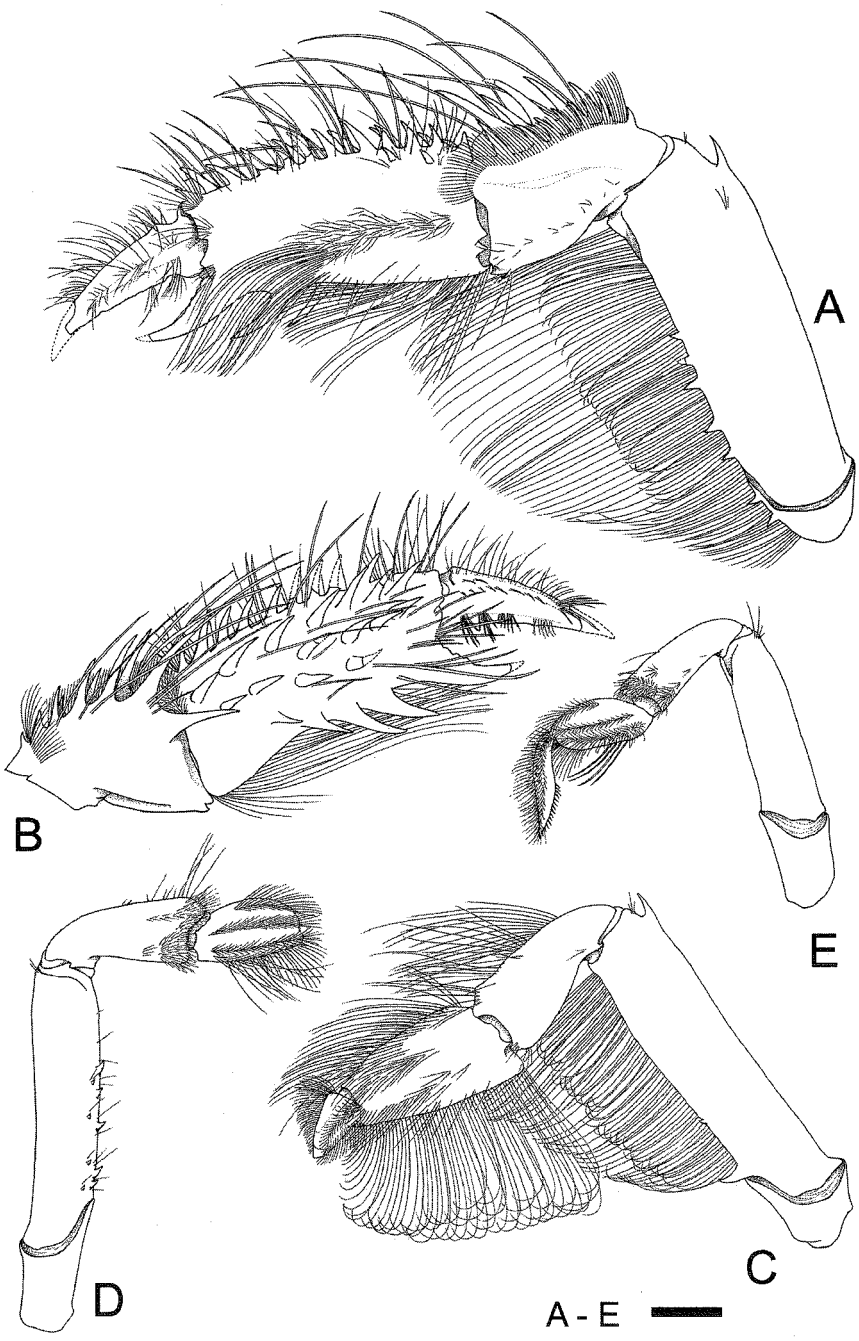

Fig. 3. *Upogebia saigusai* sp. nov. A-E, holotype female, RMNH D 51729 (TL = 20.6 mm), from estuary of Mitara River, Iriomote Island. A, P1, lateral view; B, P1, inner view; C, P2; D, P3; E, P4. Scale, 1 mm.

corners; infrarostral spine absent; dorsal surface with shallow median furrow extending from near rostral tip to gastric region; dorsal surface of rostrum and gastric region scattered with tubercles or denticles among thick tufts of setae. Lateral ridge of gastric region projecting forward with rounded tooth, bearing row of twelve teeth, and thick setae in anterior half; lateral longitudinal groove broad and deep in anterior half, and narrow and divergent backwards in posterior half. No hepatic spine. Anterolateral surface of carapace armed with six teeth (fig. 1B), anterior one distinct and located posterior to eyestalk. Linea thalassinica present only on anterior part of carapace.

Eyestalk (fig. 1B) stout, failing to reach tip of rostrum. A1 peduncle (fig. 2C) overreaching distal margin of A2 penultimate segment; proximal segment bearing strong sharp ventral spine, tip of which reaching to distal margin of penultimate segment. A2 segment 2 (fig. 2D) with strong sharp ventral spine. Epistome terminating in sharp spine.

