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Two new species of *Galloisiana* Caudell, 1924 (Insecta, Grylloblattodea) from Western Honshu Island, Japan

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Abstract

Two new species of *Galloisiana* Caudell, 1924, *G. harimensis* **sp. nov.** and *G. kawamurai* **sp. nov.**, are described. In general appearance, both new species resemble *G. nipponensis* (Caudell & King, 1924), the type species of the genus. Molecular phylogeny reconstructed in the present study shows that the new species belong to clades different from that of *G. nipponensis*. Morphologically, the three species can be distinguished based on the male genitalia, although the females resemble each other.

Keywords

Ice crawlers, male genitalia, mitochondrial DNA, phylogeny, taxonomy

Introduction

The genus *Galloisiana* Caudell, 1924 comprises 11 species worldwide (Storozhenko 1986, 1988; Kim and Lee 2007; Vrsansky et al. 2001). This genus is distributed in East Asia, including Japan, eastern Russia, China, and the Korean Peninsula (Kim and Lee 2007; Nakahama and Uchifune 2016). Storozhenko (1986, 1988) and Kim and Lee

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(2007) conducted comprehensive studies on Asian species of *Galloisiana* and provided identification keys to the genera and species.

Currently the following five species are known from Japan: *G. chujoi* Gurney, 1961, *G. kiyosawai* Asahina, 1959, *G. nipponensis* (Caudell & King, 1924), *G. notabilis* Silvestri, 1927 and *G. yuasai* Asahina, 1959. Nakahama and Uchifune (2016) provided keys to known japanese species. *Arctigalloisiana yezoensis* (Asahina, 1961) was formerly included in *Galloisiana*, but was transferred to the genus *Arctigalloisiana* by Nakahama et al. (2023). However, the taxonomic descriptions of some species remain insufficient. For example, *G. notabilis* was described based on immature specimens, and the morphological traits of adults remain unknown. *Galloisiana kiyosawai* and *G. chujoi* were described solely from female specimens, and male morphological data remain unavailable. These insects are partially subterranean and generally considered to have low dispersal ability and are therefore likely to comprise many geographically differentiated populations (Nakahama et al. 2023). However, morphological differences among species are often unclear, and species diversity therefore remains poorly understood. In fact, some entomologists have recognized several Japanese populations of *Galloisiana* that have not yet been identified to species level (e.g., Nakahama and Uchifune 2016). To clarify the species diversity of *Galloisiana* in Japan, we conducted inventory surveys and attempted species delimitation using both morphological and molecular data. As a result, two undescribed species were recognized from western Honshu, Japan, and are described herein.

Materials and methods

Specimens were collected from various sites in Japan. For *Galloisiana chujoi*, *G. nipponensis* and *G. yuasai*, some of their specimens were collected from areas close to their type localities. Morphological examination was done using a Nikon SMZ 1270 microscope. Male genitalia were cleared with a 10% KOH solution. Multi-focused images were produced using Helicon Focus software ver. 4.2.9. from several series of source images obtained with a Canon EOS 60D camera attached to the microscope. All measurements are given in millimeters. The specimens used for measurements and the measurement data are shown in Table 1. Abbreviations and terminology follow Schoville (2012): Ant2L, second antennomere length; Ant3L, third antennomere length. Type material designated in the present study is deposited in the Museum of Nature and Human Activities, Hyogo, Japan (**MNHAH**).

Phylogenetic analysis

Genomic DNA was extracted from the middle leg using the Chelex method protocol (Miura et al. 2017). Two primer pairs were used to amplify the mitochondrial COII gene, nuclear 28S rRNA (28S) genes [COII: COII-F-leucine 5'-TCTAATATGGCAGATTAGTGC-3' and COII-2-R-lysine 5'-GAGACCAGTACTTGCTTTCAGT-

Table 1. Measurements and meristic data for *Galloisiana* specimens used in descriptions. L, left; R, right; (+s), number of additional fine setae; x, lost.

	***G. harimensis* sp. nov.**					***G. kawamurai* sp. nov.**					***G. nipponensis***			
Registration No. in the depository	B2-595388	B2-595378	B2-595389	B2-595377	B2-595376	B2-595371	B2-595373	B2-595374	B2-595372	B2-595375	B2-595382	B2-595390	B2-595391	B2-595392
Status of specimen	Paratype	Holotype	Paratype	Paratype	Paratype	Holotype	Paratype	Paratype	Paratype				"Topotype"	
Sex	Male	Male	Female	Female	Female	Male	Male	Female	Female	Female	Male	Female	Female	Female
Head width	3,70	3,40	4,40	4,60	4,00	3,35	3,10	3,15	3,15	3,75	3,90	4,00	4,05	4,10
Eye length	0,42	0,41	0,43	0,50	0,38	0,37	0,31	0,35	0,36	0,46	0,45	0,48	0,43	0,43
Eye width	0,18	0,20	0,20	0,26	0,18	0,18	0,17	0,16	0,18	0,25	0,25	0,30	0,25	0,25
Interorbital distance	3,20	2,93	3,95	3,95	3,50	3,05	2,73	2,70	2,75	3,35	3,55	3,55	3,50	3,60
Antennimere I length	0,60	0,53	0,60	0,65	0,58	0,52	0,52	0,47	0,46	0,56	0,62	0,65	0,58	0,55
Antennimere II length	0,25	0,25	0,26	0,30	0,28	0,18	0,21	0,18	0,18	0,25	0,30	0,30	0,23	0,25
Antennimere III length	0,60	0,50	0,73	0,60	0,50	0,41	0,42	0,38	0,40	0,45	0,62	0,65	0,66	0,52
Maxiraly palpomere III length	0,81	0,67	0,81	0,81	0,75	0,68	0,62	0,63	0,61	0,73	0,71	0,81	0,81	0,71
Maxiraly palpomere IV length	0,73	0,58	0,75	0,73	0,62	0,62	0,51	0,55	0,56	0,70	0,58	0,75	0,72	0,68
Pronotum length	3,90	3,60	4,25	4,45	3,95	3,75	3,50	3,20	3,10	3,85	4,00	4,25	3,95	4,05
Pronnotum width	3,35	3,40	3,75	3,85	3,45	3,25	2,85	2,80	2,65	3,30	3,55	3,65	3,60	3,50
Subgenital plate length	1,02	0,97	-	-	-	0,77	0,72	-	-	-	1,05	-	-	-
Subgenital plate width	1,55	1,37	-	-	-	1,40	1,25	-	-	-	1,40	-	-	-
Right coxopodite length	1,33	1,12	-	-	-	1,05	0,96	-	-	-	1,37	-	-	-
Right coxopodite width	0,85	0,85	-	-	-	0,80	0,76	-	-	-	0,95	-	-	-
Right stylus length	0,73	0,70	-	-	-	0,60	0,58	-	-	-	0,78	-	-	-
Left coxopodite length	1,03	0,83	-	-	-	0,90	0,83	-	-	-	1,02	-	-	-
Left coxopodite width	1,28	1,25	-	-	-	1,20	1,05	-	-	-	1,25	-	-	-
Left stylus length	0,76	0,70	-	-	-	0,58	0,60	-	-	-	0,78	-	-	-
Female ovipositor Length_dorsal	-	-	4,00	3,95	3,70	-	-	3,50	3,35	3,75	-	x	3,90	4,10
Female ovipositor Length_ventral	-	-	3,65	3,50	3,35	-	-	2,85	2,90	3,30	-	x	3,40	3,35
No. of antennimere	L: 32, R: 41	L: 42, R: 42	L: 24, R: 41	L: 27×, R: 45	L: 42, R: 43	L: 36, R: 35	L: 37, R: 37	L: 11×, R: 36	L: 35, R: 23×	L: 38, R: 38	L: 44, R: 43	L: x, R: 43	L: 43, R: x	L: 42, R: 30
No. of macrosetae on cervical sclerite	L: 5 (+s2), R: 5 (+s2)	L: 5, R: 5	L: 5 (+s2), R: 4	L: 5 (+s2), R: 6	L: 4 (+s2), R: 4 (+s1)	L: 3 (+s1), R 4	L: 4 (+s1), R: 4 (+s2)	L: 4 (+s1), R: 4	L: 4, R: 4	L: 4 (+s1), R: 4 (+s1)	L: 8, R: 8	L: 6, R: 6 (+s1)	L: 8, R: 8	L: 9, R: 7 (+s2)
No. of cercal segments	L: x, R: 10	L: 10, R: 10	L: 11, R: 11	L: 11, R: 11	L: 9, R: 10	L: 10, R: 10	L: 10, R: 10	L: 9, R: 9	L: 9, R: 9	L: 10, R: 10	L: 10, R: 10	L: x, R: x	L: 9, R: 9	L: 9, R: 9

CATC-3' (Svenson and Whiting 2004), 28S: 28SL 5'-CCCGTCTTGAAACACG-GACCAA-3' and 28SH 5'-CCACAGCGCCAGTTCTGCTTA-3' (Muraji and Tachikawa 2000). PCR was performed in a final volume of 10 μL, containing 1 ng of template DNA, 5 μL of KOD One® PCR Master Mix (Toyobo, Osaka, Japan), and 0.15 μL of each primer at 20 μM. The PCR cycling conditions of both primer pairs were as follows: template denaturation at 95 °C for 5 min, followed by 37 cycles of denaturation at 94 °C for 10 s, annealing at 52 °C for 5 s, and extension at 72 °C for 15 s; and a final extension at 72 °C for 5 min. After checking the presence and quality of amplicons by electrophoresis on 1% agarose gels, sequencing was performed bidirectionally at Eurofins Genomics in Tokyo, Japan, using the same primers used for PCR.

