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The genus *Paduniella* (Trichoptera: Psychomyiidae) in Japan

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Abstract

The Japanese *Paduniella* Ulmer species are reviewed with descriptions of 3 new species. *Paduniella communis* Li & Morse and *P. uralensis* Martynov are recorded from Japan for the first time and redescribed. Records of *P. amurensis* Martynov from Japan are based on misidentification. Illustrations of male genitalia are provided for each species.

Key words: Trichoptera, Psychomyiidae, *Paduniella*, new species, taxonomy, male genitalia, Japan

Introduction

Species of the genus *Paduniella* Ulmer are small caddisflies in the family Psychomyiidae, widely distributed in the northern hemisphere and the Afrotropical Region. Previously, *P. amurensis* Martynov was the only species of *Paduniella* reported in Japan, recorded from central Honshu (Tanida 1999, Nishimoto & Morita 2001). However, careful examination of the male genitalia of a series of *Paduniella* collections from Japan has revealed that 5 species of *Paduniella* occur in Japan. *Paduniella uralensis* Martynov and *P. communis* Li & Morse are recorded from Japan for the first time, and 3 previously undescribed species are recognized. One of the new species is very similar to *P. communis* and the other 2 to *P amurensis* and *P. paramurensis* Li & Morse. Examination of specimens from Lake Biwa, where Tanida (1999) recorded *P. amurensis* and Nishimoto and Morita (2001) and Nozaki and Nakamura (2005) identified *P. amurensis*, indicates those records are in error and *P. amurensis* should be removed from the faunal list of Japan.

In this paper male genitalia are illustrated and described for all 5 species. I have many series of associated females but have not included them because further examination of internal genitalic characters is needed for species discrimination.

Morphological terminology follows that of Li and Morse (1997). Material is deposited in the Lake Biwa Museum, Shiga (LBM), and the author's personal collection (HN). All material is preserved in alcohol.

Paduniella communis Li & Morse, 1997 (Figs 1−2)

Paduniella communis Li & Morse 1997: 282.
Paduniella sp.: Tanida 1997: 446 (in part).

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Diagnosis. The short phallobase, the strongly arched phallicata, and the long, strongly arched, apically notched paramere of the male phallic apparatus are distinctive. The phallic median process is absent and the inferior appendages are not bifid apically.

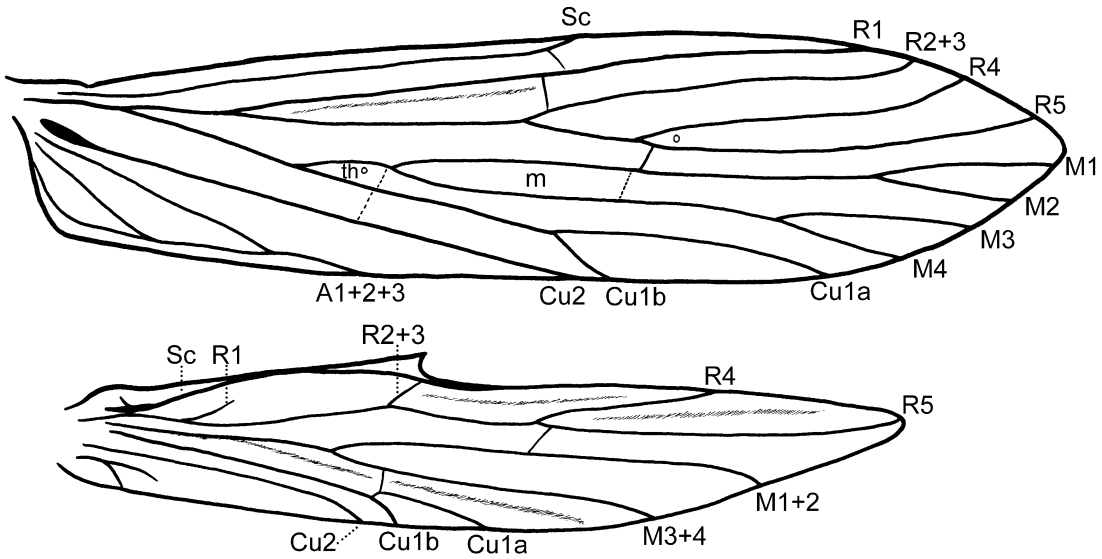

FIGURE 1. Forewing and hind wing venation of male *Paduniella communis* Li & Morse. Abbreviations: *A1*, *A2*, *A3* = anal veins 1-3; *Cu1a*, *Cu1b*, *Cu2* = cubital veins 1a, 1b, and 2; *M1*, *M2*, *M3*, *M4* = median veins 1-4; m = median cell; *R1*, *R2*, *R3*, *R4*, *R5* = radial veins 1-5; *Sc* = subcostal vein, th = thyridial cell.

