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Redescription of mature larva and biological notes on the nominotypical subgenus *Gonioctena* Chevrolat (Coleoptera: Chrysomelidae: Chrysomelinae) from South Korea

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Abstract

The mature larvae of the nominotypical subgenus *Gonioctena* Chevrolat, 1836 are redescribed and illustrated: *G. coreana* (Bechynĕ, 1948), *G. gracilicornis* (Kraatz, 1879), *G. jacobsoni* (Ogloblin & Medvedev, 1956), and *G. viminalis* (Linnaeus, 1758). The tubercular pattern, chaetotaxy, and shape of tarsugulus were used as diagnostic characters for the species determination of *Gonioctena* s. str. larvae. The literature on larval morphology of each species has been summarized. Furthermore, the biology, behavior, and host plant are presented. Ovoviviparity is newly reported in *G. coreana*.

Key words: Leaf beetles, *Gonioctena*, larva, morphology, biology, ovoviviparity

Introduction

The genus *Gonioctena* Chevrolat, 1836 is one of the largest genera of the leaf beetle subfamily Chrysomelinae, with more than 110 valid species in nine subgenera (Cho 2016, 2017a, b; Cho & Borowiec 2016; Cho *et al*. 2016a, b; Sprecher-Uebersax & Daccordi 2016). The nominotypical subgenus is the most speciose and widely distributed, with 46 described species known from the Holarctic and Oriental Regions. Members of the subgenus *Gonioctena* can be easily distinguished from those of other subgenera by the presence of pronotal trichobothria only on the posterior angles. The adults and larvae of the subgenus feed externally on the foliage of various Betulaceae, Fabaceae, Rosaceae, and Salicaceae species, but each species has a narrow range of host plants (Jolivet & Hawkeswood 1995; Mardulyn *et al.* 1997). Ovoviviparity is the most common mode of reproduction in the nominotypical subgenus (Bontems 1988; Cho & Borowiec 2014), and it is associated with the reduction in the thickness of the egg chorion and the size of the egg bursters (Cox 1994). The larva of *Gonioctena* s. str. is characterized by a pair of defensive glands on the anterior margin of the abdominal segment VIII; they are everted when faced with a threat (Fig. 44).

The literature concerning to larval morphology of 23 species (50%) of *Gonioctena* s. str. is already available (Chapuis & Candèze 1853; Letzner 1855; Hennig 1938; Peterson 1960; Kimoto 1962b; Medvedev 1964; Ogloblin & Medvedev 1971; Kimoto & Takizawa 1994, 1997; Steinhausen 1994; Cho & Lee 2010; Suenaga 2012, etc.). The major contribution was made by Takizawa (1976, 1989), who presented the complete larval descriptions of Japanese and Canadian species, with notes on biology and subgeneric classification. Medvedev & Zaitsev (1978) gave a key to the mature larvae of the species from the Russian Far East, which was subsequently modified by Medvedev & Zaitsev (1980), Medvedev (1982), and Zaitsev & Medvedev (2009). However, a detailed morphological description of the mature larva of various species, including tubercular pattern, chaetotaxy, and lower mouth parts, is unavailable, which makes it difficult to identify them. Herein, the inadequately described mature larva of *Gonioctena coreana* (Bechynĕ), *G. gracilicornis* (Kraatz), *G. jacobsoni* (Ogloblin & Medvedev), and *G. viminalis* (Linnaeus) is redescribed and illustrated in detail. The literature on larval morphology, key, and illustration of each species has been summarized. Notes on biology, ovoviviparity, host plant, and a key to the mature larva of Korean *Gonioctena* are also provided.

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Material and methods

The adults and larvae collected from field were maintained in plastic containers (10 cm diameter and 12 cm deep) with leaves of host plant and examined daily. All larval specimens used in the study were preserved in 70% ethanol. To examine the morphological characters, some larvae were dissected, cleared in 10% sodium hydroxide solution, rinsed with distilled water, and then mounted on slides with glycerine and Swan's liquid (20 g distilled water, 15 g gum arabic, 60 g chlorhydrate, 3 g glucose, and 2 g glacial acetic acid). Descriptions and illustrations were prepared using a Nikon SMZ800 stereomicroscope and a Nikon ECLIPSE 80i light microscope with phase contrast; each microscope was equipped with a camera lucida. The terminology used on the larval tubercle follows Kimoto (1962a) and Takizawa (1976). In the description, the letters L, S, and M after Arabic numerals within parentheses signify long, short, and minute setae on the tubercle, respectively. The studied material has been deposited in the entomological collection of the Nakdonggang National Institute of Biological Resources, Sangju and H.-W. Cho's private collection, Yecheon, South Korea.

Results

Gonioctena coreana (Bechyně, 1948)

(Figs 1–6, 25, 30–33)

Gonioctena (*Gonioctena*) *coreana*: Medvedev & Zaitsev 1978: 118 (key to larva, illustration of abdominal segment I); Zaitsev & Medvedev 2009: 145 (key to larva, after Medvedev & Zaitsev 1978).

Last instar larva. Body length 9.8–11.0 mm, width 3.1–3.3 mm, head width 1.80–1.90 mm (n = 5). Body elongate, rather broad, widest at abdominal segments III–IV, thence moderately narrowed posteriorly and slightly convex dorsally (Fig. 1). General coloration of integument yellowish-white, but densely covered with strongly sclerotized platelets; dorsal tubercles dark brown, whereas ventral ones paler; head blackish-brown with anterior half of clypeus yellowish-brown; legs dark brown to brown. Eversible glands present on anterior margin of abdominal segment VIII. Pseudopods absent.

Head. Hypognathous, rounded, strongly sclerotized (Fig. 2). Vertex with 4 pairs of minute setae; epicranium with 8 pairs of setae; temporal side of head with 2 pairs of setae. Epicranial suture distinct; frontal suture not reaching antennal socket; endocarina well developed. Frons slightly depressed medially, with 5 pairs of setae. Clypeus almost straight at anterior margin, with 3 pairs of setae. Labrum deeply emarginate with 2 pairs of setae and 1 pair of campaniform sensilla placed medially and 2 pairs of minute setae placed at anterior border (Fig. 4); epipharynx with 4 pairs of stout setae at anterior margin. Mandible palmate, 5-toothed, with 2 setae and 2 campaniform sensilla (Fig. 6). Maxillary palp 3-segmented; palpomere I transverse with 1 seta and 2 campaniform sensilla; II rectangular with 3 setae and 1 campaniform sensillum; III subconical with 1 seta, 1 digitiform sensillum and 1 campaniform sensillum on sides and a group of peg-like sensilla at the apex; palpifer distinct with 2 setae (Fig. 5). Mala rounded with 15 setae and 1 campaniform sensillum; stipes longer than wide with 3 setae; cardo with 1 seta. Labial palp 2-segmented; palpomere I rectangular with 1 campaniform sensillum; II subconical with 1 campaniform sensillum on outer margin and a group of peg-like sensilla at the apex. Hypopharyngeal area with 3 pairs of minute setae and 2 pairs of campaniform sensilla. Prementum with 1 pair of setae; postmentum widely covered with spinules, with 3 pairs of setae. Stemmata 6 on each side, 4 of them located above antenna and 2 behind antenna. Antenna short, 3-segmented; antenomere I transverse with 2 campaniform sensilla; II stout, more or less as wide as long, with a conical sensorium and 4 minute setae apically; III subconical with 6 minute setae apically.

