

RESEARCH PAPER

Two new species of the genus *Cryptostemma* from Japan (Hemiptera: Heteroptera: Dipsocoridae)

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Abstract. *Cryptostemma miyamotoi* sp. nov. and *C. pavelstysi* sp. nov. from Japan are described. Habitus images and illustrations of diagnostic features, including genitalic structures, are provided. A key to the Eastern Palaearctic species is offered to facilitate identification. Habitats and behavior of the two new species are discussed based on the field and laboratory observations. The gender agreement of *Pachycoleus japonicus* (Miyamoto, 1964) is corrected.

Key words. Hemiptera, Heteroptera, Dipsocoromorpha, Dipsocoridae, *Cryptostemma*, *Pachycoleus*, bionomics, new species, taxonomy, Japan, Palaearctic Region

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Introduction

The small dipsocoromorphan family Dipsocoridae comprises only three genera, *Alpagut* Kiyak, 1995 (= *Harpago* Linnavuori, 1951, preoccupied) (Palaearctic), *Cryptostemma* Herrich-Schaeffer, 1835 (cosmopolitan), and *Pachycoleus* Fieber, 1860 (Palaearctic), with more than 30 described species (ŠTYS 1995, WEIRAUCH & ŠTYS 2014, WEIRAUCH & FERNANDEZ 2015). There have been some publications reviewing regional faunas: JOSIFOV (1967) for the Palaearctic Region, HEISS & PÉRICART (2007) for Europe, McATEE & MALLOCH (1925) and WYGODZINSKY (1951) for the Neotropical Region, and HILL (1987) for the Australian Region.

Dipsocoridae in the Eastern Palaearctic Region, in contrast to those in other areas, have been documented by only a few studies. SHIRAKI (1954) first recorded a species of Dipsocoridae (as *Cryptostemma* sp.) from Japan, with a note on its morphology. MIYAMOTO (1957, 1961) studied the ovariole number and the morphology of the alimentary organs of *Cryptostemma* spp. Shortly after that, MIYAMOTO (1964) described *C. japonicum* from Japan. Subsequently, WU (1967) described two species from Taiwan, namely *C. wygodzinskyi* and *C. digitum*. KERZHNER (1974) recorded *C. japonicum* from the Russian Far East, and REN & YANG (1991) also recorded that species from China (Guangxi). KERZHNER (1995) placed *C. japonicum* in the subgenus

Pachycoleus of the genus *Cryptostemma*. PLUOT-SIGWALT & PÉRICART (2003) elevated *Pachycoleus* to generic rank. After that, AUKEMA et al. (2013) followed their generic treatment, but did not correct the generic placement of *C. japonicum* in the Palaearctic catalogue. Very recently, KIM et al. (2019) recorded that species from the Korean Peninsula and proposed a new generic combination for *Pachycoleus japonicus*. Dipsocoridae from the Eastern Palaearctic are represented only by three species, although many undescribed species have been recognized by some authors (e.g., MIYAMOTO 1961, HIURA 1967).

Through careful examination of specimens collected by the authors and their colleagues, as well as of material deposited in several institutions, we have found two undescribed *Cryptostemma* species from Japan. In the present study, we describe them as new species, and present their bionomics.

Materials and methods

Examination of external characters and genitalia was carried out using a binocular microscope (Stereoscopic Zoom Microscope SMZ1500; Nikon). The abdomen was macerated in hot 1–5% potassium hydroxide (KOH) solution for 5–10 min (the period of heating needed to be adjusted according to the freshness of the specimen), and then dissected. The genital structures were dissected



with micro-pins in glycerin on a hole glass slide under a binocular microscope (Stereoscopic Zoom Microscope SMZ1500; Nikon). For line drawings of genital structure, the abdomen was put on loosened fibers of tissue paper to keep a stable position in glycerin. Line drawings (Figs 9–28) were principally made with the aid of an eyepiece grid. Photographs (Figs 1–8) were taken using a digital camera (EOS 70D; Canon) equipped with an extreme macro lens (MP-E 65 mm F2.8 1–5×; Canon) and a flashlight (Speedlite 430EX III-RT; Canon), and then combined using the automontage software CombineZP. Habitus images of living individuals (Figs 29–30) were taken with a digital camera (EOS 70D; Canon) equipped with an extreme macro lens (MP-E 65mm F2.8 1–5×; Canon) and a flashlight (Macro Twin Lite MT-24EX; Canon). All digital images were edited and assembled using the Adobe Photoshop CC 2018 software.

All measurements are presented in millimeters. Terminology of genitalic structures follows HILL (1987), PLUOT-SIGWALT & PÉRICART (2003), and KNYSHOV et al. (2018).

Depositories of the specimens are abbreviated as follows:

ELKU	Entomological Laboratory, Kyushu University, Fukuoka, Japan;
NMNS	National Museum of Natural Science, Taichung, Taiwan;
NMPC	National Museum, Prague, Czech Republic;
OMNH	Osaka Museum of Natural History, Osaka, Japan;
TKPM	Tokushima Prefectural Museum, Tokushima, Japan.

For comparison with the new species listed below, *Cryptostemma digitum* Wu, 1967 was examined. The data of the material were as follows: **TAIWAN:** Pingtung Co., Jiupeng Vill., Mancho Town, Chunggang stream, 22°06'49.2"N 120°53'09.3"E, 6 m alt., 20.iii.2017, 8 ♂♂, 7 ♀♀, K. Yamada & J. F. Tsai (TKPM, NMNS).

Taxonomy

Cryptostemma Herrich-Schaeffer, 1835

Diagnosis. HEISS & PÉRICART (2007) provided the following diagnostic characters to distinguish *Cryptostemma* from the other two known genera of Dipsocoridae, *Alpagut* and *Pachycoleus*: left laterotergite VI transformed as appendage of genital complex; left and right laterotergites VIII appendage-like, articulated, and prehensile; parameres asymmetrical; seminal capsule subspherical, not fixed by surrounding cuticules, loculus capsulae lacking.

