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Two new thermophilic species of the plant bug genus *Plagiognathus* from Japan and Taiwan (Hemiptera: Heteroptera: Miridae)

Tomohide Yasunaga

Research Associate, Division of Invertebrate Zoology, American Museum of Natural History, Central Park at 79th Street, New York, NY 10024, c/o Nameshi 2-33, Nagasaki 852-8061, Japan

Email: yasunagat.amnh@gmail.com

urn:lsid:zoobank.org:author:34CD61EF-8E8E-4047-83B9-2A7AD6441C6A

Abstract. Two new species of the Holarctic phyline plant bug genus *Plagiognathus* Fieber, 1858 are described from Japan and Taiwan, namely *Plagiognathus marinoccidens* sp. nov. (Japan) and *P. chengshingi* sp. nov. (Taiwan). They are uniquely inhabiting warm temperate or subtropical climatic zones, unusual for the generally temperate distribution. The present finding also represents the first distributional record of the genus from Taiwan, the northeastern Oriental Region. A brief note on biology, food-preference, oviposition behavior and immature forms for *P. marinoccidens* is given. A key and checklist are provided to aid in identification and recognition of all known *Plagiognathus* congeners from Japan and Taiwan.

Key words. Phylinae, *Plagiognathus*, new species, Japan, Taiwan, key, SEM documentation.

INTRODUCTION

Plagiognathus Fieber, 1858 (tribe Phylini: subtribe Oncotylina) is a large Holarctic genus, comprising approximately 120 valid species (Schuh 2001; 2002–2013). The majority occur in the Nearctic Region and twenty-three species are currently known from the Palearctic Region (Aukema, 2018). Five species have been reported from Japan (Yasunaga, 2001; 2022), whereas no reliable record has been associated with Taiwan, the northeasternmost area of the Oriental Region.

During my continuing effort to update the phyline fauna of the eastern Asia, after a series of recent works (e.g., Yasunaga & Duwal 2019, 2021; Yasunaga et al. 2019, 2021; Yasunaga 2021, 2022), two undescribed species undoubtedly belonging to *Plagiognathus* have been confirmed. One species inhabits Japanese hop, *Humulus japonicus* (Cannabaceae) and was previously regarded as a thermophilic or vernal variant of *P. amurensis* Reuter (Yasunaga & Takai 2016); the other was collected from central Taiwan, or subtropical climatic zone (available specimens kept in the collection of National Museum of Natural Science, Taiwan). These species, *Plagiognathus marinoccidens* n. sp. (from Japan) and *P. chengshingi* n. sp. (Taiwan), are accordingly diagnosed and described in the present paper. The biology, food-preference, oviposition and immature forms observed for *P. marinoccidens* are briefly documented. A key is also provided to aid in identification of the Japanese and Taiwanese congeners. Scanning electron micrographs are shown for all treated taxa.

MATERIAL AND METHODS

Matrix code labels, which uniquely identify each specimen and are referred to as 'unique specimen identifier' (USI), are attached to the holotypes and some representative specimens. The USI codes [e.g., AMNH_PBI 0012345] comprise an institution and project code (AMNH_PBI) and a unique number (0012345). These specimens are searchable (by species name) on 'Heteroptera Species Pages' (http://research.amnh.org/pbi/heteropteraspeciespage/).

Rearing methodology mainly followed Fukuda et al. (2020) and Miyazaki et al. (2020); dried brine-shrimp eggs were placed on a folded tissue paper immersed with diluted fermented milk beverage in an acrylic container (110L × 85W × 35D mm), along with a few pieces of the host plant stem-vines (Fig. 3E–F).

Terminology mainly follows several comprehensive works treating phyline taxa (e.g., Schuh 1984; Menard et al. 2014; Schwartz et al. 2018; Yasunaga 2022). Synonymic lists for known taxa are omitted, as several comprehensive catalogs (including searchable online versions) are now available (Schuh 1995; Kerzhner & Josifov 1999; Schuh 2002–2013 online catalog; Aukema et al. 2013; Aukema 2018 online catalog). The suprageneric classification system for the subfamily Phylinae follows Schuh & Menard (2013) and Menard et al. (2014).

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Measurements are given in millimeters; for some of the SEM images, scale bars are shown in micrometers (μm). Scanning electron micrographs were taken with Hitachi Miniscope® (TM 4000II); the genitalic structures were also observed using a Nikon Eclipse Ci upright microscope, with a Photophase-Unit. For SEM documentation of the male and female genitalic structures, the delicate minute organs were dipped and washed in 60–70% ethyl alcohol after dissection under Olympus SZX-12 binocular stereoscopic microscope, placed on filter paper until dry, carefully attached to cards (ca. 5 × 15 mm) using water soluble wood glue, and finally placed in the SEM chamber for examination (without vapor deposition of metals).

Institutional abberviations

AMNH = American Museum of Natural History, New York, USA
CNC = Canadian National Collection of Insects, Ottawa, Ontario
NBIC = Nagasaki Biopark (Zoo) Insect Collection, Saikai, Japan
NMNS = National Museum of Natural Science, Taichung, Taiwan
TYCN = T. Yasunaga Collection, Nagasaki, Japan.

Abbreviations for morphological structures

Male genitalia

FS = field of stiff setae
GP = secondary gonopore
HP = hypophysis (apical parts of parameres)
LP = left paramere
PB = primary blade (of vesical appendage)
PT = phallotheca
RP = right paramere
SB = sensory lobe

Female genitalia

IRS = interramal sclerite
LOV = lateral oviduct
PMS = posterior margin sclerite (on interramal sclerite)
SCR = sclerotized ring
SPG = spermathecal gland.

Checklist of *Plagiognathus* in Japan and Taiwan

Subfamily Phylinae Douglas & Scott 1865
Tribe Phylini Douglas & Scott, 1865
Subtribe Oncotylina Douglas & Scott, 1865
Genus *Plagiognathus* Fieber 1858

P. amurensis Reuter, 1883 (Figs 1F–G, 2H−I, 3K–L, 4, 5I–L, 6A−D, 7D, 9J−O) – Distribution: Japan (Honshu, Shikoku), continental China and Russian Far East, Korea – Host: *Humulus japonicus* Sieb. & Zucc. (Cannabaceae), mostly on inflorescences both in Japan and Korea (Yasunaga 2001; Duwal et al. 2010; Yasunaga & Takai 2016), *Artemisia vulgaris* (Asteraceae) (Kerzhner 1988).

P. chengshingi Yasunaga sp. nov. – Taiwan (Nantou, Taichung) – Unknown.

P. chrysanthemi (Wolff, 1804) (Figs 2E, 4) – Japan (Hokkaido, Chishima Islands); known widely from the Holarctic Region (e.g., Wheeler & Henry 1992; Yasunaga 2001) – *Artemisia* spp. (Asteraceae), *Trifolium* spp. and *Vicia cracca* L. (Fabaceae), etc. (Kerzhner 1988; Yasunaga 2001).

P. collaris (Matsumura, 1911) (Figs 2F–G, 4) – Japan (Hokkaido, Honshu, Chishima Islands), NE China, Korean Peninsula, Russian Far East including Magadan and Sakhalin – polyphagous species; in northern Japan, known to be associated with *Artemisia* spp., *Filipendula camtschatica* (Pall.) Maxim. (Rosaceae) and *Vicia cracca* L. (Fabaceae). (Yasunaga 2001).

P. marinoccidens Yasunaga sp. nov. – Japan (Kyushu: Nagasaki Prefecture) – *Humulus japonicus* (young leaves, stem-vines and inflorescences); frequent predation on aphids was observed.

P. pini Vinokurov, 1978 (Figs 2K, 4) – Japan (Hokkaido, Chishima Islands), Russia (Primorsky Territory, Sakhalin and Yakutia) – *Pinus pumila* (Pall.) Regel (Pinaceae) (Kerzhner 1988; Yasunaga 2001).

P. yomogi Miyamoto, 1969 (Figs 1J–L, 2J, 4, 5M−O, 7C, 8H−O) – Japan (Hokkaido, Honshu, Shikoku, Kyushu), Korea, Russia (Primorsky Territory) – *Artemisia* spp. (Miyamoto 1969; Yasunaga 1999).

TAXONOMY

Plagiognathus Fieber, 1858

Diagnosis. East Asian congeners of *Plagiognathus* are recognized by the following combination of characters: Body elongate and subparallel-sided (♂)/ elongate-ovoid (♀), small to moderate in size (total length 2.9–4.5 mm); coloration variable (Figs 1–2); dorsum generally shining, with uniformly distributed, dark, simple setae, lacking silvery or wooly recumbent setae; vesica always with two apical blades (cf. Figs 6, 8B–C, 9D–F); sclerotized rings large, contiguous to each other mesally (Fig. 7); and posterior wall of bursae simple (cf. Figs 8E–F, 9H–I). As suggested by Schuh (2001), this large Holarctic genus is defined principally by the form of the male genitalia, such as twisted, often sigmoid vesica with two apical blades and rather slender, lanceolate right paramere. Some species of *Plagiognathus* exhibit great similarity in external appearance to certain members of *Europiella* Reuter, 1909; however, *Europiella* is distinct in having both silvery and simple setae on dorsum, right paramere remarkably widened and often squared, vesica apically with membranous area, and sclerotized ring small and

narrow-rimmed (e.g., Schuh et al. 1995; Yasunaga 2022). Further diagnostic characters and a redescription for *Plagionathus* were provided by Schuh (2001).