Thorax. Prothorax with D-DL-EP (47–54L 5–7S) largest; P (5–6S); ES-SS (5–6S) (Fig. 25). Meso- and metathorax with Dai (1L 2S); Dae (1L 1–3S); ad1 (1M) and ad2 (1M); DLai (2–4S); Dpi (1L 3–4S); Dpe-DLpi (3–5L 2–7S) larger than Dpi; DLe (4–7L 6S 3M) large and produced laterally; EPa (4–6S); EPp (3–4L 1–3S); P (3–4S); SS (1S); ES (2–3S); sternal region with 4 additional setae arising from sclerotized bases. Mesothoracic spiracles annuliform; peritreme fused with EPa. Legs rather stout; tibia with 9 setae; tarsungulus large, strongly curved, basal tooth well developed, with 1 seta (Fig. 3).

Abdomen. Segments I–V with Dai (1L 2–3S) on both sides fused; Dae (1L 4S 1M); DLai (1L 3–4S); DLae (1S

2M) small, sometimes divided into 2 tubercles; Dpi (1L 3–4S); Dpe (1L 3–4S); DLp (3L 1–2S); EP (4–6L 3–5S) produced laterally; P (3L 2S 1M); PS-SS (4–5S); ES (2S); as1 (1M) and as2 (1S). Segment VI with Dai and Dae, Dpi and Dpe fused respectively. Segments VII–VIII each with dorsal and dorso-lateral tubercles completely fused (6–8L 10–13S 1M and 6–9L 7–13S 7–12M respectively). Segment IX with dorsal to epipleural tubercles completely fused (7L 11–12S 2M). Segment X with pygopod well developed. Spiracles present on segments I–VIII.

Diagnosis. The last instar larva of *Gonioctena coreana* is very similar to those of *G. gracilicornis* and *G. viminalis* in the body shape, coloration, and tubercular pattern. However, this species can be distinguished by the tubercle Dai on meso- and metathorax with 1 long and 2 short setae (1 long and 1 short setae in the other species), and Dpi on both sides of abdominal segments I–V completely separated (completely fused in *G. gracilicornis* and weakly fused in *G. viminalis*).

Material examined. 16 larvae, South Korea, Gangwon Prov., Samcheok, Wondeok-eup, Nogok-ri, Gilgok Valley, 37°12'50.7"N, 129°19'04.1"E, 9.V.2005, H.W. Cho; 11 larvae, South Korea, Gyeongbuk Prov., Yeongyang-gun, Subi-myeon, Suha-ri, Suha Valley, 36°49'46.9"N, 129°16'08.8"E, 7.V.2005, H.W. Cho; 21 larvae, same data as preceding one except for 30.IV.2006.

Distribution. Mongolia, Russia (Far East), China (Jilin), North Korea, South Korea.

Biological notes. Overwintered adults appear during late April; they mate and lay eggs on the leaves of *Salix gracilistyla*. The females laid larvae that were enclosed within chorion (Fig. 30), and they hatched after several hours; therefore, this species is ovoviviparous. The early instar larvae gregariously feed on young leaves (Fig. 31), but become solitary as they mature (Fig. 32). They raise the tip of the abdomen everting glands when threatened. There are four larval instars, and pupation occurs in soil. The adults emerge during late May (Fig. 33); they feed and hibernate without mating. The larvae take 9–11 days to pupate, and then take 7–8 days to emerge as adults at room temperature.

Gonioctena gracilicornis (Kraatz, 1879)

(Figs 7–12, 26, 34–37)

Gonioctena gracilicornis: Medvedev & Zaitsev 1980: 105 (key to larva, illustration of seta, tarsugulus).

Gonioctena (*Gonioctena*) *gracilicornis*: Medvedev & Zaitsev 1978: 119 (key to larva, illustration of mesonotum, tarsugulus); Medvedev 1982: 179 (key to larva, illustration of tarsugulus); Zaitsev & Medvedev 2009: 145 (key to larva, after Medvedev & Zaitsev 1978).

Last instar larva. Body length 10.6–11.7 mm, width 3.1–3.3 mm, head width 1.60–1.70 mm (n = 5). Body elongate, rather broad, widest at abdominal segments III–IV, thence moderately narrowed posteriorly and slightly convex dorsally (Fig. 7). General coloration of integument yellowish-white, but densely covered with strongly sclerotized platelets; tubercles dark brown, whereas ventral ones paler; head blackish-brown with anterior half of clypeus brown; legs dark brown to brown. Eversible glands present on anterior margin of abdominal segment VIII. Pseudopods absent.

Head. Hypognathous, rounded, strongly sclerotized (Fig. 8). Vertex with 4 pairs of minute setae; epicranium with 7 pairs of setae; temporal side of head with 3 pairs of setae. Epicranial suture distinct; frontal suture not reaching antennal socket; endocarina well developed. Frons slightly depressed medially, with 5 pairs of setae. Clypeus almost straight at anterior margin, with 3 pairs of setae. Labrum deeply emarginate with 2 pairs of setae and 1 pair of campaniform sensilla placed medially and 3 pairs of minute setae placed at anterior border (Fig. 10); epipharynx with 3 pairs of stout setae at anterior margin. Mandible palmate, 5-toothed, with 2 setae and 2 campaniform sensilla (Fig. 12). Maxillary palp 3-segmented; palpomere I transverse with 1 seta and 2 campaniform sensilla; II rectangular with 3 setae and 1 campaniform sensillum; III subconical with 1 seta, 1 digitiform sensillum and 1 campaniform sensillum on sides and a group of peg-like sensilla at the apex; palpifer distinct with 2 setae (Fig. 11). Mala rounded with 15 setae and 1 campaniform sensillum; stipes longer than wide with 3 setae; cardo with 1 seta. Labial palp 2-segmented; palpomere I rectangular with 1 campaniform sensillum; II subconical with 1 campaniform sensillum on outer margin and a group of peg-like sensilla at the apex. Hypopharyngeal area with 3 pairs of minute setae and 2 pairs of campaniform sensilla. Prementum with 1 pair of setae; postmentum widely covered with spinules, with 3 pairs of setae. Stemmata 6 on each side, 4 of them located

above antenna and 2 behind antenna. Antenna short, 3-segmented; antenomere I transverse with 2 campaniform sensilla; II stout, more or less as wide as long, with a conical sensorium and 4 minute setae apically; III subconical with 6 minute setae apically.