Discussion. *Cryptostemma* is more species-rich than the other two genera and currently composed of approximately 20 recent species from all zoogeographical regions (WYGODZINSKY 1950, 1952, 1955; HILL 1987; LINNAVUORI 1974; ŠTYS 1977; KERZHNER 1995; HEISS & PÉRICART 2007; AUKEMA et al. 2013; WEIRAUCH & FERNANDEZ 2015) and one fossil species from Eocene amber of France (HARTUNG et al. 2017). Of the extant species, nine are known from the Neotropical Region, six from the Palaearctic Region, and five from the Australian Region (e.g., HILL 1987, KERZHNER 1995, WEIRAUCH & FERNANDEZ 2015). The genus is also present in the Ethiopian Region (Sudan, Madagascar) and North America (LINNAVUORI 1974, ŠTYS 1977). In the

East Palaearctic Region, four species, including the two new species described below, are recognized: *C. digitum* Wu, 1967 (Taiwan), *C. wygodzinskyi* Wu, 1967 (Taiwan), *C. miyamotoi* sp. nov. (Japan), and *C. pavelstysi* sp. nov. (Japan).

Previous authors provided generic diagnoses (e.g., REUTER 1891, MCATEE & MALLOCH 1925, WYGODZINSKY 1948, LINNAVUORI 1951, JOSIFOV 1967), but this genus is still not defined by consistent diagnostic characters. HEISS & PÉRICART (2007) provided the structures of male abdominal appendages and parameres and female genitalia as diagnostic characters for recognizing three dipsocorid genera, but their keys are generally restricted to the western Eurasian species. Eventually a world revision would be required to redefine *Cryptostemma*.

Through examination of the Taiwanese *C. digitum* specimens and the two Japanese species, it was revealed that these species share characteristic features, such as the dextrally curved pregenital abdomen, left sternite VII shaped as an appendage-like structure, and extremely enlarged right laterotergite VIII. WU (1967) described that *C. digitum* has appendage-like left laterotergite VI. Based on our careful examination of *C. digitum* specimens, this character was proven to be sternite VII, not laterotergite VI.

Judging from the illustration of *C. wygodzinskyi* by WU (1967), it was recognized that the species also has appendage-like left laterotergite VII, so WU seems to have misidentified laterotergite VII for VI. As did WU (1967), JOSIFOV (1967) also misidentified the laterotergite VII for VI, and subsequent authors who followed them might have done the same. The past authors might have wrongly interpreted homology of the sclerites; therefore, comparative morphological studies on male abdomen are indispensable to evaluate their homology carefully.

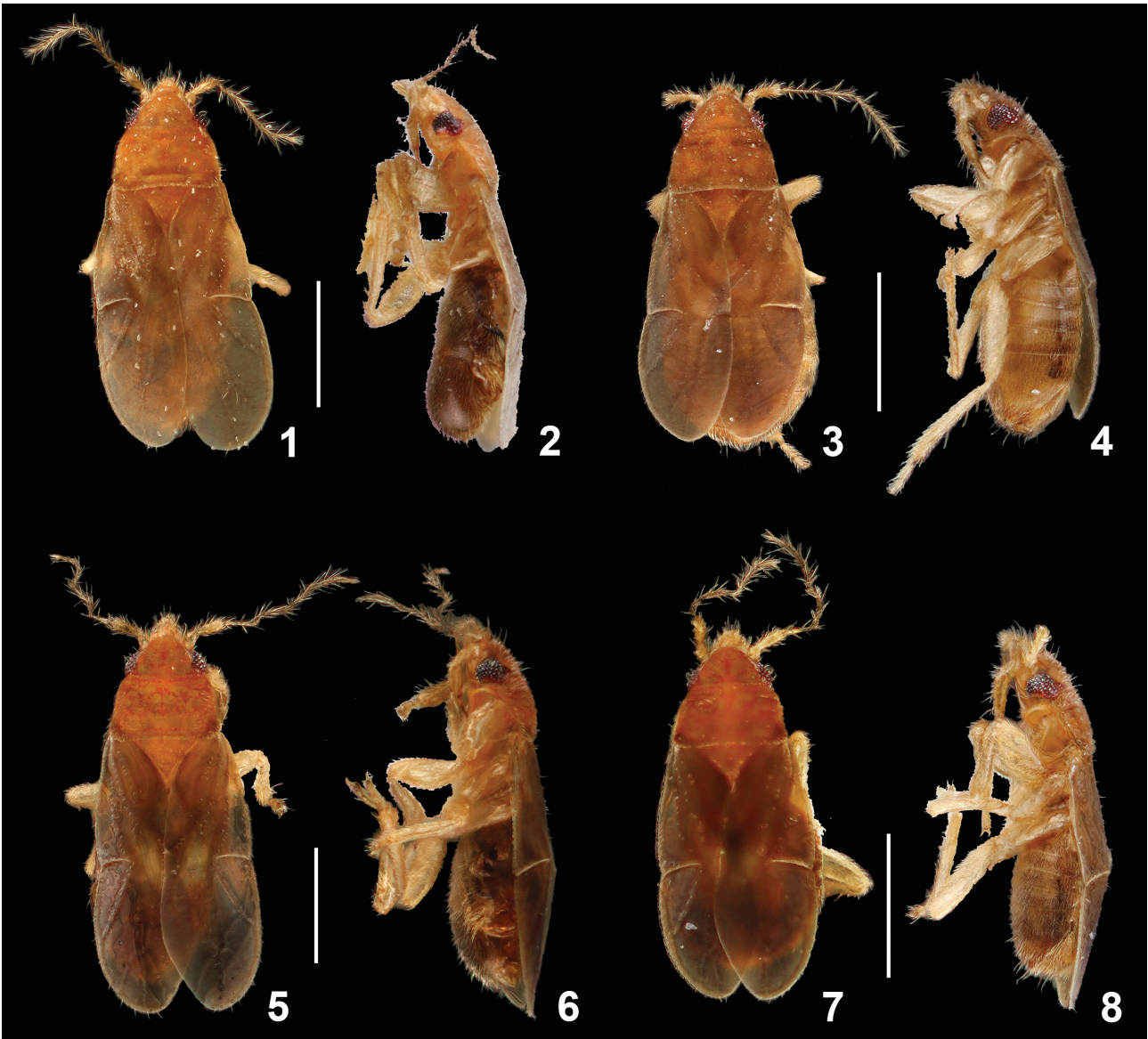
Cryptostemma miyamotoi sp. nov.