MAFFT version 7.526 with the L-INS-i algorithm was used to align COII and 28S sequences (Katoh and Standley 2013). The Maximum Likelihood phylogenetic analysis was conducted using IQ-TREE version 3.0.1 with ultrafast bootstrap approximation (UFBoot) based on 1000 replicates (Wong et al. 2025). Substitution models were selected using ModelFinder implemented in IQ-TREE version 3.0.1 based on the Bayesian information criterion (BIC). Selected models for both COII and 28S were GTR+F. The resulting tree was visualized and edited with FigTree version 1.4.3.

Sequence data obtained in the present study was deposited in DDBJ/EMBL/GenBank (Table 2). Other sequence data by previous authors were obtained from the National Center for biotechnology Information (NCBI).

Results

We constructed the phylogenetic tree of Grylloblattidae Walker, 1914, which includes the newly collected specimen (Fig. 1). The mean likelihood values (lnL) of ML trees were -9063.6723.

Galloisiana spp. in Hyogo, Shiga, Mie, and Kagawa Prefectures currently belongs to a well-supported clade (SH-aLRT = 100%, UB = 100%) containing Kinki and Shikoku Districts in Japan. The clade is divided into three subclades. First subclade consists of *G. chujoi*, which was not fully supported, and second subclade consists *G.* sp. 4 in Mie and Shiga Prefectures, which was fully supported, and third subclade consists of *G.* sp. 5 in Hyogo Prefectures, which was also fully supported. In ML trees, multiple individuals evaluated all showed monophyly for *G.* sp. 4, and *G.* sp. 5, all of which were well-supported (*G.* sp. 4: SH-aLRT = 100%, UB = 100%, *G.* sp. 5: SH-aLRT = 99.6%, UB = 100%).

Taxonomy

Genus *Galloisiana* Caudell, 1924

Species composition. *Galloisiana chujoi* Gurney, 1961; *G. harimensis* sp. nov.; *G. kawamurai* sp. nov.; *G. kiyosawai* Asahina, 1959; *G. kouensis* Namkung, 1974;

Table 2. List of the species used in the phylogenetic analysis with collected locality, accession numbers in COII sequnces in DNA Data Bank of Japan (DDBJ), and voucher specimens in Museum of Nature and Human Activities Hyogo (MNHAH).

Species name	Locality	Accession number			References
		COII sequnece in DDBJ	28S sequence in DDBJ	Voucher specimens in MNHAH	
Galloisiana kawamurai	Inabe City, Mie Pref. Japan	PZ419935	PZ456507	B2-595371	Our study
	Inabe City, Mie Pref. Japan	PZ419936	PZ456508	B2-595372	Our study
	Inabe City, Mie Pref. Japan	PZ419937	PZ456509	B2-595373	Our study
	Inabe City, Mie Pref. Japan	PZ419938	PZ456510	B2-595374	Our study
	Taga Town, Shige Pref., Japan	PZ419934	PZ456506	B2-595375	Our study
Galloisiana harimensis	Sayo Town, Hyogo Pref., Japan	PZ419939	PZ456511	B2-595376	Our study
	Sayo Town, Hyogo Pref., Japan	PZ419940	PZ456512	B2-595377	Our study
	Sayo Town, Hyogo Pref., Japan	PZ419941	PZ456513	B2-595378	Our study
Galloisiana nipponensis	Gunma Pref., Japan	KC142758	KC142398		(Schoville et al. 2013)
	Gunma Pref., Japan	KC142754	KC142396		(Schoville et al. 2013)
	Nikko City, Tochigi Pref., Japan	PZ419929	PZ456501	B2-595379	Our study
	Nikko City, Tochigi Pref., Japan	PZ419930	PZ456502	B2-595380	Our study
	Nikko City, Tochigi Pref., Japan	PZ419931	PZ456503	B2-595381	Our study
	Nikko City, Tochigi Pref., Japan	PZ419932	PZ456504	B2-595382	Our study
Galloisiana yuasai	Nagano Pref., Japan	KC142818	KC142416		(Schoville et al. 2013)
	Nagano Pref., Japan	KC142848	KC142428		(Schoville et al. 2013)
	Nagano Pref., Japan	PZ419933	PZ456505	B2-595383	Our study
Galloisiana kiyosawai	Nagano Pref., Japan	KC142780	KC142406		(Schoville et al. 2013)
	Nagano Pref., Japan	KC142781	-		(Schoville et al. 2013)
Galloisiana chujoi	Megishima Island, Kagawa Pref., Japan	PZ419928	PZ456500	B2-595384	Our study
Galloisiana odaesanensis	Gangwon-do, South Korea	FR728655	FR728666		(Schoville and Kim 2011)
	Gangwon-do, South Korea	FR728654	-		(Schoville and Kim 2011)
Arctigalloisiana yezoensis	Higashikawa Town, Ishikari Mountains, Hokkaido, Japan	LC701059	LC730573	B2-407735	Nakahama et al. (2023)
	Higashikawa Town, Ishikari Mountains, Hokkaido, Japan	LC701060	LC730589	B2-407736	Nakahama et al. (2023)
	Higashikawa Town, Ishikari Mountains, Hokkaido, Japan	LC701062	LC730591	B2-407737	Nakahama et al. (2023)
	Higashikawa Town, Ishikari Mountains, Hokkaido, Japan	LC701061	LC730590	B2-407738	Nakahama et al. (2023)
Arctigalloisiana propnetopa	Urakawa Town, Hidaka Mountains, Hokkaido, Japan	LC701065	LC730577	B2-407745	Nakahama et al. (2023)
	Urakawa Town, Hidaka Mountains, Hokkaido, Japan	LC701066	LC730576	B2-407746	Nakahama et al. (2023)
Arctigalloisiana yubariensis	Atsuma Town, Yubari Mountains, Hokkaido, Japan	LC701073	LC730581	B2-407749	Nakahama et al. (2023)
Arctigalloisiana yubariensis	Atsuma Town, Yubari Mountains, Hokkaido, Japan	LC701074	LC730582	B2-407750	Nakahama et al. (2023)
	Atsuma Town, Yubari Mountains, Hokkaido, Japan	LC701076	LC730583	B2-407752	Nakahama et al. (2023)
	Atsuma Town, Yubari Mountains, Hokkaido, Japan	LC701077	LC730584	B2-407755	Nakahama et al. (2023)
Grylloblattina djakonovi kurentzovi	Beriozovii Stream, Krai, Primorskii, Russia	DQ457357	DQ457323		(Jarvis and Whiting 2006)
	Mt. Krinitshnaya, Krai, Primorskii, Russia	DQ457358	DQ457324		(Jarvis and Whiting 2006)
Grylloblatta barberi	Wilson Ice Cave, State of Ohio, USA	FJ918624	FJ918686		(Schoville and Roderick 2010)