Thorax. Prothorax with D-DL-EP (49–59L 3–5S) largest; P (2L 1S); ES-SS (4S) (Fig. 26). Meso- and metathorax with Dai (1L 1S); Dae (1L 1S); ad1 (1S) and ad2 (1S); DLai (2–3L 0–1S); Dpi (1L 2S); Dpe-DLpi (5–6L 1–2S) slightly larger than Dpi; DLe (8–10L 3S 1M) large and produced laterally; EPa (5–6L); EPp (3–4L); P (3–4S); SS (1S); ES (2–3S); sternal region with 3 additional setae arising from sclerotized bases. Mesothoracic spiracles annuliform; peritreme fused with EPa. Legs rather stout; tibia with 9 setae; tarsungulus large, strongly curved, basal tooth weakly developed, with 1 seta (Fig. 9).

Abdomen. Segments I–V with Dai (1L 1–2S) on both sides fused; Dae (1L 2S 1M); DLai (1L 2–4S); DLae (1S 2M) small; Dpi (1L 3S) on both sides fused; Dpe (1L 2S); DLp (3L 1M); EP (8–10L 0–1S) produced laterally; P (3–4L 2–3M); PS-SS (4–5S); ES (2–3S); as1 (1M) and as2 (1S). Segment VI with Dai and Dae, Dpi and Dpe fused respectively. Segments VII–VIII each with dorsal and dorso-lateral tubercles completely fused (8–9L 8–10S 2–4M and 6–8L 5S 12M respectively). Segment IX with dorsal to epipleural tubercles completely fused (10–11L 5–6S 2–3M). Segment X with pygopod well developed. Spiracles present on segments I–VIII.

Diagnosis. The last instar larva of *Gonioctena gracilicornis* is very similar to that of *G. viminalis* in the body shape, coloration, and tubercular pattern. However, this species can be distinguished by the tubercles covered with relatively long setae (relatively short in *G. viminalis*), tubercle Dpi on both sides of abdominal segments I–V completely fused (weakly fused in *G. viminalis*), and basal tooth of tarsungulus weakly developed (well developed in *G. viminalis*).

Material examined. 6 larvae, South Korea, Gyeongbuk Prov., Bonghwa-gun, Socheon-myeon, Buncheon-ri, 36°57'22.9"N, 129°04'30.3"E, 13.V.2006, H.W. Cho; 4 larvae, South Korea, Gangwon Prov., Pyeongchang-gun, Yongpyeong-myeon, Nodong-ri, Nodong Valley, 37°42'06.3"N, 128°28'53.9"E, 31.V.2006, H.W. Cho; 5 larvae, same data as preceding one except for 6.VI.2009; 5 larvae, South Korea, Gangwon Prov., Pyeongchang-gun, Daegwallyeong-myeon, Hoenggye-ri, 37°40'49.2"N, 128°44'58.1"E, 27.V.2018, H.W. Cho.

Distribution. Russia (East Siberia, Far East, Sakhalin), Mongolia, China (Heilongjiang), North Korea, South Korea.

Biological notes. Overwintered adults appear during mid-May (Fig. 37); they mate and lay 5–11 eggs per cluster on the leaves of *Salix koriyanagi*. The eggs contain fully developed embryos and hatch after several hours (Fig. 34). The newly hatched larvae gregariously feed on young leaves (Fig. 35), but become solitary as they mature (Fig. 36). They raise the tip of the abdomen everting glands when disturbed. There are four larval instars, and pupation occurs in soil. The adults emerge during mid-June, and they feed and hibernate without mating. The larvae take 10–11 days to pupate, and then take 6–8 days to emerge as adults at room temperature.

Gonioctena jacobsoni (Ogloblin & Medvedev, 1956)

(Figs 13–18, 27–28, 38–41)

Gonioctena (*Gonioctena*) *jacobsoni*: Medvedev & Zaitsev 1978: 120 (key to larva, illustration of mesonotum); Medvedev 1982: 179 (key to larva); Zaitsev & Medvedev 2009: 147 (key to larva, after Medvedev & Zaitsev 1978).

Last instar larva. Body length 8.5–8.9 mm, width 2.7–2.9 mm, head width 1.50–1.60 mm (n = 5). Body elongate, rather broad, widest at abdominal segments III–IV, thence moderately narrowed posteriorly and slightly convex dorsally (Fig. 13). Color polymorphism present; dark type with dorsal tubercles brown to dark brown and ventral ones pale brown (Fig. 40), sometimes pronotum unpigmented; light type with tubercles pale yellowish-brown except dorsal tubercles of abdominal segments VII–IX (Fig. 39). General coloration of integument yellowish-white in alcohol, moderately covered with weakly sclerotized platelets; head blackish-brown with anterior half of clypeus yellowish-brown; legs yellowish-brown with apex of femur, tibia and tarsungulus dark brown. Eversible glands present on anterior margin of abdominal segment VIII. Pseudopods absent.

Head. Hypognathous, rounded, strongly sclerotized (Fig. 14). Vertex with 5 pairs of minute setae; epicranium with 7 pairs of setae; temporal side of head with 4 pairs of setae. Epicranial suture distinct; frontal suture not reaching antennal socket; endocarina well developed. Frons slightly depressed medially, with 5 pairs of setae. Clypeus almost straight at anterior margin, with 3 pairs of setae. Labrum deeply emarginate with 2 pairs of setae

and 1 pair of campaniform sensilla placed medially and 3 pairs of minute setae placed at anterior border (Fig. 16); epipharynx with 3 pairs of stout setae at anterior margin. Mandible palmate, 5-toothed, with 2 setae and 2 campaniform sensilla (Fig. 18). Maxillary palp 3-segmented; palpomere I transverse with 1 seta and 2 campaniform sensilla; II rectangular with 3 setae and 1 campaniform sensillum; III subconical with 1 seta, 1 digitiform sensillum and 1 campaniform sensillum on sides and a group of peg-like sensilla at the apex; palpifer distinct with 2 setae (Fig. 17). Mala rounded with 15 setae and 1 campaniform sensillum; stipes longer than wide with 3 setae; cardo with 1 seta. Labial palp 2-segmented; palpomere I rectangular with 1 campaniform sensillum; II subconical with 1 campaniform sensillum on outer margin and a group of peg-like sensilla at the apex. Hypopharyngeal area with 3 pairs of minute setae and 2 pairs of campaniform sensilla. Prementum with 1 pair of setae; postmentum without spinules, with 3 pairs of setae. Stemmata 6 on each side, 4 of them located above antenna and 2 behind antenna. Antenna short, 3-segmented; antenomere I transverse with 2 campaniform sensilla; II stout, more or less as wide as long, with a conical sensorium and 4 minute setae apically; III subconical with 5 minute setae apically.