(Figs 1–4, 9, 11–19, 29)

Cryptostemma sp. A: HIURA (1967): 80.

Type material. HOLOTYPE: ♂ (Figs 1–2), JAPAN: Shimane Pref.: Izumo-shi: Inome-cho / Inome-gawa / 35.440804, 132.710732 / 4.vii.2015: Masakazu HAYASHI leg. [printed], [a card with locality data and collector in Chinese script, printed]; mounted on a triangular card, in intact condition (TKPM). PARATYPES: JAPAN: HONSHU: same data as holotype, 1 ♂ (Fig. 9) 1 ♀ (TKPM). SHIKOKU: Tokushima Pref.: 1 ♀, Tokushima-shi, Kamihachiman-chô, Sonosegawa-Riv., 11.vi.2007, K. Yamada (TKPM); 1 ♂ (Fig. 29), Sanagouchi-son, Shimo, 34°00'45"N, 134°28'45"E, 36 m alt., 21.v.2016, K. Yamada (TKPM); 1 ♀, same locality, 4.vi.2016, K. Yamada (TKPM); 2 ♀♀ (one in Figs 3–4), same locality, 26.iv.2018, K. Yamada (TKPM); 1 ♂, same locality, 18.v.2018, K. Yamada (TKPM); 1 ♀, Kamiyama-chô, Jinryô-hon-uetsuno, 13.vii.1953, I. Hiura (OMNH); 1 ♂, same locality, 20.vii.1953, I. Hiura (OMNH); 1 ♂ (Figs 11–18), same locality, 12.viii.1953, I. Hiura (OMNH); 12 ♂♂ 7 ♀♀ (one in Fig. 19), Kamiyama-chô, Jinryô, 27.viii.1953, I. Hiura (OMNH, ELKU). KYUSHU: Nagasaki Pref.: 1 ♂ 1 ♀, Nagasaki-shi, Mieda-chô, 32°49'13"N, 129°43'57"E, 7 m alt., 29.iii.2018, K. Yamada (TKPM).

Differential diagnosis. Recognized by the combination of the following characters: Body small in size (1.4–1.7 mm), uniformly yellowish-brown coloration, narrowly darkened posterior angles of pronotum, left side of sternite VII branched in middle, very large and U-shaped right laterotergite VIII with mitten-shaped apex of large anterior process,

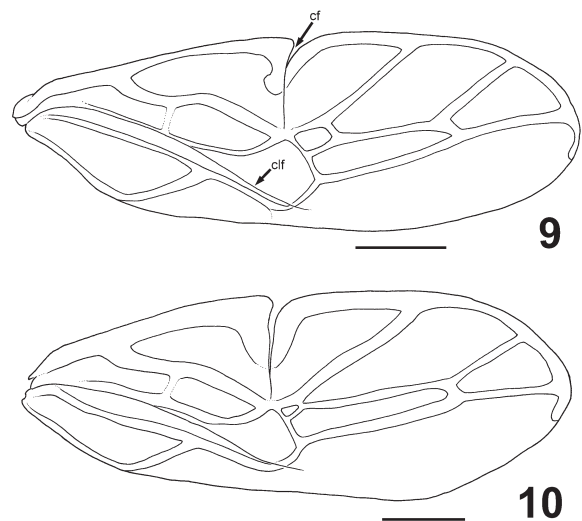


Figs 1–8. Habitus of Japanese *Cryptostemma* spp., dorsal (1, 3, 5, 7) and lateral (2, 4, 6, 8) views. 1–4 – *Cryptostemma miyamotoi* sp. nov., holotype, male (1–2) and female (3–4); 5–8 – *C. pavelstysi* sp. nov., holotype, male (5–6) and female (7–8). Scale bars = 0.5 mm.

and large asymmetrical sternite VIII. It is most similar to *C. digitum* Wu, 1967 in size, coloration, and general abdomen configuration, but distinguished from that species by the left side of sternite VII branched in middle (in *C. digitum*, spatulate, apically truncated), left laterotergite VIII expanded at apex with triangular subapical flange (in *C. digitum*, not expanded at apex, with no flange), and posterior process of right laterotergite VIII slender and narrowed apicad (in *C. digitum*, bearing an elongate process basally and bifurcated at apex).

Description. Male. Body elongate-oval, small (1.4–1.7 mm).

Coloration (Figs 1–2, 29). Head uniformly yellowish-brown; eyes and ocelli dark red; antennae pale yellow to brown; labium pale yellow. Pronotum yellowish-brown, with posterior angles narrowly darkened. Scutellum overall yellowish-brown. Forewing brownish, somewhat darker than pronotum. Venter of thorax uniformly yellowish-brown. Abdomen dark brown. **Surface and vestiture.** Head impunctate, sparsely covered with short



Figs 9–10. Right forewings of Japanese *Cryptostemma* spp. 9 – *Cryptostemma miyamotoi* sp. nov., male; 10 – *C. pavelstysi* sp. nov., male. Abbreviations: cf = costal fracture; clf = claval fracture. Scale bars = 0.2 mm.

semi-erect setae; clypeus, bucculae, and labrum with dense semi-erect setae (Figs 1, 3), with 5–6 pairs of very long erect setae on each side of clypeus, inner side of antennal insertion, and on each side behind ocellus; apex of clypeus with single long erect seta; eyes with scattered short setae. Antennal segments I and II with short semi-erect setae (Figs 1, 3); segments III and IV sparsely covered with mix of short and longer setae, of which longest setae much longer than twice width of corresponding segment (Figs 1, 3). Labium sparsely covered with mix of short and longer setae. Pronotum impunctate, with sparse short setae, and with pair of relatively long setae near posterolateral angles. Legs shiny, densely covered with short setae. Forewings with extremely short setae on marginal vein. Abdomen densely covered with short reclining setae; left side of sternite VII with dense and long pilosity on middle surface (Figs 11–13); left laterotergite VIII with long stout setae on basal 1/3 of inner and outer surface (Figs 11–12, 14); right laterotergite VIII basally with distinctively longer setae (Figs 11, 15); sternite VIII and pygophore densely covered with mix of short and longer setae (Figs 11–12); left paramere bearing longer stout setae intermixed with short setae, apical process with five short setae on middle part (Figs 16–17); right paramere with short setae and row of very short setae on outermost margin (Fig. 18).

