

Four New Species of *Parorthocladius* (Diptera: Chironomidae: Orthoclaadiinae) Found in Korea

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ABSTRACT

The genus *Parorthocladius* is a small group among the subfamily Orthoclaadiinae (Diptera: Chironomidae). A total of ten species of *Parorthocladius* have been recorded in the world, of which two species were found from Japan, three species from China, and three species from the Russian Far East. Only one species, *P. nudipennis* is widely distributed in Europe and the Russian Far East. This genus can be distinguished from other genera by the absence of acrostichals on the thorax, wing vein R₄₊₅ ending proximal to the tip of vein M₃₊₄, anal point parallel side, rounded apically. We report four new species of *Parorthocladius* collected in Korea and described them with illustrations. As a result, fourteen species of *Parorthocladius* have been recorded in the world.

Keywords: taxonomy, new species, *Parorthocladius*, Chironomidae, Korea

INTRODUCTION

The genus *Parorthocladius* is a small group among the subfamily Orthoclaadiinae (Chironomidae, Diptera). Ashe and O'Conner (2012) listed seven species of *Parorthocladius* in a world catalog of Orthoclaadiinae. The type species, *P. nudipennis* (Kieffer in Kieffer and Thienemann, 1908) was found in European countries and the Russian Far East (Ashe and O'Conner, 2012). *Parorthocladius korneyevi* was reported from Ukraine (Baranov, 2011). Two species, *P. furudoquartus* (Sasa and Arakawa, 1994) and *P. negoroi* Yamamoto, 2011 were found in Japan. Three new species (*P. concretus*, *P. cristatus*, and *P. univentrus*) were reported in China (Lin and Wang, 2005). In 2015, Makarchenko and Makarchenko reported three new species (*P. tazovskiensis*, *P. plolabius*, and *P. tyurkini*) which were collected in the Russian Far East. Thus, a total of 10 species recorded in the world. All of them are distributed in the Palearctic and Oriental regions. Here, we report four new species of *Parorthocladius* collected in Korea.

MATERIALS AND METHODS

Chironomid adults were collected by sweeping on grasses at

Gawha-ro, Buk-myeon, Gapyeong-gun, Gyeonggi-do in July 2019. The collected adults were preserved in 75% ethanol. For slide preparation, the adults were transferred to distilled water. On a slide, the antennae, head, wings, abdomen, and hypopygium of each specimen were dissected in Hoyer's solution under a stereomicroscope and covered by two cover glasses, one on the head, antennae, wings, and hypopygium and the other one on thorax, legs, and abdomen. The length of the wing from the apex to the arculus represented the size of the body. The antennal ratio was calculated by dividing the length of the longest segment by the combined length of the remaining segments (excluding the pedicel). The leg ratio of the foreleg was calculated by dividing the length of the first tarsal segment by the length of the tibia. Abbreviations for wing length, antennal ratio, leg ratio, radius-median cross vein, median-cubital cross vein, and forked-Cu are WL, AR, LR, RM, MCu, and FCu, respectively. The terminology followed Sæther (1980).

The holotype specimens are deposited in the National Institute of Biological Resources (NIBR), and the other type and non-type specimens are deposited in the Collection of Arthropods of Medical Importance Bank, Department of Environmental Medical Biology, College of Medicine, Yonsei University (AMIB).