Redescription. Forewing length 2.2-3.2 mm (n=10) in male. Forewings dark grey, narrow, each with acute apex; hind wings pale gray, each acuminate with extremely acute apex and pointed costal projection. Venation (Fig. 1) typical for genus; forewings each with forks II, III, IV, and V; *Sc* relatively short, connected distally to *R1* by crossvein *sc-r1*; discoidal cell open; median cell closed by indistinct crossvein; thyridial cell very small with crossvein *m-cu* obscure; darker pigmentation behind *R1* between branching point of *R* vein and crossvein *r*; hind wings each with forks II and V; *Sc* curved anterad, contiguous with costal margin at midlength; *R1* very short and *R2+3* ending at *Sc*; crossvein *m-cu* connected to branching point of *Cu1* vein; 2 anal veins very short; darker pigmentation anterior of *R4* and *R5* and behind *M* and *M3+4*. **Male genitalia** (Fig. 2). Tergum IX in dorsal view (Fig. 2A) produced posteriorly as triangular lobe. Sternum IX flat ventrally in lateral view, with posterior margin weakly convex in ventral view; in lateral view (Fig. 2B) extended anterodorsad on each side, with dorsal edges about 3 times as long as mesoventral surface, gradually narrowing and reaching to distal ends of sclerotized strips of segment IX. Sclerotized strips (scl.str.) of segment IX very narrow in lateral view (Fig. 2 B). Superior appendages (sup.app.) in dorsal view (Fig. 2A) elongate-oval, each with apex somewhat acute. Inferior appendages (inf.app.) in ventral view (Fig. 2 C) expanded distally, each with acute apicomesal margin; mesal branch of each inferior appendage (m. b. inf.app.) elongate, triangular, with truncate apex in ventral view; basodorsal edge distinctly extended anteroventrad in lateral view (Fig. 2B). Median process of phallus absent. Phallicata (phc.) elongate, highly compressed laterally, strongly curved near base, slightly widening distally, with basal hump on outer (morphologically dorsal) surface forming deep notch at junction of phallobase in lateral view (Fig. 2B); shallow groove on apicodorsal edge of phallicata; phallobase (phb.) short, about 1/8 length of phallicata; paramere (para.) arising dorsobasally of phallicata, strongly curved along dorsal edge of phallicata, with U-shaped notch apically (Fig. 2D).

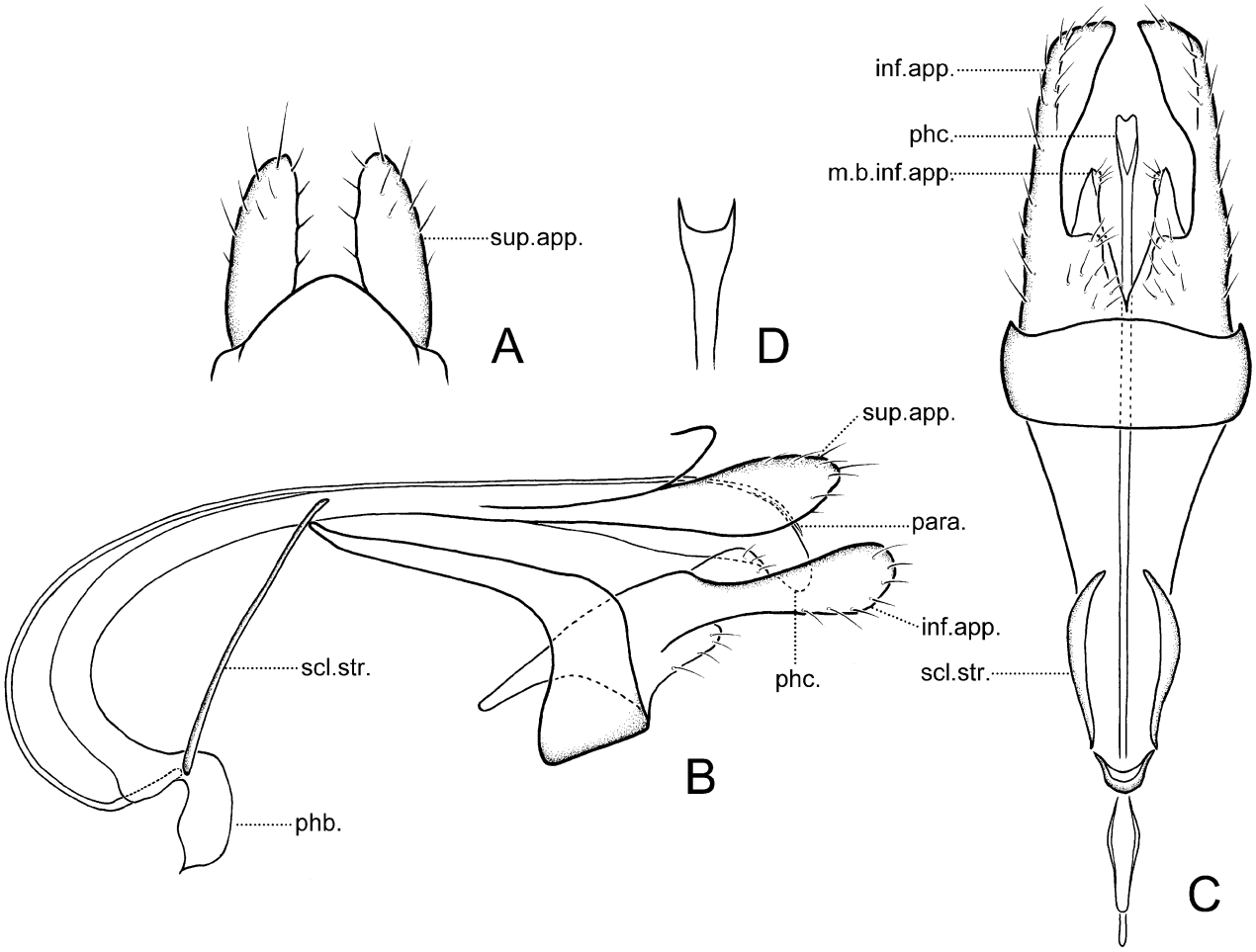

FIGURE 2. Male genitalia of *Paduniella communis* Li & Morse. A, dorsal; B, left lateral; C, ventral; D, apex of paramere, dorsocaudal. Abbreviations: inf.app. = inferior appendage; m.b.inf.app. = mesal branch of an inferior appendage; para. = paramere; phb. = phallobase; phc. = phallicata; scl.str. = sclerotized strip; sup.app. = superior appendage.