Structure. *Head* triangularly produced anteriorly with round apex (Figs 1, 3); head width across eyes approximately 1.7 times wider than interocular distance; eyes small, granulate; ocellus touches median margin of respective eye. Antennal segment I stout, slightly longer than its diameter; segment II pyriform, almost same width as segment I, approximately twice longer than segment I; segments III longer than segment IV. Labium reaching to posterior part of prosternum; segment I wider than other segments, slightly longer than width; segment III approximately 1.3 times longer than segment II; segment IV approximately as long as segment II. *Thorax:* pronotum trapezoidal in dorsal view (Figs 1, 3), approximately 0.6 of its basal width in length; anterior margin slightly curved; lateral margin weakly carinate; posterior margin slightly concave; pronotal collar sulcus developed only laterally; posterior disc medially with transverse shallow sulcus. *Legs:* each femur incrassate, with fore femora rather thickened; fore tibiae thickened toward apex, fore tibiae with scattered 5–6 long slender spines, and apically with dense slender spines on ventral surface (without tibial comb); mid tibiae slightly expanded at apex, bearing several spines on apicoventral and outer surfaces, with spine shorter than maximum width of mid tibia; hind tibiae distinctly longer than fore and mid tibiae, bearing 4 longer spines on outer surface and 5 apical spines, of which longer spine approximately as long as maximum width of hind tibia; tarsal formula 3-3-3. *Forewing:* surpassing apex of abdomen; marginal vein loop cut by costal fracture; venation as shown in Fig 9. *Pregenital abdomen:* all segments strongly asymmetrical; right laterotergites II–VII not clearly divided into dorsal and ventral laterotergites (weakly sclerotized between dorsal

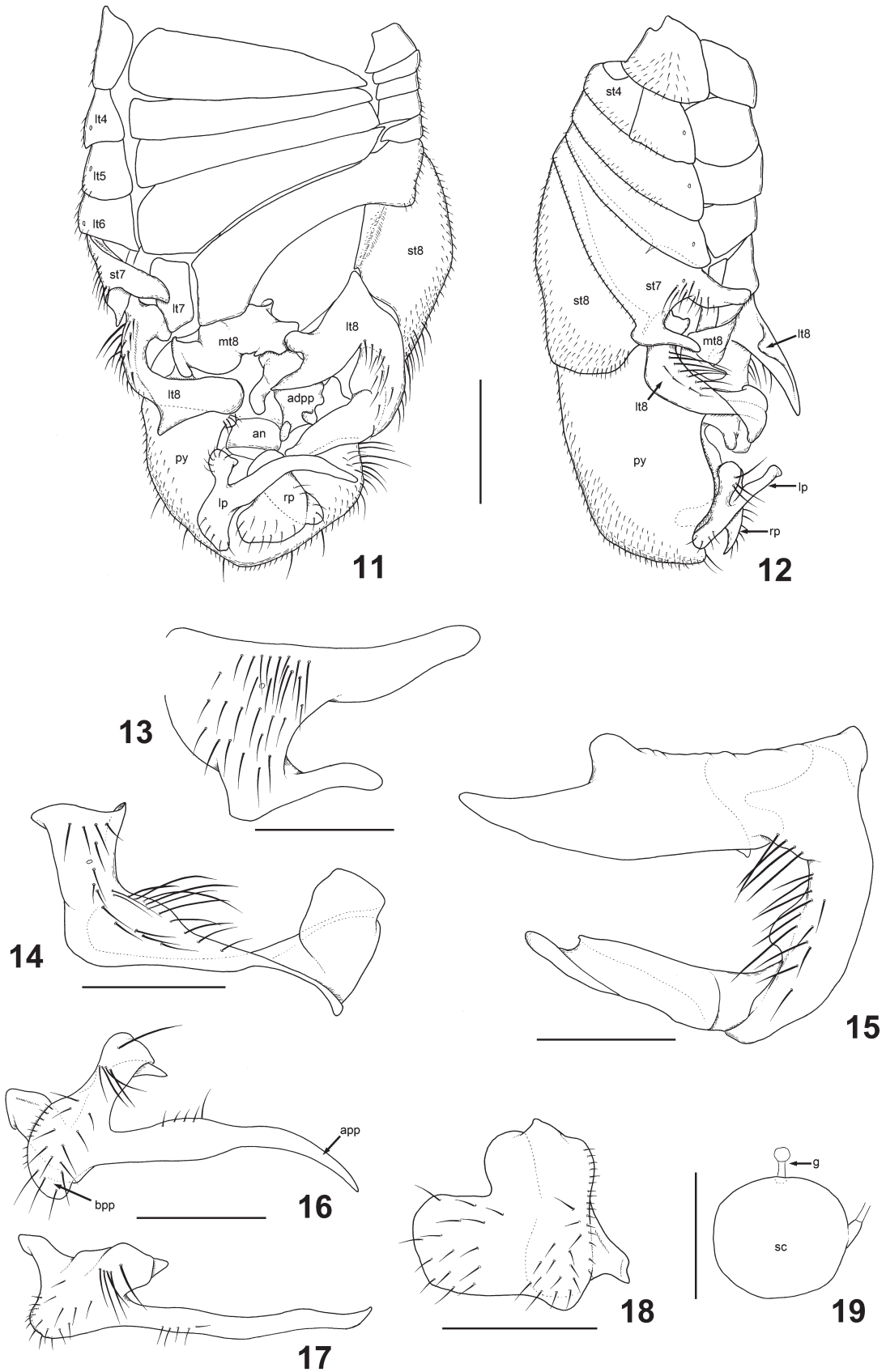
and ventral laterotergites) (Figs 11–12); mediotergite III–VI narrowed dextrally (Fig. 11); mediotergite VII enlarged, posterior margin concave medially (Fig. 11); left laterotergites present on segments IV and VII (not divided into dorsal and ventral laterotergites), left laterotergites V and VI fused with respective sternites (Figs 11–12); left side of sternite VII produced, branched in middle with long anterior process and short posterior process (Figs 11–13); spiracles located on laterotergites IV–VII (on left side, located on laterotergites IV–VI and sternite VII), and subbasally on left laterotergite VIII (Figs 11–14). *Genitalia:* mediotergite VIII asymmetrical, complicatedly shaped, with small dorsally elevated projection on left side (Fig. 11); left laterotergite VIII basally bent, weakly twisted, expanded at apex, with triangular subapical flange (Figs 11, 14); right laterotergite VIII very large, flattened, U-shaped with large anterior process and small posterior process, large anterior process apically mitten-shaped, small posterior process slender and narrowed apicad (Figs 11, 15); sternite VIII very large, asymmetrical, narrowed dextrally in ventral view. Pygophore large and oval, slightly shorter than sternite VIII, anterodorsally with ridges and process (anterodorsal projection) (Figs 11–12); anterodorsal projection very large, hand-like shaped with small dorsally elevated process on each corner (Fig. 11); left paramere elongate, subequal in length to left laterotergite VIII, with two basal extensions and apical process, two basal extensions present with distinct anterior extension and oval posterior extension (basal process), apical process slender and apex weakly curved posteriad (Figs 11–12, 16–17); right paramere short and flattened, with two large rounded lobes, of which anterior one with small triangular process (Figs 11, 18).

