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SHORT NOTE

Morphology of mature larva, bionomics and life cycle of *Attalus* (*Attalus*) *elongatulus* (Coleoptera: Malachiidae)

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Abstract. The morphological structure of mature larvae of *Attalus* (*Attalus*) *elongatulus* Lewis, 1895 as well as its bionomics and life cycle are described for the first time. In the family Malachiidae, an univoltine life cycle is newly disclosed, and the sclerites on the larval abdominal tergites are discovered for the first time in this study. The microhabitat of *A. elongatulus* remains insufficiently explored, although the adults were found on the plants of cliff-lined coasts such as Pittosporaceae and Lauraceae. Two overwintering mature larvae were found on the rocks on the seashore. It is suggested that this species locally inhabits the warm microclimatic zones with a rich flora along cliff-lined coasts dispersed within the temperate zone of Japan.

Key words. Coleoptera, Cleroidea, Malachiidae, Attalini, developmental period, larva, microhabitat, morphology, voltinism, Japan

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Introduction

The malachiid genus *Attalus* Erichson, 1840 is very species-rich, containing hundreds of species found in all geographic regions of the world. About 90 species are distributed in the Palaearctic region (Mayor 2002, 2004). In Japan this genus is represented by 17 species-group taxa (i.e., species and subspecies), most of them distributed in the range from Kyushu to Nansei Islands in southwestern Japan, all of them belonging to the nomino-typical subgenus *Attalus* s. str.: *Attalus amami* Satô, 1986, *A. chujoanus* Wittmer, 1982, *A. flavoapicalis* Pic, 1933, *A. kaimon* Nakane, 1987, *A. kojimai* Asano, 2018, *A. nipo-nensis* Pic, 1907, *A. volcanus* Asano, 2018, *A. kurosawai kurosawai* Satô, 1986, *A. kurosawai ejimai* Nakane, 1989, *A. okinawanus* Wittmer, 1960, *A. papilioformis* Wittmer, 1997, *A. takizawai* Asano, 2018, *A. trochantinus* Wittmer, 1982, *A. walteri* Satô, 1986, and *A. yonaguni* Satô, 1986. Only two closely related species, *A.* (*Attalus*) *elongatulus* Lewis, 1895 and *A.* (*A.*) *shimamori* Asano, 2018, can be found in the north of Kyushu Island, Japan (Nakane 1987, 1989; Satô 1985, 1986; Wittmer 1971, 1982, 1997; Satô & Wittmer 1989; Asano 2018). Adults of *A. elongatulus* were chiefly found, here and there, in the coastal regions of several Japanese islands: Honshû, Shikoku, Kyûshû, Ikinoshima, Tsushima, and Yakushima. The microhabitat of *A. elongatulus* remains insufficiently explored.

To date, adults of *A. elongatulus* have been found on plants growing on the rocky coasts such as Pittosporaceae and Lauraceae, (Asano 2018). Therefore, it was assumed that the species was only distributed in warm, plant-covered zones along the cliff-lined coasts, scattered in the humid subtropical climate zone.

Recently, two overwintering mature larvae probably belonging to *A. elongatulus* were found in Shikoku under rocks in the supralittoral zone. Their breeding was attempted but, unfortunately, they died before pupation. During the ensuing summer, adult specimens of this species were collected, bred, and their larvae successfully raised in captivity. In this paper, mature larval morphological structures, bionomics, and life cycles of *A. elongatulus* are presented.

Material and methods

The mature larvae of *Attalus elongatulus* were collected on 22 January 2022 at Ikata town, Ehime Prefecture, Japan, then acquired from captive breeding and died on 18 May 2022. Four adult specimens were collected on 4 June

2022 at Saki, Mikuni town, Fukui Prefecture, Japan from flowers of a Lauraceae using a sweeping net. The adult specimens were transferred to plastic containers together with inflorescences of *Argyranthemum frutescens* (L.) (Asteraceae). Their larvae were put into the plastic containers separately. Containers were kept at room temperature. The specimens were provided with food (pollen for the adults, dead chironomid larvae for the larvae), and larval molts were checked every morning from 18 June 2022 through 8 July 2023. Specimen examined is a sixth instar larva which died on 13 March 2023.

Observations were made under a dissecting stereoscope (Olympus SZX7) and compound microscope (Nikon LABOPHOT and Olympus CH2). Photographs were taken with Canon Power shot D16 and EOS D7 digital cameras. Specimen was fixed in 70% ethanol. The head capsule, mouth parts, legs and urogomphi were removed and immersed in 10% KOH solution at room temperature for 24 hours, and then soaked with water.