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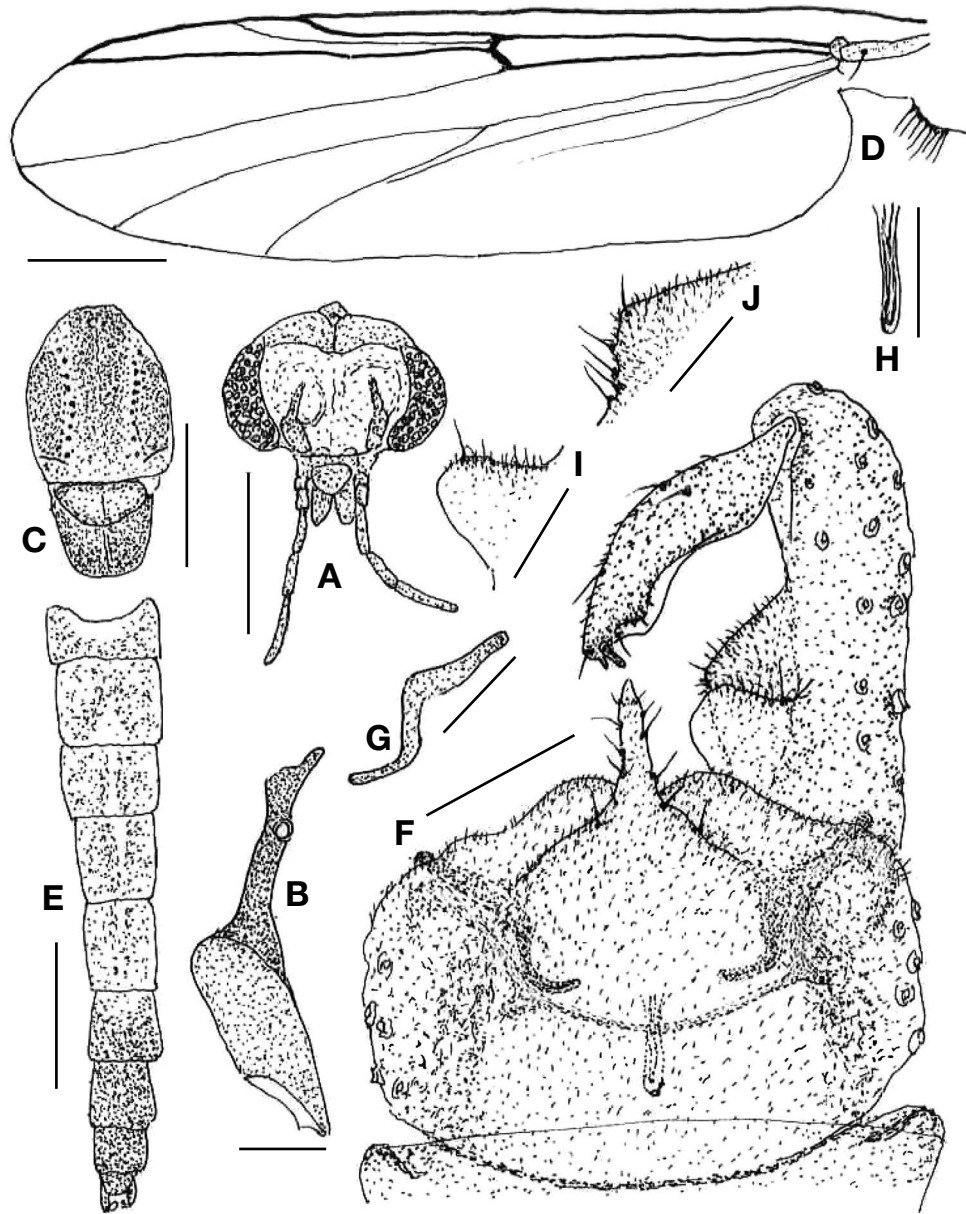


Fig. 1. *Parorthocladius gyeongiensis* n. sp. (male). A, Head; B, Tentorium; C, Thorax; D, Wing; E, Abdomen; F, Hypopygium; G, Phallapodeme; H, Virga; I, Dorsal one of inferior volsella; J, Ventral one of inferior volsella. Scale bars: A, D=0.3 mm, B, G–J=0.03 mm, C, E=0.5 mm, F=0.05 mm.

SYSTEMATIC ACCOUNTS

Order Diptera

Family Chironomidae

Subfamily Orthocladiinae

¹*Genus *Parorthocladius* Thienemann

²**Parorthocladius gyeongiensis* n. sp. (Fig. 1)

Material examined. Holotype, ♂ (RCH-14276), Korea: Gyeonggi-do, Gapyeong-gun, Buk-myeon, Gawha-ro, 5 Jul 2019 Yoon HS (NIBR). Paratypes, 4♂♂ (RCH-14235, 14271, 14272, 14273), *ditto* (AMBI).

Diagnosis. Medium-sized, brownish species (WL 1.6 mm). Eye bare. Acrosticals absent. Wing membrane hyaline, bare. Costa not extended. R_{4+5} above M_{3+4} . Cu_1 straight. Squama with setae. Mid and hind tarsi I–II with pseudospurs. Pulvil-

Korean name: ¹*수염깃깔따구속 (신칭), ²*경기수염깃깔따구 (신칭)

lus absent. Anal tergite round, median and apical setae absent; transverse sternapodeme long, very narrow, arched, with a horn at each end; virga with 4 long spines (weakly developed). Anal point moderately long (variable in length), tapered distally, with 5–6 lateral setae on each side. Gonocoxal inner lobe double: dorsal one square, pale yellow, bare, except distal margin with microtrichia; ventral one triangular, with microtrichia and 4 setae on apical margin. Gonostylus parallel-sided, slightly bent inward, with broad crista dorsalis and megaseta. AR 1.15. LR 0.76.