Female (Figs 3–4, 19). Similar to male in coloration, surface, and vestiture, slightly smaller than male, rather ovoid; tarsal formula 2-2-3; forewing usually not surpassing apex of abdomen; abdomen symmetrical. *Genitalia:* spermatheca as shown in Fig. 19; seminal capsule spherical, very tiny (diameter less than 0.05 mm), turns into caudal appendage on one side and forms short canal leading to spermathecal duct; spermathecal gland fused on top of seminal capsule, bulbous, very small.

Measurements (δ n = 8 / δ n = 7, holotype in parentheses). Body length 1.46–1.66 (1.46) / 1.33–1.62; head width across eyes 0.30–0.34 (0.30) / 0.31–0.33; interocular distance 0.17–0.21 (0.20) / 0.20–0.22; length of antennal segments I – 0.05–0.07 (0.06) / 0.05–0.07, II – 0.10–0.12 (0.10) / 0.11–0.12, III – 0.31–0.38 (0.31) / 0.30–0.39, and IV – 0.26–0.30 (0.26) / 0.25–0.31; length of labial segments II – 0.08–0.09 (0.08) / 0.07–0.08, III – 0.11–0.12 (0.11) / 0.11–0.13, and IV – 0.08–0.09 (0.08) / 0.08–0.09; length of pronotum along meson 0.23–0.25 (0.23) / 0.24–0.26; width of pronotum 0.40–0.47 (0.40) / 0.43–0.46; length of forewing 1.06–1.30 (1.06) / 0.90–1.20; length of hind tibiae 0.45–0.49 (unmeasurable) / 0.43–0.45.

Etymology. Named in honor of the late Dr. S. Miyamoto, in recognition of his outstanding contributions to study of Dipsocoromorpha.

Distribution. Japan (Honshu, Shikoku, Kyushu).



Figs 11–19. Morphological details of *Cryptostemma miyamotoi* sp. nov., male (11–18) and female (19). 11–12 – abdomen (mediotergite II and sternite II omitted), dorsal (11) and lateral (12) views; 13 – left side of sternite VII, laterodorsal view; 14 – left laterotergite VIII, laterodorsal view; 15 – right laterotergite VIII, laterodorsal view; 16–17 – left paramere, dorsal and anterior views; 18 – right paramere, dorsal view; 19 – spermatheca. Abbreviations: adpp = anterodorsal projection of pygophore; an = anophore; app = apical process of paramere; bpp = basal process of paramere; g = spermathecal gland; lp = left paramere; lt4–8 = laterotergite IV–VIII; mt8 = mediotergite VIII; py = pygophore; rp = right paramere; sc = seminal capsule; st4, 7, 8 = sternite IV, VII, VIII. Scale bars = 0.2 mm for 11–12; 0.1 mm for 13–18; 0.05 mm for 19.

***Cryptostemma pavelstysi* sp. nov.**

(Figs 5–8, 10, 20–28, 30)

Type material. HOLOTYPE: ♂ (Figs 5–6), ‘JAPAN: Ishigaki-jima, / Miyara-gawa, / 24°25’32”N 124°12’03”E, / 63 m, 19–20 XI 2017, / K. Yamada’ [printed]; mounted on a triangular card, in intact condition (TKPM). PARATYPES: JAPAN: RYUKYUS: Ishigaki-jima Is.: 18 ♂♂ (one in Fig. 10, one in Figs 20–27) 12 ♀♀ (one in Figs 7–8, one in Fig. 28), same data as holotype (TKPM, NMPC); 23 ♂♂ (one in Fig. 30) 5 ♀♀, near Nagura Dam, 14.xi.2018, K. Yamada (TKPM, NMNS); 2 ♂♂ 3 ♀♀, Shiramizu, 17.iii.2000, M. Hayashi et al. (TKPM).