Species name	Locality	Accession number			References
		COII sequnece in DDBJ	28S sequence in DDBJ	Voucher specimens in MNHAH	
Grylloblatta bifratrilecta	Carson Pass, State of California, USA	FJ918618	FJ918666		(Schoville and Roderick 2010)
	Carson Pass, State of California, USA	FJ918617	FJ918681		(Schoville and Roderick 2010)
Grylloblatta chandleri	Gray's Flat, State of California, USA	FJ918575	FJ918685		(Schoville and Roderick 2010)
Grylloblatta washoa	SE Barker Pass, State of California, USA	FJ918623	FJ918668		(Schoville and Roderick 2010)
	SE Barker Pass, State of California, USA	FJ918622	FJ918667		(Schoville and Roderick 2010)
Grylloblatta campodeiformis occidentalis	Table Mountain, State of Washington, USA	MG824755	-		(Schoville et al. 2019)
	Table Mountain, State of Washington, USA	MG824754	-		(Schoville et al. 2019)
Grylloblatta campodeiformis campodeiformis	BuValo Horn Creek, Gallatin, State of Montana, USA	DQ457367	DQ457336		(Jarvis and Whiting 2006)
Grylloblatta chirurgica	Goat peak Trail, Yakima, State of Washington, USA	DQ457362	DQ457329		(Jarvis and Whiting 2006)
	Surprise Cave, Skamania, State of Washington, USA	DQ457364	DQ457331		(Jarvis and Whiting 2006)
Grylloblatta gurneyi	Merrill Ice Cave, Siskiyou, State of California, USA	DQ457348	DQ457314		(Jarvis and Whiting 2006)
	Cox Ice Cave, Siskiyou, State of California, USA	DQ457349	DQ457315		(Jarvis and Whiting 2006)
Grylloblatta rothi	Mackenzie Pass, Deschutes, States of Oregon, USA	DQ457341	DQ457306		(Jarvis and Whiting 2006)
Grylloblatta rothi	South Sister, States of Oregon, USA	KP972434	-		(Schoville et al. 2015)
Grylloblatta sculleni	USA, OR, Mary's Peak, Benton, States of Oregon, USA	DQ457368	-		(Jarvis and Whiting 2006)
Grylloblatta siskiyouensis	Oregon Caves, States of Oregon, USA	JN612961	-		(Schoville 2012)
Grylloblatta oregonensis	Oregon Caves, States of Oregon, USA	JN612962	-		(Schoville 2012)
Grylloblatta marmoreus	Marble Valley of Marble Mountains, State of California, USA	JN612963	-		(Schoville 2012)
	Marble Valley of Marble Mountains, State of California, USA	JN612964	-		(Schoville 2012)
Tyrannophasma gladiator	Brandberg, Namibia	DQ457369	DQ457338		(Jarvis and Whiting 2006)

G. nipponensis (Caudell & King, 1924); *G. notabilis* Silvestri, 1927; *G. odaesanensis* Kim & Lee, 2007; *G. olgae* Vrsansky & Storozhenko, 2001; *G. sinensis* Wang, 1987; *G. sofiae* Szeptycki, 1987; *G. ussuriensis* Storozhenko, 1988; *G. yuasai* Asahina, 1959.

Diagnosis. The genus *Galloisiana* can be distinguished from the genera *Grylloblatta* Walker, 1914 and *Grylloprimevala* Zhou & Ren, 2023 by having two teeth on each lacinia, whereas the latter genera have a single tooth on each lacinia. From genera *Grylloblattella* Storozhenko, 1988, *Galloisiana* can be distinguished by convex or straight posterior margin of the pronotum, and from *Grylloblattina* Bey-Bienko, 1951, can be distinguished by not having macrosetae on the inner margin of the cervical sclerite. From genera *Grylloblattella* and *Arctigalloisiana*, *Galloisiana* can be distinguished by

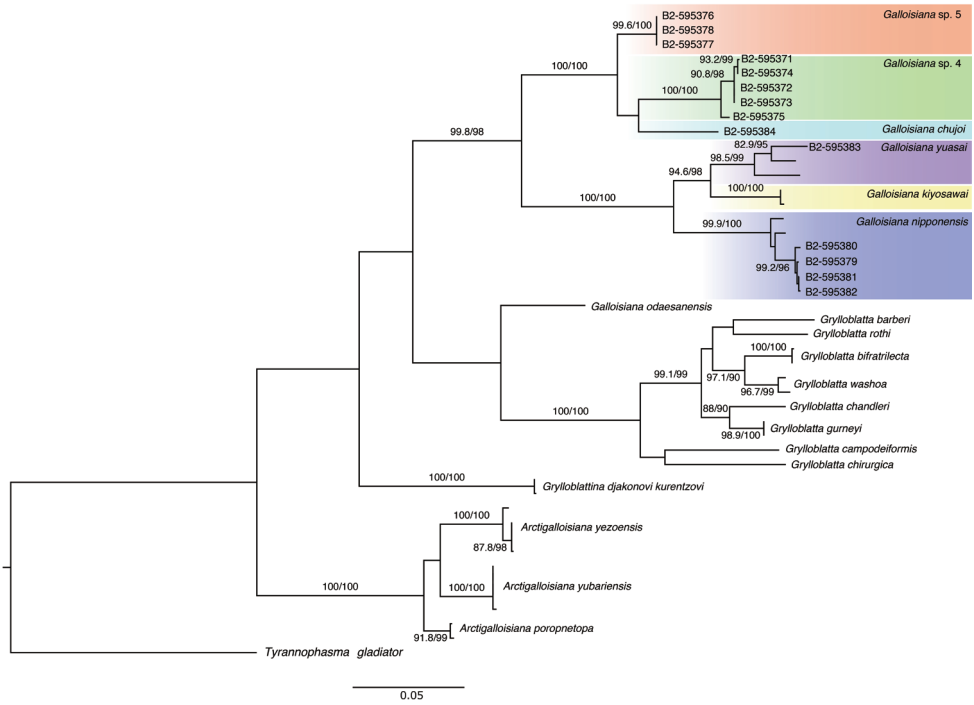

Figure 1. Maximum likelihood tree of Grylloblattidae based on combined COII and 28S sequences. Japanese *Galloisiana* species are highlighted in color. OTUs with registration codes beginning with "B2-" are newly obtained and analyzed in the present study.

having well-developed tarsal pulvillus. Also, *Galloisiana* has macrosetae on the cervical sclerite whereas *Arctigalloisiana* has no macrosetae on the cervical sclerite. Genus *Namkungia* is most close to *Galloisiana* but the latter can be distinguished by twelve cercomeres from the former is seven-eleven cercomeres.

Geographical range. East Asia.

Remarks. The genus *Namkungia* was erected for *Namkungia briyongensis* (Namkung 1974), formerly placed in *Galloisiana* (Storozhenko and Park 2002). Several molecular works have revealed that the establishment of *Namkungia* resulted in polyphyly of *Galloisiana* (Schoville and Kim 2011; Schoville 2014; Nakahama et al. 2023). Reconsideration of the genera *Galloisiana* and *Namkungia* is necessary on the basis of both morphology and molecular phylogeny.

Recently, a monotypic genus *Grylloprimevala* was established based on three males, and this genus is close to *Galloisiana* clade (Zhou et al. 2023). However, the male genitalia illustrated in the original figures appear to be poorly developed and possibly immature. Although it remains unclear whether all examined males are immature, further morphological clarification, including the discovery and characterization of females, is required.

***Galloisiana harimensis* sp. nov.**
https://zoobank.org/B31B6083-4D81-4F51-BE92-0FA12DC31BA2
Figs 2–3, 8A, B

Galloisiana sp. 5 in Fig. 1.
Galloisiana sp. 5: Nakahama and Uchifune 2016, 169, fig. 02–10, 02–11.

Japanese name. Harima-Garoa-mushi.

Type material. • ***Holotype* male** (MNHAH B2-595378), Funakoshi, Sayo-cho, Sayo-gun, Hyogo Pref., 6.XII.2022, T. Yamasaki leg. ***Paratypes*:** • 2 females (MNHAH B2-595376, B2-595377), same locality and date as in holotype, N. Nakahama leg.; • 1 male (MNHAH B2-595385), same locality, 10.XII. 2025, H. Osaki leg.; • 2 females (MNHAH B2-595386, MNHAH B2-595387), same locality, N. Nakahama leg.; • 1 male (004 MNHAH B2-595386), • 1 female (MNHAH B2-595393, MNHAH B2-595394, MNHAH B2-595389), • 1 juvenile (MNHAH, no registration), same locality, 8.XII.2018–13.III.2019, by bait trap, R. Wakimura leg.; • 1 female (MNHAH B2-595395), • 1 juvenile (MNHAH, no registration), same loc.,1. IV.2018–16.VII.2018, by bait trap, R. Wakimura leg.