Distribution. *Paduniella communis* is common in central eastern China (Li & Morse 1997). In Japan, this species is known from Ishigaki and Iriomote Islands (Okinawa) of the southern Ryukyus in southwestern Japan.

Material examined. JAPAN. Okinawa: Nagura-gawa, Ishigaki-jima, Ishigaki-shi, 26.iii.1995, F. Nishimoto, 6 males (HN); Omoto, Ishigaki-jima, Ishigaki-shi, 24.iii.1996, F. Nishimoto, 1 male (HN); Nagura-gawa, Takeda, Ishigaki-jima, Ishigaki-shi, 12.x.1999, K. Konishi, 27 males (HN); same, except 19.x.1999, 30 males (HN); Nagura-gawa, Shiramizu, Ishigaki-jima, Ishigaki-shi, 11.iv.2005, T. Ito, 111 males (HN); Maezato-dam, Ishigaki-jima, Ishigaki-shi, 12.iv.2005, T. Ito, 33 males (HN); Miyara-gawa, Ishigaki-jima, Ishigaki-shi, 12.iv.2005, T. Ito, 2 males (HN); Otomi-rindo, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 13.iii.1992, M. Sato, 9 males (HN); Nishifunatsuki-gawa, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 20.iii.1996, F. Nishimoto, 13 males (HN); Mihara, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 21.iii.1996, F. Nishimoto, 14 males (HN); Nishifunatsuki-gawa, Omiya, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 23.iii.1999, T. Ito & A. Ohkawa (HN); Omija-gawa, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 24.iii.1999, T. Ito & A. Ohkawa, 123 males (HN); Aira-gawa, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 25.iii.1999, T. Ito & A. Ohkawa, 35 males (HN); same locality, 13-17.iii.2002, T. Yoshida & H. Sugaya, 25 males (Malaise trap) (HN); Kanpira-no-taki, Urauchi-gawa, Iriomote-jima, Taketomi-cho, Yaeyama-gun, 14.iv.2005, T. Ito, 2 males (HN).

Remarks. Males from Okinawa have the apical portion of each inferior appendage widened and extended mesad in ventral view, but according to the original illustration (Li & Morse 1997), it is relatively slender and does not extend mesad. In addition, it seems likely that the phallicata is more strongly curved in Japanese specimens. However, Yang compared these illustrations of Japanese specimens with Chinese *P. communis*, and indicated (pers. comm.) that the small curvature difference in the paramere and phallicata is no more than intraspecific variation and for now they should be called *P. communis*. I concur with her taxonomic judgment.

Paduniella uralensis Martynov, 1914 (Fig. 3)

Paduniella uralensis Martynov 1914: 5; Lepneva 1928: 25; Martynov 1929: 30; Martynov 1934a: 207; Martynov 1948: 908; Tanida 1993: 58.

Mesopaduniella uralensis: Lestage 1926:385.

Paduniella uralensis bicornis: Martynov 1934a: 208; Martynov 1934b: 334.

Diagnosis. The shape of the phallic apparatus is characteristic for this species. The phallicata is enlarged at the apex, forming dorsal and ventral sharp points in lateral view. The median process of the phallus is thickened and sinuate in lateral view. The superior appendages are also distinctive, each with an acute apical projection directed posteromesad.

Redescription. Forewing length 2.4-2.8 mm (n=5) in male. Forewing dark grey and hind wing pale gray. Venation typical for genus. **Male genitalia** (Fig. 3). Tergum IX in dorsal view (Fig. 3A) with apical margin slightly convex. Sternum IX convex ventrally in lateral view, with posterior margin slightly concave in ventral view; in lateral view (Fig. 3B) dorsal edges each extended anterodorsad as narrow process more than twice as long as wide at midlength, reaching to distal ends of sclerotized strips of segment IX. Sclerotized strips (scl.str.) of segment IX relatively thick, each with distal portion enlarged dorsally in lateral view (Fig. 3B). Superior appendages (sup.app.) in dorsal view (Fig. 3A) slightly widened distally, each with concave posterior margin, posteromesal corner extended into acute, finger-like process and posterolateral corner distinctly produced; in lateral view (Fig. 3B) sharply bent posteroventrad at midlength. Inferior appendages (inf.app.) each gradually tapering to blunt unforked apex in lateral view (Fig. 3B); mesal branches of inferior appendages (m.b.inf.app.) each short, knob-like projection in ventral view (Fig. 3C). Single median process (med.proc.) arising proximally between sclerotized strips of segment IX, evenly thick and sinuate in lateral view (Fig. 3B), extending slightly beyond posterior edge of tergum IX. Phallicata (phc.) enlarged at apex to form dorsal and ventral sharp points in lateral view (Fig. 3B); phallobase (phb.) short, 1/3 length of phallicata; paramere (para.) arising dorsobasally of phallicata, acute and almost cylindrical.

Distribution. *Paduniella uralensis* was previously known from Russia and China. In Japan, specimens were collected in western Honshu (Hyogo, Shimane, and Yamaguchi).

Material examined. JAPAN. Hyogo: Ibo-gawa, Imajyuku, Yamasaki-cho, Shiso-shi, Shiso-gun, 23.ix.1997, H. Nishimoto, 3 males (HN). **Shimane:** Koto-gawa, Kama, Shuho-cho, Mine-shi, Mine-gun, 7.x.2001, H. Nishimoto, 1 male (HN). **Yamaguchi:** Tachikue-kyo, Otsutachi-cho, Izumo-shi, 14.ix.1993, H. Nishimoto, 1 male (HN).