Differential diagnosis. Recognized by the combination of the following characters: Body small in size (1.4–1.7 mm), reddish-brown to darker orange-brown head and pronotum, pronotum being widely darkened at posterior angles and sometimes darkened along posterior margin, smoky dark brown forewings with 2 obscure paler markings on area between costal fracture and claval fracture, apex of left side of sternite VII truncate, very large and U-shaped right laterotergite VIII with knife-shaped large anterior process, and large asymmetrical sternite VIII. Similar in general appearance and general configuration of abdomen to *C. digitum* and *C. miyamotoi*, but distinguished from *C. digitum* by the knife-shaped large anterior process of right laterotergite VIII (in *C. digitum*, anterior process of right laterotergite VIII apically bifurcated), and from *C. miyamotoi* by the shape of left side of sternite VII, left and right laterotergite VIII, and parameres. In addition, a pair of dorsal abdominal gland scars are present in *C. pavelstysi*, but not in *C. miyamotoi*.

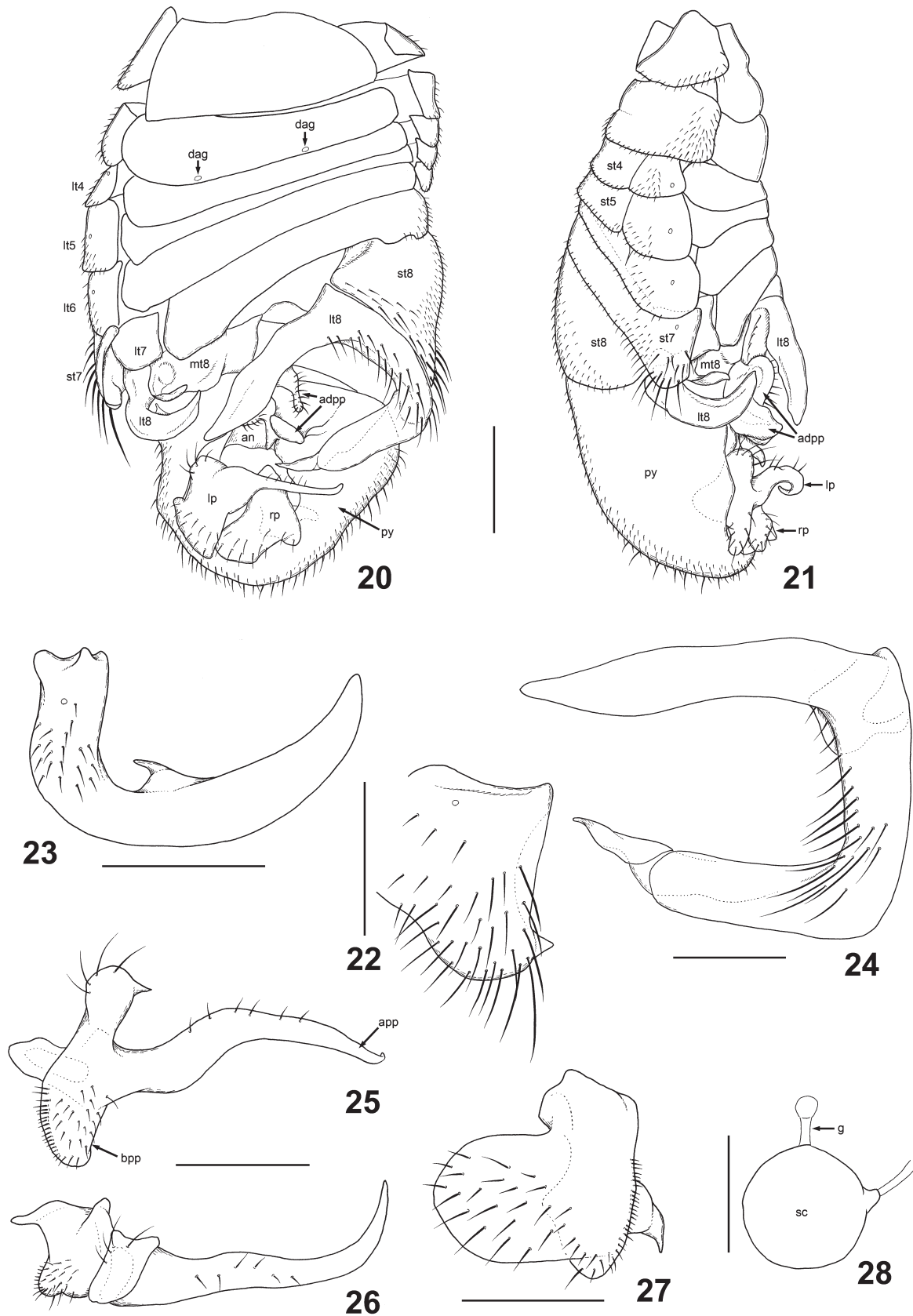
Description. Male. Body elongate-oval, small (1.4–1.7 mm).

Coloration (Figs 5–6, 30). Head reddish-brown to darker orange brown; eyes and ocelli dark red; antennae pale yellow to brown; labium pale yellow. Pronotum reddish-brown to darker orange brown, with posterior angles widely darkened, sometimes darkened along posterior margin. Scutellum reddish-brown to darker orange brown. Forewings smoky dark brown, with 2 obscure paler markings on area between costal fracture and claval fracture. Venter of thorax uniformly yellowish-brown. Abdomen dark brown.

Surface and vestiture. Head impunctate, sparsely covered with short semi-erect setae; clypeus, bucculae, and labrum with dense semi-erect setae (Figs 5, 7), with 5–6 pairs of very long erect setae on each side of clypeus, inner side of antennal insertion, and each side behind ocellus; apex of clypeus with single long erect seta; eyes with scattered short setae. Antennal segments I and II with short semi-erect setae (Figs 5, 7); segments III and IV sparsely covered with mix of short and longer setae, of which longest much longer than twice width of corresponding segment (Figs 5, 7). Labium sparsely covered with mix of short and longer setae. Pronotum impunctate, with sparse short setae, and with pair of relatively long setae near posterolateral angles. Legs shiny, densely covered with short setae. Forewings with extremely short setae on marginal vein. Abdomen densely covered with short reclining setae; left side of sternite VII with dense and long pilosity (Figs 20–22); left laterotergite VIII basally with sparse short setae (Figs 20–21, 23); right laterotergite VIII basally with distinctive longer setae (Figs 20, 24); sternite

VIII and pygophore densely covered with mix of short and longer setae (Figs 20–21); left paramere with 4–5 longer stout setae on anterior extension, basal process with row of very short setae on outer margin, apical process with 6 short setae on middle part (Figs 25–26); right paramere with row of very short setae on outermost margin (Fig. 27).