Description (male, n = 5). HEAD (Fig. 1A): Yellowish-brown. Eye bare, dorsomedial extension very short (wedge-shape). Antenna yellowish brown, with 13 segments. AR 1.15 (0.97–1.48). Palp yellowish brown, with 5 segments: 29, 40, 99, 99, 136 μm (1 : 1.4 : 3.4 : 3.4 : 4.7). Clypeus yellowish brown, with 9–12 setae. Tentorium dark brown, shown in Fig. 1B. THORAX (Fig. 1C): Yellowish-brown in ground color. Scutum yellowish-brown, vittae brown; acrosticals absent; 8–12 dorsocentrals and 4–5 prealars each side. Scutellum light brown, with 15–20 bi-serial setae. Postnotum dark brown. Haltere dark brownish pale. WING (Fig. 1D): WL 1.61 (1.47–1.93) mm. Membrane bare, hyaline. All veins pale yellow, bare except 7 minute setae on basal half of R. Costa not produced. R_{2+3} ending near R_1 . R_{4+5} above M_{3+4} . Cu_1 straight. Anal lobe normally developed. Squama with setae. Arculus and brachiolum brownish pale with 1 seta. LEGS: Uniformly light brown. Fore tibia with 1 spur, mid tibia with 2 spurs, hind tibia with 2 spurs and combs. Mid and hind tarsi I–II with 2 short pseudospurs. Pulvillus absent. LR 0.76 (0.73–0.82). ABDOMEN (Fig. 1E): Tergite I–V dirty, pale dark brown; tergite VI–VIII dark brown. HYPOPYGIUM (Fig. 1F): Anal tergite, round-shape; apical and median setae absent, with 4–5 strong setae on each lateral side; transverse sternapodeme pale, long, very narrow, arched, with a horn at each end; phallapodeme dark brown, apical tip arched (Fig. 1G); virga pale, with 4 long spines (34 μm) (Fig. 1H). Anal point long (38–59 μm , tapered distally, tip round, with 5–6 lateral setae on each side. Gonocoxite parallel-sided; gonocoxal inner lobe (inferior volsella) double: dorsal one square-shape, pale yellow, bare, except distal margin with microtrichia (Fig. 1I); ventral one triangular, with microtrichia and 4 setae along the apical margin (Fig. 1J). Gonostylus parallel-sided, slightly bent inward, with broad crista dorsalis and dark brown megaseta.

Etymology. The new species named after the collection locality.

Remarks. The Korean species is similar to *P. lazavskiensis* Makarchenko and Makarchenko, 2015 in most characters. But This species showed a considerable range of variation in some characters, such as the wing length (1.5–1.9 mm, *P. gyeongien-*

sis vs 2.0–2.1 mm, *P. lazavskiensis*), the number of the scutellar setae (15–20 bi-serial setae vs without), the size of palp segments, the antennal ration, length of the anal point, and etc. (Makarchenko and Makarchenko, 2015).

^{1*}*Parorthocladus jini* n. sp. (Fig. 2)

Material examined. Holotype, ♂ (RCH-14245), Korea: Gyeonggi-do, Gapyeong-gun, Buk-myeon, Gawha-ro, 5 Jul 2019, Yoon HS (NIBR). Paratypes, 2♂♂ (RCH-14222, 14290), ditto (AMBI).

Diagnosis. Medium-sized, brown species (WL 1.88 mm). Eye bare. Acrosticals absent. Scutal tubercle absent. R_{4+5} above M_{3+4} . Cu_1 straight. Mid and hind tarsi I–II with 1–2 pseudospurs. Pulvillus absent. Anal tergite round, double-layered, with 2 apical setae, median setae absent; transverse sternapodeme sclerotized, long, narrow, arched, with a horn at each end; phallapodeme sclerotized, straight, parallel-sided, with hooked anterior tip; virga absent. Inferior volsella double: dorsal one round, pale, bare, and ventral one shallow, scalene triangle, spherical tip distally directed with 1 seta. Gonostylus with well-developed crista dorsalis and dark brown megaseta. AR 1.06. LR 0.75.