Remarks. Japanese specimens identified as *Paduniella uralensis* appear to belong to the subspecies *P. uralensis uralensis* Martynov because the posterolateral corners of the superior appendages are distinctly produced.

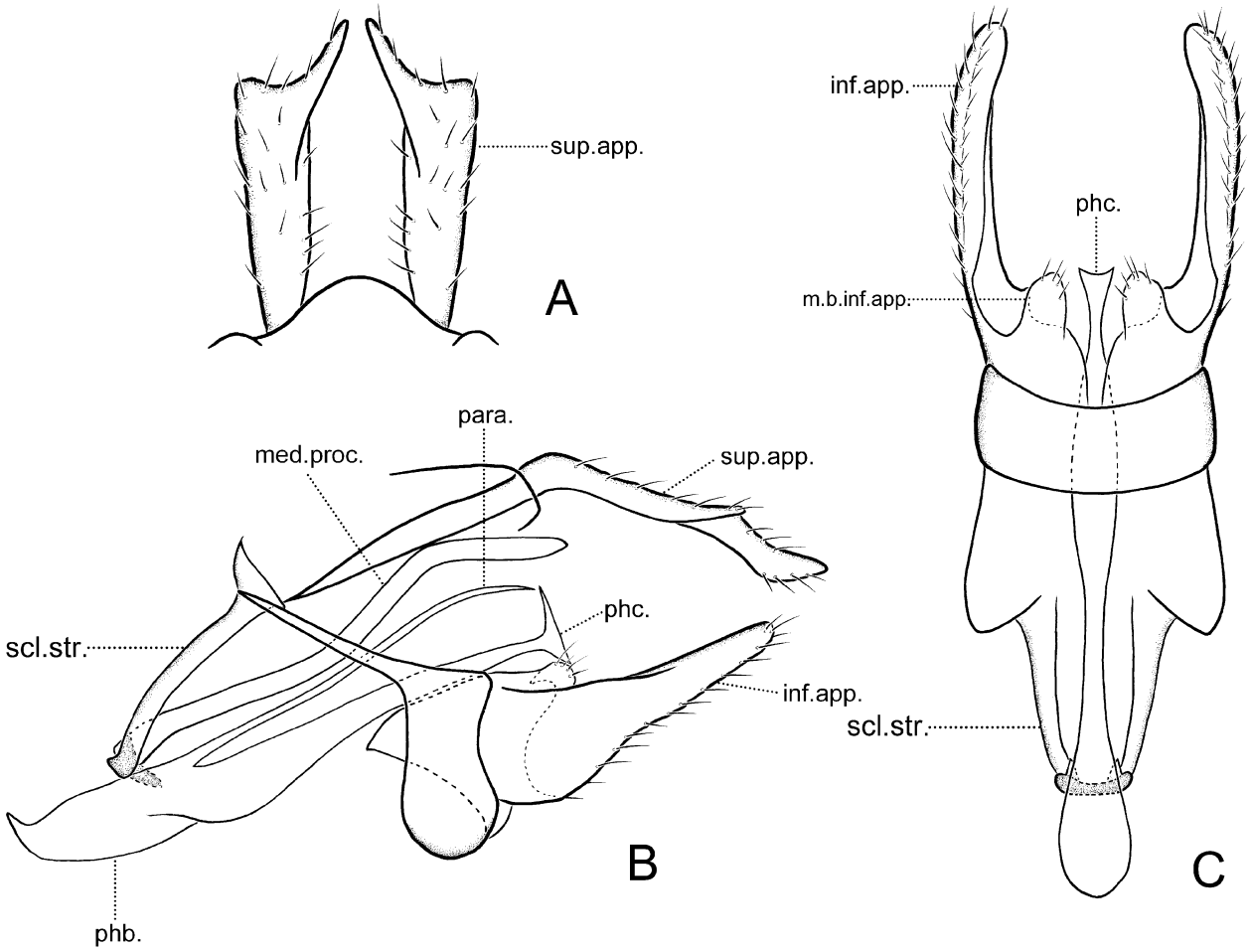

FIGURE 3. Male genitalia of *Paduniella uralensis* Martynov. A, dorsal; B, left lateral; C, ventral. Abbreviations: inf.app. = inferior appendage; m.b.inf.app. = mesal branch of an inferior appendage; med.proc. = median process; para. = paramere; phb. = phallobase; phc. = phallicata; scl.str. = sclerotized strip; sup.app. = superior appendage.

Paduniella amamiensis new species (Fig. 4)

Paduniella sp.: Tanida 1997: 446 (in part).

Diagnosis. This species is very similar to *P. communis* but can be easily distinguished by the shape of the phallic apparatus. The phallicata is less expanded near the junction with the phallobase and the paramere is not forked apically.

Description. Forewing length 2.5-3.0 mm (n=5) in male. Forewing dark grey and hind wing pale gray. Venation typical for genus. **Male genitalia** (Fig. 4). Tergum IX in dorsal view (Fig. 4A) produced posteriorly as triangular lobe. Sternum IX slightly convex ventrally in lateral view and convex posteriorly in ventral view, in lateral view (Fig. 4B) gradually narrowing and extending anterodorsad, each side with dorsal margin about 3 times as long as ventromesal surface, reaching to distal ends of sclerotized strips of segment IX. Sclerotized strips (scl.str.) of segment IX very narrow in lateral view (Fig. 4 B). Superior appendages (sup.app.) in dorsal view (Fig. 4A) elongate-oval, each with rounded apex. Inferior appendages (inf.app.) in ventral view (Fig. 4C) expanded distally; mesal branches of inferior appendages (m.b.inf.app.) each triangular with acute apex in ventral view; basodorsal edge extending anteroventrad into finger-like process. Median process absent. Phallicata

(phc.) relatively long, highly compressed laterally, in lateral view (Fig. 4B) convex dorsally, slightly enlarged distally, with apex downcurved; phallobase (phb.) short, about 1/7 length of phallicata; paramere (para.) arising dorsobasally of phallicata, strongly curved along dorsal edge of phallicata, with apex acute.