Mxp3 (fig. 1F) narrow.

P1 subchelate (fig. 3A, B). Ischium bears two small sharp spines on ventral margin. Merus with sharp subterminal spine on dorsal margin; row of five small sharp spines in proximal half of ventral margin. Carpus triangular; row of five sharp spines on dorsal edge, another, parallel row of five long sharp spines on dorsomesial margin, and another two sharp spines on mesiodistal margin; thick setae present laterally on those dorsal spines; distoventral corner with small, round spine. Palm oblong, armed with row of 12 sharp spines on dorsal margin, and with 16 sharp scattered spines on mesial surface; ventral margin bearing three strong sharp spines in its distal half, distally protruded forward to form sharp fixed finger; lateral surface bears oblique row of setae in ventroproximal half, distally directed downward and then proximally to ventral margin. Dactylus longer than fixed finger, unarmed on cutting edge; lateral surface beset with two rows of short setae merging with each other in distal half; mesial surface with median carina bearing more than 10 tubercles; fixed finger armed with four small, thick teeth in proximal half of cutting edge. Tips of both dactylus and fixed finger missing.

P2 (fig. 3C) simple, ischium unarmed. Merus with sharp subterminal spine on dorsal margin, and with two sharp spines on proximal half of ventral margin; anterior spine minute, and proximal one of strong shape. Carpus with long slender setae on distal half of dorsal surface. Propodus with two rows of short setae on distal half of lateral surface; row of long setae on dorsal and ventral margins.

P3 (fig. 3D) also simple. Merus bears four small ventral spines, above which four spinal granules on lateral surface. Carpus merged with short setae on distal margin. Propodus with three rows of short setae on lateral surface. Dactylus lacking.

P4 (fig. 3E) unarmed. Carpus bordered distally with short setae on lateral surface. Propodus with three rows of short setae on lateral surface. Dactylus bearing eight interspaced tubercles on dorsolateral surface; distal half of ventral margin with small comb-like setae.

P5 missing.

Abdominal somite 6 broader than long; posterior margin smoothly carinate; lateral margin with triangular median protrusion.

Telson (fig. 2F) broader than long; lateral margins concave in posterior half; dorsal surface with concave posteromedian plate in posterior two-thirds, surrounded by distinct transverse median and lateral carinae with median ditch; posterior margin convex.

Uropodal endopod broad, posterior margin failing to reach that of telson; two small tubercles in middle of posterior margin; anterodistal corner protruded. Exopod overreaches endopod; one small spine on anterodistal corner; eight spinal tubercles on posterior margin. Protopod with two spines on distal margin.

Remarks. — The present new species, *U. saigusai*, is closely similar to *U. snelliusi* Ngoc-Ho, 1989 in the spinulation of the P1 merus and palm, and also in the shape of the tail-fan. However, the two species differ from each other: in *U. snelliusi* the rostrum bears one sharp ventrodistal spine and has four front teeth on the dorsal surface, and the P1 carpus bears a row of small dorsal spines; whereas in *U. saigusai* the rostrum bears no ventrodistal spine and has only two frontal teeth, the P1 carpus bears a row of seven strong dorsal spines and another row of five long sharp spines on dorsomedial margin. The spines of the row on the anterolateral margin of the carapace in *U. saigusai* are stronger than those in *U. snelliusi*.

Etymology. — We dedicate one of three new present species to Prof. Dr. M. Saigusa in honour of his scientific dedication; he gave us the opportunity to collect and examine these specimens after his scientific expeditions to the Ryukyus in 2003-2005. The specific name hence is a noun in the genitive singular.

Type locality. — Estuary of Mitara River, Iriomote Island, Japan.

Habitat and distribution. — Burrowing in the sandstone at the intertidal zone, estuary of Mitara River, Iriomote Island, Japan.

Upogebia iriomotensis sp. nov. (figs. 4-5)

Material examined. — Holotype, RMNH D 51730, ovig. female (TL/CL, 35.4/10.5 mm), estuary of Urauchi River, northeast of Iriomote Island, 24°24.4′N 123°46.4′E, 2.vi.2004, leg. H. Ikeda, Y. Hirano, and T. Nanri. Paratypes, SDO 014, 1 male (TL/CL, 27.9/8.5 mm), 1 female (TL/CL, 33.0/8.8 mm), Funaura Bay, north coast of Iriomote Island, 24°23.5′N 123°49.2′E, 23.xi.2003, leg. M. Saigusa, H. Ikeda, and Y. Hirano; paratypes, SDO 015, 2 females (TL/CL, 39.5-40.1/11.2-11.3 mm), 2 ovig. females (TL/CL, 31.7-33.0/9.6-9.9 mm), Funaura Bay, north coast of Iriomote Island, 24°23.5′N 123°49.2′E, 3.vi.2004, leg. T. Nanri and M. Saigusa; paratypes, SDO 016, 5 males (TL/CL, 22.3-29.0/6.8-10.6 mm), 7 females (TL/CL, 29.0-44.2/8.5-12.5 mm), Funaura Bay, north