Description (male, n = 3). HEAD (Fig. 2A): Yellowish-brown. Eye bare, dorsomedial extension very short (wedge-shape). Antenna light brown, with 13 segments. AR 1.06 (1.03–1.12). Palp pale dark brown, with 5 segments: 23, 46, 113, 90, 130 μm (1 : 2.0 : 4.9 : 3.9 : 5.7). Clypeus yellowish-brown, square in shape, with 7–13 segments. Tentorium as shown in Fig. 2B. THORAX (Fig. 2C): Yellowish-brown in ground color. Anteprepronotum brownish-yellow, normally developed. Scutum yellowish-brown, vittae brown; acrosticals absent, 6–9 dorsocentrals and 3–5 prealars each side. Scutellum light brown, with 8–10 setae. Postnotum dark brown. Haltere pale. WING (Fig. 2D): WL 1.88 (1.73–2.10) mm. Membrane hyaline, bare. Veins pale yellow (difficult to observe), all veins bare except R (4 minute setae basally). Costa not extended. R_{2+3} ending on basal 1/3 between R_1 and R_{4+5} . R_{4+5} above M_{3+4} . Cu_1 straight. Anal lobe well developed. Squama with 12–15 setae. Arculus pale brown, brachiolum pale brown with 1 seta. LEGS: Uniformly yellowish brown. Fore tibia with 1 long spur; mid tibia with 2 short spurs, tarsi I–II with 1 pseudospur; hind tibia with 1 long and 1 short spurs, and 9 comb spines; tarsi I–II with 1–2 pseudospurs. Pulvillus absent. LR 0.75 (0.73–0.77). ABDOMEN (Fig. 2E): Tergite I–IV pale dark brown, tergite V–VIII brown. HYPOPYGIUM (Fig. 2F): Anal tergite round, double-layered, with 2 apical and 4 lateral setae, median setae absent; all apodemes dark brown (sclerotized); transverse sternapodeme long, very narrow, arched with a horn at each end;

Korean name: ^{1*}진수염깃갈따구 (신칭)