Diagnosis. The presence of compound eyes readily distinguishes *G. harimensis* sp. nov. from the following three species, all of which lack compound eyes: *G. chujoi*, *G. notabilis*, and *G. ussuriensis*. Based on the Ant3L/Ant2L ratio, *G. harimensis* sp. nov. can be distinguished from *G. kiyosawai*, *G. kouensis*, *G. olgae*, and *G. sofiae*, all of which have values of 3.0 or more, because the value in *G. harimensis* sp. nov. does not exceed 3.0 (male: 2.00–2.40; female: 1.79–2.81). *Galloisiana harimensis* sp. nov. can be distinguished from *G. sinensis* by the shape of the posterior margin of the pronotum, which is convex in the former but concave in the latter. In addition, *G. harimensis* sp. nov. can be distinguished from *G. odaesanensis* by having more than 40 antennomeres in the former (when not damaged) and fewer than 40 in the latter.

In general appearance, *Galloisiana harimensis* sp. nov. is close to *G. nipponensis*, but the new species can be distinguished from the latter by the following characteristics; each cervical sclerite with four to six macrosetae in *G. harimensis* sp. nov., while with six to nine macrosetae in *G. nipponensis* (male, Fig. 2C vs. Fig. 6C; female, Fig. 3C vs. Fig. 7C). In male, sclerotized apical surface of left phallomere with a distinct bump, while without bump in *G. nipponensis* (Figs 2E, 8C vs. Figs 6E, 8E). For differences between *G. harimensis* sp. nov. and *G. kawamurai* sp. nov., see Diagnosis in *G. kawamurai* sp. nov.

Measurements (2 males/3 females). Head width 3.40–3.70/4.00–4.60. Eye length 0.41–0.42/0.38–0.50; width 0.18–0.20/0.18–0.26. Interorbital distance 2.93–3.20/3.95. Antennomere length I, 0.53–0.60/0.58–0.65; II, 0.25/0.26–0.30; III, 0.50–0.60/0.50–0.73. Maxillary palpomere III, 0.67–0.81/0.75–0.81; IV, 0.58–0.73/0.62–0.75. Pronotum length 3.60–3.90/3.95–4.45; width 3.35–3.40/3.45–

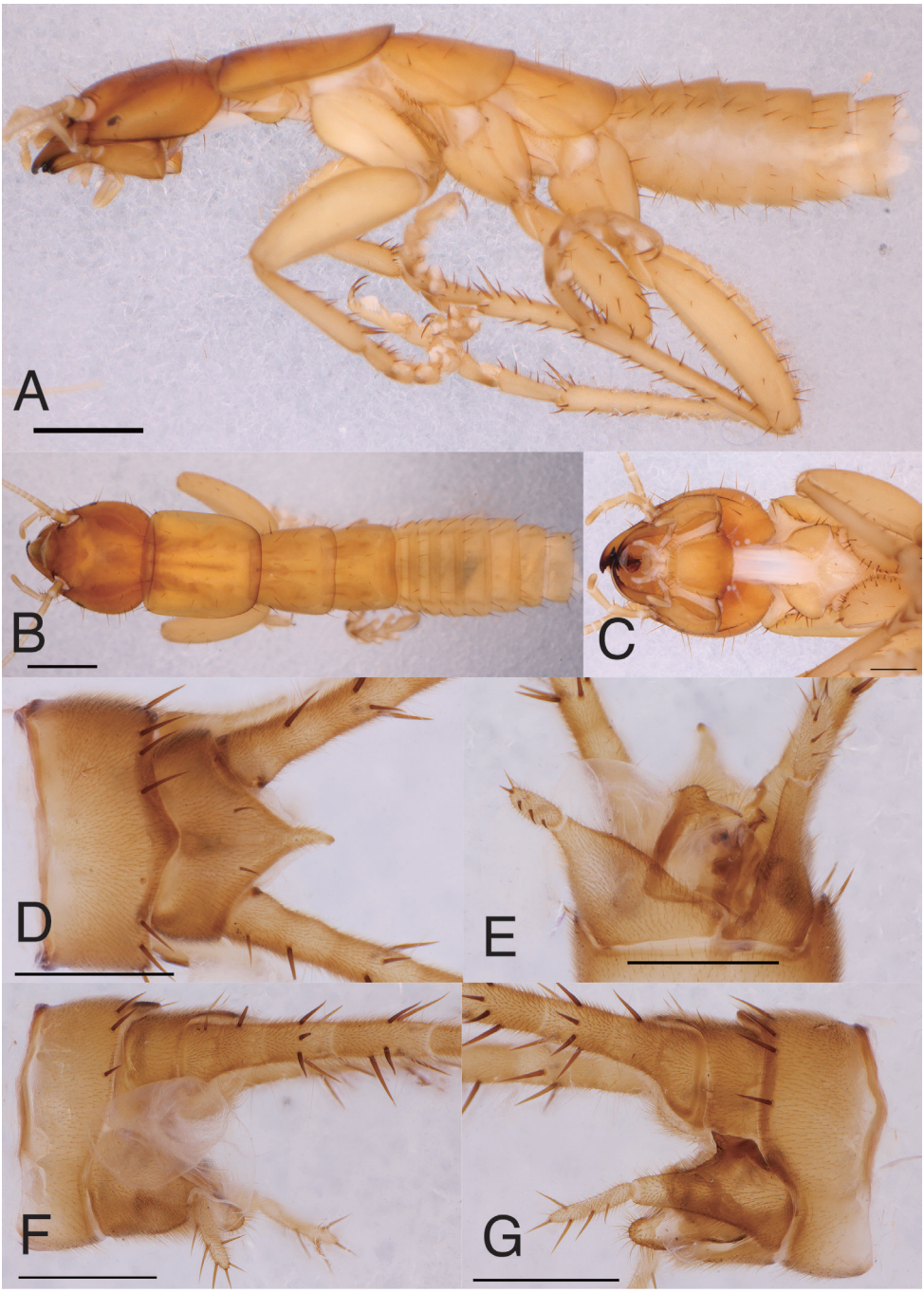

Figure 2. *Galloisiana harimensis* sp. nov., male (B2-595378). **A** habitus, lateral view **B** habitus, dorsal view **C** head and pronotum, ventral view **D** subgenital plate, dorsal view **E** genitalia, ventral view **F** same, right **G** same, left. Scale bars: 2 mm (**A, B**); 1 mm (**C–G**).

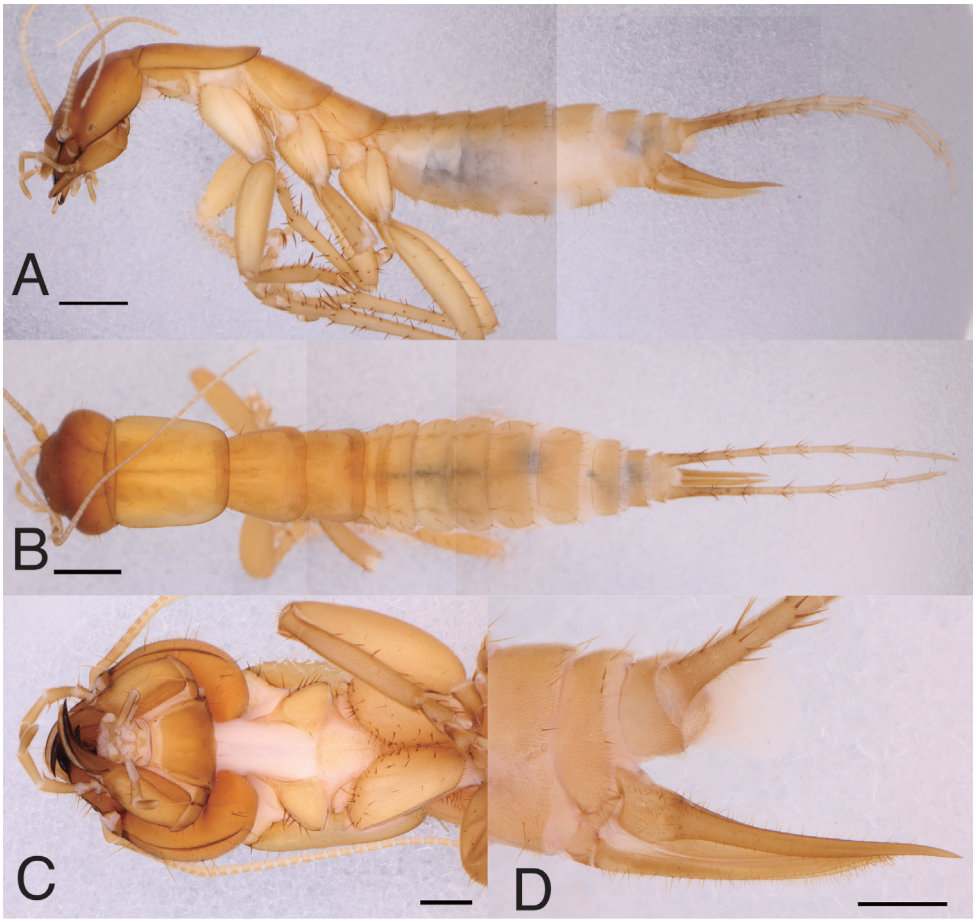

Figure 3. *Galloisiana harimensis* sp. nov., female (B2-595376). **A** habitus, lateral view **B** habitus, dorsal view **C** head and pronotum, ventral view **D** ovipositor, lateral (left) view. Scale bars: 2 mm (**A, B**); 1 mm (**C, D**).