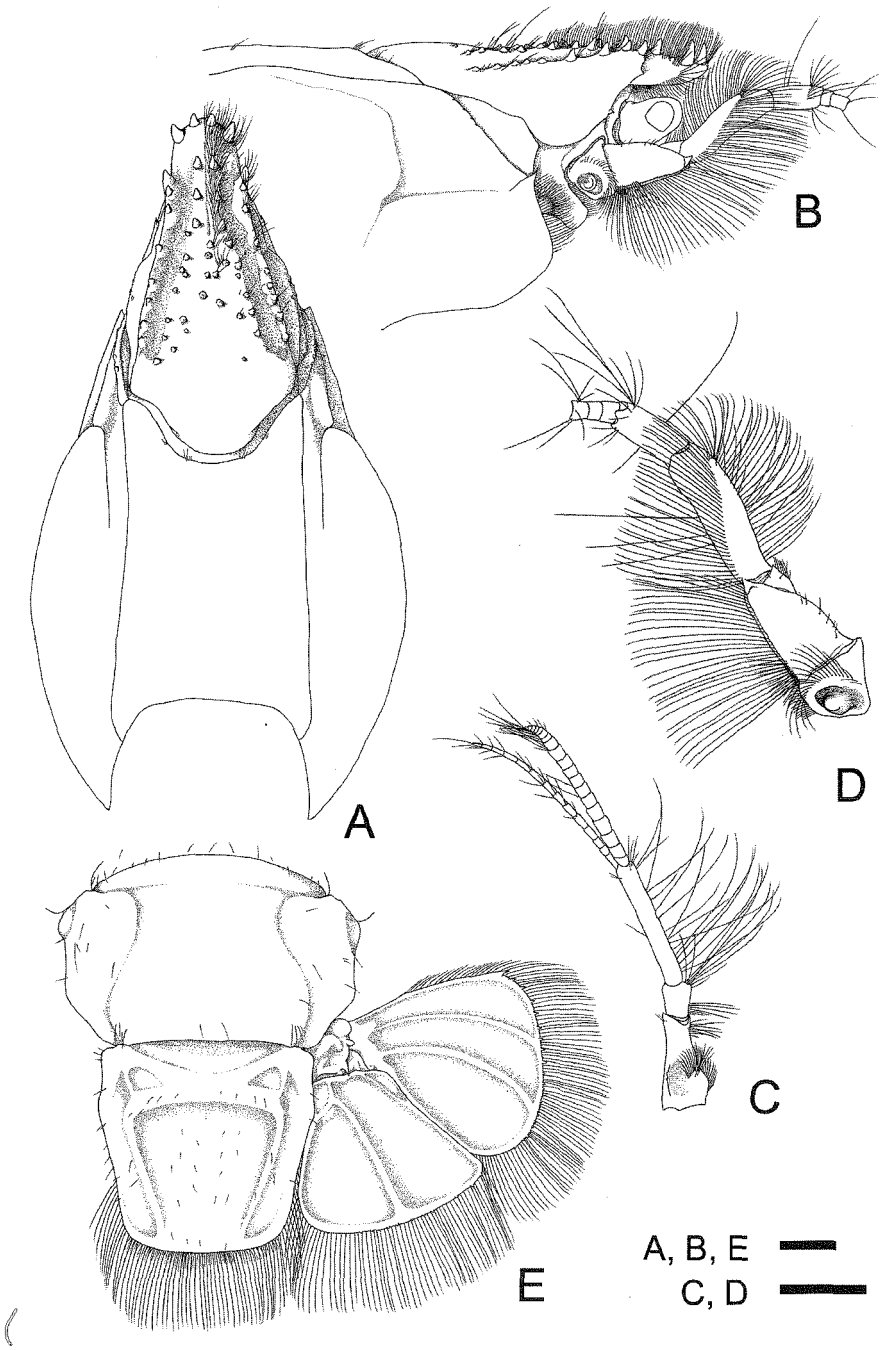

Fig. 4. *Upogebia iriomotensis* sp. nov. A-E, holotype, ovig. female, RMNH D 51730 (TL = 35.4 mm), from estuary of Urauchi River, Iriomote Island. A, carapace, dorsal view; B, carapace, lateral view; C, A1; D, A2; E, telson and uropod. Scale, 1 mm.