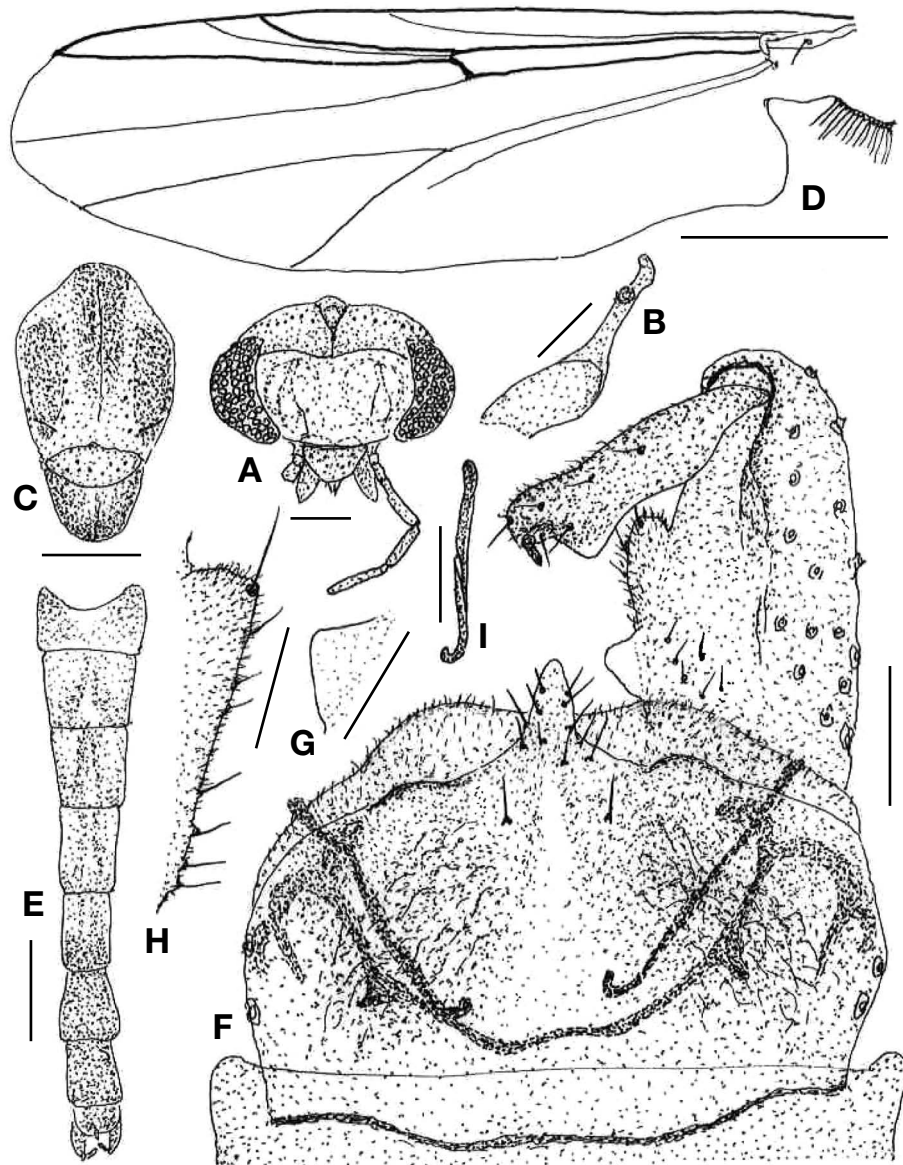


Fig. 2. *Parorthocladus jini* n. sp. (male). A, Head; B, Tentorium; C, Thorax; D, Wing; E, Abdomen; F, Hypopygium; G, Dorsal inferior volsella; H, Ventral inferior volsella; I, Phallapodeme. Scale bars: A, C, E=0.3 mm, B, F, I=0.05 mm, D=0.5 mm, G, H=0.03 mm.

phallapodeme long, straight, parallel-sided, with hooked basal tip (Fig. 2I); virga absent. Anal point half overlying, short, tapered distally, tip round, with 9–11 lateral and dorsal setae. Gonocoxite roughly parallel-sided; inferior volsella (gonocoxal inner lobe): dorsal one round, bare, pale (Fig. 2G); ventral one long, shallow, scalene triangular, spherical tip distally directed, with 1 apical, 4 latero-basal setae and microtrichia (Fig. 2H). Gonostylus parallel-sided, narrowed basally, with well-developed crista dorsalis and dark brown megaseta.

Etymology. This new species named in honor of Dr. Jin LB who is the senior author's teacher.

Remarks. The present species can be identified by the combination of the following characters: (1) the transverse sternapodeme long, very narrow, arched with a prominent horn at each end, (2) the phallapodeme sclerotized, straight, parallel-sided, with a hooked tip, (3) the anal point short, tapered distally, tip round, with 9–11 lateral and dorsal setae, (4) the inferior volsella (gonocoxal inner lobe) double: dorsal one pale, round, bare, and ventral one long, shallow, scalene triangular, tip directed distally, and the gonostylus with well-developed crista dorsalis.