In larval description, the terminology follows Asano (2021); the following abbreviations are used: BL – length of body, from anterior margin of frons to apex of urogomphi; BW – maximum width of body; HL – maximum length of head capsule; HW – maximum width of head capsule; PL – maximum length of pronotum; PW – maximum width of pronotum; TL – maximum length of tibia; UL – maximum length of urogomphi.

Results

Sixth instar larva of *Attalus* (*Attalus*) *elongatulus* Lewis, 1895

(Figs. 1–5, 8)

Material examined. 1 larva (instar 6), bred specimen, fixed on 13 March 2023 (parents collected on 4 June 2022 at Saki, Mikuni town, Fukui Prefecture, Japan, M. Asano leg.).

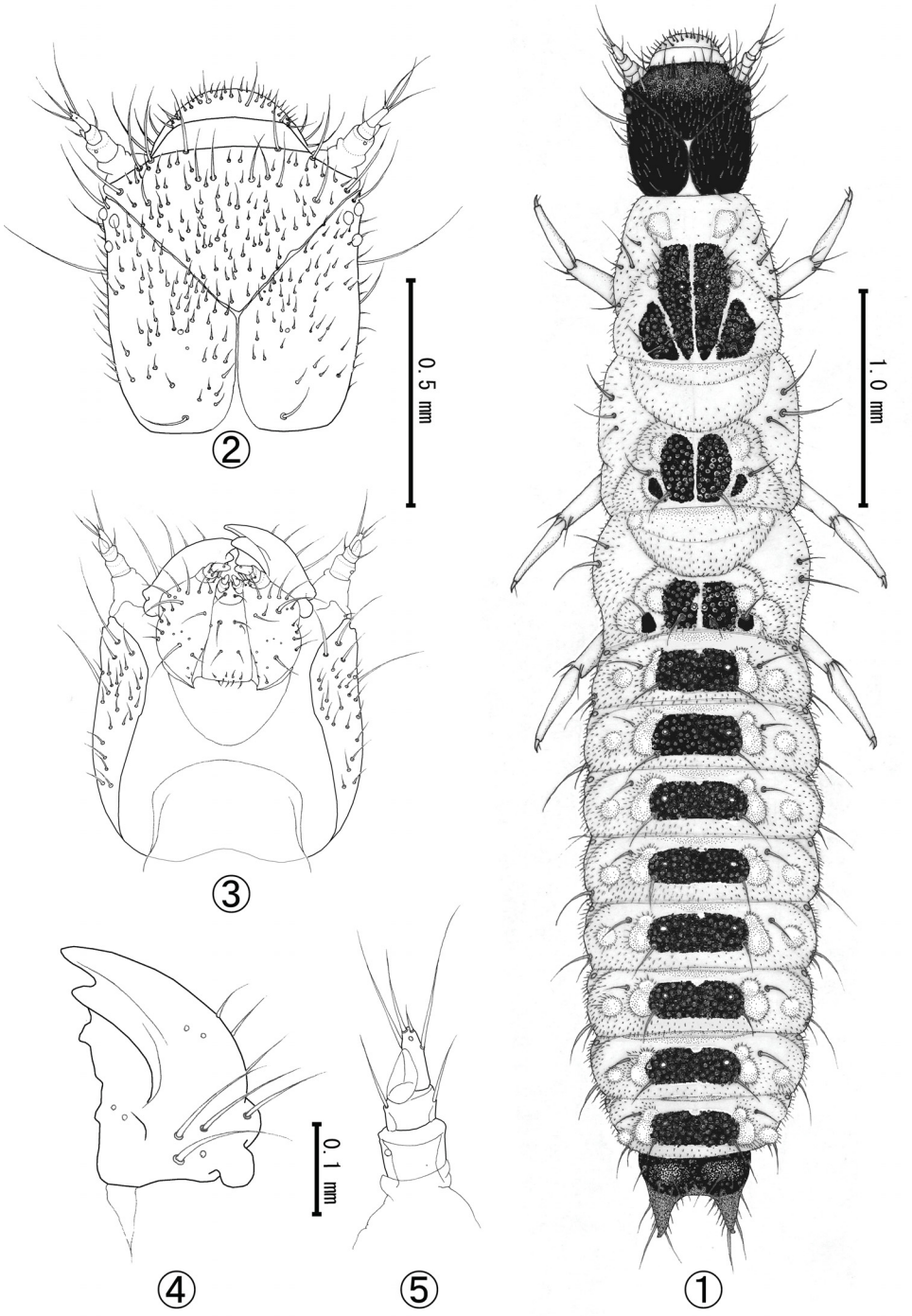
Description of larva. ***Coloration.*** Head capsule dark brown except for brown anterior part of frons. Body cream white except for black sclerites on dorsal part of prothorax, mesothorax, metathorax and abdomen. Sclerites on thoracic tergites black. Legs translucent. Sclerites of abdominal tergites black. Urogomphi black except for dark brown posterior portion (Fig. 8).