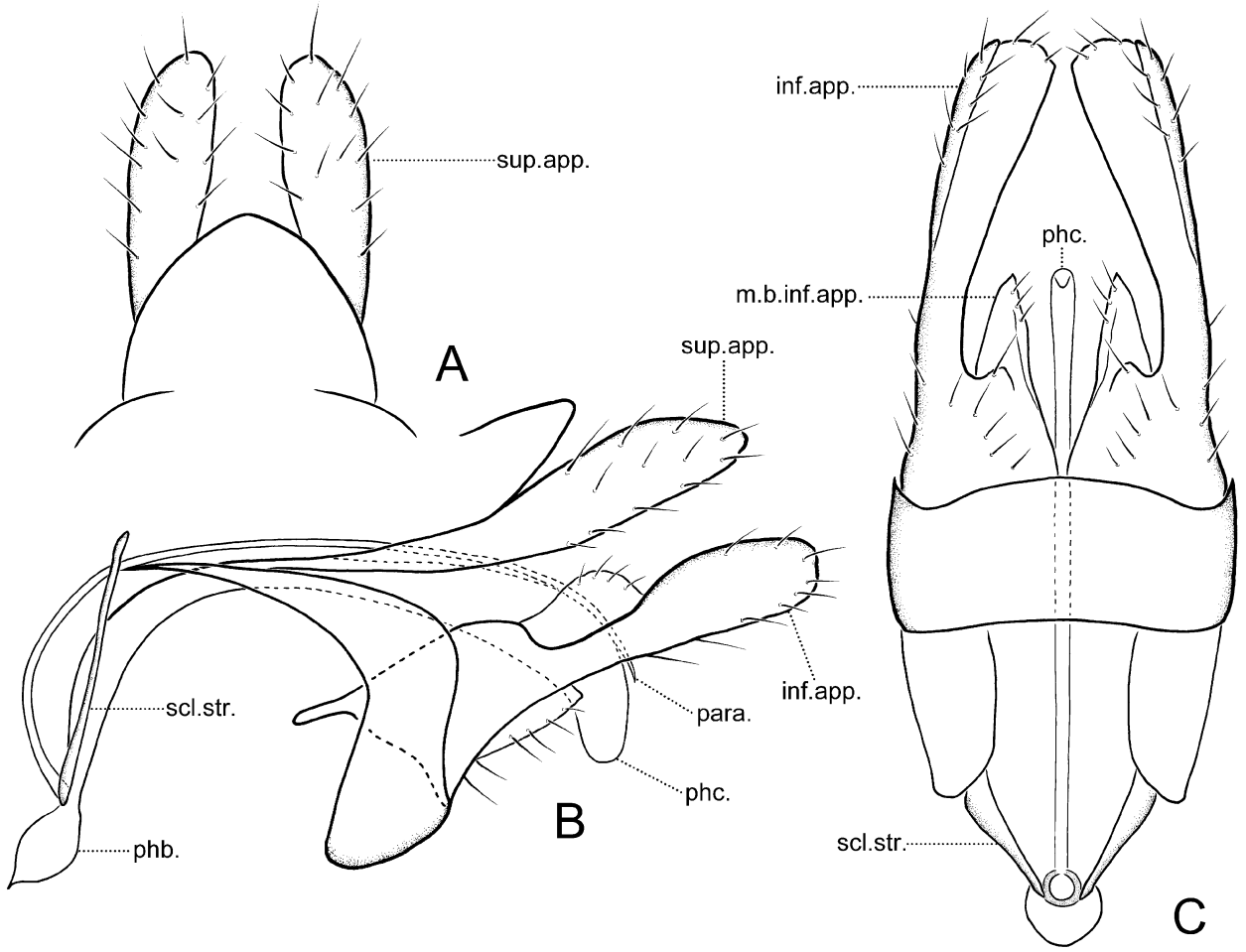

FIGURE 4. Male genitalia of *Paduniella amamiensis* new species. A, dorsal; B, left lateral; C, ventral. Abbreviations: inf.app. = inferior appendage; m.b.inf.app. = mesal branch of an inferior appendage; para. = paramere; phb. = phallobase; phc. = phallicata; scl.str. = sclerotized strip; sup.app. = superior appendage.

Distribution. This species is restricted to, but abundant on, Amami-Oshima Island (Kagoshima), an island of the northern Ryukyus.

Material examined. Holotype.–Male: **JAPAN. Kagoshima:** Yakugachi-gawa, Kamiyakugachi, Sumiyou-cho, Amami-shi, Amami-Oshima, 28.iii.1998, H. Nishimoto (LBM). Paratypes.-Same data as holotype, 6 males (HN); Kawauchi-gawa, Uken-son, Oshima-gun, Amami-Oshima, 23.iii.1997, F. Nishimoto, 6 males (HN); Yakugachi-gawa, Sumiyou-cho, Amami-shi, Amami-Oshima, 24.iii.1997, F. Nishimoto, 7 males (HN); Taguchi-gawa, Tatsugo-cho, Oshima-gun, Amami-Oshima, 27.iii.1998, H. Nishimoto, 21 males (HN); Kawauchi-gawa, Uken-son, Oshima-gun, Amami-Oshima, 29.iii.1998, 6 males (HN); Materia-no-taki, Naon, Yamato-son, Oshima-gun, Amami-Oshima, 29. iii.1998, H. Nishimoto, 1 male (HN); same, except F. Nishimoto, 3 males (BLM).