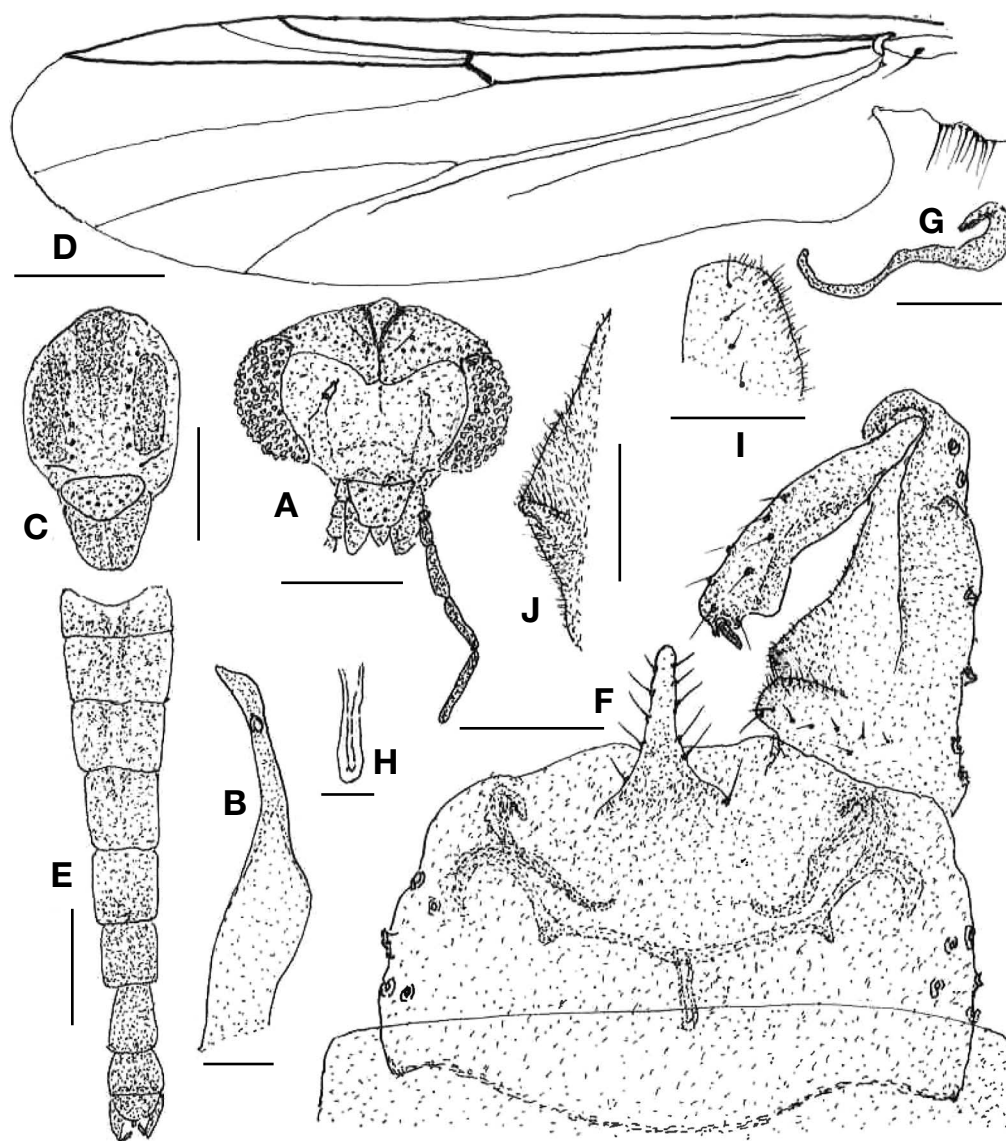


Fig. 3. *Parorthocladus paranegoroi* n. sp. (male). A, Head; B, Tentorium; C, Thorax; D, Wing; E, Abdomen; F, Hypopygium; G, Phallapodeme; H, Virga; I, Dorsal one of inferior volsella; J, Ventral one of inferior volsella. Scale bars: A=0.2 mm, B, G, I, J=0.03 mm, C, E=0.4 mm, D=0.3 mm, F=0.05 mm, H=0.01 mm.

¹**Parorthocladus paranegoroi* n. sp. (Fig. 3)

Material examined. Holotype: ♂ (RCH-14243), Korea: Gyeonggi-do, Gapyeong-gun, Buk-myeon, Gawha-ro, 5 Jul 2019, Yoon HS (NIBR). Paratype, ♂ (RCH-14221), *ditto* (AMBI).

Diagnosis. Medium-sized, brownish species (WL 1.7 mm). Eye bare. Acrosticals absent. Wing membrane bare. Costa not extended. R₄₊₅ above M₃₊₄. Cu₁ straight. Mid and hind tarsi I-II with 2 short, pseudospurs. Pulvillus absent. Anal tergite

without apical and median setae, with 5–6 lateral setae each side; weak virga with 2 spines. The anal point rather short, broadened at base, tip round, with 5 lateral setae on each side. Gonocoxal inner lobe (inferior volsella) double: dorsal one somewhat square, pale, with 5–6 minute, dorsal setae; ventral one shallow triangular. Gonostylus with well-developed crista dorsalis. AR 0.32. LR 0.75.

Description (male, n = 2). **HEAD** (Fig. 3A): Brown. Eye bare, dorsomedial extension very short (wedge-shape). Antenna brown, with 13 segments. AR 0.32. Palp brown, with 5 seg-

Korean name: ¹*옆네고로수염깃잡파구 (신칭)

ments: 24, 54, 96, 96, 139 μm (1 : 2.3 : 4.0 : 4.0 : 5.8). Clypeus light brown, square in shape, with 9–11 setae. Tentorium was shown in Fig. 3B. THORAX (Fig. 3C): Yellowish-brown in ground color. Anteprenotum pale brown, normally developed. Scutum light brown, vittae brown; acrosticals absent, 6–9 dorsocentrals, and 4 prealars each side. Scutellum light brown, with 22–25 setae. Postnotum brown. Haltere brownish pale. WING (Fig. 3D): WL 1.7 (1.6–1.8) mm. Membrane hyaline, bare. Veins pale yellow, all bare except R. Costa not extended. R_{2+3} ending near R_1 . R_{4+5} above M_{3+4} . Cu_1 straight. Anal lobe well developed. Squama with setae. Arculus brown. Brachiolum brown, with 1 seta. LEGS: Uniformly light brown. Fore tibia with 1 long, narrow spur; mid tibia with 2 short spurs, tarsi I–II with 2 pseudospurs; hind tibia with 1 long spur, 1 short spur, and 9 comb spurs; hind tarsi I–II with 1–2 pseudospurs. Pulvillus absent. LR 0.75 (0.73–0.76). ABDOMEN (Fig. 3E): Tergite I–V dirty, pale brown, tergite VI–VIII brown. HYPOPYGIUM (Fig. 3F): Anal tergite yellowish-brown, apical and median setae absent, 11–12 side setae present; transverse sternapodeme long, narrow, arched, with a triangular horn at each end; phallapodeme bent at near apical tip (Fig. 3G). Virga with 2 spines (Fig. 3H). Anal point 50 μm long, distal side pale, tip round, broadened at base, with 5–6 lateral setae on each side. Gonocoxite slightly narrowed distally; inferior volsella (gonocoxal inner lobe) double: dorsal one somewhat square-shape, with 5–6 short, dorsal setae and microtrichia along the distal margin (Fig. 3I); ventral one shallow triangular, covered with microtrichia (Fig. 3J). Gonostylus narrow at the base, crista dorsalis well developed, with dark brown megaseta.