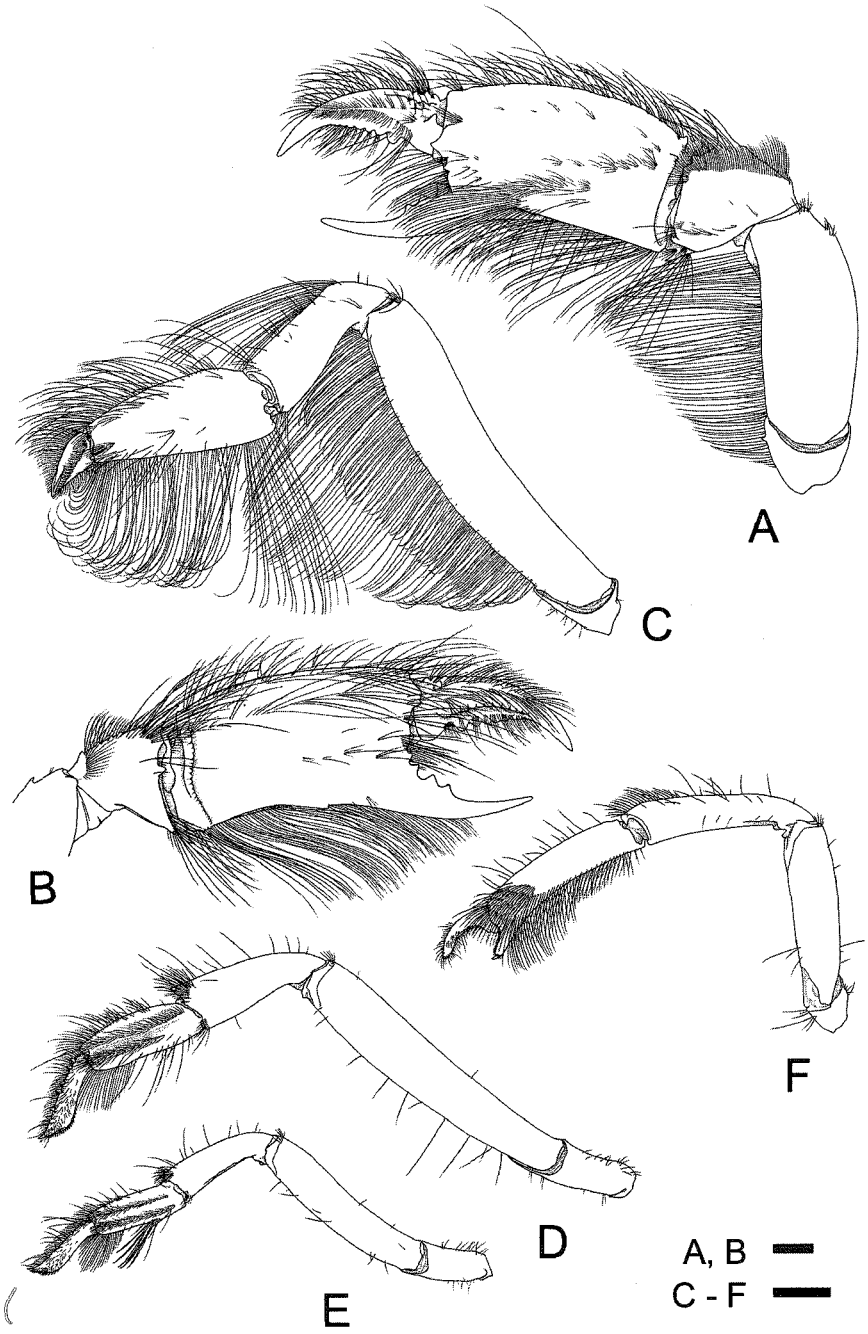

Fig. 5. *Upogebia iriomotensis* sp. nov. A-B, male, RMNH D 51730 (TL = 30.5 mm); C-E, holotype, ovig. female, SDO 030A (TL = 35.4 mm). A, male P1, lateral view; B, same P1, inner view; C, female P2; D, same, P3; E, same, P4; E, same, P5. Scale, 1 mm.

coast of Iriomote Island, 24°23.5′N 123°49.2′E, 5.vi.2004, leg. T. Nanri and M. Saigusa; paratypes, SDO 017, 1 male (TL/CL, 34.7/9.6 mm), 1 female (TL/CT, 35.3/10.4 mm), Funaura Bay, north coast of Iriomote Island, 24°23.5′N 123°49.2′E, 8.xi.2004, leg. H. Ikeda, Y. Hirano, and O. Gusev; paratypes, SDO 023, 4 males (TL/CL, 20.2-35.5/6.3-10.4 mm), 5 females (TL/CL, 28.4-44.1/8.7-11.9 mm), estuary of Urauchi River, northeast of Iriomote Island, 24°24.4′N 123°46.4′E, 10.xi.2004, leg. H. Ikeda, Y. Hirano, and T. Nanri; paratypes, SDO 024, 4 males (TL/CL, 21.4-26.9/6.8-8.1 mm), 4 females (TL/CL, 32.5-39.0/9.5-11.0 mm), Funaura Bay, north coast of Iriomote Island, 24°23.5′N 123°49.2′E, 18.xi.2004, leg. H. Ikeda, T. Nanri, and Y. Hirano; SDO 025, 5 males (TL/CL, 13.9-40.1/3.9-11.7 mm), 7 females (TL/CL, 14.7-39.2/4.7-10.5 mm), same data as in SDO 024; paratypes, SDO 030C, 9 males (TL/CL, 16.6-32.5/5.5-9.8 mm), 5 females (TL/CL, 16.6-39.3/4.8-12.4 mm), 2 ovig. females (TL/CL, 34.0-37.1/10.6-11.2 mm), same data as in holotype, RMNH D 51730.