3.85. Subgenital plate length 0.97–1.02; width 1.37–1.55. Right coxopodite length 0.83–1.03; width 1.25–1.28. Right stylus length 0.70–0.73. Left coxopodite length 1.12–1.33; width 0.85. Left stylus length 0.70–0.76. Ovipositor length dorsal 3.70–4.00; ventral 3.35–3.65.

Male (Fig. 2A–C). Antennomere number on right antennae 32 to 42 and on left antennae 41 to 42; third antennomere longer than second one; Ant3L/Ant2L more than 2.00. Compound eyes well-developed, tinged with black. Interocular distance slightly narrower than pronotum width. Maxillary palpomere IV very slightly shorter than maxillary palpomere III. Pronotum longer than wide; square-shaped with convex anterior and truncated posterior margins. Each cervical sclerite with five macrosetae, sometime with additional fine two setae. Cerci composed of ten cercomeres.

Genitalia (Figs 2D–G, 8A, B). Subgenital plate with long distal process. Right coxopodite with narrow part apically, which is longer than that of left coxopodite; in-

ner margin of right coxopodite weakly concave in proximal half in ventral view; dorsal margin of right coxopodite bearing flatten projection, which is usually hidden between copulatory sclerite and subgenital plate. Left coxopodite with short narrow part apically; inner margin sloping with very weak undulation. Right phallomere weakly sclerotized in entire right surface. Left phallomere mainly membrane, with belt-shaped sclerotized zone running dorsoventrally; distal surface of sclerotized zone with distinct bump. Principal copulatory process well-sclerotized, apically with two wing-like projections.

Female (Fig. 3A–C). Antennomere number on right antennae 41 to 43 and on left antennae 42; third antennomere longer than second one; Ant3L/Ant2L varying 1.79–2.81. Compound eyes well-developed, tinged with black. Interocular distance slightly wider than pronotum width. Maxillary palpomere IV very slightly shorter than maxillary palpomere III. Pronotum longer than wide; square-shaped with convex anterior and truncated posterior margins. Each cervical sclerite with four to six macrosetae, sometime with additional fine one or two setae. Cerci composed of ten or eleven cercomeres.

Ovipositor (Fig. 3D). Both dorsal and ventral valves shorter than pronotum, weakly curved.

Etymology. The specific name "*harimensis*" refers to "Harima" which is the old name for the central-western area of Hyogo Prefecture, Japan.

Galloisiana kawamurai sp. nov.

https://zoobank.org/69F3B949-562F-456E-B0C4-9C27EB89BC67

Figs 4, 5, 8C, D

Galloisiana. sp. 4 in Fig. 1.

Japanese name. Suzuka-Garoa-mushi.

Diagnosis. The presence of compound eyes readily distinguishes *G. kawamurai* sp. nov. from the following three species, all of which lack compound eyes: *G. chujoi*, *G. notabilis*, and *G. ussuriensis*. Based on the Ant3L/Ant2L ratio, *G. kawamurai* sp. nov. can be distinguished from *G. kiyosawai*, *G. kouensis*, *G. olgae*, and *G. sofiae*, all of which have values of 3.0 or more, because the value in *G. kawamurai* sp. nov. does not exceed 3.0 (male: 2.00–2.28; female: 1.90–2.22). *Galloisiana kawamurai* sp. nov. can be distinguished from *G. sinensis* by the shape of the posterior margin of the pronotum, which is convex in the former but concave in the latter. In addition, *G. kawamurai* sp. nov. can be distinguished from *G. odaesanensis* by having four macrosetae on the cervical sclerite in the former and six in the latter.

In general appearance, *Galloisiana kawamurai* sp. nov. is close to *G. nipponensis* and *G. harimensis* sp. nov., but *G. kawamurai* sp. nov. can be distinguished from the latters by the following characteristics; each cervical sclerite with three or four macrosetae in *G. kawamurai* sp. nov., while with eight macrosetae in *G. nipponensis* (male, Fig. 4C vs. Fig. 6C; female, Fig. 5C vs. Fig. 7C), and four or five macrosetae in *G. harimensis* sp. nov. (male, Fig. 4C vs. Fig. 2C; female, Fig. 5C. vs. Fig. 3C). In male,

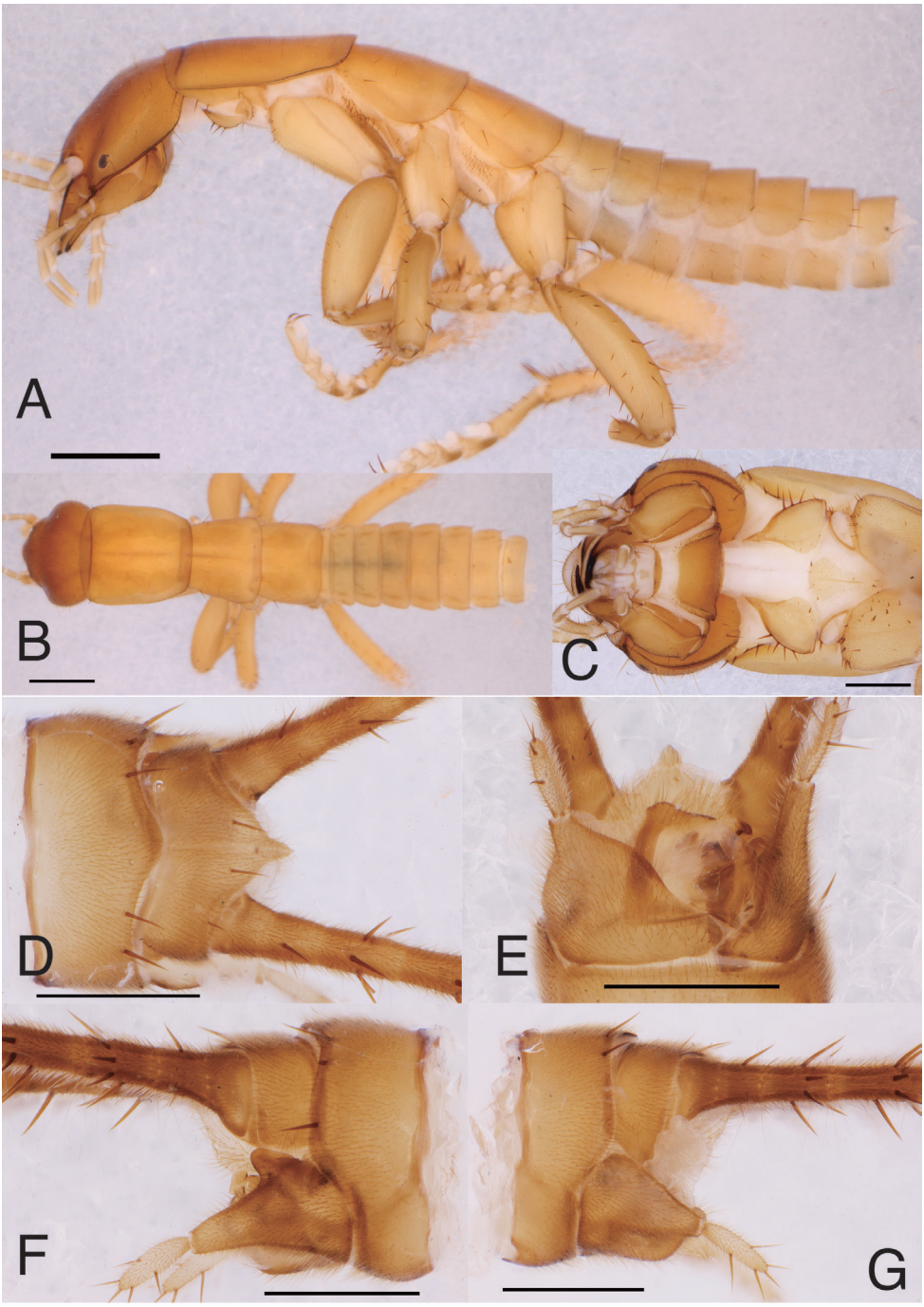

Figure 4. *Galloisiana kawamurai* sp. nov., male (B2-595371). **A** habitus, lateral view **B** habitus, dorsal view **C** head and pronotum, ventral view **D** subgenital plate, dorsal view **E** genitalia, ventral view **F** same, right **G** same, left. Scale bars: 2 mm (**A, B**); 1 mm (**C–G**).