Discussion

Plagiognathus forms one of the largest genera among the plant bug subfamily Phylinae and is known to comprise more than 120 described species; of these about 80 % are Nearctic elements (Schuh 2001, 2002–2013; Aukema 2018). Nonetheless, more than a few species appear to be wrongly placed in *Plagiognathus* and require further verification by dissecting the male genitalia (Schuh 2001). For eastern Asia, six congeners were reported by Yasunaga (2001), in addition to *P. obscuriceps* (Stål, 1858) occurring in northern Russian Far East and eastern Siberia and associated with *Salix* spp. (Salicaceae) (Kerzhner 1988).

In Japan and adjacent regions, the fauna of *Plagiognathus* species has previously been the subject of several recent works, and the known congeners were considered to occur predominantly in the temperate or colder climatic zones (Duwal et al. 2016; Yasunaga & Takai 2016; Yasunaga 2022). Nonetheless, two uniquely thermophilic species (described below) are now confirmed from the warm temperate zone in southwestern Japan as well as subtropical zone in Taiwan.

As pointed out by Schuh (2001), many *Plagiognathus* species are host-specific and arboreal. However, most of the East Asian congeners were confirmed to be associated with dicot herbaceous plants (Yasunaga 2001; Duwal et al. 2016), except for *P. pini* (a specialist of the boreal creeping pine, *Pinus pumila*). Several members (e.g., *P. arbustorum*) were also documented to prey on aphids or psyllids (Wheeler 2001). A univoltine life cycle is assumed for these East Asian species, but collection records suggest that a new species from Taiwan, *P. chengshingi* sp. nov., may have two or more generations per year. Although Kerzhner (1988) reported *Artemisia vulgaris* (Asteraceae) as the host plant of *P. amurensis* in Russian Primorsky Territory, it does not appear the breeding host of this hop-inhabiting phyline (Yasunaga 2001; Duwal et al. 2010).

Key to species known in Japan and Taiwan

1. Head and pronotum wholly pale yellow-green (fading to pale brown or stramineous brown in dry-preserved specimens); antennal segment II pale brown, sometimes with dark extreme base [if body widely pale then antennal segment II uniformly darkened: pale variant of *P. yomogi* (cf. Fig. 1L)] ..... ***P. chrysanthemi*** (Wolf, 1804)
– Head and at least anterior part of pronotum fuscous, brown or reddish brown; antennal segment uniformly darkened 2
2. Currently assumed to be endemic to Taiwan; ventral color pattern on metafemur as in Fig. 1C–E ..... ***P. chengshingi*** sp. nov.
– Known from Japan (and temperate or colder climatic zones in China, Korea and Russian Far East) 3
3. Habitat restricted to *Pinus pumila* at alpine or boreal zone (currently restricted to Taisetsu Mountains in Hokkaido) ..... ***P. pini*** Vinokurov, 1878
– Associated with herbs or shrubs of dicot angiosperms 4
4. Total body length more than 4 mm; dark spots on metafemur arranged in rows or sometimes partly fused (cf. Fig. 4) ..... ***P. collaris*** Matsumura, 1911
– Body less than 4 mm (mostly < 3.7 mm) in total length; metafemoral dark spots distributed randomly 5
5. Antennal segment III as long as or shorter than head width across eyes; thermophilic species currently restricted to coastal zones of western Kyushu ..... ***P. marinoccidens*** sp. nov.
– Antennal segment III longer than head width across eyes; known from temperate and cold temperate zones 6
6. Dorsum uniformly fuscous, shining; cuneus usually uniformly fuscous; metafemoral dark spots smaller, rather sparsely distributed; associated with *Artemisia* spp. ..... ***P. yomogi*** Miyamoto, 1969
– Dorsum not much shining, variable in color, pale brown or reddish brown [if dorsum widely darkened, then anterior and posterior margins of cuneus pale brown or yellow-orange]; anterior margin and apex of cuneus (sometimes whole cuneus) pale; dark spots on metafemur larger, densely distributed; *Humulus japonicus* ..... ***P. amurensis*** Reuter, 1883

Plagiognathus chengshingi sp. nov.

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Figs 1A−E, 5A−D, 7A, 8A−F

Diagnosis. Based on the similarity in the general shape and the male genitalia, this new species is assumed to be most closely related to *P. yomogi* Miyamoto, from which *P. chengshingi* sp. nov. can be distinguished by the following characters: Generally paler general coloration; antennal segment III obviously shorter than width of head across eyes; profemur lacking dark stripe along anterior margin; smaller peritreme of metathoracic scent efferent system (Fig. 5B–C, vs 5N in *P. yomogi*); longer and slenderer apical blades of vesica (Fig. 8B–C, vs Fig. 8M–N); relatively narrow female sclerotized ring (Fig. 7A, vs Fig. 7C); and wider interramal sclerite laterally with sparsely distributed, comb-shaped microstructures (Fig. 8E, vs Fig. 8I).

Etymology. Named in honor of Dr Cheng Shing Lin, the former curator of NMNS, Taiwan, who contributed to clarification of the Taiwanese fauna of the Miridae as

well as collected the specimens of this new species; a noun in the genitive case.

Type material

Holotype. TAIWAN – ♂; Taichung, Waipu, 24°20′ N, 120°41′ E, sweep-netting, 24 Aug. 2000, C. S. Lin and W. T. Wang (NMNS) (AMNH_PBI 00380758).

Paratypes (all deposited in NMNS). TAIWAN – 1 ♂, 1 ♀ (NMNS), same collection data as for holotype • 1 ♀, Nantou, Chichi, 23°50′ N, 120°48′ E, sweep-netting, 14 Mar 2002, C.S. Lin • 1 ♀; Nantou, Tungpu, 2000 m alt., 23°34′ N, 120°53′ E, 18−21 Sep 1981, T. Lin and W.S. Wang • 1 ♀, same locality as for preceding, 10–14 Jan. 1983, K.C. Chau and P. Huang.

Description

General shape not sexually dimorphic; female has slightly larger size, wider vertex and shorter antennal segment II (Table 1) as in many other phylines. Body elongate-ovoid, relatively small in size; basic coloration variable but usually dark brown; dorsal surface widely shiny dark brown (Fig. 1B), sometimes orange-brown (Fig. 1A), with uniformly distributed, brown, simple setae, lacking silvery setae (cf. Fig. 1B; dorsal vestiture shown in Fig. 5A rubbed off). Head usually shiny fuscous, with sparsely distributed, silky, upright setae; vertex pale orange-brown to castaneous brown; buccula usually yellowish brown. Antenna almost uniformly dark brown; male segment II about as long as basal width of pronotum; segment III and IV slightly lighter; segment III as long as or shorter than head width across eyes. Labium shiny pale reddish brown, about as long as metafemur; its apex reaching but not exceeding apex of mesocoxa; apical part of segment IV darkened. Pronotum, mesoscutum and scutellum shining, varying from reddish brown (Fig. 1A) to dark brown (Fig. 1B);

Table 1. Measurements for *Plagiognathus* species. Abbreviations: F = female; FM = femur; HT = holotype; L = length; LBM = labium; M = male; PRN = pronotum; PT = paratype; TB = tibia; VTX = vertex (interocular space); W = width; 1G = 1st annual generation; 2G = 2nd generation.

Plagiognathus		**Body**	**Head**	**VTX**	**PRN**	**Max**	**Antennomere L**				**LBM**	**Metaleg L**	
		L	W	W	W	W	I	II	III	IV	L	FM	TB
chengshingi	HT M	**3.11**	**0.71**	**0.33**	**1.05**	**1.26**	**0.29**	**1.05**	**0.65**	**0.41**	**1.20**	**1.20**	**1.73**
M (N = 3)	PT M	3.19	0.69	0.33	1.04	1.28	0.29	1.05	0.66	–	1.25	1.20	1.71
	PT M	3.06	0.64	0.32	0.95	1.16	0.27	1.02	0.65	0.41	1.17	1.08	1.58
	PT F	3.33	0.71	0.36	1.07	1.38	0.29	0.86	0.62	0.39	1.23	1.20	1.67
F (N=3)	PT F	3.26	0.71	0.38	1.05	1.35	0.27	0.87	0.59	0.44	1.25	1.20	1.65
	PT F	3.19	0.72	0.36	1.10	1.35	0.27	1.04	–	–	1.26	1.26	1.80
***marinoccidens* (1G)**	MAX	3.19	0.69	0.33	0.99	1.20	0.26	0.98	0.63	0.47	1.20	1.14	1.68
M (N = 3)	MIN	2.94	0.65	0.32	0.92	1.14	0.21	0.95	0.62	0.33	1.11	1.07	1.64
	MEAN	**3.09**	**0.67**	**0.32**	**0.96**	**1.17**	**0.23**	**0.96**	**0.62**	**0.41**	**1.15**	**1.10**	**1.66**
	MAX	3.43	0.73	0.38	1.16	1.47	0.30	0.95	0.75	0.54	1.26	1.20	1.82
F (N = 5)	MIN	2.94	0.69	0.33	1.05	1.35	0.24	0.84	0.59	0.32	1.10	1.05	1.70
	MEAN	**3.21**	**0.71**	**0.36**	**1.09**	**1.41**	**0.27**	**0.90**	**0.66**	**0.44**	**1.19**	**1.16**	**1.74**
***marinoccidens* (2G)**	MAX	3.48	0.75	0.36	1.17	1.46	0.30	1.20	0.75	0.50	1.29	1.34	1.91
M (N = 3)	MIN	3.01	0.69	0.32	1.02	1.32	0.27	1.05	0.69	0.47	1.20	1.20	1.71
	MEAN	**3.29**	**0.72**	**0.34**	**1.11**	**1.38**	**0.28**	**1.13**	**0.74**	**0.48**	**1.23**	**1.24**	**1.83**
	MAX	3.70	0.77	0.42	1.25	1.64	0.30	1.19	0.75	0.47	1.35	1.34	1.95
F (N = 5)	MIN	2.96	0.66	0.35	1.04	1.38	0.26	0.81	0.60	0.38	1.10	1.16	1.65
	MEAN	**3.46**	**0.72**	**0.39**	**1.19**	**1.55**	**0.29**	**1.02**	**0.68**	**0.44**	**1.27**	**1.28**	**1.84**
amurensis	MAX	4.09	0.75	0.36	1.23	1.50	0.33	1.29	0.87	0.56	1.38	1.38	2.10
M (N = 6)	MIN	3.19	0.71	0.33	1.05	1.31	0.26	1.14	0.75	0.42	1.20	1.25	1.85
	MEAN	**3.72**	**0.74**	**0.35**	**1.17**	**1.42**	**0.30**	**1.22**	**0.81**	**0.49**	**1.31**	**1.34**	**2.00**
	MAX	3.92	0.75	0.41	1.29	1.65	0.32	1.13	0.80	0.50	1.40	1.43	2.10
F (N = 5)	MIN	3.50	0.72	0.39	1.19	1.50	0.30	1.05	0.75	0.45	1.28	1.23	1.85
	MEAN	**3.69**	**0.74**	**0.40**	**1.25**	**1.61**	**0.30**	**1.07**	**0.77**	**0.47**	**1.34**	**1.34**	**1.97**
yomogi	MAX	3.36	0.69	0.33	1.07	1.34	0.29	1.08	0.75	0.48	1.22	1.23	1.83
M (N = 4)	MIN	2.70	0.65	0.32	0.95	1.17	0.26	0.90	0.72	0.45	1.08	1.05	1.64
	MEAN	**3.12**	**0.66**	**0.33**	**1.01**	**1.26**	**0.27**	**1.00**	**0.73**	**0.46**	**1.18**	**1.17**	**1.73**
	MAX	3.26	0.71	0.38	1.11	1.43	0.29	0.99	0.74	0.50	1.28	1.28	1.85
F (N = 3)	MIN	3.01	0.65	0.36	1.01	1.40	0.26	0.93	0.71	0.47	1.20	1.23	1.80
	MEAN	**3.15**	**0.67**	**0.37**	**1.06**	**1.41**	**0.27**	**0.96**	**0.72**	**0.48**	**1.24**	**1.25**	**1.82**