Etymology. The present species named after the morphologically similar species, *P. negoroi*.

Remarks. This new species is similar to *P. negoroi* Yamamoto, 2011 in morphological characters of the head, thorax, and hypopygium. However, the followings are different: the value of the antennal ratio (0.32 vs. 1.40), the wing length (1.7 mm vs. 2.3 mm), the oral projection at each end of transverse sternapodeme (present vs absent), and the dorsal one of gonocoxal inner lobe (pale vs well sclerotized) (Yamamoto, 2011).

¹**Parorthocladius stipes* n. sp. (Fig. 4)

Material examined. Holotype, ♂ (RCH-14279), Korea: Gyeonggi-do, Gapyeong-gun, Buk-myeon, Gawha-ro, 5 Jul 2019, Yoon HS (NIBR).

Diagnosis. Yellowish-brown, small species (WL 1.25 mm). Eye bare. Acrosticals absent. Wing hyaline, bare. R_{4+5} above M_{3+4} . Cu_1 straight. Squama with 18 setae. Mid tarsi I–III with

2 pseudospurs; hind tarsi I–III with a pseudospur. Pluvillus absent. Anal tergite round, apical and median setae absent; transverse sternapodeme long, narrow, arched, without horn at each end; virga absent. Anal point relatively large, tapered distally, tip round, with 3–4 lateral setae on each side. Gonocoxal inner lobe single, shallow, with 5 baso-marginal setae and microtrichia ventrally. Gonostylus clavate-shape, without crista dorsalis, with dark megaseta. AR 1.16. LR 0.78.

Description (male, n = 1). HEAD (Fig. 4A): Brownish-yellow. Eye bare, not produced dorso-medially. Antenna yellowish-brown, with 13 segments. AR 1.16. Palp (Fig. 4B) with 5 segments (segments I–IV light brown, segment V pale brown): 27, 29, 107, 111, 168 μm (1 : 1.1 : 4.0 : 4.1 : 6.2). Clypeus yellowish-brown, with 8 setae. THORAX (Fig. 4C): Brownish-yellow in ground color. Anteprenotum pale yellow, with 1 ventral seta. Scutum brownish-yellow, vittae brown; acrosticals absent, 7–8 dorsocentrals arising from the tiny pit and 2 prealars each on side. Scutellum brownish yellow, with 5 setae. Postnotum brown. Haltere pale yellow. WING (Fig. 4D): WL 1.25 mm (0.45 mm wide). Membrane hyaline, bare. All veins pale yellow, bare. Costa slightly produced. R_{2+3} ending on basal 2/5 between R_1 and R_{4+5} . R_{4+5} above M_{3+4} . Cu_1 straight. Anal lobe moderately developed. Squama with 18 setae. Arculus and brachiolum brownish pale, with 1 seta. LEGS: Fore leg brown, mid and hind legs brownish yellow. Fore tibia with 1 long spur; mid tibia with 1 spur, mid tarsi I–III with 2 pseudospurs; hind tibia with a long spurs and comb spurs, hind tarsi I–III with a pseudospur. Pulvillus absent. LR 0.78. ABDOMEN (Fig. 4E): Tergite I–V pale brown, tergite VI–VIII brown. HYPOPYGIUM (Fig. 4F): Anal tergite round, apical and median setae absent; lateral and transverse sternapodeme pale, long, narrow, arched, without oral projection at each end; phallapodeme straight, poorly developed; virga absent. Anal point relatively large (45 μm long, 25 μm wide at base), tapered distally, tip round, with 4–5 lateral setae on each side. Gonocoxite parallel-sided; inferior volsella (gonocoxal inner lobe) single, shallow, somewhat spherical triangular, with 5 baso-marginal setae, ventral surface with short setae, and microtrichia (Fig. 4G). Gonostylus broadened distally, forming a clavate-shape, with dark megaseta, without crista dorsalis.