distal process of subgenital plate very short in *G. kawamurai* sp. nov., while long in *G. nipponensis* and *G. harimensis* sp. nov. (Figs 4D, 8D vs. Figs 2D, 6D, 8B, F); stylus slender oval in *G. kawamurai* sp. nov., while slender tube-shaped in *G. nipponensis* and *G. harimensis* sp. nov. (Fig. 4E–G vs. Figs 2E–G, 6E–G); distal surface of right phallomere with a weak bump in *G. kawamurai* sp. nov., while without bump in *G. nipponensis* (Figs 4E, 8C vs. Figs 6E, 8E) and with distinct bump in *G. harimensis* sp. nov. (Figs 4E, 8C vs. Figs 2E, 8A).

Type material. • ***Holotype*** **male** (MNHAH B2-595371), 35.207508°N, 136.446975°E, Shinodachi, Fujiwara-cho, Inabe-shi, Mie Pref., 21.XI.2021, K. Kawamura leg. ***Paratypes*****:** • 1 female (MNHAH B2-595372), same data as in the holotype; • 1 male (MNHAH B2-595373), same locality, 23.XI.2021, K. Kawamura leg.; • 1 female (MNHAH B2-595374), same locality, 23.XI.2021, K. Kawamura leg.

Another specimen examined. • 1 female (MNHAH B2-595375), 35.258477°N, 136.368730°E, Kawachi, Taga-cho, Inukami-gun, Shiga Pref.

Measurements (2 males/3 females). Head width 3.10–3.35/3.15–3.75. Eye length 0.31–0.37/0.35–0.46; width 0.17–0.18/0.16–0.25. Interorbital distance 2.73–3.05/2.70–3.35. Antennomere length I, 0.52/0.46–0.56; II, 0.18–0.21/0.18–0.25; III, 0.41–0.42/0.38–0.43. Maxillary palpomere III, 0.62–0.68/0.61–0.73; IV, 0.51–0.62/0.56–0.70. Pronotum length 3.50–3.75/3.10–4.00; width 2.85–3.25/2.65–3.30. Subgenital plate length 0.72–0.77; width 1.25–1.40. Right coxopodite length 0.96–1.05; width 0.76–0.80. Right stylus length 0.58–0.60. Left coxopodite length 0.83–0.90; width 1.05–1.20. Left stylus length 0.58–0.60. Ovipositor length dorsal 3.35–3.75; ventral 2.85–3.30.

Male (Fig. 4A–C). Antennomere number on right antennae 35 to 37 and on left antennae 36 to 37; third antennomere longer than second one; Ant3L/Ant2L more than 2.00. Compound eyes well-developed, tinged with black. Interocular distance slightly narrower than pronotum width. Maxillary palpomere IV very slightly shorter than maxillary palpomere III. Pronotum longer than wide; square-shaped with convex anterior and truncated posterior margins. Each cervical sclerite with three or four macrosetae, sometime with additional fine one seta. Cerci composed of ten cercomeres.

Genitalia (Fig. 4D–G). Subgenital plate with short distal process. Right coxopodite with narrow part apically, which is longer than that of left coxopodite; inner margin of right coxopodite weakly concave in proximal half in ventral view; dorsal margin of right coxopodite bearing flatten projection, which is usually hidden between copulatory sclerite and subgenital plate. Left coxopodite with short narrow part apically; inner margin sloping with very weak undulation. Right phallomere weakly sclerotized in entire right surface. Left phallomere mainly membrane, with belt-shaped sclerotized zone running dorsoventrally; distal surface of sclerotized zone with weak bump. Principal copulatory process well-sclerotized, apically with two wing-like projections.

Female (Fig. 5A–C). Antennomere number on right antennae 36 to 38 and on left antennae 38; third antennomere longer than second one; Ant3L/Ant2L 1.72–2.11. Compound eyes and pronotum almost same as in male. Maxillary palpomere IV very

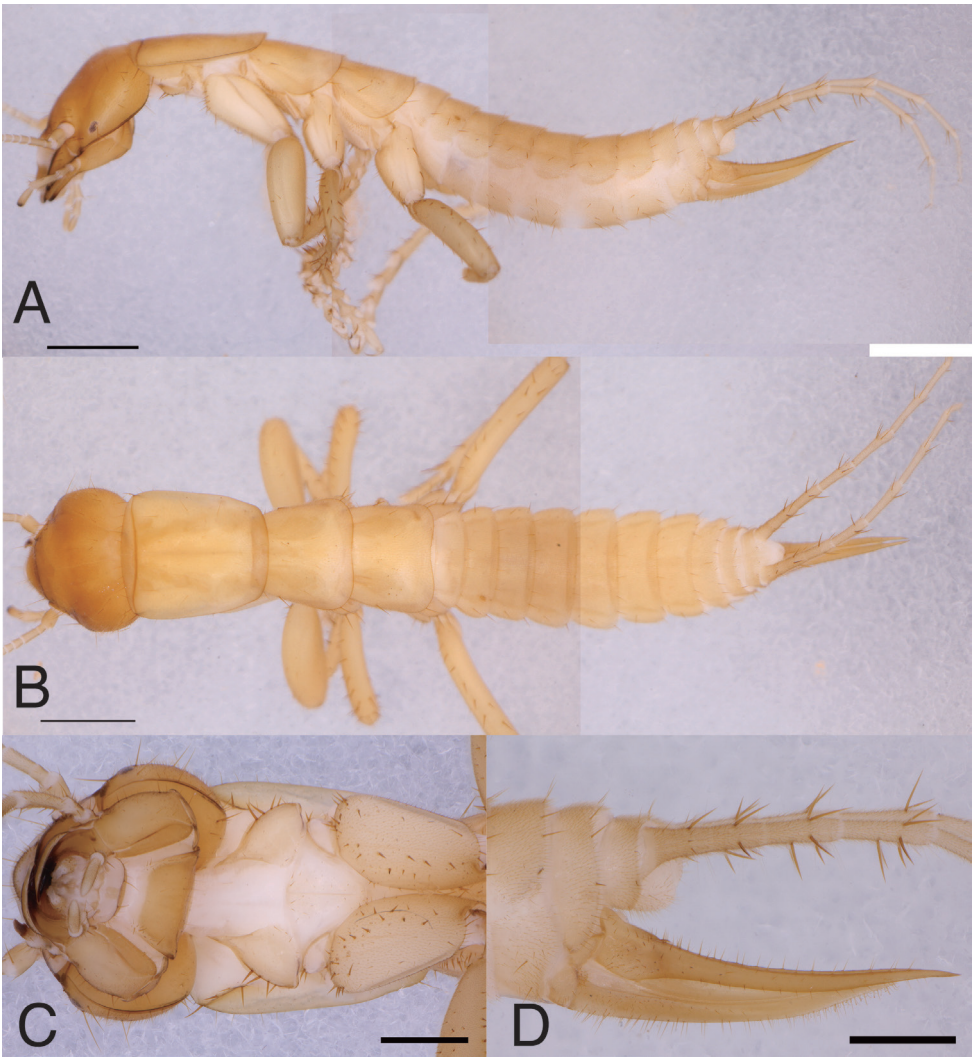

Figure 5. *Galloisiana kawamurai* sp. nov., female (B2-595374). **A** habitus, lateral view **B** habitus, dorsal view **C** head and pronotum, ventral view **D** ovipositor, lateral (left) view. Scale bars: 2 mm (**A, B**); 1 mm (**C, D**).

slightly shorter than maxillary palpomere III. Each cervical sclerite with four macrosetae, sometime with additional fine one seta. Cerci composed of ten cercomeres.

Ovipositor (Fig. 5D). Both dorsal and ventral valves shorter than pronotum, weakly curved.

Etymology. The specific name "*kawamurai*" is a patronym honoring Mr. Kohei Kawamura, in recognition of his contribution to the present study.