Etymology. The specific epithet refers to the regional name (Amami) of the type locality, Amami-Oshima.

Paduniella tanidai new species (Fig. 5)

Paduniella sp.: Tanida & Nishino 1992: 28.
Paduniella amurensis: Tanida, Nishino & Uenishi 1999: 391 (misidentification).
Paduniella amurensis: Nishimoto & Morita 2001: 74 (misidentification).
Paduniella amurensis: Nozaki & Nakamura 2005: 220 (misidentification).

Diagnosis. This species closely resembles *P. amurensis* in the male genitalia. Both species have bifurcate inferior appendage apices, elongate superior appendages, a slender median process, and a distinct phallic apparatus which bears a relatively thick phallicata and a small knob at the junction of the paramere with the phallicata. It is distinguished by the more deeply cleft apex of each inferior appendage and the short and obtuse median process which does not extend beyond the posterior margin of tergum IX. The distinctive shape of the median process of this species also separates it from *P. paramurensis*.

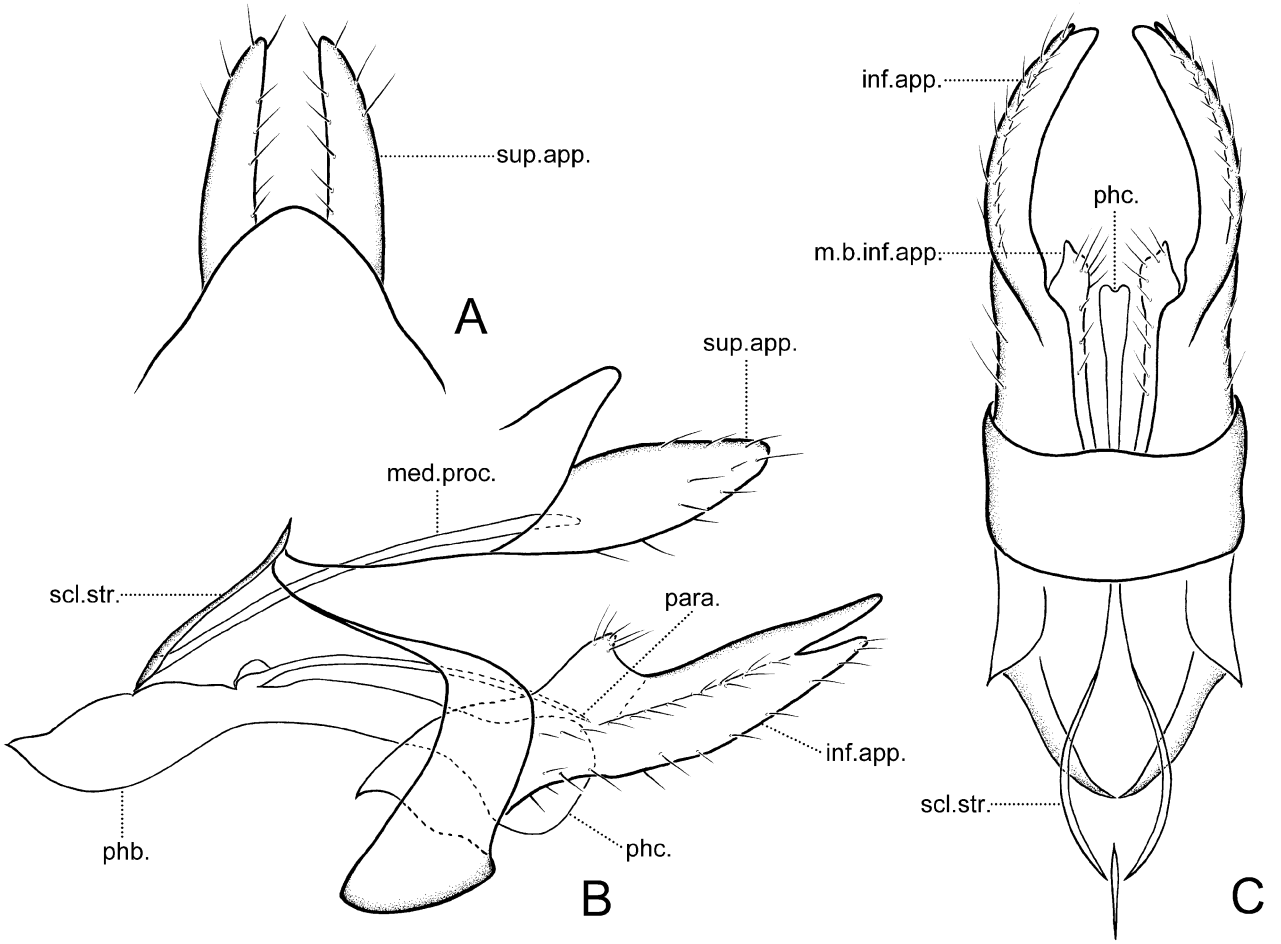

FIGURE 5. Male genitalia of *Paduniella tanidai* new species. A, dorsal; B, left lateral; C, ventral. Abbreviations: inf.app. = inferior appendage; m.b.inf.app. = mesal branch of an inferior appendage; med.proc. = median process; para. = paramere; phb. = phallobase; phc. = phallicata; scl.str. = sclerotized strip; sup.app. = superior appendage.