scutellum shallowly and transversely rugose; thoracic pleura shining, varying from fuscous (Fig. 1C) to pale reddish brown with darkened parts (Fig. 1D); metathoracic scent efferent system yellowish brown, with small peritreme (Fig. 5B–C). Hemelytron variable in color as in pronotum; lateral margin of corium and basal and

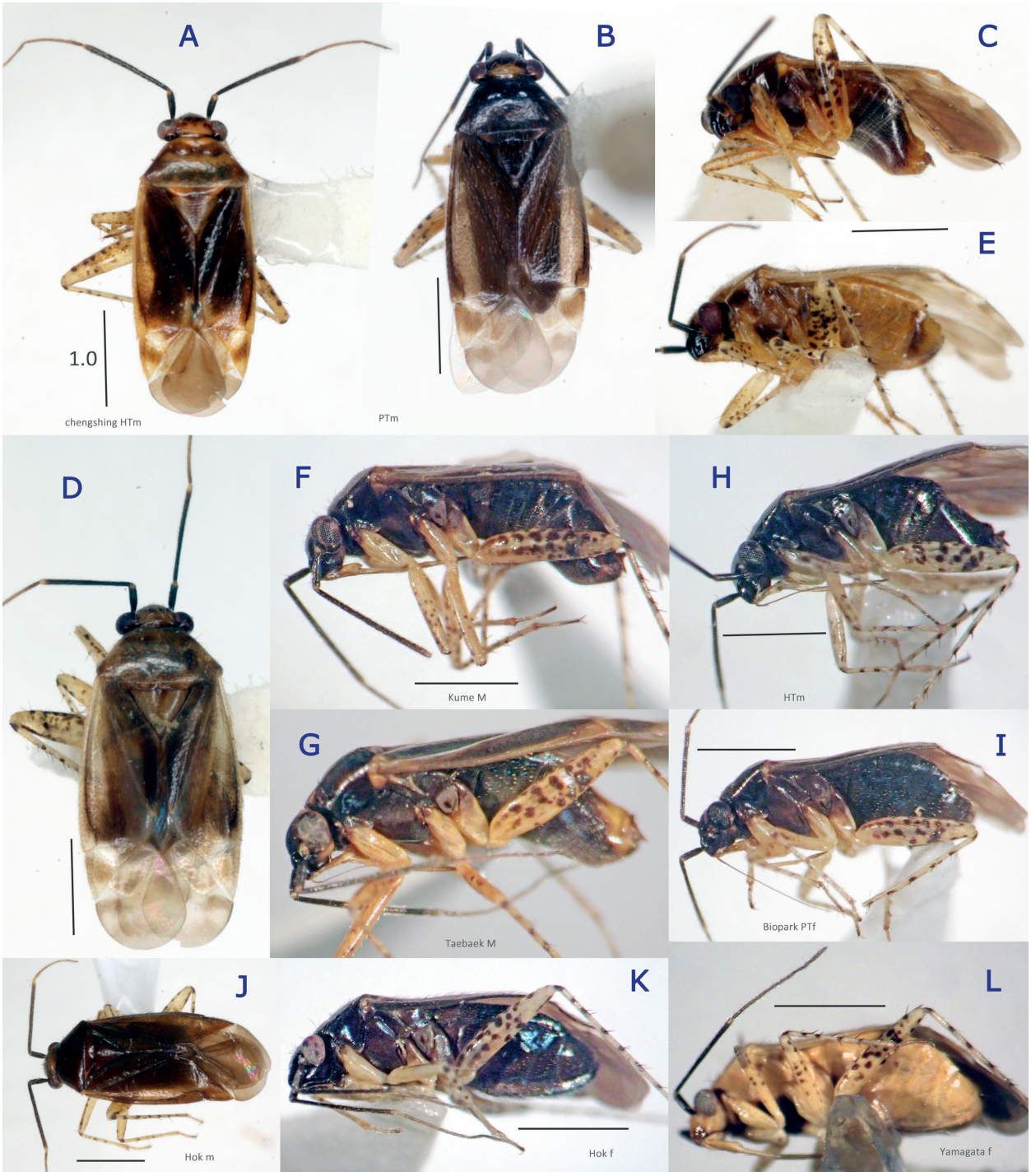

Fig. 1. Dorsal (A–B, D, J) and left lateral (C, E−I, K−L) habitus images of *Plagiognathus* spp. **A**. *P. chengshingi* sp. nov., holotype, ♂. **B−C**. *P. chengshingi* sp. nov., paratype, ♂. **D−E**. *P. chengshingi* sp. nov., paratype, ♀. **F**. *P. amurensis* from Kume Town, Okayama, Japan. **G**. *P. amurensis* from Taebaek, Kangwon-do, Korea. **H**. *P. marinoccidens* sp. nov., holotype, ♂. **I**. *P. marinoccidens* sp. nov.,paratype, ♀. **J**. *P. yomogi*, ♂ from Hokkaido, Japan. **K**. *P. yomogi*, ♀ from Hokkaido. **L.** *P. yomogi*, pale variant ♀ from Yamagata, Japan.

apical margins of cuneus usually pale; membrane pale smoky brown, semitransparent, with obscure maculae in large areolar cell and posterior to cuneal apex. All coxae yellowish brown, partly tinged with red; legs yellowish brown; each femur lacking dark stripe along anterior margin; pattern of ventral femoral spots as in Fig. 1C–E; metafemoral dark spots often fused; each tibia with a dark (knee) spot at joint with respective femur; each tarsomere III darkened; meta-tarsomere II slightly longer than III; pretarsal structure as in Fig. 5D; pulvilli relatively narrow. Abdomen shining, varying from pale brown to dark castaneous. Male genitalia (Fig. 8A−C): Right paramere relatively slender; phallotheca short, rather blunt-tipped (Fig. 8A); vesica sigmoid, with comparatively sharpened and elongate apical blades (Fig. 8B); longer (principal) blade slightly curved apically (Fig. 8C). Female genitalia (Figs 7A, 8D–G): Sclerotized ring rather narrow and small (Figs 7A, 8D); posterior wall relatively smooth (Fig 8F); interramal sclerite laterally with sparsely distributed, comb-like microstructures (Fig. 8E); apex of ovipositor (gonapophysis) I rather densely serrate (Fig. 8G).

Measurements
See Table 1. Holotype male: Total body length 3.11; head width across eyes 0.71; vertex width (interocular space) 0.33; lengths of antennal segments I–IV 0.29, 1.05, 0.65 and 0.41; total length of labium 1.20: basal width of pronotum 1.05; maximum width across hemelytra 1.26; and lengths of metafemur 1.20, tibia 1.73 and tarsus 0.41, respectively.

Biology
Unknown.