Diagnosis. — Rostrum with four frontal spines; no infrarostral spine; lateral ridge of gastric region scarcely developed, with strong frontal spine. Anterolateral margin of carapace armed with small ocular spine. P1 subchelate; merus armed with subterminal spine on dorsal margin, and unarmed on ventral margin; palm bearing small proximal spine on dorsal margin; fixed finger slender, with three distinct teeth in proximal half of cutting edge.

Description of female holotype. — Small sized species. Rostrum (fig. 4A, B) a little longer than broad, rounded on frontal margin, bearing four spines, no infrarostral spine; gastric region with two rows of three tubercles along median furrow in its anterior two-thirds, and posterior to it with scattered tubercles and small slender setae. Lateral ridge of gastric region scarcely developed, with strong frontal spine, and posterior to it row of eight spines, reaching to middle of eyestalk; lateral longitudinal groove narrow, bearing nine to eleven spines on median margins. Hepatic spine present. Anterolateral margin of carapace armed with small ocular spine. Linea thalassinica present throughout.

Eyestalk (fig. 4B) stout, and reaches to two-thirds length of rostrum. A1 peduncle (fig. 4C) longer than flagellum, and unarmed. A2 peduncle segment 2 (fig. 4D) with no spine on ventral margin.

P1 subchelate. Ischium with small spine on ventral margin. Merus armed with subterminal spine on dorsal margin, and unarmed on ventral margin. Carpus triangular; with long sharp distal spine on dorsal margin, two sharp distal spines on ventral margin, and small spine on distomesial margin. Palm oblong; dorsal margin beset with row of slender setae, bearing small spine at proximal corner; ventral margin medially with rudimentary tubercle; mesial surface with row of small tubercles along proximal margin. Dactylus incurved distally, and longer than fixed finger; dorsal surface proximally with four small tubercles; cutting edge with subproximal tubercle and distal to it row of round tubercles; lateral surface with two rows of setae merged with each other in distal half. Fixed finger slender, cutting margin with three distinct teeth in proximal half.

P2 (fig. 5C) slender. Ischium unarmed. Carpus with tuft of long slender setae on dorsal margin. Propodus with slender setae on dorsal and ventral margins. Dactylus with row of thick setae on lateral surface.

P3 (fig. 5D) unarmed on ischium and merus. Carpus bearing distal spine and tuft of setae around dorsal corner. Propodus with two rows of setae on lateral surface; slender setae on anterior half of ventral margin. Dactylus with row of seven small tubercles and slender setae on dorsal margin.

P4 (fig. 5E) with unarmed ischium and merus. Carpus with tuft of setae on dorsodistal angle. Propodus bearing two rows of setae on lateral surface. Dactylus with row of five tubercles on dorsal margin.

P5 subchelate. Ischium and merus unarmed. Carpus with setae on dorsal corner. Propodus with tuft of thick setae on distolateral surface and with row of setae on ventral margin. Dactylus spoonlike in form, bearing very short setae on its cutting edge. Tip of fixed finger ending with small spine.

Abdominal somite 6 (fig. 4E) broader than long; with shallow S-shaped grooves on dorsal surface.

Telson (fig. 4E) as long as broad; posterior margin slightly convex; lateral margin slightly concave; dorsal surface with slightly elevated transverse carina: some short setae scattered over dorsal surface.

Uropodal endopod and exopod slightly shorter than telson. Endopod with ten rounded small spines on distal margin; exopod with small sharp spine on anterodistal angle, and ten to fifteen small spines on distal margin.

Male. — P1 palm (fig. 5A, B) broader than that of female; dactylus proximally with row of five distinct lateral tubercles and two mesial tubercles on dorsal margin. P5 (fig. 5F) same as in female.

Remarks. — This species is closely similar to *U. baweana* Tirmizi & Kazmi, 1979, because the lateral ridges of the gastric regions are not projecing forward; the infrarostral spine is absent; the P1 is subchelate; the P1 fixed finger is denticulate proximally on the prehensile margin; and the telson is not tuberculous on the dorsal surface. However, there are some decisive differences between the two species: in *U. baweana*, the P1 merus bears no subterminal spine on the dorsal margin, and the P1 carpus is not provided with a dorsodistal and a ventrodistal spine, whereas in *U. iriomotensis* the P1 merus bears a subterminal spine on the dorsal margin and the P1 carpus bears a strong dorsodistal spine and a sharp distoventral spine.