Description. Forewing length 2.2-3.7 mm (n=10) in male. Forewing dark grey and hind wing pale gray. Venation typical for genus. **Male genitalia** (Fig. 5). Tergum IX in dorsal view (Fig. 5A) produced posteriorly as triangular lobe. Sternum IX slightly convex ventrally in lateral view, slightly sinuate posteriorly in ventral view; in lateral view (Fig. 5B) each side narrowing anterodorsally into dorsal extension about twice as long as wide at midlength, reaching to distal ends of sclerotized

strips of segment IX. Sclerotized strips (scl.str.) of segment IX very narrow and slightly sinuate in lateral view. Superior appendages (sup.app.) in dorsal view (Fig. 5A) slender, each with acute apex. Inferior appendages (inf.app.) in lateral view (Fig. 5 B) gradually narrowed posteriorly, each with deep notch in apical margin; prominent lateral ridge extending basad from apical notch, bearing row of setae; mesal branches of inferior appendages (m.b.inf.app.) each having well-developed basomesal extension, inflated and pointed apically; basodorsal edge not extended anteroventrad. Single median process (med.pro.) arising ventrally between sclerotized stripes of segment IX, slender, cylindrical, not extended distad beyond posterior margin of tergum IX, with blunt apex. Phallicata (phc.) compressed laterally, enlarged apically in lateral view (Fig. 5B), with small knob at junction of paramere (para.); phallobase (phb) more than 1/2 length of phallicata; paramere arising dorsobasally of phallicata, acute and almost cylindrical.

Distribution. Among the Japanese *Paduniella* species, this species has the most widespread distribution and has been collected in central and western Honshu (Aichi, Gifu, Nara, Shiga, Kyoto, Osaka, and Shimane) and Shikoku (Tokushima).

Material examined. Holotype.–Male [abdomen removed]: **JAPAN. Aichi:** Tomoe-gawa, Kugyudaira, Toyota-shi, 30.v.2000, H. Nishimoto (BLM). Paratypes.-**Aichi:** Yahagi-gawa, Hiradobashi-cho, Toyota-shi, 14.vi.1999, H. Nishimoto, 2 males (BLM); Yahagi-gawa, Fusso-cho, Toyota-shi, 16.vi.2007, H. Nishimoto, 1 male (HN). **Gifu:** Nagara-gawa, Kuromata, Ogaki-shi, 3.x.2001, S. Kondo, 1 male (HN); Kiso-gawa, Iki-cho, Kagamigahara-shi, 11.viii.2008, H. Nishimoto, 1 male (HN). **Shiga:** Lake Biwa, Mizugahama, Omihachiman-shi, 6.vi.1991, M. Uenishi, 2 males (HN). **Nara:** Nabari-gawa, Hirose, Yamazoe-mura, 28.viii.1997, K. Tojo, 2 males (HN); same, except 5.ix.1998, 2 males (HN). **Osaka:** Yodo-gawa, Hiratsuka-shi, 10.viii.2007, S. Tsukaguchi, 3 males (HN). **Tokushima:** Yoshino-gawa, Kawatakitajima, Yamakawa-cho, Oe-gun, 28.x.2004, K. Nio, 1 male (HN).

Other material examined. JAPAN. Shiga: Lake Biwa, Mizugahama, Omihachiman-shi, 6.vi.1991, M. Uenishi, 1 male (HN). **Kyoto:** Kizu-gawa, Kasachi-cho, 2.ix.1997, K. Tojo, 8 males (HN). **Shimane:** Gono-kawa, Shiki, Misato-cho, Ochi-gun, 14.v.2004, S. Nakamura, 1 male (HN).

Etymology. This species is named for Kazumi Tanida, Osaka Prefecture University, who first recorded the occurrence of *Paduniella* in Japan on the basis of Lake Biwa specimens of this species.

Remarks. This species is extremely similar to *P. amurenis* and has been confused with it. Examination of *P. amurensis* specimens collected from Lake Biwa (Shiga), Yahagi River (Aichi) and Gono River (Shimane) indicates the records based on those specimens (Tanida, 1999; Nishimoto and Morita, 2001; Nozaki and Nakamura, 2005) are actually *Paduniella tanidai*.

Three males of *P. tanidai* from Lake Biwa have forewing lengths ranging from 3.3 to 3.7 mm. They are larger than other specimens collected in rivers where forewing lengths do not exceed 2.6 mm.

Paduniella horaiensis new species (Fig. 6)

Diagnosis. This species is most similar to the Chinese *P. paramurensis* with which it shares short and subtriangular superior appendages, a long and acute median process, and a narrow proximal portion of the phallicata in the male genitalia. It can be easily distinguished by the entire apices of the inferior appendages. In contrast, closely related *P. paramurensis*, *P. amurensis* and *P. tanidai* all have the inferior appendages bifurcate apically.

Description. Forewing length 2.2-2.9 mm (n=8) in male. Forewings dark grey and hind wings pale gray. Venation typical for genus. **Male genitalia** (Fig. 6). Tergum IX in dorsal view (Fig. 6A)

with apical margin roundly produced. Sternum IX flat ventrally in lateral view, sinuate posteriorly in ventral view; in lateral view (Fig. 6B) with each end tapered and extending proximally beyond juncture of phallicata and phallobase, reaching to distal ends of sclerotized strips of segment IX. Sclerotized strips (scl.str.) of segment IX slightly tapered and curved dorsad in lateral view (Fig. 6 B). Superior appendages (sup.app.) in dorsal view (Fig. 6A) elongate-oval, each with apex subacute. Inferior appendages (inf.app.) in lateral view (Fig. 6B) each with narrow distal portion entire; mesal branches of inferior appendages (m.b.inf.app.) broad, each with rounded apical margin in ventral view; basodorsal edge extended anteroventrad into finger-like process in lateral view (Fig. 6B). Single median process (med.proc.) of phallus arising ventrally between sclerotized stripes of segment IX, slender, extending distad beyond posterior margin of tergum IX, apically acute. Phallicata (phc.) very narrow basally, enlarged apically in lateral view (Fig.6B), slightly expanded apically in ventral view (Fig. 6C); phallobase (phb.) as long as phallicata; paramere (para.) arising dorsobasally of phallicata, acute, sinuous, and almost cylindrical.