Plagiognathus marinoccidens sp. nov.
urn:lsid:zoobank.org:act:B0A83320-5C9E-41B5-9247-26B4424B4E60
Figs 1H–I, 2A−D, 3A–K, 4, 5E−H, 6E–H, 7B, 9A−I

Diagnosis. Recognized by its small size; generally fuscous body (Figs 2A–D, 3B); uniformly darkened head; short antennal segment II; relatively long labium that is longer than metafemur; relatively narrow peritreme of scent efferent system (Fig. 5G); creamy yellow femora and tibiae; rather stout, blunt-tipped phallotheca (Fig. 9B); short, slender apical blades of vesica (Fig. 6E–H, 9E–F); and relatively narrow interramal sclerite (Fig. 9H) with densely distributed, comb-like microstructures (Fig. 9I), in addition to unique thermophilic habitat preference. This new species is assumed to be sister to *P. amurensis*, from which *P. marinoccidens* sp. nov. can be distinguished by the characters mentioned in the above key (couplet 4), smaller size, generally fuscous basic coloration (Fig. 2A–D, vs 2H–I), slenderer vesical blades (Fig. 9E, vs 9O), smaller sclerotized rings (Fig. 9G, vs 9J), and more densely distributed microstructures on the narrower interramal sclerite (Fig. 9H–I, vs 9K–L). Paler color variant (Fig. 3C–D) was confirmed in the 2nd (autumn) generation females; however, only three of 43 specimens had the paler coloration, and extent of the pale grayish brown parts on the dorsum is rather restricted (Fig. 3C), by comparison with *P. amurensis* (Fig. 2I).

Plagiognathus marinoccidens sp. nov. is also externally very similar to *P. yomogi*, but this *Artemisia*-inhabiting phyline is allopatric (known from colder climatic zones) and has the following different features: antennal segment III longer than head width across eyes; anterior margin of profemur usually with a dark stripe; metafemur with sparser dark spots ventrally (Fig. 4); metathoracic scent efferent system triangular, with wider peritreme (Fig. 5N); phallotheca tapered and sharpened apically (Fig. 8L); vesical with thick primary blade (Fig. 8N); and inner half area of interramal sclerite smooth, lacking microstructures (Fig. 8J).

The nymphs (Figs 3H–K) of *P. marinoccidens* sp. nov. are recognized readily by the generally pale green coloration, annulated antennae and striped femora. The final instar nymph of the new species is very similar to that of *P. amurensis* (Fig. 3M); the former can be distinguished from the latter by the yellowish basic coloration, darkened apical ¼ of the antennal segment II and enlarged dark spots on the metatibia.

Etymology. From Latin, marinus (marine, of the sea) combined with occidens (west), referring to the restricted habitats of this new species along the westernmost coastal zone of Mainland Japan; an adjective.

Type material

Holotype. JAPAN – ♂ (AMNH) (AMNH_PBI 00380759), Kyushu, Nagasaki Pref., Nagasaki City, Kabashima Island, 32°33′22.2″ N, 129°46′39.2″ E, on *Humulus japonicus* (sweep-netting young leaves and stems), 15 Jun. 2013, T. Yasunaga.

Paratypes. JAPAN – 1 ♂, 1 ♀ (TYCN), same locality data as for holotype • 1 ♂ (TYCN), Nagasaki City, Kinkai-Tonehara (harbor), 32°54′04.1″ N, 129°47′42.1″ E, on *Humulus japonicus* (young leaves and stems), 2 Jun 2022, T. Yasunaga • 1 ♀ (TYCN), Nagasaki City, Kohno'ura-Ougiyama, 32°53′20.9″ N, 129°43′26.3″ E, UV lighting, 23 Jul. 2022, T. Yasunaga • 32 ♂♂, 13 ♀♀ (AMNH, NBIC, TYCN), Nagasaki City, Kohno'ura Harbor (Fig. 3A), 32°52′54.7″ N, 129°40′44.7″ E, on *Humulus japonicus* (inflorescences and leaves), 1 Oct 2022, T. Yasunaga • 8 ♂♂, 2 ♀♀ (TYCN) (4th or 5th instar nymphs when collected and reared with synthetic diet, then emerging on 3–5 Oct 2022) • 20 ♂♂, 22 ♀♀ (CNC, NMNS, TYCN) same collection data as for preceding • same collection data as for preceding, 8 Oct. 2022 • 2 ♂♂, 7 ♀♀ (3rd–5th instar nymphs when collected and reared, then emerging on 9–13 Oct. 2022, and 1♂ dead on Oct. 21, 1 ♀ on Oct. 30, 1 ♂, 3 ♀♀ on Nov. 5 and 3 ♀♀ on Nov. 6) (TYCN) • 17 ♂♂, 6 ♀♀ (AMNH, TYCN), same collection data

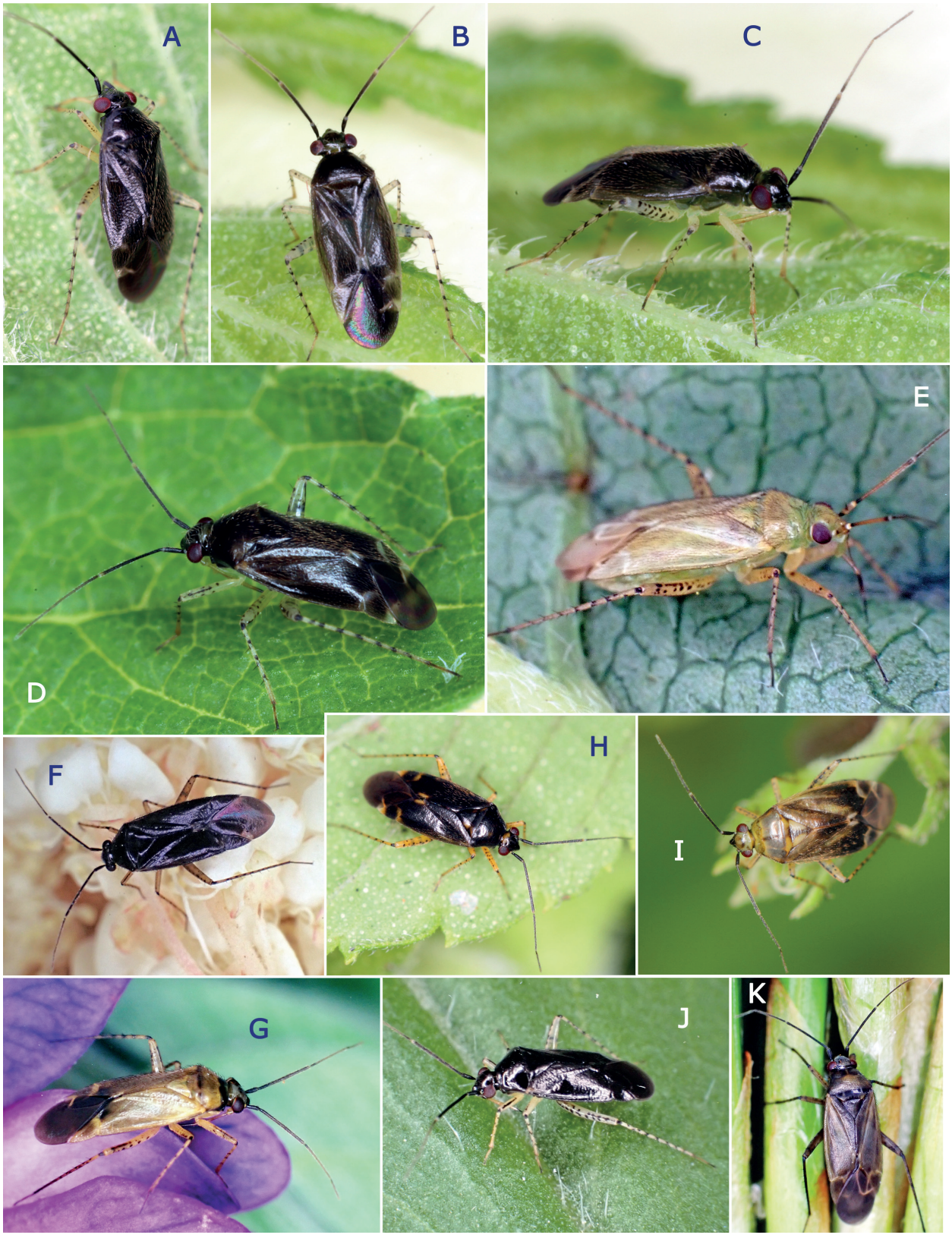

Fig. 2. Habitus images of living individuals of Japanese *Plagiognathus* spp. **A–B**. *P. marinoccidens* sp. nov., ♂. **C–D**. .*P. marinoccidens* sp. nov., ♀. **D**. *P. marinoccidens* sp. nov., ♀. **E**. *P. chrysanthemi*, ♀. **F**. *P. collaris*, ♂. **G**. *P. collaris*, ♂, pale variant. **H**. *P. yomogi*, ♂. **I**. *P. yomogi*, ♀. **J**. *P. yomogi*, ♂. **K**. *P. pini*, ♂. H–I. Courtesy of M. Takai.