Etymology. — The species is named after the type locality, Iriomote Island, with the suffix "-ensis", for indicating a geographical name. The name is an adjective agreeing in gender with the (feminine) generic name.

Type locality. — Funaura Bay, north coast of Iriomote Island, burrowing in sandstone at intertidal zone.

Habitat and distribution. — Burrowing in the sandstone at intertidal zone, Funaura Bay, Iriomote Island, and estuary of Urauchi River, Iriomote Island, Japan.

Upogebia spinidactylus sp. nov. (figs. 6-7)

Material examined. — Holotype, RMNH D 51731, female (TL/CL, 34.11/9.6 mm), Funaura Bay, north coast of Iriomote Island, 24°23.5′N 123°49.2′E, 5.vi.2004, leg. T. Nanri and M. Saigusa. Paratype, SDO 018, 1 male (TL/CL, 21.1/6.1 mm), same data as holotype; paratypes, SDO 019C, 2 males (TL/CL, 32.3-33.4/9.6-10.0 mm), 1 female (TL/CL, 39.0/10.7 mm), 2 ovig. females (TL/CL, 35.3-39.0/9.7-11.0 mm), same data as holotype; paratype, SDO 020, 1 male (TL/CL, 30.8/9.4 mm), 1

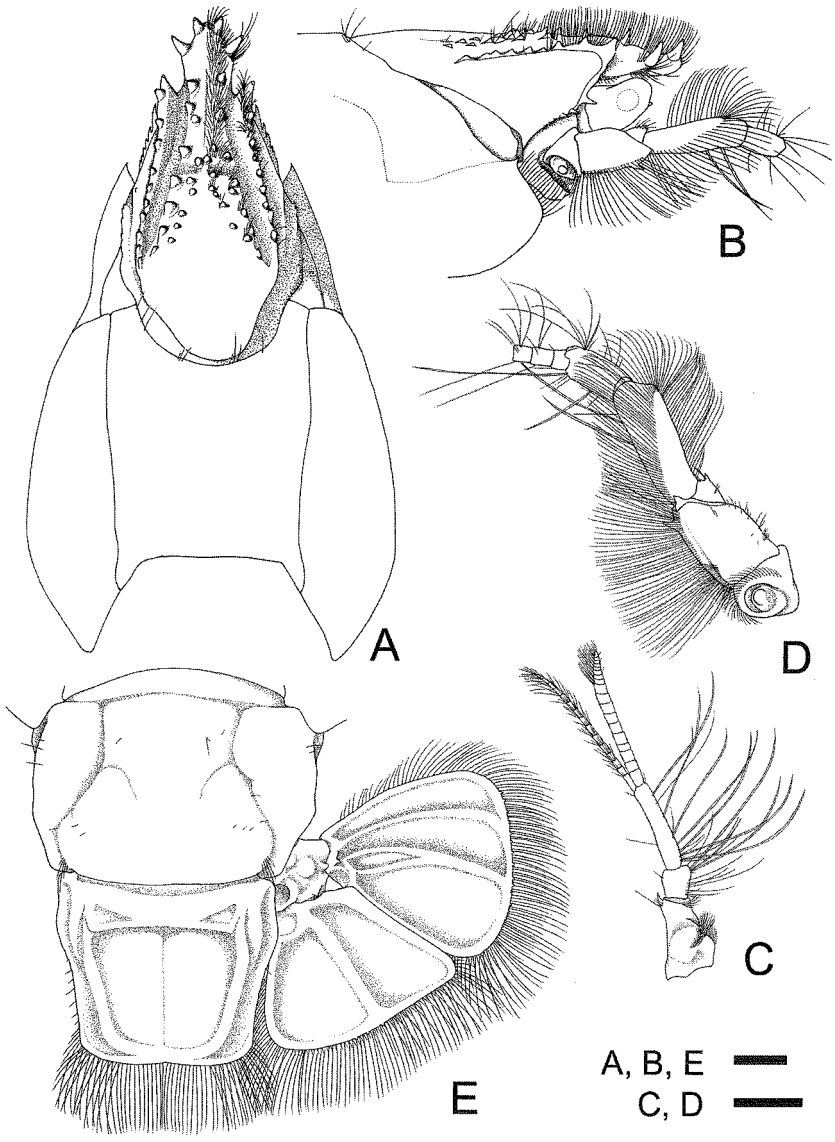

Fig. 6. *Upogebia spinidactylus* sp. nov. A-E, holotype female, RMNH D 51731 (TL/CL = 34.11/9.6 mm), Funaura Bay, Iriomote Island. A, carapace, dorsal view; B, carapace, lateral view; C, A1; D, A2; E, telson and uropod. Scale, 1 mm.