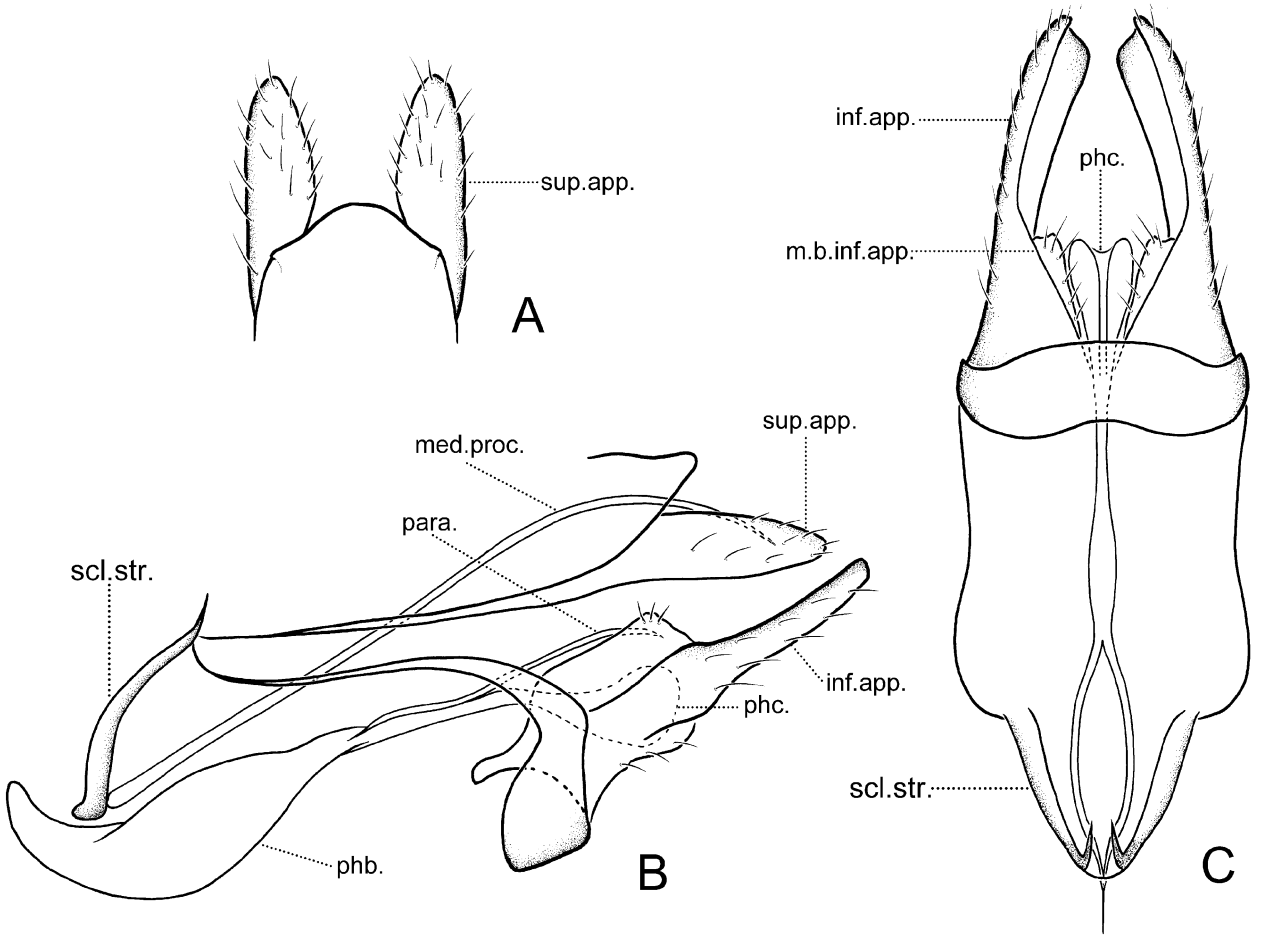

FIGURE 6. Male genitalia of *Paduniella horaiensis* new species. A, dorsal; B, left lateral; C, ventral. Abbreviations: inf.app. = inferior appendage; m.b.inf.app. = mesal branch of an inferior appendage; med.proc. = median process; para. = paramere; phb. = phallobase; phc. = phallicata; scl.str. = sclerotized strip; sup.app. = superior appendage.

Distribution. This species is known from central and western Honshu (Aichi and Hiroshima) and Shikoku (Kochi).

Material examined. Holotype.–Male: **JAPAN. Aichi:** Kansa-gawa, Nakashima, Shinshiro-shi, 4.vii.1998, H. Nishimoto (BLM). Paratypes.-Same data as holotype, 1 male (HN); same, except 15.ix.2007, 2 males (BLM); Koma-gawa, Tauchi, Shitara-cho, Kitashitara-gun, 1.vii.2007, H.

Nishimoto, 2 males (HN). **Hiroshima:** Ohta-gawa, Shimominauchi, Yuki-cho, 22.vi.2003, S. Nakamura, 2 males (HN). **Kochi:** Shirai-dani, Terakawa, Ino-cho, 1.vii.2005, M. Takai, 4 males (HN).

Etymology. The name is derived from the old name of the type locality, Horai-cho, where this species was first found.

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