Structure. Head capsule square, with dense short setae; frons large, with 7 pairs of long setae; epicranial plate with 4 pairs of long setae (Fig. 2). Labrum about 2.3 times as broad as long, with 29 setae (Fig. 2). Number of stemmata 4; anterior 3 arranged in transverse row and posterior one on anterior portion of epicranial plate. Antennae 3-segmented; 2nd segment with conical sensorium and two long setae; 3rd segment with 3 long and 1 short seta (Fig. 5). Mandible bidentate, with sharp apical teeth; cutting edge distinctly denticulate, ventral margin ridged laterally; with 4 long setae, face ridged and provided with tooth, outer margin of face with 4 long setae (Fig. 4). Maxillary palpi 3-segmented; 1st palpomere with pore; 2nd one with 2 short setae; 3rd palpomere longer than preceding one, with pore and sensilla (Fig. 3). Labial palpi 2-segmented; 1st palpomere with short seta and pore; 2nd palpomere with pore and sensilla (Fig. 3). Prementum with pair of setae (Fig. 3). Maxillary stipes and postmentum with dense setae, the former with 15 setae, the latter with 17 pairs of setae and 6 pairs of pores (Fig. 3). Cardo invaginated behind stipes, only basal border seen ventrally (Fig. 3). Thoracic and abdominal tergites bearing dense short setae and with sclerotized parts in middle (Fig. 1). Pronotum subtrapezoid, subequal in width, about 1.3 times as broad as head; bearing 7 pairs of long setae on anterior portion, bearing 4 pairs of long setae on posterior portion, with pair of pores; 2 pairs of sclerotized slabs are evident dorsally (Fig. 1); central pair conspicuous, long, inverted triangular, lateral one smaller, semilunar. Mesonotum subrectangular, about 1.4 times broader than long; bearing 3 pairs of long setae on anterior portion, 2 pairs of setae on basal portion, with pair of pores; 2 pairs of sclerotized slabs are evident dorsally (Fig. 1), central pair conspicuous, vertical pair large, oblong, lateral pair small. Metanotum subrectangular, about 1.7 times broader than long; bearing 2 pairs of setae on anterior portion, 2 pairs of long setae on basal portion of tergite, with pair of pores; 2 pairs of sclerotized slabs are evident dorsally (Fig. 1), central one oblong, lateral one oval, small. Abdomen with 9 tergites, last one (= IX) bearing pair of urogomphi (Fig. 1). Tergites I–VIII each with 4 pairs of long stout setae and pair of pores, with large and transversal sclerites in middle (Fig. 1). Urogomphi short, subparallel-sided, curved upwards in apical portion, with 14 or 15 pairs of long setae on dorsal surface (Fig. 1). Legs elongate, with dense short strong setae. Femora elongate, with several long setae on posterior margin. Claw slender, with single short seta (Fig. 1).

Measurements (in mm; n = 1). BL: 5.69; HL: 0.72; HW: 0.58; PL: 0.81; PW: 0.80; PTL: 0.58; UL: 0.43.

Larval development and bionomics. Eggs hatched eight days after oviposition (18 June 2022). The first larval stage of this species is foetomorphic, it undergoes one instar stage inactive and non-feeding (Asano 2018). The first molt occurred one day after hatching. Thereafter, the growth of the larvae fed by dead chironomid larvae was closely observed; they underwent six larval molts before prepupation. The second molt occurred 20 days after the first (9 July 2022); the third molt occurred 54 days after the second (1 September 2022) and the fourth molt occurred 27 days after the third (28th September 2022); the fifth molt occurred 40 days after the fourth (7 November 2022); the sixth molt occurred 47 days after the fifth (24 December 2022). Two larvae became prepupa on 18 June 2023, but they died before pupation. Three further larvae could become prepupae, but they died as well before pupation in captivity. The larvae of this species may need to be exposed to some external stimuli to pupate.