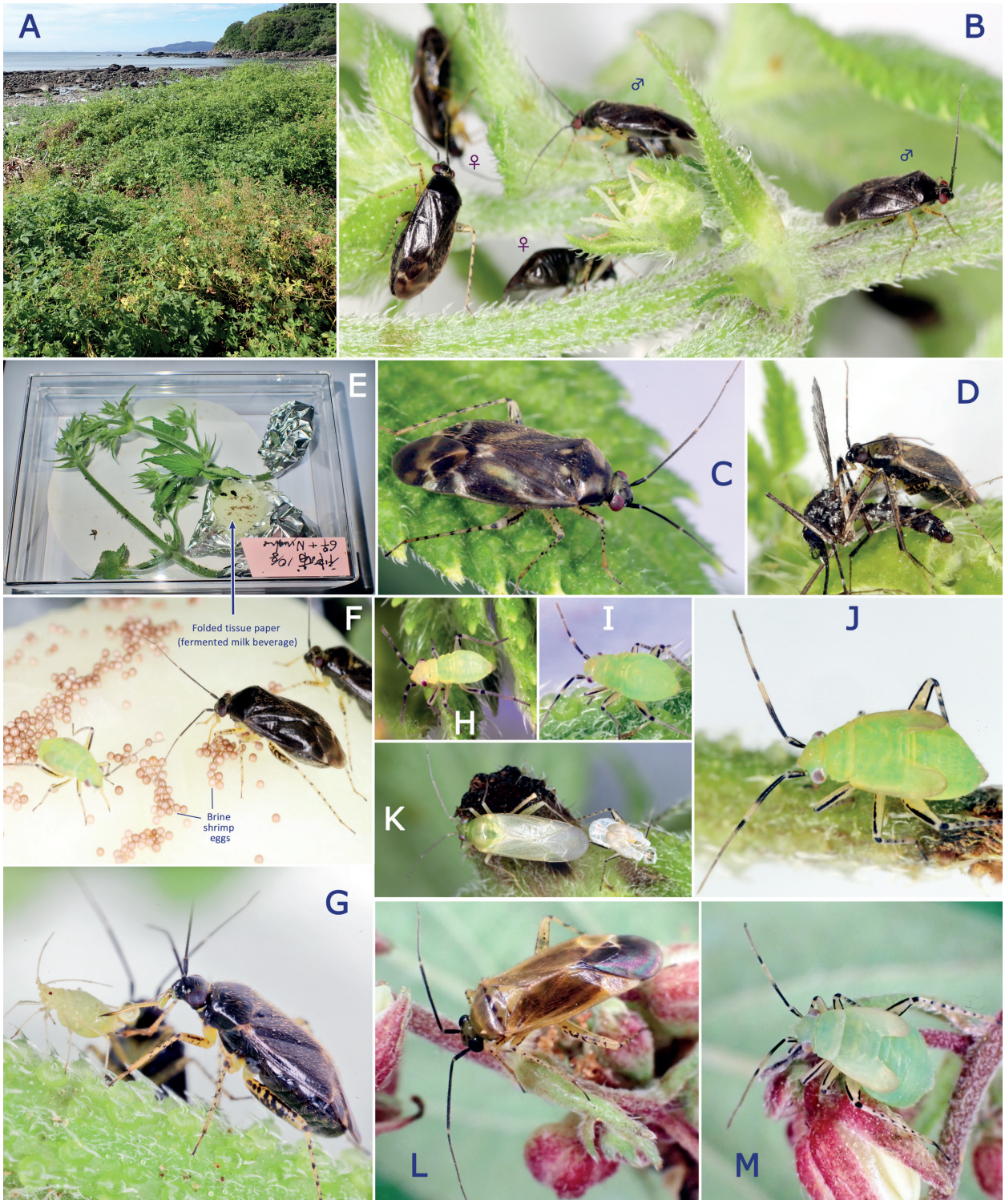

Fig. 3. Habitat and habitus images of living individuals of *Plagiognathus marinoccidens* sp. nov. (B–K, the 2nd generation collected at Fig. A, with reared samples, F–K) and *P. amurensis* (L–M, from Suwon, Korea). **A**. Vegetation of *Humulus japonicus* at sandy beach in Nagasaki, Japan, habitat of *P. marinoccidens* sp. nov. **B**. Adults on the breeding host. **C**. Paler variant ♀. **D**. Same, scavenging on cadaver of a mosquito, *Aedes albopictus*. **E**. Rearing kit with pieces of the host plant and synthetic diet. **F**. Adults and 5th instar nymph (left) feeding on synthetic diet. **G**. A female preying on an aphid. **H**. First instar nymph. **I**. Third instar. **J**. Final instar. **K**. Unpigmented adult ♂, just completing eclosion. **L**. Adult ♂, with orange-brown dorsum. **M**. Final instar nymph.

as for preceding, 12 Nov. 2022 • 1 ♂, 2 ♀♀ (NBIC, TYCN), Nagasaki Pref., Saikai City, Seihi Town, Nagasaki Biopark (Zoo), 32°59′19″ N, 129°47′14″ E, UV lighting, 20 Jun. 2013, T. Yasunaga.

Description

General shape not sexually dimorphic; female has slightly larger size, wider vertex and shorter antennal segment II (Table 1) as in above new species; color variation not significant but body partly pale grayish brown in 2nd (autumn) generation female as in Fig. 2A–D; 2nd generation slightly larger than the 1st (Table 1). Body rather elongate, subparallel-sided, small-sized; basic coloration fuscous (pale variant rarely present in 2nd generation female, with partly grayish brown head, pronotum, lateral margins of scutellum, posterior part of clavus and ventral posterior part of abdomen, cf. Fig. 3C–D); dorsal surface widely shiny fuscous (Fig. 2A–D), with uniformly distributed, pale, simple setae, lacking silvery setae (Figs 2A–D, 3C, G, 5D). Head, including vertex and frons, shiny fuscous, with sparsely distributed, pale, upright setae. Antenna almost uniformly dark brown; male segment II about as long as basal width of pronotum; segment III and IV whitish in fresh specimens (e.g., Fig. 2B); segment III as long as or shorter than head width across eyes. Labium shiny creamy yellow, longer than metafemur; its apex slightly surpassing apex of mesocoxa; apical half of segment IV dark reddish brown. Pronotum, mesoscutum and scutellum uniformly fuscous, shining; scutellum flat; thoracic pleura almost uniformly darkened (Fig. 1H–I); metathoracic scent efferent system dark brown, with small, narrow peritreme (Fig. 5G). Hemelytron uniformly shiny fuscous, except for basal margin and apex of cuneus pale; membrane smoky brown, with posteriorly whitish vein. All coxae creamy yellow, with more or less darkened bases; legs creamy yellow; each femur without noticeable dark stripe along anterior margin; pattern of ventral femoral spots as in Figs 1H–I, 4; metafemoral dark spots generally smaller than those of *P. amurensis* (cf. Figs 1F–G, 4); each tibia with a dark (knee) spot at joint with respective femur; apex of each tarsomere III darkened; pretarsal structure as in Fig. 5H; claws rather slender and sharpened, with pulvilli somewhat widened

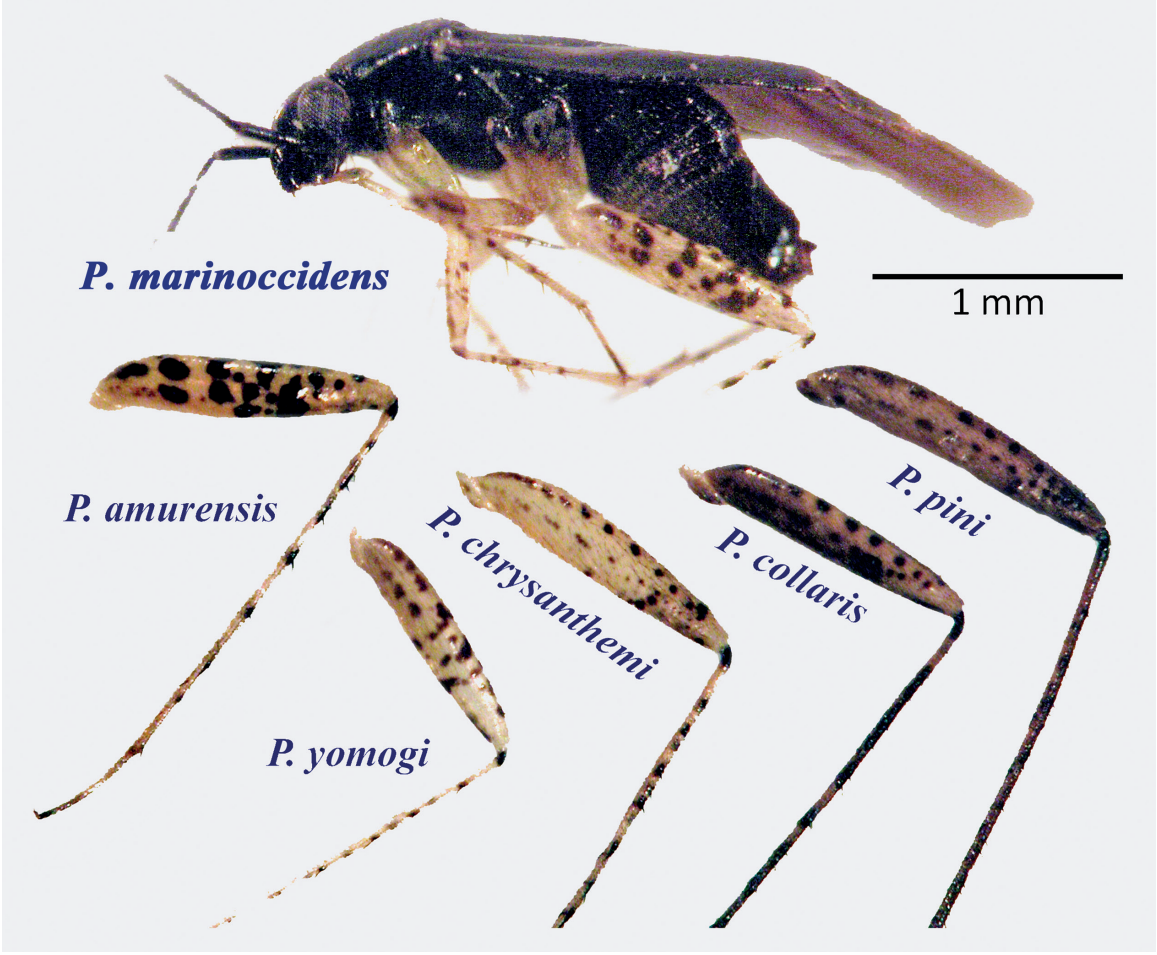

Fig. 4. Metafemoral ventral dark spot pattern of six Japanese *Plagiognathus* spp.