Structure. **Head** triangularly produced anteriorly with round apex (Figs 5, 7); head width across eyes approximately 1.6 times wider than interocular distance; eyes small, granulate; ocellus touches median margin of respective eye. Antennal segment I stout, slightly longer than its diameter; segment II pyriform, almost same width as segment I, approximately twice longer than segment I; segments III approximately 1.3 times longer than segment IV. Labium reaching posterior part of prosternum; segment I wider than other segments, slightly longer than width; segment III approximately 1.6 times longer than segment II; segment IV slightly longer than segment II. **Thorax:** pronotum trapezoidal in dorsal view (Figs 5, 7), approximately 0.53 times basal width of pronotum in length; anterior margin slightly curved; lateral margin weakly carinate; posterior margin slightly concave; pronotal collar sulcus developed only laterally; posterior disc medially with transverse shallow sulcus. **Legs:** each femur incrassate, of which fore femora rather thickened; fore tibiae thickened toward apex, with scattered 5–6 long slender spines, and apically with dense slender spines on ventral surface (without tibial comb); mid tibiae slightly expanded at apex, bearing several spines on apicoventral and outer surfaces, spine shorter than maximum width of mid tibiae; hind tibiae distinctly longer than fore and mid tibiae, bearing 4 longer spines on outer surface and 5 apical spines, of which longer spine approximately as long as maximum width of hind tibiae; tarsal formula 3-3-3. **Forewing** surpassing apex of abdomen; marginal vein loop cut by costal fracture; venation as shown in Fig 10. **Pregenital abdomen:** all segments strongly asymmetrical; right laterotergites II–VII not clearly divided into dorsal and ventral laterotergites (weakly sclerotized between dorsal and ventral laterotergites) (Figs 20–21); mediotergite II–VI a little narrowed dextrally (Fig. 20); pair of dorsal abdominal gland scars present near posterior margin of mediotergite III; posterior margin of mediotergite VII concave medially (Fig. 20); left laterotergites present on IV, V, and VII (not divided into dorsal and ventral laterotergites), left laterotergites VI fused with sternite (Figs 20–21); left side of sternite VII spatulate, apically truncated, with small process on posterior angle (Fig. 22); spiracles located on laterotergites IV–VII (on left side, located on laterotergite IV–VI and sternite VII), and subbasally on left laterotergite VIII (Figs 20–23). **Genitalia:** mediotergite VIII asymmetrical, complicatedly shaped, with distinctive dorsally elevated projection on left side (Fig. 20); left laterotergite VIII falcate, medially with triangular flange (Figs 20, 23); right laterotergite VIII very large, flattened, U-shaped with large anterior process and slightly shorter posterior process, large anterior process knife-shaped, posterior process almost as wide as anterior process and tapering apicad (Figs 20, 24); sternite VIII



Figs 20–28. Morphological details of *Cryptostemma pavelstysi* sp. nov., male (20–27) and female (28). 20–21 – abdomen, dorsal (20) and lateral (21) views; 22 – left side of sternite VII, laterodorsal view; 23 – left laterotergite VIII, laterodorsal view; 24 – right laterotergite VIII, laterodorsal view; 25–26 – left paramere, dorsal and anterior views; 27 – right paramere, dorsal view; 28 – spermatheca. Abbreviations: adpp = anterodorsal projection of pygophore; an = anophore; app = apical process of paramere; bpp = basal process of paramere; dag = dorsal abdominal gland scars; g = spermathecal gland; lp = left paramere; lt4–8 = laterotergite IV–VIII; mt8 = mediotergite VIII; py = pygophore; rp = right paramere; sc = seminal capsule; st4, 5, 7, 8 = sternite IV, V, VII, VIII. Scale bars = 0.2 mm for 20–21; 0.1 mm for 22–27; 0.05 mm for 28.

very large, asymmetrical, narrowed dextrally in ventral view. Pygophore large and oval, maximum length approximately as long as that of sternite VIII, anterodorsally with ridges and process (anterodorsal projection) (Figs 20–21); anterodorsal projection very large, with large dorsally elevated process and spatulate process (Figs 20–21); left paramere elongate, longer than left laterotergite VIII, with two basal extensions and apical process, two basal extensions present with distinct anterior extension and large basal process, apical process slender and sinuate, apically curved inwardly (Figs 20–21, 25–26); right paramere short and flattened, with two distinct lobes, large rounded lobe and smaller angulate lobe (Figs 20, 27).

Female (Figs 7–8, 28). Similar to male in coloration, surface, and vestiture, slightly smaller than male, rather ovoid; tarsal formula 2-2-3; forewing sometimes not surpassing apex of abdomen; abdomen symmetrical. *Genitalia*: spermatheca as shown in Fig 28; seminal capsule spherical, very tiny (diameter less than 0.05 mm), turns into caudal appendage on one side and forms short canal leading to spermathecal duct; spermathecal gland fused on top of seminal capsule, bulbous, very small but longer than that of *C. miyamotoi*.