Thorax. Prothorax with D-DL-EP (13–17L 41–51S) largest; P (4S); ES-SS (2L 3S) (dark type in Fig. 27, light type in Fig. 28). Meso- and metathorax with Dai (1L 3–4S); Dae (1L 2S); ad1 (1M) and ad2 (1M); DLai (5–8S); Dpi (1L 4–5S); Dpe-DLpi (1–2L 7–8S) larger than Dpi; DLe (4–5L 17–22S 1M) large and produced laterally; EPa (8–10S); EPp (2L 8–10S); P (1S 2M); SS (1S); ES (2L); sternal region with 4 additional setae arising from sclerotized bases. Mesothoracic spiracles annuliform; peritreme fused with EPa. Legs rather stout; tibia with 9 setae; tarsungulus large, strongly curved, basal tooth well developed, with 1 seta (Fig. 15).

Abdomen. Segments I–VI with Dai, Dae and DLai enlarged and completely fused (3L 11–16S), forming a transverse band; DLae (1S 2M) small; Dpi and Dpe enlarged and completely fused (2L 6–8S), forming a transverse band; DLp (1L 3–6S 1M); EP (3–5L 13–16S) produced laterally; P (1L 6–10S 1M); PS-SS (4S) divided into 4 small tubercles; ES (1S); as1 (1S) and as2 (1S); sternal region with a short additional seta arising from sclerotized base. Segments VII–VIII each with dorsal and dorso-lateral tubercles completely fused (3L 18–21S 3–4M and 3L 10–12S 8–9M respectively). Segment IX with dorsal to epipleural tubercles completely fused (8–9L 7–11S 1–2M). Segment X with pygopod well developed. Spiracles present on segments I–VIII.

Diagnosis. The last instar larva of *Gonioctena jacobsoni* is similar to that of *G. ogloblini* in the fused dorsal tubercles on abdomen and presence of color polymorphism. However, this species can be distinguished from *G. ogloblini* by the dorsal and dorso-lateral tubercles on meso- and metathorax separated, DLae and DLp on abdominal segments I–VI separated from other dorsal tubercles, and light type with tubercles unpigmented except dorsal tubercles of abdominal segments VII–IX (tubercles fused and light type with all tubercles unpigmented in *G. ogloblini*).

Material examined. 29 larvae, South Korea, Gangwon Prov., Pyeongchang-gun, Jinbu-myeon, Mt. Odaesan, 37°47'34.0"N, 128°33'39.7"E, 15.V.2005, H.W. Cho; 30 larvae, same data as preceding one except for 5.V.2006; 5 larvae, same data as preceding one except for 26.V.2018.

Distribution. Russia (East Siberia, Far East), Mongolia, China (Heilongjiang), South Korea.

Biological notes. Overwintered adults appear during early May (Fig. 41). The first instar larvae are also found on the leaves of *Populus maximowiczii* during early May (Fig. 38), but the eggs were not found in the field. This species is probably ovoviviparous. The larvae feed on the leaves, making small holes. The larva raises the tip of the abdomen everting glands when disturbed. The larvae are solitary during the instar stages, and the fourth instar larva pupates in soil. The adults emerge during early June; they feed and hibernate without mating. The larvae take 15–17 days to pupate, and then take 9–11 days to emerge as adults at room temperature.

***Gonioctena viminalis* (Linnaeus, 1758)**

(Figs 19–24, 29, 42–45)

Chrysomela (*Gonioctena*) *viminalis*: Letzner 1855: 109 (description of larva, pupa).

Phytodecta viminalis: Henriksen 1927: 335 (description of larva, key, illustration of larval habitus); Medvedev 1964: 508, 509 (illustration of larval habitus, head).

Phytodecta (*Phytodecta*) *viminalis*: Hennig 1938: 119, 123 (description of larva, key, illustration of pronotum); Ogloblin & Medvedev 1971: 74 (key to larva, illustration of abdominal segment III).

Gonioctena (*Gonioctena*) *viminalis*: Medvedev & Zaitsev 1978: 119 (key to larva, illustration of frons, clypeus, labrum,

mesonotum, tarsus); Booth *et al.* 1990: 281 (illustration of larval habitus, after Medvedev 1964); Steinhausen 1966: 319 (illustration of labrum), 1994: 277 (key to larva, illustration of abdominal segments I–II, VII–VIII, tarsugulus); Warchałowski 1994: 103 (key to larva); Zaitsev & Medvedev 2009: 146 (key to larva, after Medvedev & Zaitsev 1978).

Last instar larva. Body length 9.2–10.2 mm, width 2.9–3.1 mm, head width 1.70–1.80 mm (n = 5). Body elongate, rather broad, widest at abdominal segments III–IV, thence moderately narrowed posteriorly and slightly convex dorsally (Fig. 19). General coloration of integument yellowish-white, but densely covered with strongly sclerotized platelets; tubercles dark brown, whereas ventral ones paler; head blackish-brown with anterior half of clypeus yellowish-brown; legs dark brown to brown. Eversible glands present on anterior margin of abdominal segment VIII. Pseudopods absent.