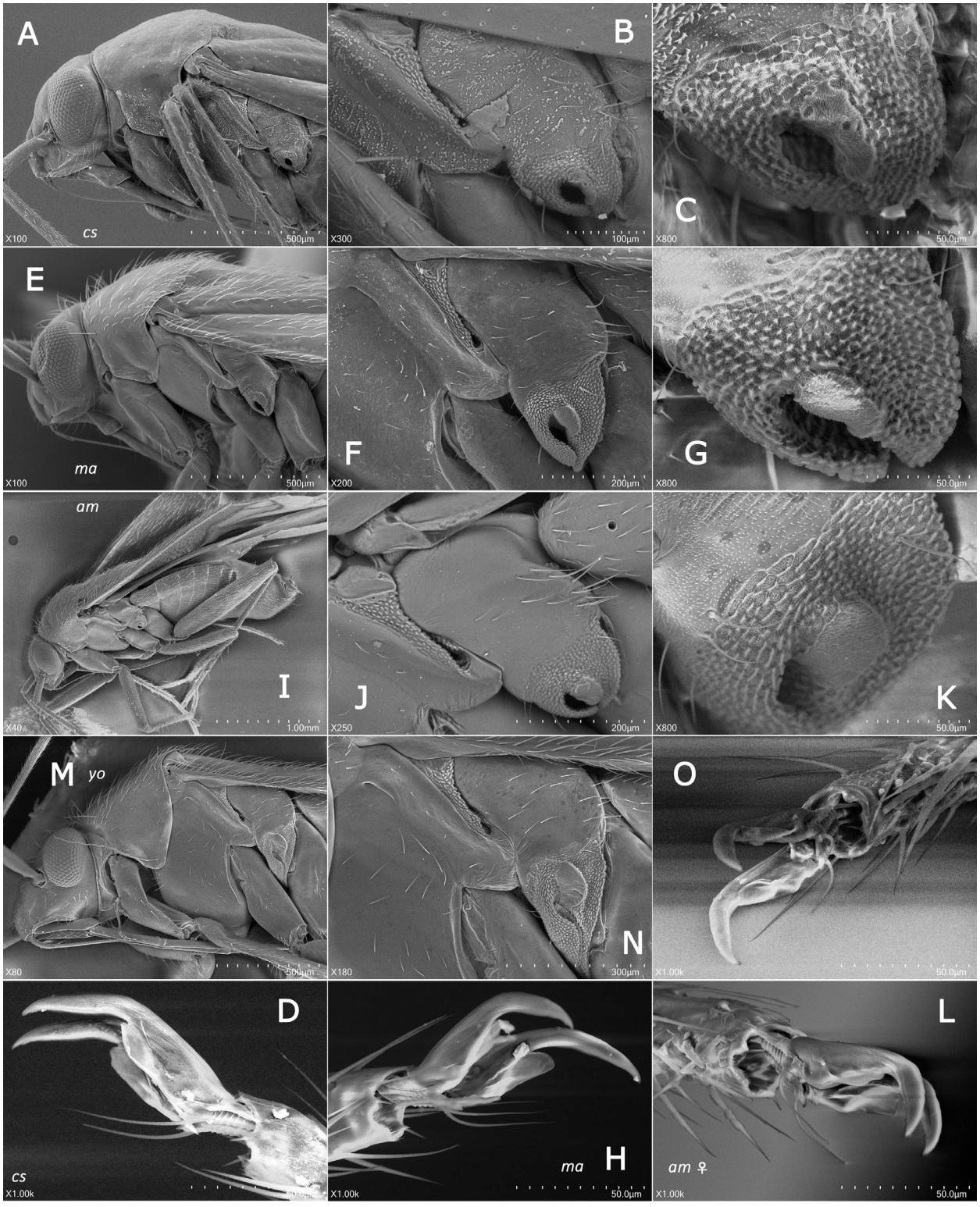

Fig. 5. A–D. Scanning electron micrographs for *Plagiognathus chengshingi* sp. nov. **E–H**. *P. marinoccidens* sp. nov. **I–L**. *P. amurensis*. **M–O**. *P. yomogi*. **A, E, I, M**. Left lateral habitus. **B, F, J, N**. Thoracic pleura, left lateral view. **C, G, K**. Metathoracic scent efferent system. Ventral habitus. **D, H, L, O**. Pretarsal structure of metaleg.

towards apex. Abdomen almost entirely shiny fuscous in both sexes. Male genitalia (Figs 6E–H, 9A−F): Right paramere relatively wide, somewhat flattened (Fig. 9A); hypophysis of left paramere sub-triangular (Fig. 9C); phallotheca rather stout, blunt-tipped (Fig. 9B); vesica sigmoid but not coiled, with short, slender apical blades that are not thickened basally (Figs 6E–H, 9E–F). Female genitalia (Figs 7B, 9G–I): Sclerotized ring rather small, with thicker anterior margin (Figs 7B, 9G); posterior wall relatively narrow (Fig 9H); interramal sclerite (except for its smooth inner corner) with densely distributed, comb-like microstructures (Fig. 9I).

Measurements

See Table 1. Holotype male: Total body length 3.19; head width across eyes 0.68; vertex width (interocular space) 0.33; lengths of antennal segments I–IV 0.21, 0.95, 0.63 and 0.33; total length of labium 1.20: basal width of pro-

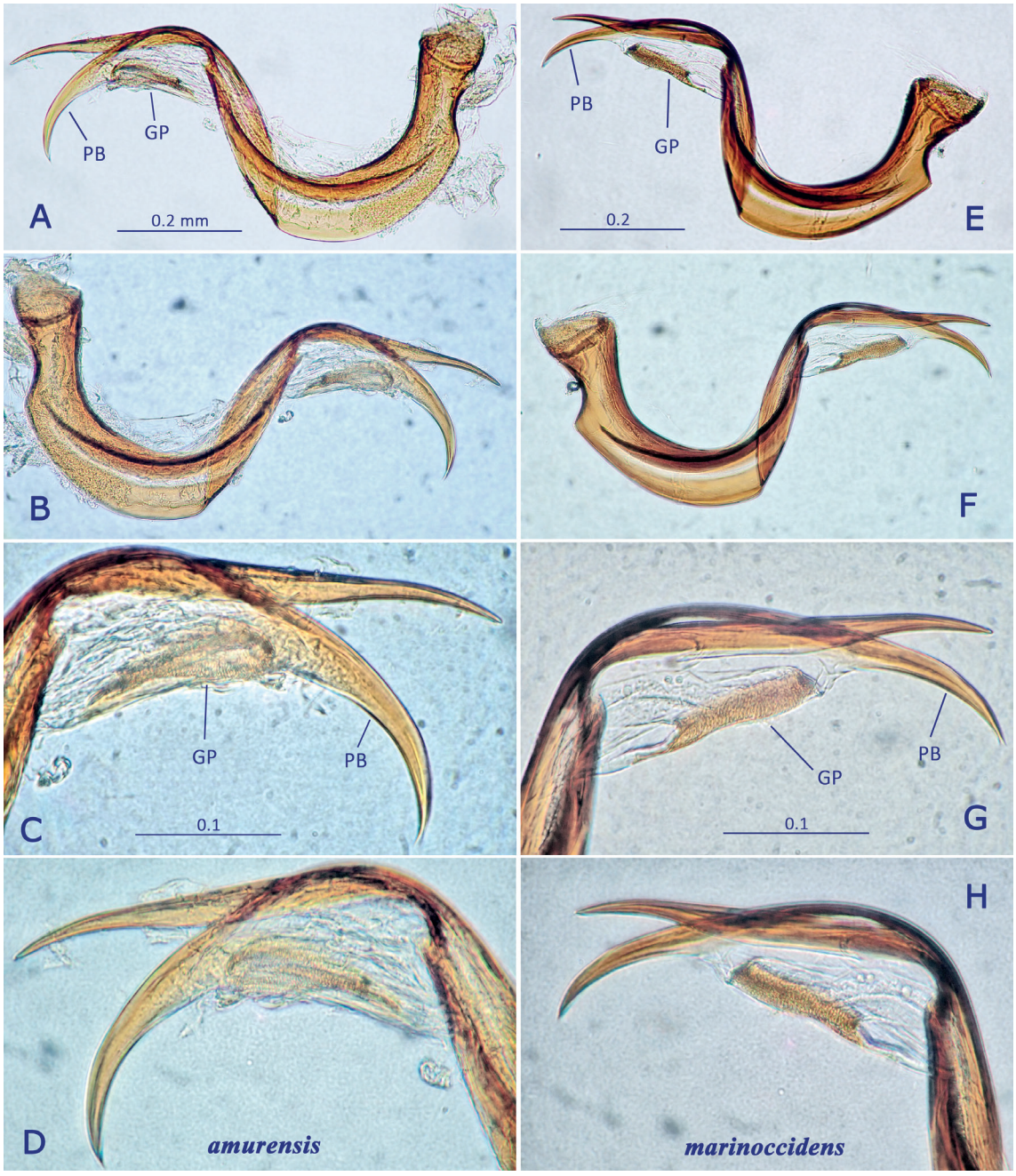

Fig. 6. A–D. Male genitalia (vesica) of *Plagiognathus amurensis* from Suwon, Korea. **E–H**. *P. marinoccidens* sp. nov. from Nagasaki, Japan. Abbreviations: see Material and methods.

notum 0.99; maximum width across hemelytra 1.20; and lengths of metafemur 1.08, tibia 1.68 and tarsus 0.47, respectively.