Remarks. The clade of *G. kawamurai* sp. nov. and *G. chujoi* is well supported (Fig. 1). Because *G. kawamurai* sp. nov. has compound eyes, it can be distinguished from *G. chujoi*. In the original description of *G. chujoi*, the lengths of maxillary pal-

pomeres III and IV were described as nearly equal (Gurney 1961), and this feature was emphasized as a diagnostic character separating the species from *G. notabilis*, which also lacks compound eyes (Nakahama and Uchifune 2016). In the present study, maxillary palpomere IV is very slightly shorter than III in *G. kawamurai* sp. nov. However, as Gurney (1961) did not provide measurements of maxillary palpomeres, a direct comparison between *G. kawamurai* sp. nov. and *G. chujoi* is not possible.

Galloisiana nipponensis (Caudell & King, 1924)

Figs 6–8E, F

Galloisia nipponensis Caudell & King, 1924: 54, figs 1–3.
Galloisiana nipponensis: Caudell, 1924: 92; Silvestri 1927: 107, figs I (1–13), II (1–8), III (1–4); Kishida 1929: 104; Matsumura 1931: 1373; Asahina and Asahina 1933: 630; Walker 1937: 9; Gurney 1937: 160, figs 2–6; Gurney 1948: 95, figs 1–2, 5–7; Asahina 1959: 250, fig. 1a–d; Gurney 1961: 74; Fukushima 1969: 16, figs A1–3; Pravdin and Strozhenko 1977: 356; Nagashima 1982: 52; Yamasaki 1982: 333; Nakahama and Uchifune 2016, 168, figs 01–07, 01–08.
Galloisidea (sic.) *nipponensis*: Shiraki, 1932: 2038.

Material examined. • 1 male (MNHAH B2-595382), 36.722512°N, 139.484130°E, southeast side of Chuzenji Lake, Chugushi, Nikko-shi, Tochigi Pref., 6.X.2024, N. Ogawa leg.; • 1 female (MNHAH B2-595381), 36.721266°N, 139.481590°E, southeast side of Chuzenji Lake, Chugushi, Nikko-shi, Tochigi Pref., 5.X.2024, N. Ogawa leg.; • 2 juveniles (MNHAH B2-595379, MNHAH B2-595380), same loc., A. Noishiki leg.; • 1 female (MNHAH B2-595392), Nishi-arakawa valley (alt. 500 m), Kamiterashima, Shioya-cho, Tochigi Pref., 21.IX.2010, N. Ogawa leg.; • 1 female (MNHAH B2-595390), Konseizawa, Nikko-shi, Tochigi Pref., 28.IX.2010, N. Ogawa leg.; • 1 female (MNHAH B2-595391), Nikko-shi, Tochigi Pref., 7.X.2012, O. Tominaga leg.

Measurements (1 male/3 females). Head width 3.90/4.00–4.10. Eye length 0.452/0.43–0.48; width 0.25/0.25–0.30. Interorbital distance 3.55/3.50–3.60. Antennomere length I, 0.62/0.55–0.65; II, 0.30/0.23–0.30; III, 0.62/0.52–0.66. Maxillary palpomere III, 0.71/0.71–0.81; IV, 0.58/0.68–0.72. Pronotum length 4.00/3.95–4.25; width 3.55/3.50–3.65. Subjenital plate length 1.05; width 1.40. Right coxopodite length 1.37; width 0.95. Right stylus length 0.78. Left coxopodite length 1.02; width 1.25. Left stylus length 0.78. Ovipositor length dorsal 3.90–4.10; ventral 3.35–3.40.

Male (Fig. 6A–C). Antennomere number on right antennae 43 and on left antennae 44; third antennomere longer than second one; Ant3L/Ant2L more than 2.00. Compound eyes well-developed, tinged with black. Maxillary palpomere IV very slightly shorter than maxillary palpomere III. Each cervical sclerite with eight macrosetae. Pronotum longer than wide; square-shaped with convex posterior edge; transverse sulcus at anterior margin convex. Cerci composed of ten cercomeres.

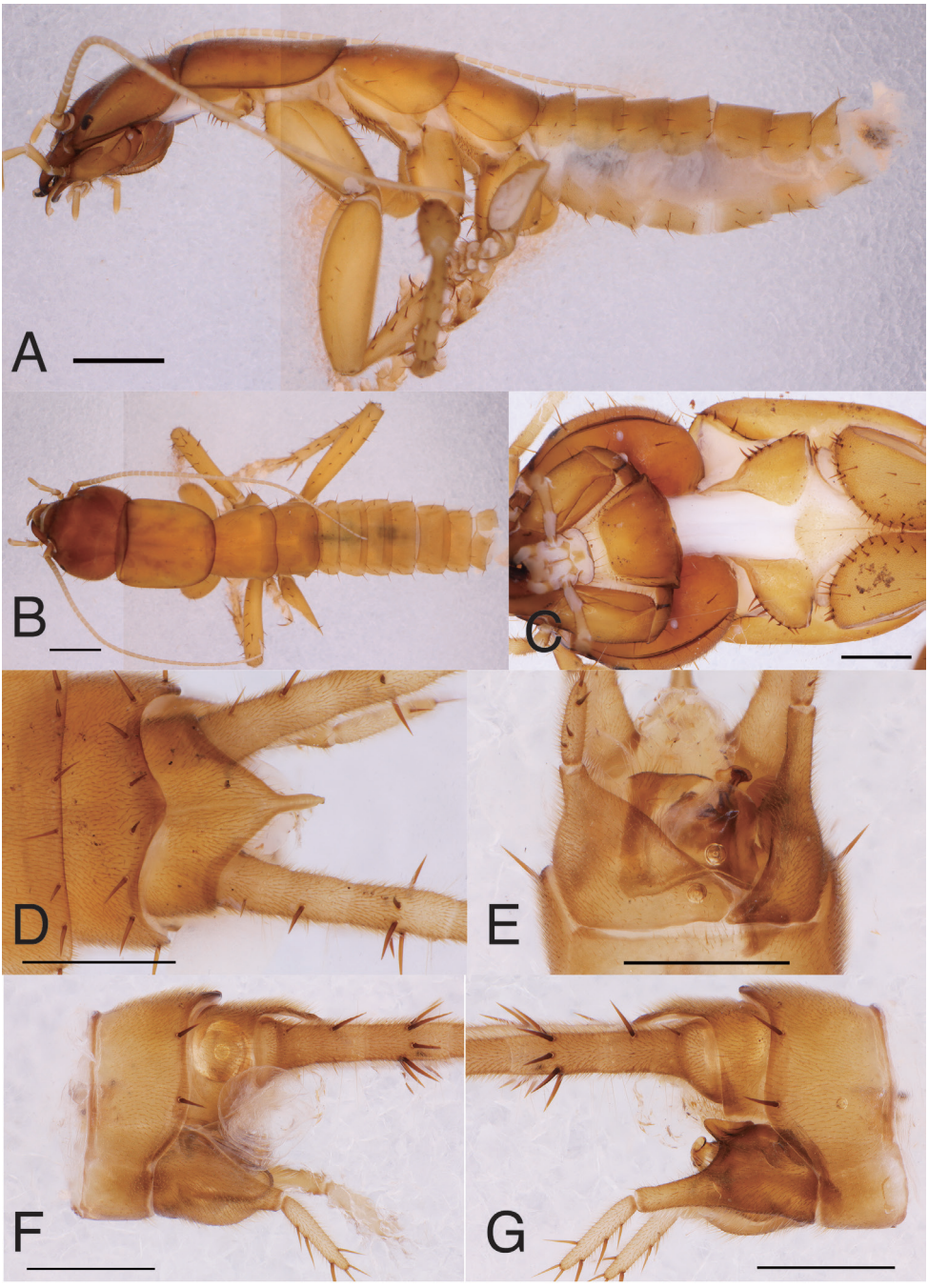

Figure 6. *Galloisiana nipponensis* (Caudell & King, 1924), male (B2-595382). **A** habitus, lateral view **B** habitus, dorsal view **C** head and pronotum, ventral view **D** subgenital plate, dorsal view **E** genitalia, ventral view **F** same, right **G** same, left. Scale bars: 2 mm (**A, B**); 1 mm (**C–G**).