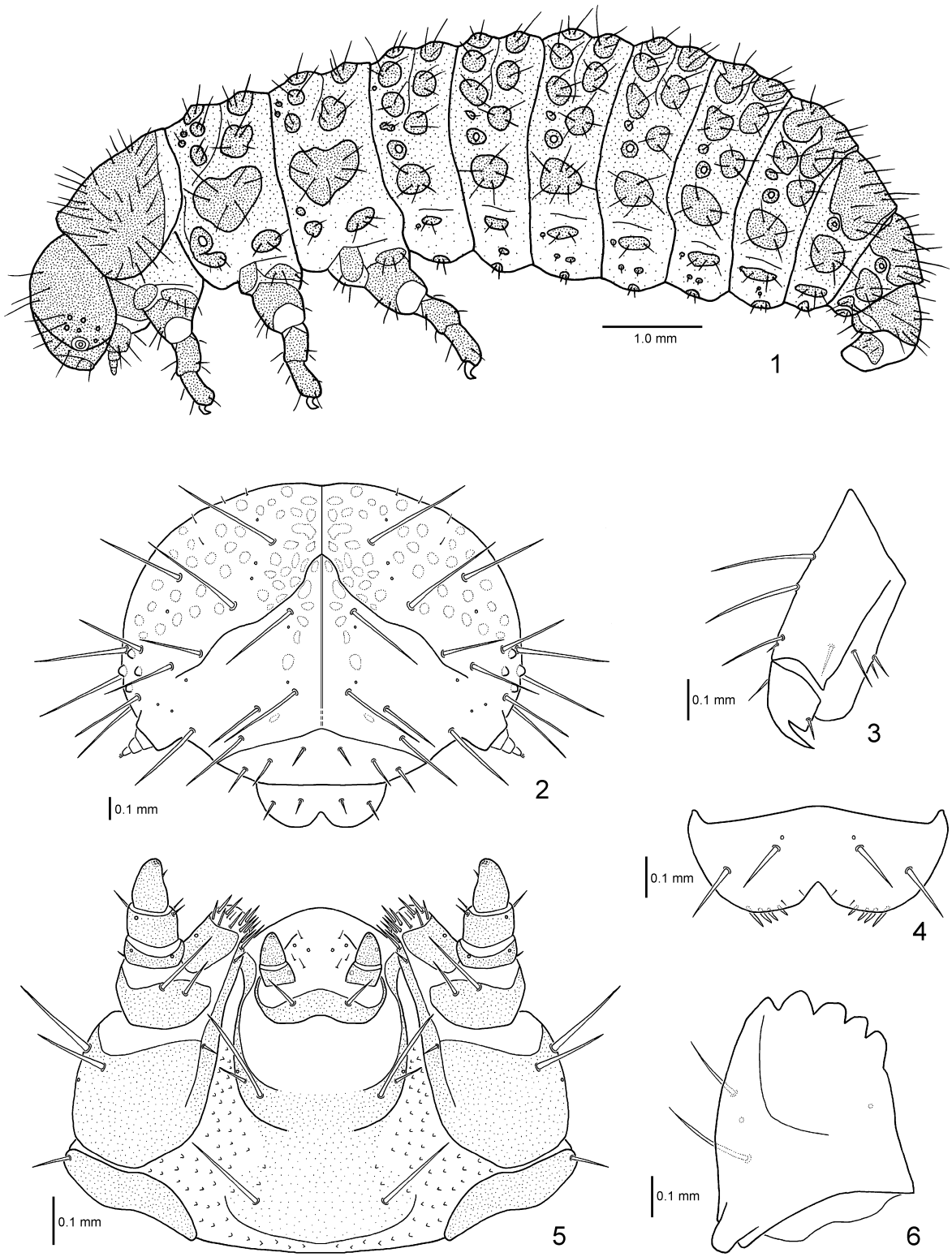
Head. Hypognathous, rounded, strongly sclerotized (Fig. 20). Vertex with 4 pairs of minute setae; epicranium with 8 pairs of setae; temporal side of head with 2 pairs of setae. Epicranial suture distinct; frontal suture not reaching antennal socket; endocarina well developed. Frons slightly depressed medially, with 5 pairs of setae. Clypeus almost straight at anterior margin, with 3 pairs of setae. Labrum deeply emarginate with 2 pairs of setae and 1 pair of campaniform sensilla placed medially and 2 pairs of minute setae placed at anterior border (Fig. 22); epipharynx with 3 pairs of stout setae at anterior margin. Mandible palmate, 5-toothed, with 2 setae and 2 campaniform sensilla (Fig. 24). Maxillary palp 3-segmented; palpomere I transverse with 1 seta and 2 campaniform sensilla; II rectangular with 3 setae and 1 campaniform sensillum; III subconical with 1 seta, 1 digitiform sensillum and 1 campaniform sensillum on sides and a group of peg-like sensilla at the apex; palpifer distinct with 2 setae (Fig. 23). Mala rounded with 15 setae and 1 campaniform sensillum; stipes longer than wide with 3 setae; cardo with 1 seta. Labial palp 2-segmented; palpomere I rectangular with 1 campaniform sensillum; II subconical with 1 campaniform sensillum on outer margin and a group of peg-like sensilla at the apex. Hypopharyngeal area with 3 pairs of minute setae and 2 pairs of campaniform sensilla. Prementum with 1 pair of setae; postmentum baso-laterally covered with spinules, with 3 pairs of setae. Stemmata 6 on each side, 4 of them located above antenna and 2 behind antenna. Antenna short, 3-segmented; antenomere I transverse with 2 campaniform sensilla; II stout, more or less as wide as long, with a conical sensorium and 4 minute setae apically; III subconical with 6 minute setae apically.

Thorax. Prothorax with D-DL-EP (15–21L 32–36S) largest; P (4S); ES-SS (5–6S) (Fig. 29). Meso- and metathorax with Dai (1L 1S); Dae (1L 1–2S); ad1 (1M) and ad2 (1M); DLai (2–4S); Dpi (1L 2–3S); Dpe-DLpi (3L 4–6S) larger than Dpi; DLe (3–5L 10–11S) large and produced laterally; EPa (2L 5–7S); EPp (3L 4–5S); P (3S); SS (1S), ES (2–3S); sternal region with 5 additional setae arising from sclerotized bases. Mesothoracic spiracles annuliform; peritreme fused with EPa. Legs rather stout; tibia with 9 setae; tarsungulus large, strongly curved, basal tooth well developed, with 1 seta (Fig. 21).