Biology

The breeding host of this new bivoltine species was confirmed as a Japanese wild hop, *Humulus japonicus*. The immature forms of the 2nd (autumn) generation were recently discovered (Fig. 3A–H), and the newly emerged adults of the 1st generation (cf. Fig. 2B) were collected from young leaves and stem vines of the host in early summer. The adults were occasionally attracted to UV light at night. Both of *Plagiognathus marinoccidens* sp. nov. and its assumed closest sibling, or *P. amurensis*, are associated with the same plant species. However, the latter seems to have a univoltine life cycle, as both of the adults and nymphs of Japanese population were only found between late August to late October (Yasunaga 2001; Yasunaga &

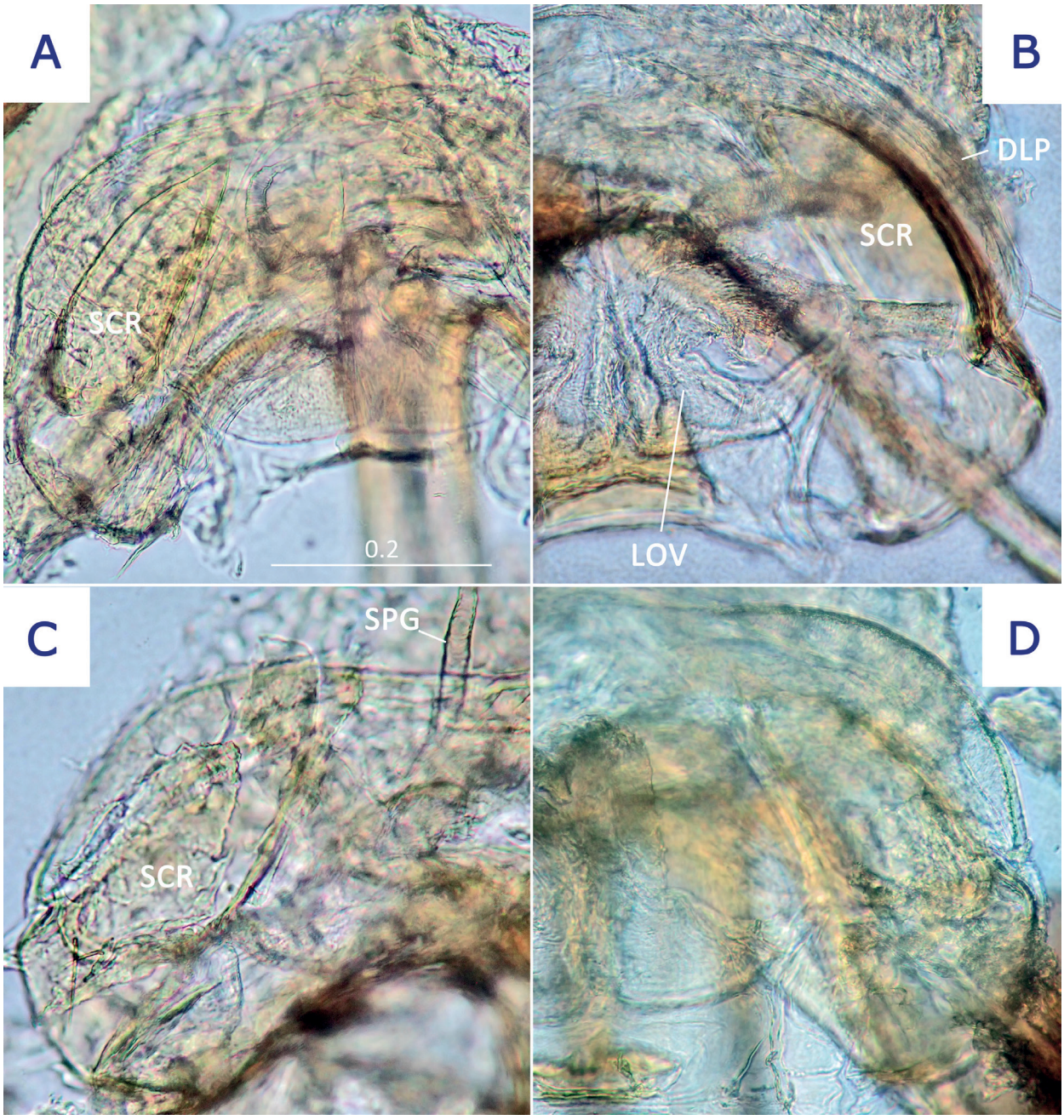

Fig. 7. Female genital chamber of *Plagiognathus* spp. in dorsal view. **A**. *P. chengshingi* sp. nov. **B**. *P. marinoccidens* sp. nov. **C**. *P. yomogi*. **D**. *P. amurensis*. Abbreviations: see Material and methods.

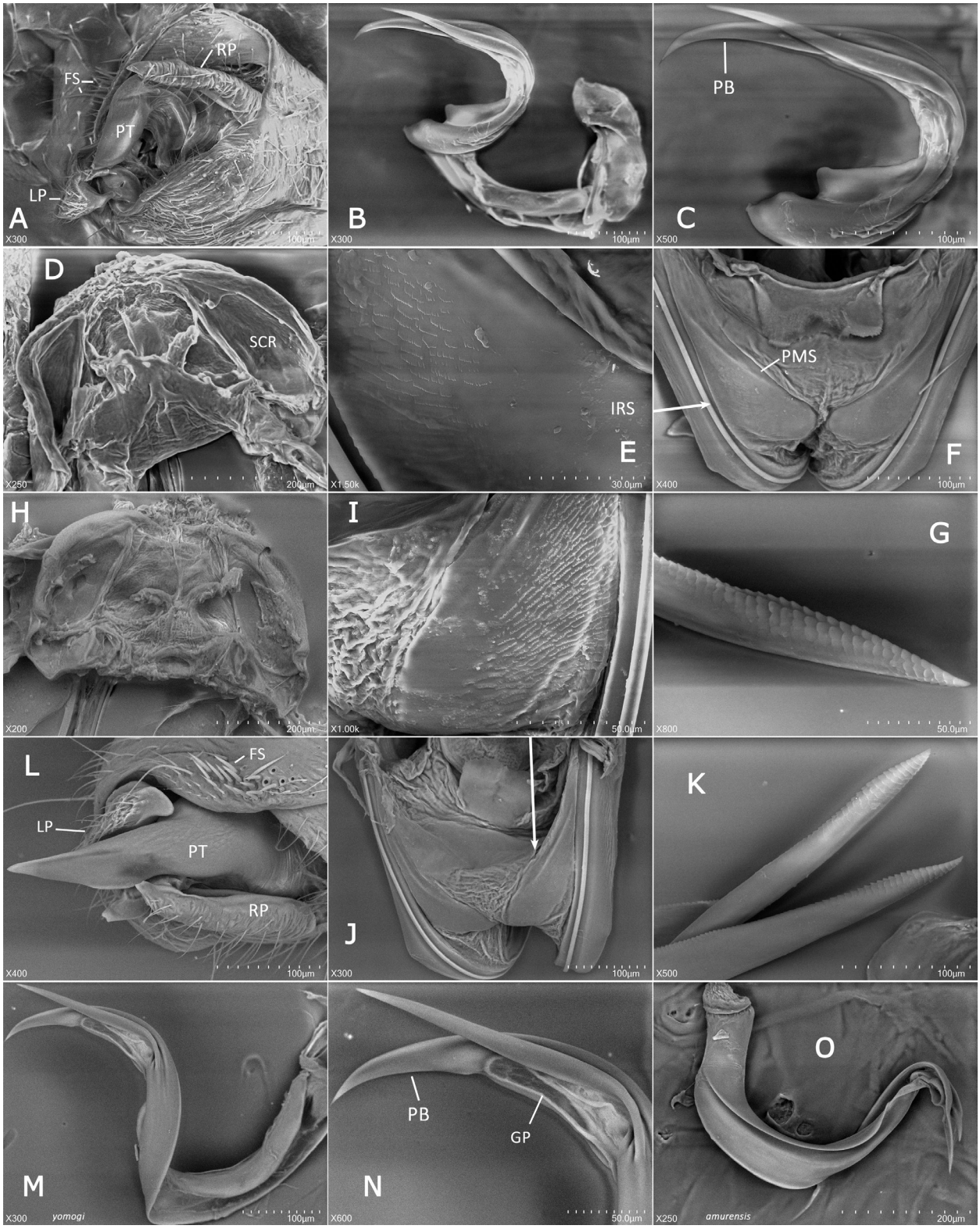

Fig. 8. A–C, L–O. Scanning electron micrographs of ♂ genitalia. **D–K**. Scanning electron micrographs of ♀ genitalia. **A–G**. *Plagiognathus chengshingi* sp. nov. **H–N**. *P. yomogi*. **O**. *P. amurensis*. **A, L**. Genital segment (pygophore) with phallotheca and parameres, dorsal view. **B−C, M−O**. Vesica. **D, H**. Genital chamber, dorsal view. **E−F, I−J**. Posterior wall. **G, K**. Apex of ovipositor (gonapophysis I). Abbreviations: see Material and methods.