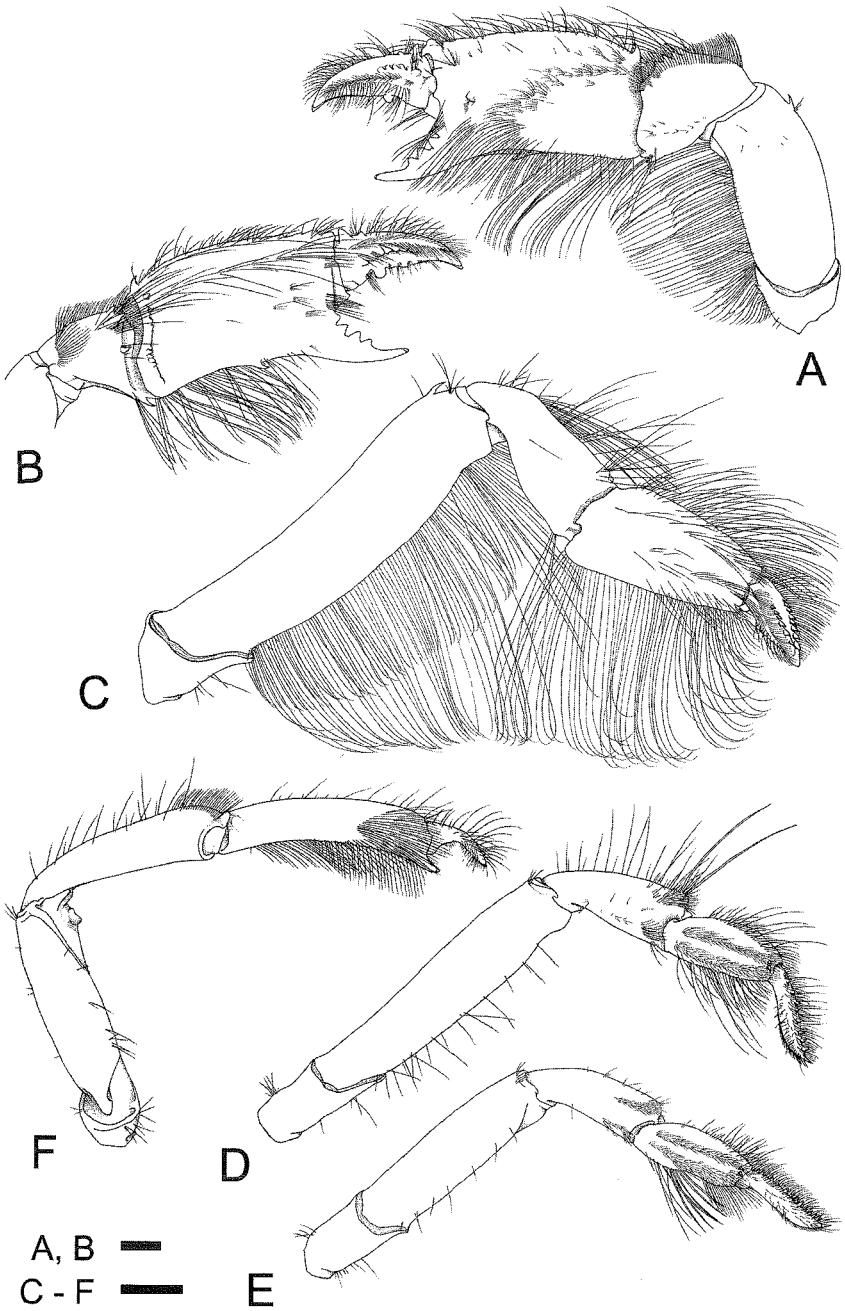

Fig. 7. *Upogebia spinidactylus* sp. nov. A-B, male, RMNH D 51731 (TL = 33.35 mm); C-F, holotype female, SDO 019A (TL/CL = 34.11/9.6 mm). A, male P1, lateral view; B, same P1, inner view; C, female P2; D, same, P3; E, same, P4; F, same, P5. Scale, 1 mm.

female (TL/CL, 35.8/10.4 mm), Funaura Bay, north coast of Iriomote Island, 24°23.5′N 123°49.2′E, 8.xi.2004, leg. H. Ikeda, O. Gusev, and Y. Hirano; paratypes, SDO 021, 8 males (TL/CL, 18.0-34.2/5.6-10.4 mm), 10 females (TL/CL, 16.4-38.3/5.7-11.1 mm), estuary of Urauchi River, northeast of Iriomote Island, 24°24.4′N 123°46.4′E, 13.xi.2004, leg. H. Ikeda, Y. Hirano, and O. Gusev; paratypes, SDO 022, 3 males (TL/CL, 25.1-29.6/7.5-8.9 mm), 3 females (TL/CL, 20.4-33.7/5.7-10.1 mm), estuary of Urauchi River, northeast of Iriomote Island, 24°24.4′N 123°46.4′E, unknown date in 2004, leg. H. Ikeda and Y. Hirano.

