



## A new species of the genus *Goera* Stephens (Trichoptera, Goeridae) found in madicolous habitats in Amami-Oshima, southwestern Japan

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### Abstract

A new species of the genus *Goera*, *G. rupicola*, is described based on adult and immature stages from Amami-Oshima, southwestern Japan. The larvae of this species inhabit wet cliff faces where water trickles over the surface. This is the first madicolous species reported in the genus *Goera*.

**Key words:** description, male, female, larva, pupa, case, wet cliff

### Introduction

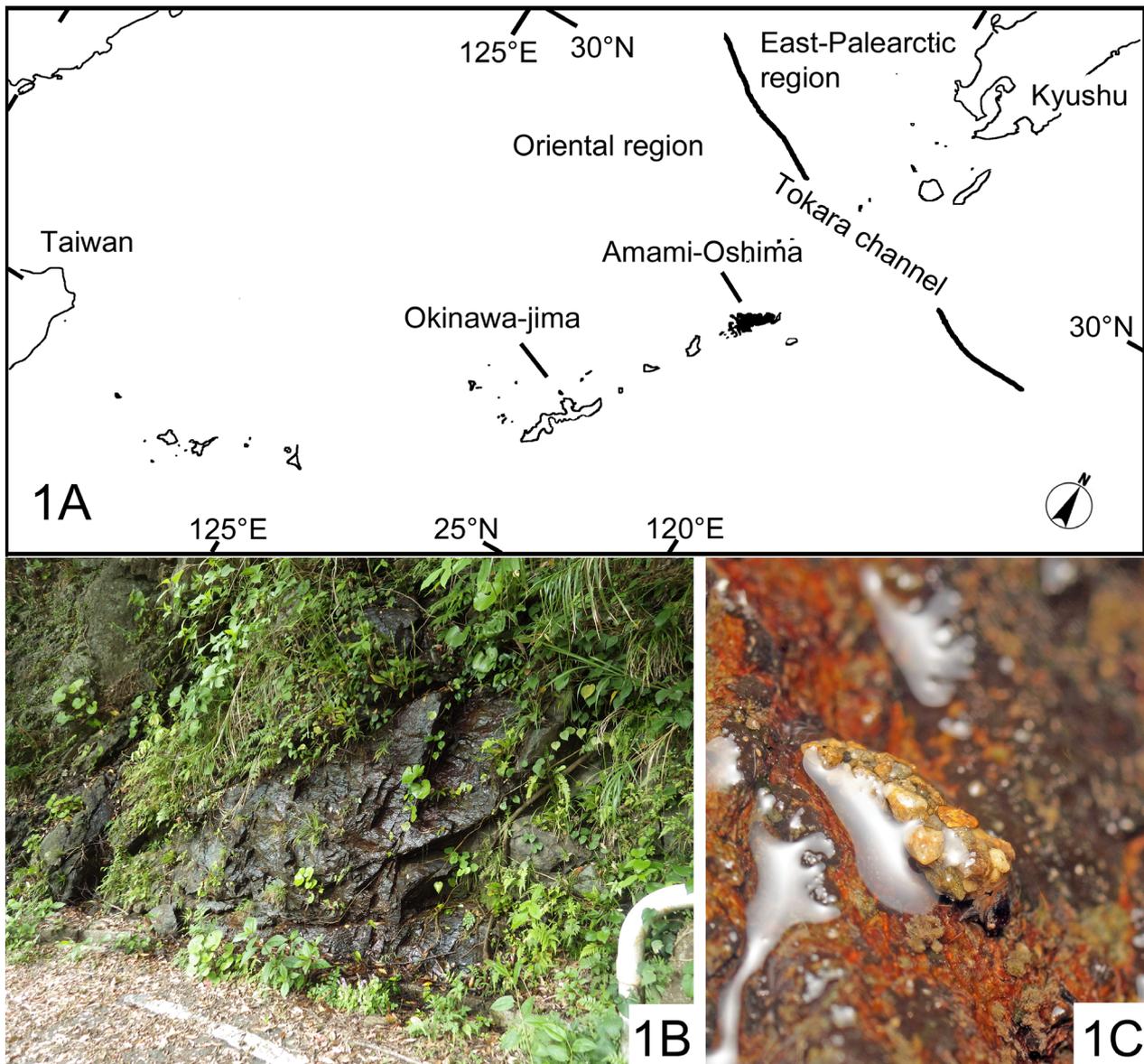
*Goera* Stephens 1829 is a large genus composed of 161 species distributed in the Holarctic, Oriental, African, and Australasian biological regions (Morse 2019). In Japan, Nozaki and Tanida (2006) reviewed Japanese species of this genus and recognized 15 species. Nozaki (2017) added two species to the Japanese fauna.