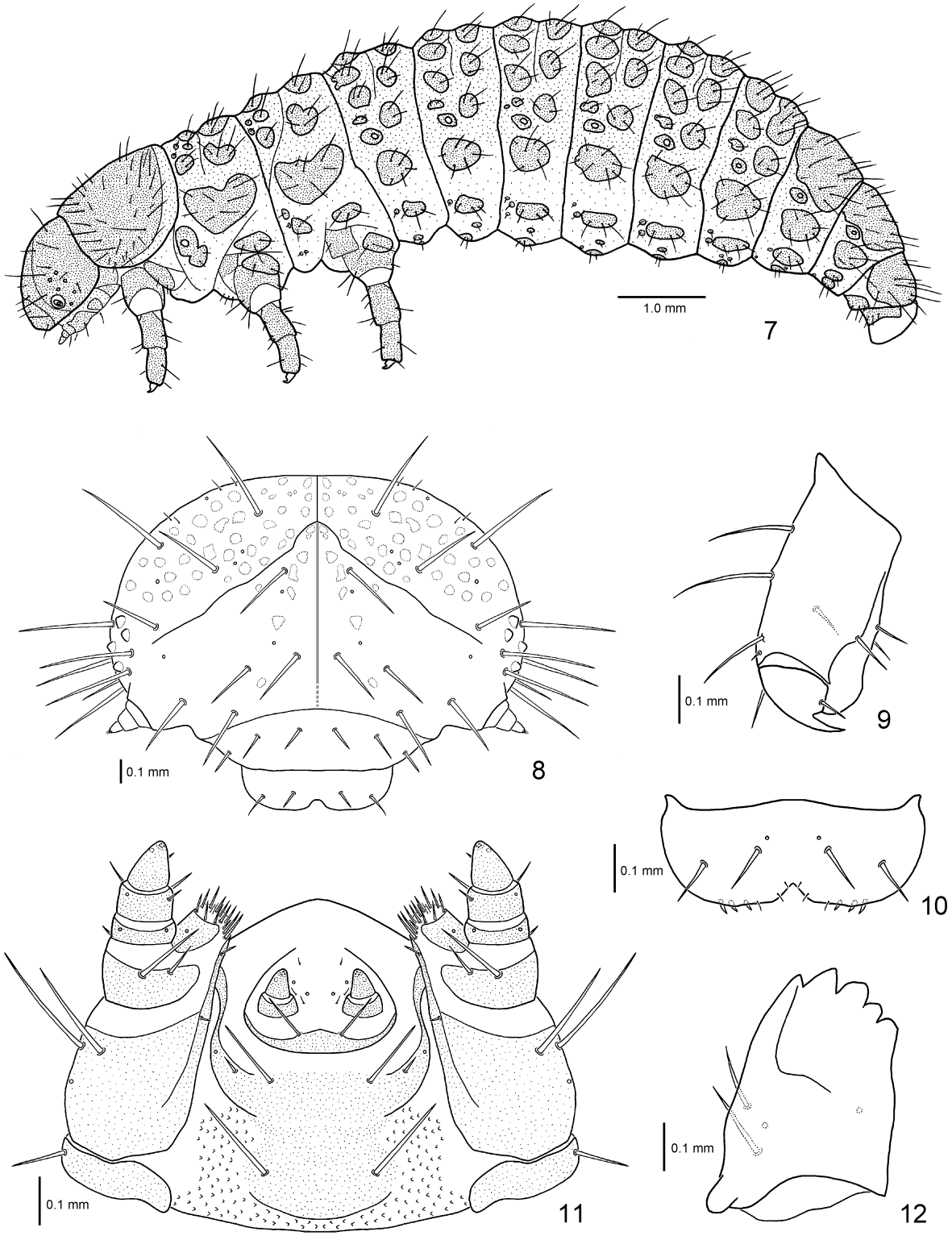
Abdomen. Segments I–V with Dai (1L 2S) on both sides fused; Dae (1L 2–3S); DLai (1L 3–4S); DLae (1S 2M) divided into 2 small tubercles; Dpi (1L 2–4S); Dpe (1L 2–3S); DLp (1L 3–4S 1M); EP (3–4L 6–7S) produced laterally; P (4S 2–3M); PS-SS (4S); ES (2–3S); as1 (1M) and as2 (1S); sternal region with a short additional seta arising from sclerotized base. Segment VI with Dai and Dae partially fused, Dpi on both sides fused. Segment VII with dorsal and dorso-lateral tubercles fused completely (6L 9S 2M) except for DLae. Segment VIII with D-DL (6L 7–10S 6–10M). Segment IX with D-DL-EP (6–8L 8–11S 2M). Segment X with pygopod well developed. Spiracles present on segments I–VIII.

Diagnosis. The last instar larva of *Gonioctena viminalis* is very similar to that of *G. gracilicornis* in the body shape, coloration, and tubercular pattern. However, this species can be distinguished by the tubercles covered with relatively short setae (relatively long in *G. gracilicornis*), tubercle Dpi on both sides of abdominal segments I–V weakly fused (completely fused in *G. gracilicornis*), and basal tooth of tarsungulus well developed (weakly developed in *G. gracilicornis*).

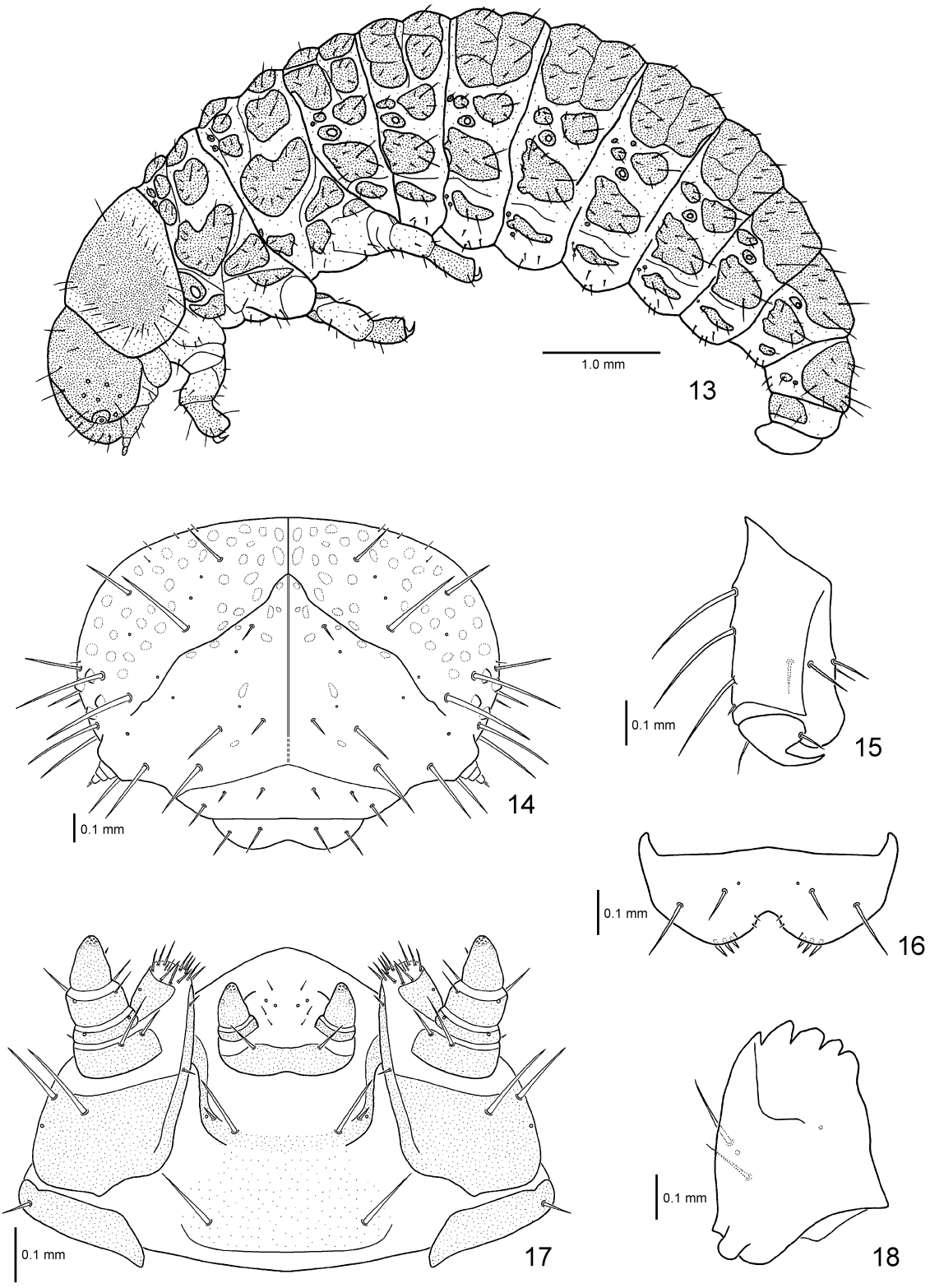
Material examined. 21 larvae, South Korea, Gangwon Prov., Taebaek, Hwangji-dong, Jeolgol Valley, 37°10'26.9"N, 128°57'13.5"E, 5.VI.2005, H.W. Cho; 8 larvae, South Korea, Gangwon Prov., Pyeongchang-gun, Jinbu-myeon, Bangadari, 37°41'43.2"N, 128°30'12.7"E, 31.V.2006, H.W. Cho; 4 larvae, South Korea, Gangwon Prov., Pyeongchang-gun, Jinbu-myeon, Mt. Odaesan, 37°47'06.0"N, 128°33'31.7"E, 31.V.2006, H.W. Cho; 3 larvae, same data as preceding one except for 7.VI.2009; 3 larvae, same data as preceding one except for 26.V.2018; 5 larvae, South Korea, Gangwon, Pyeongchang-gun, Bongpyeong-myeon, Heungjeong Valley, 37°39'55.7"N 128°18'05.6"E, 21.V.2018, H.W. Cho; 19 larvae, South Korea, Gangwon Prov., Pyeongchang-gun, Daegwallyeong-myeon, Hoenggye-ri, 37°40'49.2"N, 128°44'58.1"E, 27.V.2018, H.W. Cho.