Diagnosis. — Rostrum narrow proximally, longer than broad, with four frontal spines; infrarostral spine absent. Lateral ridge of gastric region terminated with strong spine Anterolateral margin of carapace armed with five or more spines. P1 subchelate; merus with sharp subterminal spine on dorsal margin, and unarmed on ventral margin; palm with small subdistal and subproximal spines on dorsal margin, and carinate on ventral margin; fixed finger bearing 3 (right) to 5 (left) distinct teeth on cutting edge.

Description of female holotype. — Small sized species. Rostrum (fig. 6A, B) narrow proximally, longer than broad, with four frontal spines; rostrum and anterior gastric region thickly covered with setae, and shallow median carina extended from distal end of rostrum to anterior third of gastric region; infrarostral spine absent. Lateral ridge of gastric region terminated with strong spine, and posterior to it row of eight to ten spines with short setae on anterior half of longitudinal ridge. Longitudinal groove narrow. No hepatic spine. Anterolateral margin of carapace armed with five or more spines, anterior one distinct and located posterior to eyestalk; other spines small. Linea thalassinica present.

Eyestalk (fig. 6B) stout, reaches to distal two-thirds of rostrum; small spine on inner distal surface. A1 peduncle (fig. 6C) longer than flagellum; proximal segment with small ventrodistal spine. A2 segment 2 (fig. 6D) with small subterminal spine on ventral margin. Epistome terminating with small spine.

P1 subchelate. Ischium bears small spine on ventral surface. Merus with sharp subterminal spine on dorsal margin, and unarmed on ventral margin. Carpus with two spines on dorsal margin, distal one of which distinct; small spine on dorsodistal margin, and another spine on mesiodistal margin, and sharp spine below distal angle of ventral margin. Palm oblong; with small subdistal and subproximal spines on dorsal margin, and carinate on ventral margin. Dactylus bearing triangular dorsoproximal tubercle on dorsal margin, and strong round median tubercle on cutting edge; row of small tubercles present on mesial surface. Fixed finger shorter than dactylus; 3 (on right) to 5 (on left) distinct teeth on cutting edge.

P2 (fig. 7C) unarmed on ischium, carpus, and propodus. Merus bears subterminal spine on dorsal margin. Dactylus bearing distinct dorsolateral concavity merged with dorsal and ventral rows of spines.

P3 (fig. 7D) unarmed on ischium, merus, and carpus. Propodus with two small spines on distolateral surface; two rows of short setae on lateral surface; another row of short setae on anterior half of dorsal margin. Dactylus bearing nine spines among short setae on dorsal margin.

P4 (fig. 7E) unarmed in ischium and merus. Carpus unarmed; two rows of short setae on anterior one-third of lateral surface. Propodus with two small spines on distolateral surface; two parallel rows of short setae on lateral surface. Dactylus with ten spines among dense setae on dorsal margin.

P5 (fig. 7F) subchelate. Ischium and merus unarmed. Carpus with slender setae on anterior part of dorsal margin. Propodus as long as carpus; tuft of setae on distolateral surface; row of slender setae on ventral margin. Dactylus about three times as long as fixed finger; slender setae on distal half. Tip of fixed finger corneous.

Abdominal somite 6 (fig. 6E) broader than long; posterior margin smoothly carinate; lateral margin slightly protruded on median surface.

Telson (fig. 6E) longer than broad; U-shaped carina present on dorsal surface, lateral margins largely concave in posterior two-thirds; posterior margin medially notched.

Uropodal endopod and exopod shorter than telson; endopod with three small round spines medially on posterior margin; exopod with ten to fourteen small spines on posterior margin; small spine present on proximal surface. Protopod with lateral and posterior spines.

Male. — In male (fig. 7A, B), P1 palm broader than in female; triangular spine present on ventral margin.

Remarks. — The present new species, *Upogebia spinidactylus* sp. nov. is similar to *U. carinicauda* (Stimpson, 1860) in the rostrum bearing four frontal teeth, P1 with subchelate tips, and the telson. However, this new species is different from *U. carinicauda*, because in *U. carinicauda* the rostrum is as long as broad in dorsal view, the anterolateral margin of the carapace is armed with a single spine, and the telson bears a strong transverse carina, whereas in *U. spinidactylus* sp. nov. the rostrum is narrow, the anterolateral margin of the carapace is equipped with one ocular followed by two small spines, and the transverse carina on the dorsal surface of the telson is not conspicuous.

Etymology. — The species name is a combination of the Latin "spina", spine, and the Greek "daktylos", finger, as the species characteristically shows two rows of spines on the P2 dactylus. The name is a noun in apposition to the generic name.

Type locality. — Funaura Bay, Iriomote Island.

Habitat and distribution. — Borrowing in the sandstone at the intertidal zone, Funaura Bay; estuary of Urauchi River, Iriomote Island.

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