In 2013, the junior author collected several larvae of the genus *Goera* from Amami-Oshima, the second largest island in the Ryukyu Archipelago, southwestern Japan (Fig. 1A), at a locality near where they had first been observed by T. Ito and A. Ohkawa in 1999 and 2011. The larvae were crawling on a wet cliff face where water trickled over the surface (Figs. 1B, 1C), although known larval habitats of *Goera* species are running waters and open shores of lakes (Lepneva 1966, Wiggins 1996). Shimura *et al.* (2014) recognized that these larvae belonged to a different species from that of *Goera akagiae* Tanida and Nozaki 2006 (in Nozaki & Tanida 2006), which was previously known from this island. This decision was based on the examination of the larvae and also from a single female reared in the laboratory. Pupation of this female occurred on a wet stone surface above water in a small breeding container. After this interesting discovery, Messrs. S. Inaba and S. Kushibiki kindly revisited this site in 2015 and 2019, respectively, and provided us with additional material (preserved adults and larvae, and/or living larvae). Furthermore, the senior author found several larval specimens collected from another madicolous habitat in Amami-Oshima in his collection, and they were identical to the larvae mentioned above. Based on all the material in hand, we determined that we had found a new species of *Goera*.

In this paper, we describe this new species. Descriptions and illustrations of the male, female, larva, and pupa of the new species are provided. The larval habitat and biology of this species are also reported.

### Materials and Methods

Association of adult and immature stages was based on laboratory rearing. Male and female genitalia were figured after being cleared in a 10% solution of KOH. Morphological terms mainly follow Yang and Armitage (1996) for the adults, and Wiggins (1996, 2004) for the larva and pupa. The depositories of the specimens are abbreviated as follows: Natural History Museum and Institute, Chiba (CBM); S. Inaba, Shimoda-shi, Shizuoka (SI); T. Nozaki, Ninomiya-machi, Kanagawa (TN); N. Shimura, Yokohama-shi, Kanagawa (NS).



**FIGURE 1.** Location and habitat of *Goera rupicola* sp. nov. 1A, map of Ryukyu Archipelago; 1B, larval habitat at the type locality; 1C, larva on wet cliff.

***Goera rupicola* sp. nov.**

(Figs. 1C, 2, 3)

*Goera* sp.: Shimura *et al.* 2014, 47, 59.

**Diagnosis.** The male of this species can be readily recognized from congeneric members by the simple tergum X bearing only a median dorsal process. The female of this species is distinguishable from those of other known Japanese species by the shape of the supragenital plate: In ventral aspect, the posterior margin of the supragenital plate is slightly concave in this species, but convex (round or acute) in other known Japanese species (Nozaki & Tanida 2006; Nozaki 2017). The larva of this species is easily distinguishable from that of *G. akagiae* distributed in Amami-Oshima: The head is mostly reddish brown in this species, but bears a pale transverse band posterodorsally in *G. akagiae* (Nozaki 2018).

**Adult** (Figs. 2A, 2B, 2C, 2I). Body, wings, antennae dark brown in alcohol. Forewings 4.8–5.8 mm long (n = 8) in male, 4.8–6.3 mm long (n = 5) in female. Wing venation typical for genus. Antennae slightly longer than

forewings; scape long, approximately 2 times longer than head length in male, 1.5 times longer than head length in female. In male, maxillary palpi with 2nd segment long and triangular in frontal aspect; large membranous lobe arising from base of 2nd segment, elastic, constricted in middle, with scales on mesal surface and long setae on apical half of outer surface, with finger-like lobe apicomeresally. Tibial spurs 2-4-4, outer apical spur of each foretibia less than 1/2 length of inner one. Male abdominal sternite VI with 8–15 processes (n = 8); central one spatula-shaped, longer than other spine-like ones. Female abdominal sternite VI bearing 8–10 minute processes (n = 5), central one larger than others.