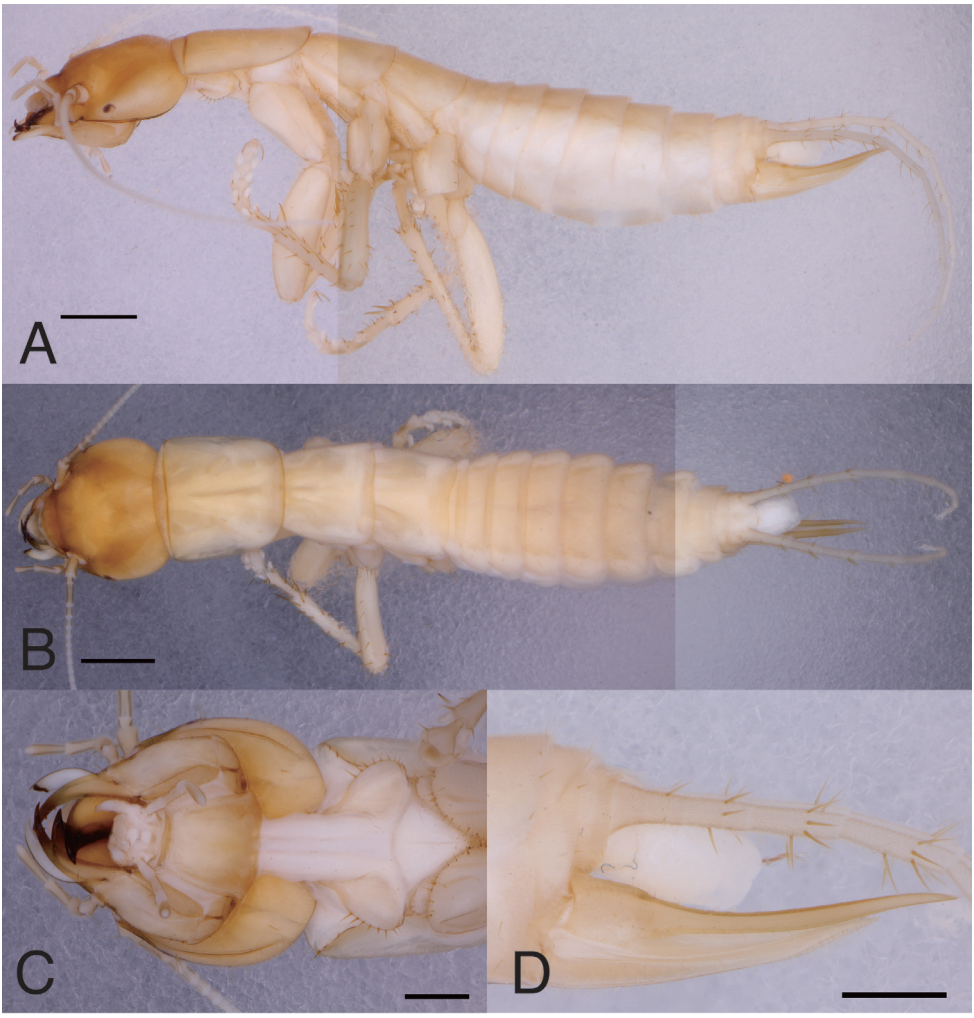

Figure 7. *Galloisiana nipponensis* (Caudell & King, 1924), female (B2-595391). **A** habitus, lateral view **B** habitus, dorsal view **C** head and pronotum, ventral view **D** ovipositor, lateral (left) view. Scale bars: 2 mm (**A, B**); 1 mm (**C, D**).

Genitalia (Fig. 6D–G). Subgenital plate with long distal process. Right coxopodite with narrow part apically, which is longer than that of left coxopodite; inner margin of right coxopodite weakly concave in proximal half in ventral view; dorsal margin of right coxopodite bearing flatten projection, which is usually hidden between copulatory sclerite and subgenital plate; right stylus long. Left coxopodite with short narrow part apically; inner margin sloping with very weak undulation; right stylus long. Right phallomere weakly sclerotized in entire right surface. Left phallomere mainly

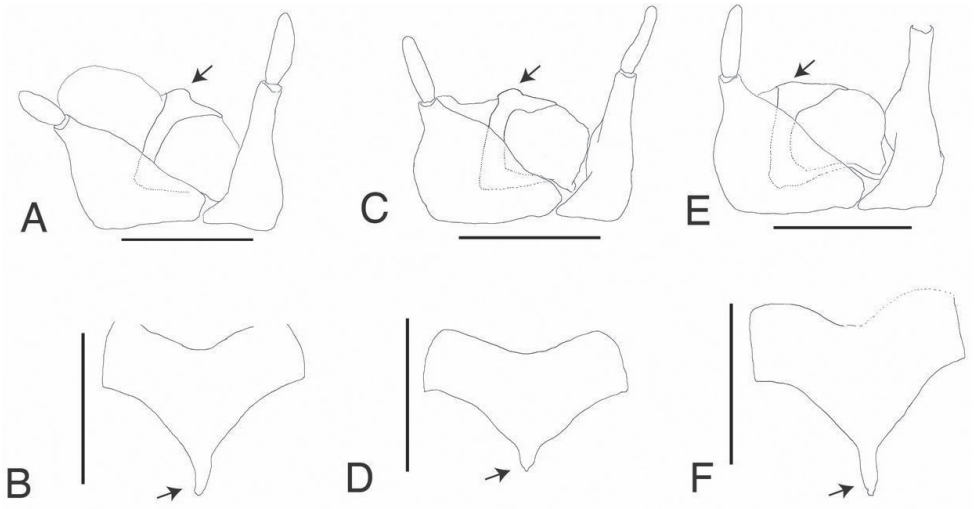

Figure 8. Comparison of male genitalia based on specimens. **A** *G. harimensis* sp. nov. (B2-595378), genitalia, ventral view **B** same, subgenital plate, dorsal view **C** *G. kawamurai* sp. nov. (B2-595371), genitalia, dorsal view **D** same, subgenital plate, ventral view **E** *G. nipponensis* (B2-595382), genitalia, ventral view **F** same, subgenital plate, dorsal view. Arrows in **A, C, E** indicate sclerotized zone of left phallomere. Arrows in **B, D, E** indicate distal process. Scale bars: 1 mm.

membrane, with belt-shaped sclerotized zone running dorsoventrally; distal surface of sclerotized zone without distinct bump. Principal copulatory process well-sclerotized, apically with two wing-like projections.

Female (Fig. 7A–C). Antennomere number on right antennae 43 and on left antennae 42 to 43; third antennomere longer than second one; Ant3L/Ant2L 2.08–2.87. Compound eyes well-developed, tinged with black. Maxillary palpomere IV very slightly shorter than maxillary palpomere III. Pronotum longer than wide; square-shaped with with convex anterior and truncated posterior margins. Each cervical sclerite with six to nine macrosetae, sometime accompany with one or two fine setae. Cerci composed of nine cercomeres.

Ovipositor (Fig. 7D). Dorsal valve almost as long as pronotum; ventral valve shorter than pronotum.

Discussion

Galloisiana harimensis sp. nov. had previously been treated as *Galloisiana* sp. 5 (Nakahama and Uchifune 2016), and *G. kawamurai* sp. nov. had also been recorded from the type-locality cave as early as the 1970s (Ichihashi et al. 1976). Although their distributions had been recognized, neither species had been formally described; thus, this study provides the first formal taxonomic description of these taxa.

Our phylogenetic analysis revealed that *G. harimensis* sp. nov. and *G. kawamurai* sp. nov. form a clade with *G. chujoi* (Fig. 1). Although Schoville et al. (2013) did not

include samples from Hyogo Prefecture, their results indicated that individuals in the Suzuka Mountains and Shikoku Island formed a single clade. Therefore, our results are consistent with those of Schoville et al. (2013). Furthermore, *G. harimensis* sp. nov., *G. kawamurai* sp. nov., and *G. chujoi* each form well-supported, distinct subclades within this clade. The phylogenetic results are also corroborated by morphological observations. Both *G. harimensis* sp. nov. and *G. kawamurai* sp. nov. possess small but distinct eyes, which clearly distinguish them from *G. chujoi*. In addition, *G. harimensis* sp. nov. and *G. kawamurai* sp. nov. can be distinguished by male genital morphology. As no male specimens of *G. chujoi* have yet been discovered, the morphology of its male genitalia remains unknown (Gurney 1961).

Additionally, numerous adult specimens have been collected from western Honshu and Shikoku, Japan; however, most available specimens are larvae or adult females because male adults are difficult to collect (Nakahama and Uchifune 2016). Because the present study relies primarily on male genital morphology for species identification, morphological identification based solely on larvae and adult females remains challenging. Consequently, further taxonomic progress will require comprehensive, systematic sampling of both male and female adults.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.
No AI tools were used in the preparation of this manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text.