Takai 2016), and the distributions of the two species are obviously disjunct from one another. Along coastal zones of Nagasaki Prefecture, the Japanese hop (often regarded as a rampant weed) grows everywhere. Nonetheless, the habitats of *P. marinocciden* are obviously restricted. Although I have carefully searched this bug at more than 20 sites for the past couple of years, only five collecting sites mentioned in the above type material section have hitherto yielded specimens. The adults of the second (autumn) generation occurring at Kohno'ura Harbor of Nagasaki City (Fig. 3A, 32°52′54.7″ N, 129°40′44.7″ E) were observed to survive until early November when the host plant starts to wither.

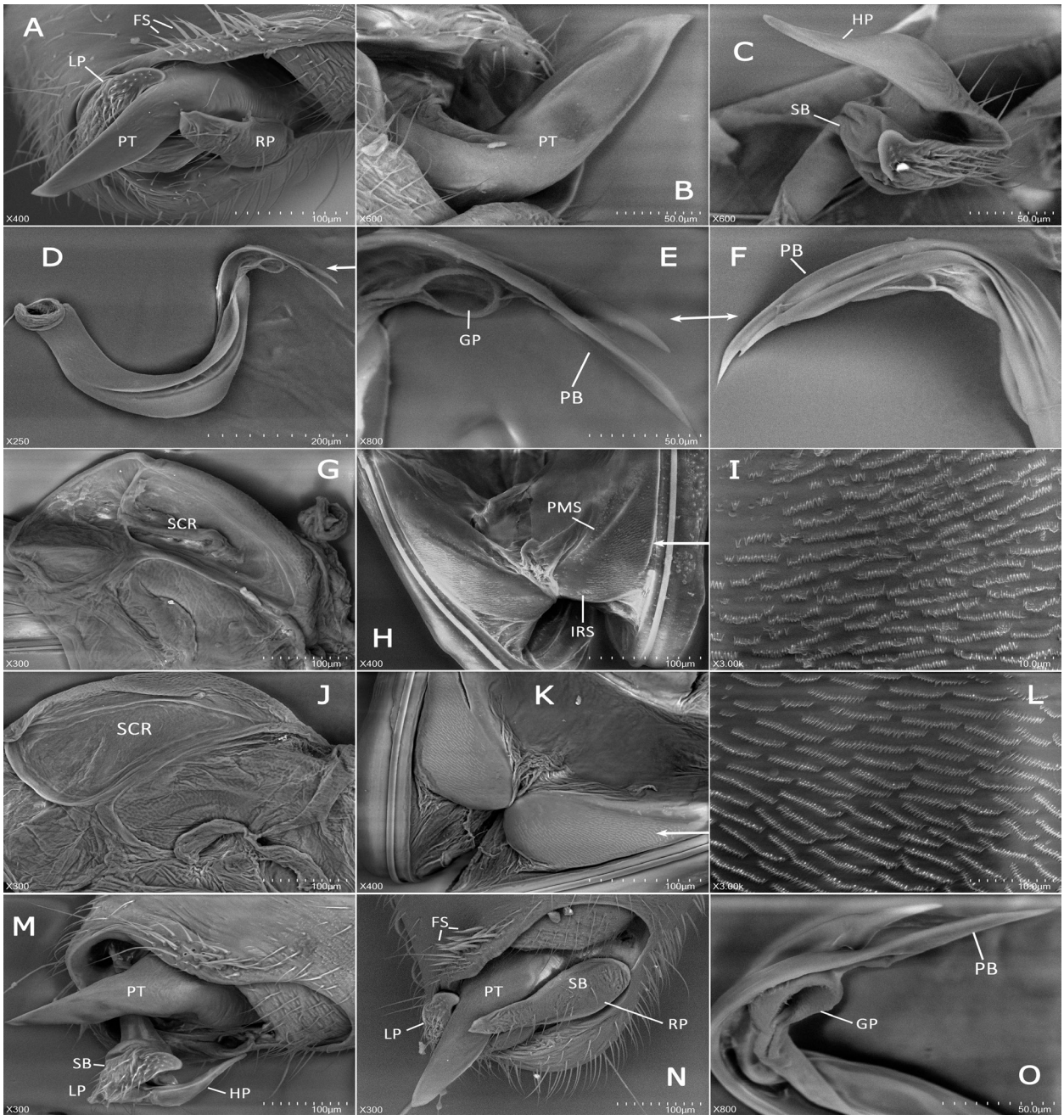

Fig. 9. A–F, M–O. Scanning electron micrographs of ♂ genitalia. **G–L**. Scanning electron micrographs of ♀ genitalia. **A–I**. *Plagiognathus marinoccidens* sp. nov. **J–O**. *P. amurensis*. **A, M–N**. Genital segment (pygophore) with phallotheca and parameres, dorsal view. **B**. Phallotheca. **C**. Left paramere. **D–F, O**. Vesica. **G, J**. Genital chamber, dorsal view. **H–I, K–L**. Posterior wall (I, L for structure of IRS in high magnification). Abbreviations: see Material and methods.

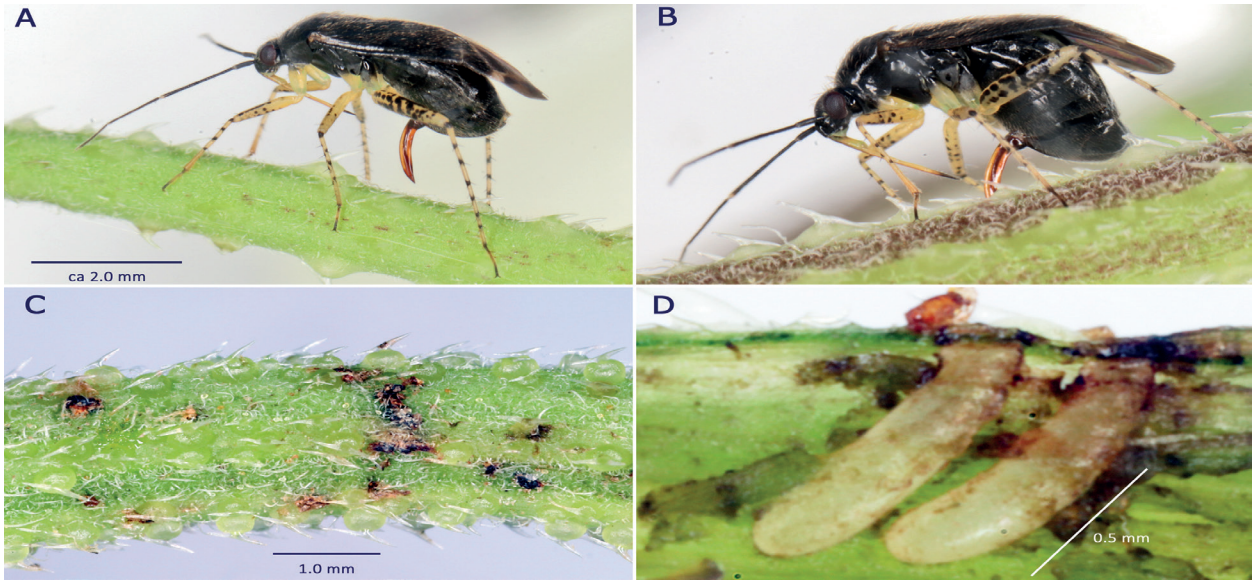

Fig 10. *Plagiognathus marinoccidens* sp. nov. **A–B**. Oviposition behavior. **C**. Brownish pasty coats sealing opercula **D**. Eggs deposited into stem-vine of the Japanese hop.

Schuh (2004) suggested that *Plagiognathus* species were associated with 39 vascular plant families and a number of members were arboreal including conifer-inhabitants. The Japanese species, except for *P. pini* Vinokurov, are known to feed on herbaceous weeds or climbers (see checklist above). So far as I am aware, predaceous food habit is yet to be reported for any Asian *Plagiognathus* species. However, both adults and immature forms of *P. marinoccidens* were recently observed to have positively preyed on an aphid, *Phorodon japonensis* Takahashi, 1965 (Aphididae) which often co-occurs with the plant bug on the Japanese hop, *Humulus japonicus* (Fig. 3H). In addition, the adults and every instar nymphs were successfully reared with a synthetic diet (diluted fermented milk beverage and dried brine shrimp eggs, Fig. 3E–F), and all the immature forms developed into adults. The newly emerged females were observed to oviposit 3–4 days after eclosion (Fig. 10A–B) and to survive for 15–29 days (see the above type material section). When the adults were reared only with the pieces of the host plant, all were dead within a week and the females did not oviposit. Based on available evidences, this new phyline species appears more or less predaceous despite being a specialist of *Humulus japonicus*. Several reared adults were also observed to scavenge on fresh cadavers of small-sized dipteran flies (*Drosophila* sp., *Megaselia* sp. and *Aedes albopictus* as in Fig. 3K). Two aphid species, *Macrosyphoniella sanborni* (Gillette) (original host: *Chrysanthemum* × *morifolium* of Asteraceae) and an undetermined aphid from *Quercus dentata* (Fagaceae), were also preyed upon by the adults of the mirid in laboratory tests. Carnivorous food habit is assumed to be essential for propagation of *P. marinoccidens*.

Details of oviposition behavior were documented for relatively few mirid bugs (Wheeler 2001). The present work confirmed that the eggs of *Plagiognathus marinoccidens* sp. nov. were deposited into the stem-vines of the host plant (Fig. 10D). The opercula were found to be wholly concealed by brownish pasty coats that at first sight seem simply the excrement (Fig. 10C). It was not until I was aware of the opercular seal that I could accurately locate the cryptically deposited eggs. However, it is currently not certain which organ (mouth, ovipositor or anus) secretes the brown matter during oviposition. The coating is considered significant for the eggs to survive for more than 7 months, since the aerial parts, or annual vines of the perennial host plant wither up in winter.

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