**Male genitalia** (Figs. 2D–2H). Segment IX short in lateral aspect, ventromesal lobe short triangular in ventral aspect. Preanal appendages very long, strongly sclerotized, fused with segment IX; each with apex directed ventromesad, narrow in lateral aspect, broader apically in dorsal and ventral aspect. Tergum X simple; median dorsal process (Figs. 2D, 2E m.d.p.) banana-shaped in lateral aspect, curved dorsad, long triangular with blunt apex in dorsal aspect, approximately 2/3 length of preanal appendages; ventrolateral processes absent. Inferior appendages, each with basal segment large, its posterior margin angulate about 1/3 from base in lateral aspect, with short blunt mesal projection in ventral aspect; distal segment with dorsolateral process smooth and triangular in lateral aspect, rectangular in ventral aspect; ventromesal process long and triangular in lateral aspect, finger-like in ventral aspect. Phallus thick, spoon-like in dorsal aspect, membranous apically.

**Female genitalia** (Figs. 2J–2K). Tergum X fused with preanal appendages, thumb-like in lateral aspect, each lobe triangular in dorsal aspect. Lamellae (Fig. 2J, 2L la) short rectangular in lateral aspect. Supragenital plate (Fig. 2L s.p.) trapezoidal, posterior margin slightly concave in middle. Gonopod plate broad, approximately 1.3 times as wide as length in ventral aspect; its apicomeresal lobe trapezoidal in ventral aspect, with short round projection apically. Spermathecal sclerite approximately half length of gonopod plate; posterodorsal part strongly sclerotized, visible in ventral aspect (marked with an arrow in Fig. 2L).

**Final instar Larva** (Figs. 1C, 3A). Length up to 7 mm. Head 0.71–0.82 mm wide (n = 10), mostly reddish brown, with transverse ridge at middle; primary seta 2 longest, approximately twice as long as seta 3; primary setae 14 and 15 located close together, both approximately 2/3 length of seta 2; seta 17 short, fine. Pronotum large, central part dome-shaped, flat laterally, each lateral margin thickened, with pair of short acute processes anterolaterally. In mesonotum, each mesal sclerite forming rounded square, with transverse ridge at posterior 1/4; each lateral sclerite with narrow anterior part and triangular posterior part, separated by ridge at middle; mesepisternum protruding anterad as long horn-like process in dorsal aspect. Metanotum with 3 pairs of sclerotized setal areas, with row of setae between *sa*2. Abdominal gills present on following segments: dorsal and ventral gills on abdominal segment II (posterior) and on segments III to VII (anterior and posterior), occasionally dorsal gills on segment VIII (anterior); gills on segment II usually single but rarely forked; gills on segments III to VII single, two- or three-branched; gills on segment VIII single. Lateral fringe present on posterior part of segment III to segment VIII, forked lamellae present laterally on segments IV to VII. Chloride epithelia long oval, present on segments VI to VIII dorsally, on segments IV to VII ventrally. Anal claws each with one accessory hook dorsally.