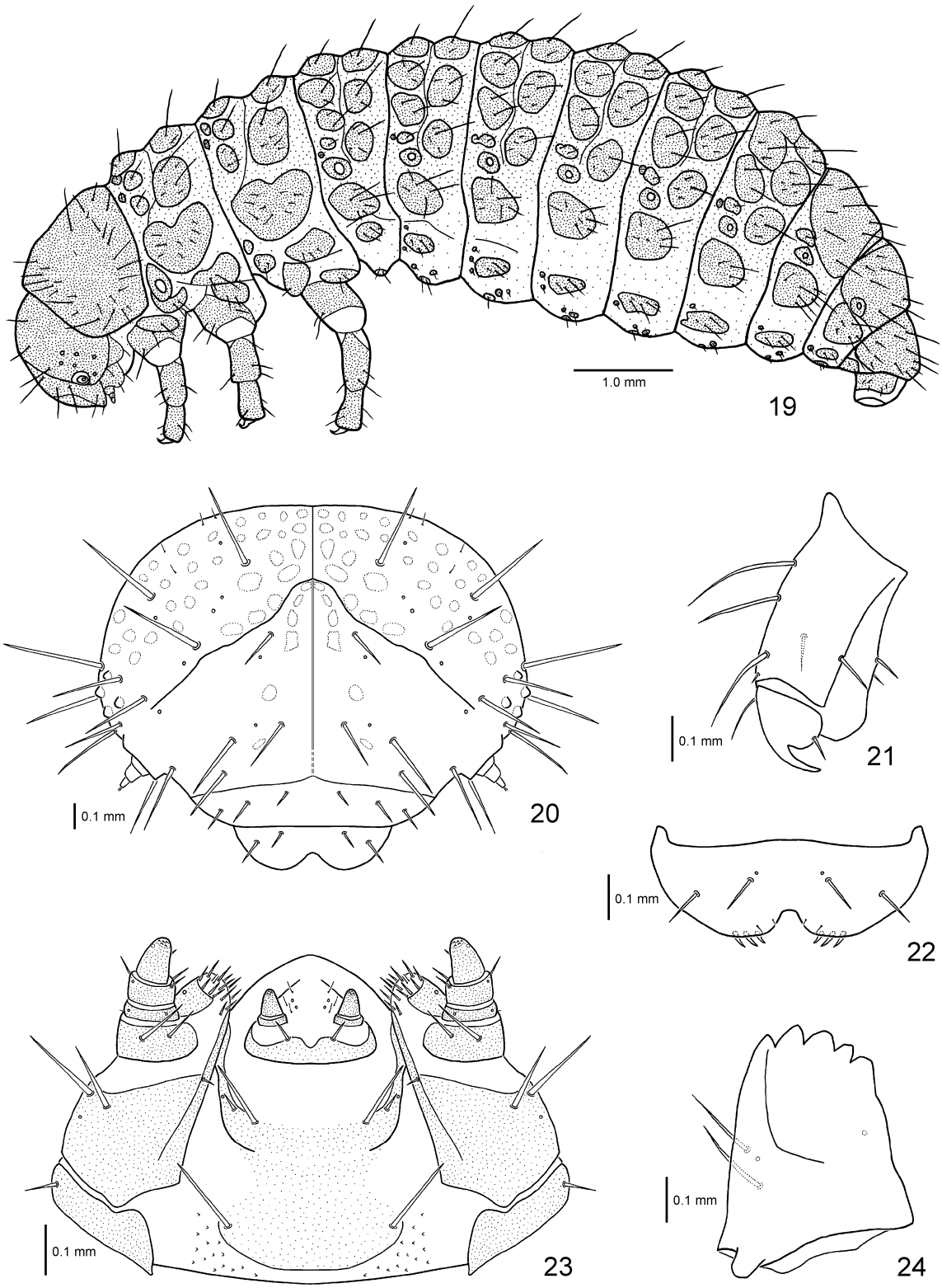
FIGURES 1–6. *Gonioctena coreana*, last instar larva. 1. lateral habitus; 2. head; 3. tibia and tarsungulus; 4. labrum; 5. maxillae and labium; 6. mandible.



FIGURES 7–12. *Gonioctena gracilicornis*, last instar larva. 7. lateral habitus; 8. head; 9. tibia and tarsungulus; 10. labrum; 11. maxillae and labium; 12. mandible.