Etymology. The new species named after the clavate-shape of the gonostylus. From Latin, *stipes* mean club.

Remarks. This new species can be distinguished by the following characters: absence of the crista dorsalis in the clavated gonostylus, a single lobe of the inferior volsella (gonocoxal inner lobe), the transverse sternapodeme without oral projection, and absence of the virga.

Korean name: ¹*곤봉수염깃갈따구 (신칭)

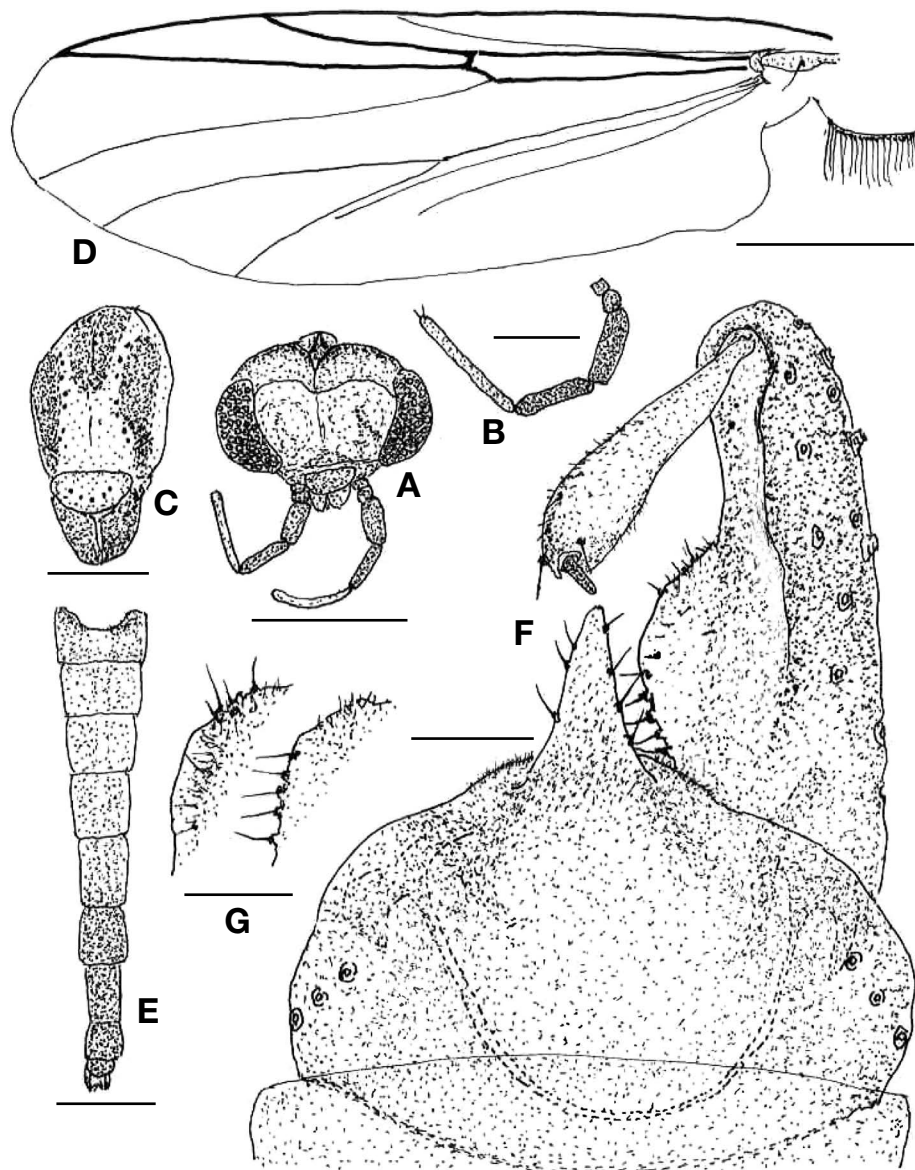


Fig. 4. *Parorthocladius stipes* n. sp. (male). A, Head; B, Palp; C, Thorax; D, Wing; E, Abdomen; F, Hypopygium; G, Inferior volsella (right: dorsal; left: ventral). Scale bars: A, C-E=0.3 mm, B=0.1 mm, F, G=0.03 mm.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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