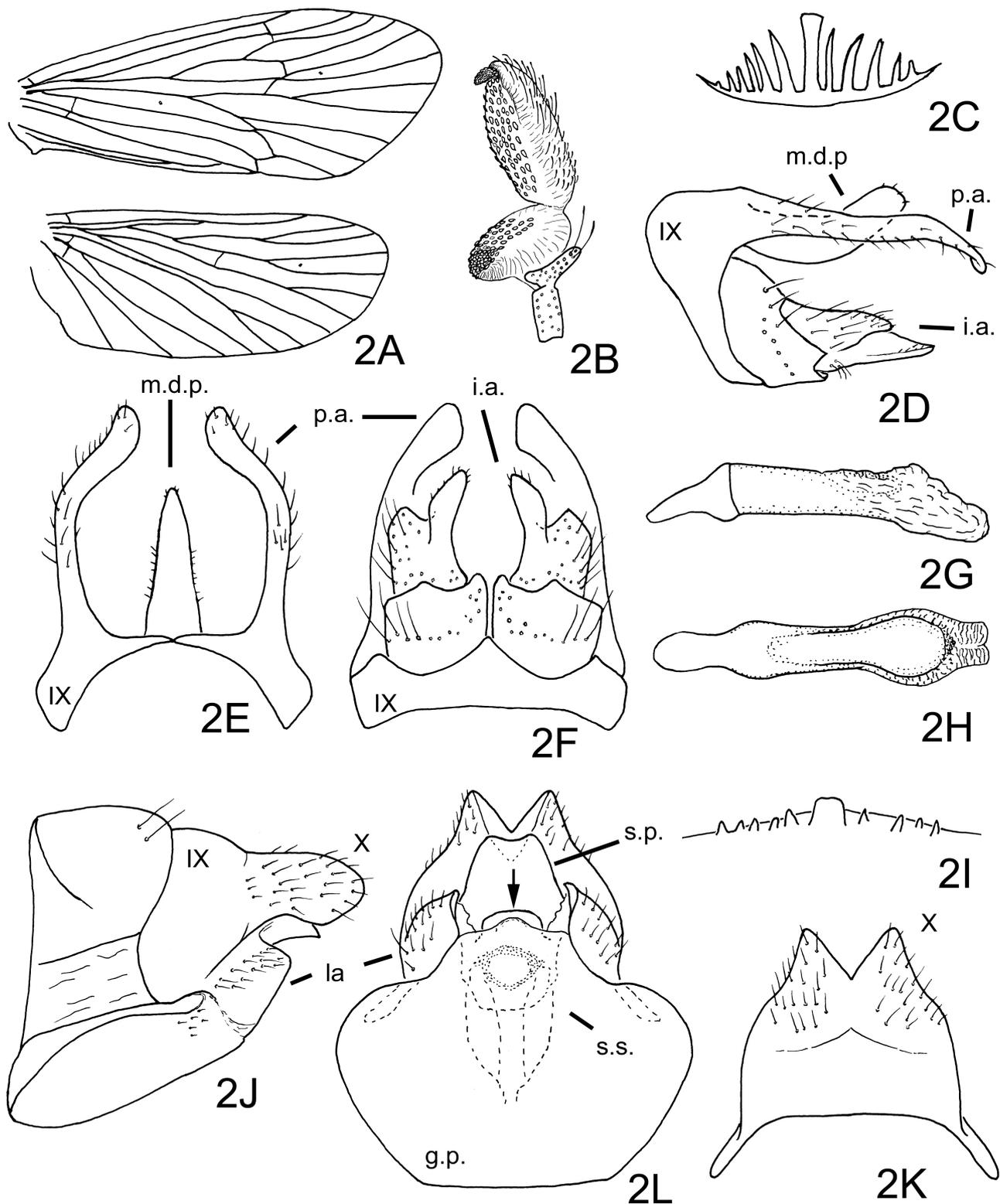
**Pupa** (3E–3H). Only pupal exuviae available for this study. Antennae approximately same length as body. Mandibles long triangular apically in dorsal aspect, without tooth. Labrum with five pairs of long, apically curved-setae near anterolaterally, with pair of short fine setae anteromesally. Tarsus of each midleg with sparse fringe of setae. Abdominal tergum I with pair of spined ridges; anterior hook plates present on terga III to VII, each with two to four spines; tergum V with pair of posterior hook plates, each with more than 20 spines. Lateral fringe present from posterior part of segment V to VIII. Abdominal gills present, single, two- or three-branched; arrangement unconfirmed because of damaged specimens. Anal process slender, with minute spines laterally; each apex curved dorsomesad, with tiny teeth.

**Case** (3B–3D, 3I–3K). Case of final instar larva up to 7 mm long, constructed of small rock fragments, with three to five larger stones along each side; posterior closure slightly bulging above center, pocket-like, with dorsal slit visible only in posterodorsal view (Fig. 3D). In pupal case, anteroventral edge fastened with silk to substrate; anterior opening closed by small stone with silk; posterior end closed by silk, with 8 or more slits along ventral margin.