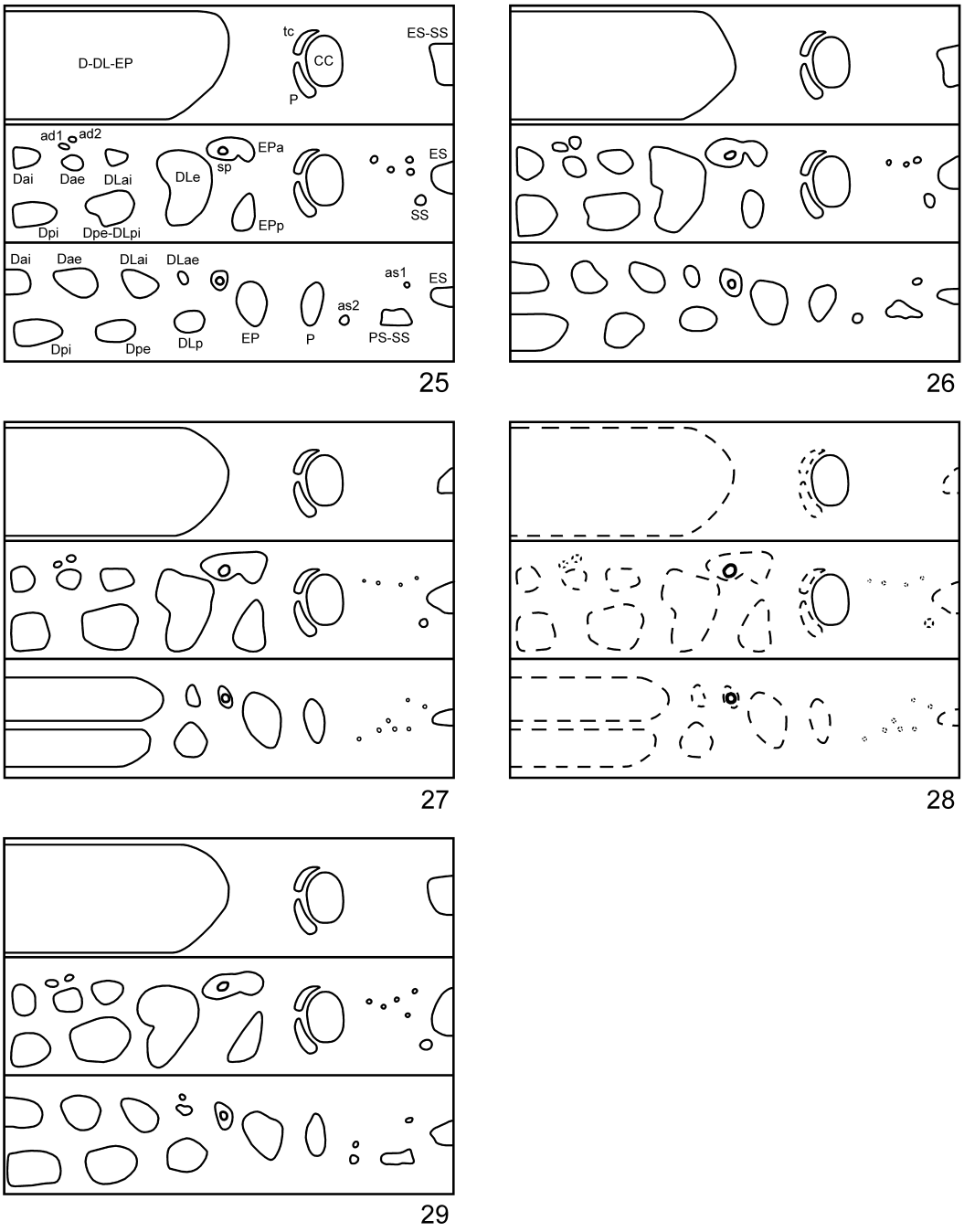
FIGURES 13–18. *Gonioctena jacobsoni*, last instar larva. 13. lateral habitus; 14. head; 15. tibia and tarsungulus; 16. labrum; 17. maxillae and labium; 18. mandible.



FIGURES 19–24. *Gonioctena viminalis*, last instar larva. 19. lateral habitus; 20. head; 21. tibia and tarsungulus; 22. labrum; 23. maxillae and labium; 24. mandible.

Distribution. Widespread trans-Palaearctic species from UK to Russian Far East.

Biological notes. Overwintered adults appear during early May (Fig. 45). A female laid 11 larvae, which were not enclosed within chorion (Fig. 42), as reported previously from Europe (Cornelius 1857). Maternal care has been reported by studies in Europe (Lengerken 1939; Vasconcellos-Neto & Jolivet 1994); however, it has not been observed in South Korea. The larvae gregariously feed on the leaves of *Salix caprea*, *Salix koreensis*, and *Salix maximowiczii* until the final instar (Fig. 43). They raise the tip of the abdomen everting glands when disturbed (Fig. 44). There are four larval instars, and pupation occurs in soil. Adults emerge during early June; they feed and hibernate without mating. The larvae take 13–15 days to pupate, and then take 8–10 days to emerge as adults at room temperature.



FIGURES 25–29. Schematic presentation of tubercular patterns (top: prothorax; middle: mesothorax; bottom: 2nd abdominal segment), last instar larva. 25. *Gonioctena coreana*; 26. *Gonioctena gracilicornis*; 27. *Gonioctena jacobsoni*, dark type; 28. *Gonioctena jacobsoni*, light type; 29. *Gonioctena viminalis*.

FIGURES 30–33. *Gonioctena coreana*. 30. newly laid larvae; 31. early instar larvae; 32. mature larvae; 33. adult.

FIGURES 34–37. *Gonioctena gracilicornis*. 34. newly laid larvae; 35. early instar larvae; 36. mature larvae; 37. adult.

FIGURES 38–41. *Gonioctena jacobsoni*. 38. first instar larvae; 39. mature larva, light type; 40. mature larva, dark type; 41. adult.

FIGURES 42–45. *Gonioctena viminalis*. 42. newly laid larvae; 43. early instar larvae; 44. mature larva everting glands (arrow); 45. adult.

Key to the mature larva of the subgenus *Gonioctena* from South Korea

1	Abdomen with dorsal tubercles fused, forming transverse bands 2
-	Abdomen with dorsal tubercles separated from each other 4
2	Meso- and metathorax with dorsal tubercles fused, forming transverse bands 3
-	Meso- and metathorax with dorsal tubercles separated from each other . . . . . *G. jacobsoni* (Ogloblin & Medvedev)
3	Abdominal segments I–VI with DLae and DLp fused with other tubercles . . . . . *G. ogloblini* Medvedev & Dubeshko
-	Abdominal segments I–VI with DLae and DLp separated from other tubercles . . . . . *G. koryeoensis* Cho & Lee
4	Meso- and metathorax with 1 long and 1 short setae on tubercle Dai; Dpi on both sides of abdominal segments I–V completely or weakly fused 5
-	Meso- and metathorax with 1 long and 2 short setae on tubercle Dai; Dpi on both sides of abdominal segments I–V completely separated . . . . . *G. coreana* (Bechyně)
5	Tubercles covered with relatively long setae; abdominal segments I–V with Dpi on both sides completely fused; basal tooth of tarsungulus weakly developed . . . . . *G. gracilicornis* (Kraatz)
-	Tubercles covered with relatively short setae; abdominal segments I–V with Dpi on both sides weakly fused; basal tooth of tarsungulus well developed . . . . . *G. viminalis* (Linnaeus)

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