Measurements (♂ n = 10 / ♀ n = 10, holotype in parentheses). Body length 1.44–1.69 (1.63) / 1.43–1.59; head width across eyes 0.29–0.33 (0.32) / 0.31–0.34; interocular distance 0.16–0.22 (0.19) / 0.19–0.22; length of antennal segments I – 0.04–0.06 (0.05) / 0.04–0.06, II – 0.11–0.13 (0.13) / 0.11–0.13, III – 0.39–0.43 (0.40) / 0.38–0.40, and IV – 0.27–0.32 (0.30) / 0.28–0.30; length of labial segments II – 0.06–0.09 (0.08) / 0.06–0.08, III – 0.11–0.13 (0.12) / 0.12–0.14, and IV – 0.08–0.10 (0.10) / 0.08–0.10; length of pronotum along meson 0.20–0.25 (0.23) / 0.23–0.25; width of pronotum 0.39–0.45 (0.43) / 0.39–0.45; length of forewing 1.04–1.25 (1.15) / 0.99–1.13; length of hind tibiae 0.42–0.47 (0.46) / 0.42–0.45.

Etymology. Dedicated to the late Dr. P. Štys, one of the world's leading heteropterists and author of many seminal papers on Dipsocoromorpha, who regretfully passed away in August 2018.

Distribution. Japan (Ryukyus: Ishigaki-jima Is.).

Key to the East Palaearctic species of *Cryptostemma* (male characters)

1. Right laterotergite VIII elongate, slender; sternite VIII much shorter than half length of pygophore.
..... *C. wygodzinskyi* Wu, 1967
- Right laterotergite VIII very large, U-shaped (Figs 11, 15, 20, 24); sternite VIII very large, approximately as long as or longer than maximum length of pygophore (Figs 12, 21). 2
2. Anterior process of U-shaped right laterotergite VIII knife-shaped, not bifurcated (Figs 20, 24).
..... *C. pavelstysi* sp. nov.
- Anterior process of U-shaped right laterotergite VIII apically mitten-shaped or bifurcated (Figs 11, 15). ... 3
3. Left side of sternite VII branched in middle (Fig. 13); left laterotergite VIII expanded at apex, with triangu-

lar subapical flange (Figs 11, 14); posterior process of U-shaped right laterotergite VIII slender and narrowed apicad (Fig. 15). *C. miyamotoi* sp. nov.

- Left side of sternite VII spatulate, apically truncated; left laterotergite VIII not expanded at apex, with no flange; posterior process of U-shaped right laterotergite VIII bearing elongate process basally and bifurcated at apex. *C. digitum* Wu, 1967

Pachycoleus japonicus (Miyamoto, 1964)

Cryptostemma japonicum Miyamoto, 1964: 571 (original description).
Pachycoleus japonicum: KIM et al. (2019): 196 (new generic placement).

Comment. KIM et al. (2019) revised the generic placement of *Cryptostemma japonicum* and placed it in the genus *Pachycoleus*. However, they did not change the ending of this species name according to the gender of the genus name. As the gender of *Pachycoleus* is masculine, the correct gender agreement is *P. japonicus*.

Bionomics

Habitat. *Cryptostemma* species inhabit interstitial spaces formed by gravel and sand along the banks of streams or rivers (e.g., ŠTYS 1990, 1995; HEISS & PÉRICART 2007; WEIRAUCH & FERNANDEZ 2015). Usually, their microhabitats are found under stones in such interspaces. *Cryptostemma* specimens can be found by turning the stones over.

Most specimens of *C. miyamotoi* sp. nov. were found under stones along the riverbanks in the low mountain area of Shimane and Tokushima Prefectures (Fig. 31). Moreover, in Nagasaki Prefecture, a few individuals of this species were recognized along the riverbanks near the mouth of rivers. Although *C. pavelstysi* sp. nov. was found in microhabitats that are similar to those of *C. miyamotoi*, its habitats are banks of streams flowing in a subtropical forest (Fig. 32) in Ishigaki Island, Ryukyu Islands, southwestern Japan.

The habitat of *C. miyamotoi* seems to range from mountain river to lowland stream. As indicated by ŠTYS (1990), the environmental type of river may be unimportant; however, no individuals of *C. miyamotoi* were found in places with heavily improved river banks. In such places, their preferred microhabitat formed by accumulated stones, pebbles, gravel, and sand, was unavailable.

Food. Unfortunately, we were unable to observe the predatory behavior of *C. pavelstysi* in the field; therefore, the first author kept individuals of *C. pavelstysi* in the laboratory and reared them in a small plastic Petri dish (35 mm in diameter). This species usually fed on tiny springtails and small dipteran larvae, but they seldom attacked the active individuals among them. Frequently, they preyed on dead or collapsed individuals. In addition, commercially available dried red worm (chironomid larvae) and flakes of tropical fish food can be used as their prey.

Mating behavior. The first author observed mating behavior in *C. pavelstysi* based on rearing in the laboratory culture. The mating behavior of *C. pavelstysi* was almost the same that of other heteropterans (e.g., some Cimicomorpha), but unlike that of *Ceratocombus coleoptratus*



Figs 29–32. Living individuals and habitats. 29 – *Cryptostemma miyamotoi* sp. nov., male; 30 – *C. pavelstysi* sp. nov., male; 31 – habitat of *C. miyamotoi*, Sonosegawa Riv., Sanagouchi-son, Tokushima Pref.; 32 – habitat of *C. pavelstysi*, near Nagura Dam, Ishigaki Is.

(Zetterstedt, 1819) (Ceratocombidae), where the male takes its place under the female during their copulation, as reported by MELBER & KÖHLER (1992).

Mating behavior in *C. pavelstysi* was considered lacking the precopulatory mate choice. The male chased and attempted to mount the female. The male jumped onto the female's dorsum and inserted his abdomen to sandwich her dorso-ventral surfaces of posterior part of abdomen from the right side by his pregenital abdominal appendages. Upon mounting, the female always struggled immediately. The male revealed noticeable mating damages, such as crooked abdomen (probably pregenital abdomen) if mating failed (pulled away from the female). The female's mating damage was unclear. In laboratory observations, contrary to expectations, copulation usually took 2–3 min. It was assumed that copulation in species with extremely elaborate male pregenital and genital structures would be long rather than short (ŠTYS 1990). The examples in our observation are not many (five couplings); therefore, none of them may have succeeded. Because we have no idea whether the copulation time was short or not, an examination of the genitalic coupling would be needed to resolve the structural correspondence between the male and female genitalia.

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