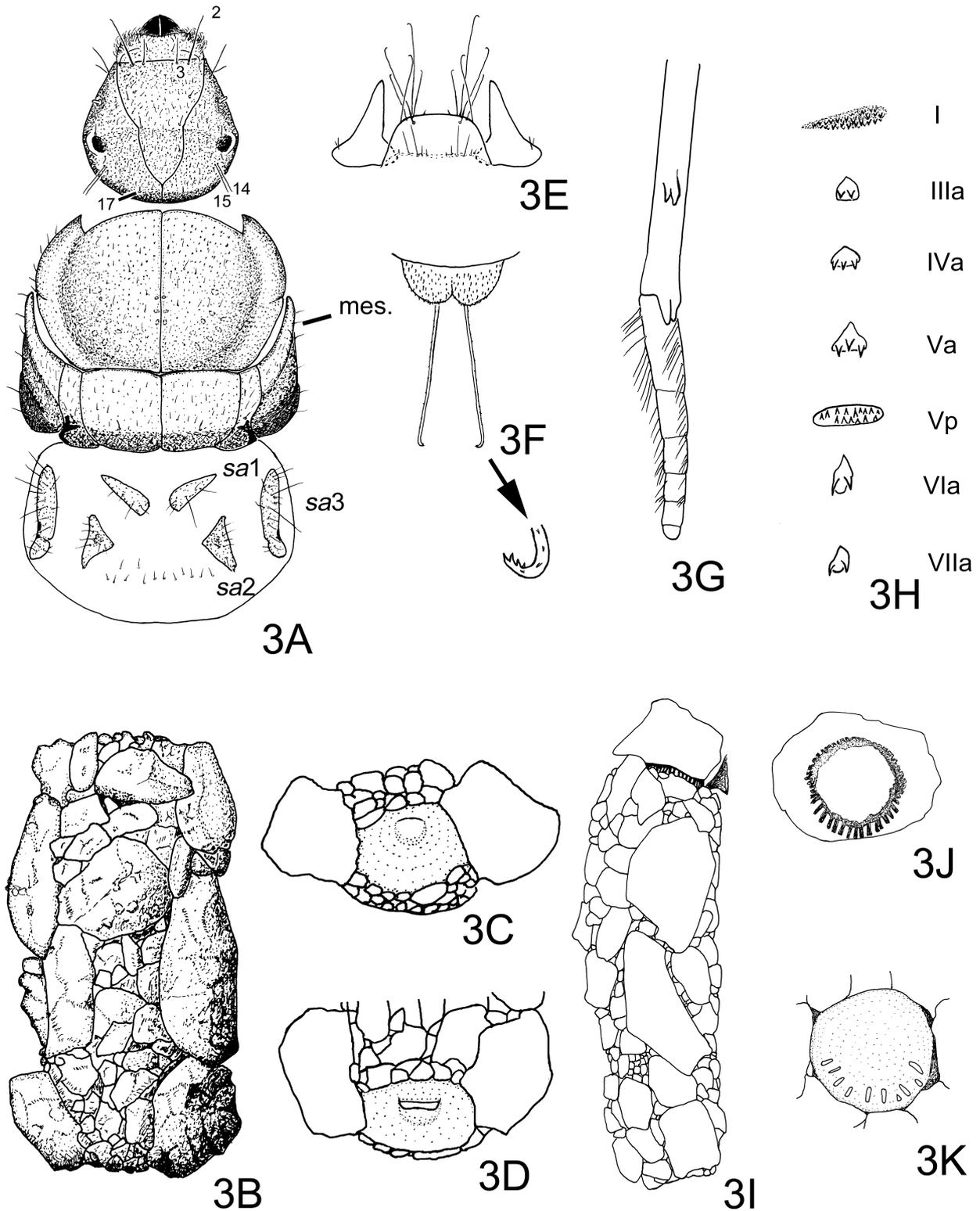
**Holotype**. Male (in alcohol). **Amami-Oshima**: Wet cliff face, Yuwangama, Yamato-son, Kagoshima, 28.355°N, 129.417°E, alt. 100 m, larva collected on 15.iii.2019 by S. Kushibiki, emerged during the period 13–26.v.2019, reared by N. Shimura (CBM-ZI 0177556).

**Paratypes**. 3 males, 4 females, same data as holotype (CBM-ZI 0177557–0177563); 3 males, same locality as

holotype, larvae collected on 15.iii.2019, adults preserved on 15.v.2019, all by S. Kushibiki (CBM-ZI 0177564–0177566).



**FIGURE 2.** Male and female of *Goera rupicola* sp. nov. 2A–2H, male: 2A, right wings, dorsal; 2B, left maxillary palpus, frontal; 2C, sternite VI posteromesal comb, ventral; 2D, genitalia, left lateral; 2E, same, dorsal; 2F, same, ventral; 2G, phallus, left lateral; 2H, same, dorsal. 2I–2L, female: 2I, sternite VI posteromesal comb, ventral; 2J, genitalia, left lateral; 2K, same, dorsal; 2L, same, ventral. Abbreviations: IX = segment IX, X = tergum X, g.p. = gonopod plate, i.a. = inferior appendage (paired), la. = lamella, m.d.p. = median dorsal process of tergum X, p.a. = preanal appendage (paired), s.p. = supragenital plate, s.s. = spermathecal sclerite. Arrow see text.



**FIGURE 3.** Final instar larva, pupa, and their cases of *Goera rupicola* sp. nov. 3A–3D, larva: 3A, head and thorax, dorsal, primary setae 2, 3, 14, 15, 17 numbered; 3B, case, dorsal; 3C, same, caudal; 3D, same, posterior part, posterdorsal. 3E–3K, pupa: 3E, labrum and mandibles, dorsal; 3F, segment X and anal processes, dorsal, apex of right anal process enlarged; 3G, tibia and tarsus of right midleg, mesal; 3H, spined ridge and hook plates (paired), dorsal; 3I, case, right lateral; 3J, anterior closure of case, posterior; 3K, posterior closure of case, caudal. Abbreviations: a = anterior; mes. = mesepisternum; p = posterior; I, III–VII = abdominal segments I, III–VII.

**Other specimens examined. Amami-Oshima:** 3 larvae, same locality as holotype, 29.iii.2014, N. Shimura (NS); 1 female with its larval and pupal exuviae, same locality as holotype, larva collected on 29.iii.2014, emerged on 30.v.2014, all by N. Shimura (TN); 1 male, same locality as holotype, 18–19.iv.2015, S. Inaba, light-pan trap (TN); 3 larvae, same locality as holotype, 18.iv.2015, S. Inaba (SI); 5 pupal exuviae, 7 pupal cases, same locality as holotype, larvae collected on 15.iii.2019 by S. Kushibiki, fixed on 13–26.v.2019 by N. Shimura (TN); 6 larvae possibly this species, madicolous habitat, near Kawauchi-gawa, Uken-son, Kagoshima, 20.iii.1999, T. Ito and A. Ohkawa (TN); 3 larvae, same locality, 25.x.2011, T. Ito (TN).

**Etymology.** *rupicola* (*rupes* + *cola*), Latin noun, “inhabitant of cliff,” referring to the larval habitat.

**Distribution.** Amami-Oshima.

**Japanese name.** Iwa-ningyo-tobikera.

**Remarks.** Dr. T. Ito provided us with several larval specimens collected from madicolous habitats in 1999 in Okinawa-Jima, the largest island in the Ryukyu Archipelago. Although these larvae and their cases are identical to those of *G. rupicola* sp. nov., we reserve the identification of the Okinawa-jima population until adult male specimens become available. A related species, indistinguishable from our new species by the larval stage, could be distributed in Okinawa-jima. For example, *Goera akagiae* and *Goera uchina* Tanida and Nozaki 2006 (in Nozaki & Tanida 2006) are distributed in Amami-Oshima and Okinawa-jima, respectively, but they cannot be separated from each other by larval morphology (Nozaki & Tanida 2006).

## Biological notes

Larvae of the genus *Goera* typically live in running waters and also at lake shores (Lepneva 1966, Wiggins 1996). *Goera akagiae*, a previously known species in Amami-Oshima, is distributed widely from small mountain brooks to large lowland streams (Nozaki & Tanida 2006; Shimura *et al.* 2014). However, larvae of *G. rupicola* sp. nov., the second *Goera* species from this island, were found only from two madicolous habitats in mountain areas. At the type locality, the larvae of this species were attached on the exposed cliff face over which a thin layer of water flows (Figs. 1B, C), and from which they were easily picked with forceps. The cliff is adjacent to a road, and isolated from a mountain stream. The environment at another site in Uken-son was very similar to that of the type locality, and the larvae were also easily found on the rock surface (Ito personal communication 7 July 2019). In laboratory observation, larvae of this species usually crawled on wet stones above water. Furthermore, the pocket-like slit which opens the posterior silken closure of the larval case may be related to this habitat. The posterior opening in cases of other *Goera* species is usually reduced with silk to a small aperture (Wiggins 1996, 2004).

The anterior opening of the larval case was tightly closed by a phragmotic shield combining the pronotum and adjacent regions of the head and mesonotum when the junior author maintained the breeding container. He could not pull the living larva from its case with forceps.

Pupation occurred also on the wet stone surface, although we could not obtain any pupal specimens in the field. Pupal exuviae of this species bear only sparse setae on their mesotarsi, not forming “swimming legs.” This reduction must reflect their habitat. These results suggest that *G. rupicola* sp. nov. is a madicolous species, unique within the genus *Goera*.

Gut contents of larvae (n = 2) were mostly fine organic particles with a small proportion of fine mineral particles and diatoms. In laboratory rearing, larvae fed on periphyton by scraping from the wet surface of stones brought from a natural river.

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