Adults of *A. elongatulus* ingested only pollen in captivity. It has been found that only two malachiid genera can breed exclusively on pollen consumption (Asano 2018, 2019). To date, three forms of adult feeding habits have been discovered in malachiine beetles: pollenophagy – *Attalus* (Asano 2018: 65) and *Holzschuhus* Wittmer, 1996 (Asano 2018: 104), predation – *Intybia* Pascoe,



Figs 1–5. Larval structures of *Attalus* (*Attalus*) *elongatulus* Lewis, 1895. 1 – habitus; 2 – head in dorsal view; 3 – head in ventral view; 4 – light antenna; 5 – left mandible.

1866 (Asano 2021b: 618) and *Laius* Guérin-Méneville, 1838 (Setoyama et al. 2020: 24), and combination of both pollen-feeding and predation – *Axinotarsus* Motschulsky, 1854 (Evers 1960: 78), *Malachius* Fabricius, 1775 (Asano 2017: 612), and *Nepachys* C. G. Thomson, 1859 (Asano 2014: 195).

In general, adults of *A. elongatulus* have a short life span, with a maximum longevity of 30 days in captivity. However, the period from oviposition to prepupation was found to be 373 days. Thus, it is possible that *A. elongatulus* has a univoltine life cycle without dormancy. In Malachiidae, a univoltine life cycle is probably rather common. Indeed, together with the species here reported, numerous other species inhabiting subarctic and temperate zones probably have a univoltine life cycle. On the other hand, at least two species, namely *Intybia takaraensis* (Nakane, 1955) and *Intybia pelegrini pelegrini* (Pic, 1910), have a multivoltine life cycle (Asano 2021b).

Figs 6–10. Photographs of larvae of *Attalus* (*Attalus*) *elongatulus* Lewis, 1895. 6 – habitat; 7 – overwintering mature larva; 8 – feeding of mature larva; 9 – eggs; 10 – third instar larvae

Given that there are indications of *A. elongatulus* inhabiting the vegetation of cliff-lined coasts, the microhabitat of this species is insufficiently explored (Asano 2018).

In the present study, adults were found on inflorescences of Japanese Cinnamon (*Cinnamomum yabunikkei* H. Ohba), and two overwintering mature larvae were found under seashore rocks (Fig. 6). These findings may confirm that this species lives on rocky escarpments close to seaside, scattered within the humid subtropical climate zone of Japan, where a warmer microclimate would be favourable for vegetable growth.

Seasonal occurrence. As reported above, adults were collected in the field on 4 June. Oviposition was observed on 18 June. The period from oviposition to prepupation was 373 days. In captivity, specimens went through the winter as the final seventh instar; they eventually became prepupa on 18 June of the following year.

Notes. So far, a mature larva has been described for eight species of tribe Attalini, namely *Nepachys japonicus* (Kiesenwetter, 1874) (Hayashi 1962), *Ifnidius petricola* Plata Negrache, 1987 (Plata & Santiago 1990), *Endeodes collaris* LeConte, 1853, *Endeodes rugiceps* Blackwelder, 1932, *Endeodes insularis* Blackwelder, 1932 (Moore 1956), *Endeodes sonorensis* Moore, 1964 (Moore 1964), *Endeodes terminalis* Marshall, 1957, and *Endeodes rothi* Moore & Legner, 1974 (Moore & Legner 1977). The *A. elongatulus* larva is however quite different from all the above listed species, at least due to the sclerotized slabs present on both thoracic and abdominal tergites. Such a character might either be common to other *Attalus* species or linked to the peculiar habitat of this species. It is interesting to note that convergent characters, and behavior, occur in other species as well, as for example in *Idgia iriomoteana* Nakane, 1980 (family Prionoceridae), which has similar sclerotized plates on thoracic and abdominal tergites (Asano 2021a: 431) together with univoltine life cycle, short term adult occurrence and adult pollen-feeding habits.

Discussion

Larvae of four genera of the tribe Attalini are usually found in rocky, arid grounds: rocks along streams (*Nepachys japonicus*), rocky shores (*Ifnidius petricola*, *Endeodes collaris*, *E. rugiceps*, *E. insularis*, and *E. sonorensis*), under dry seaweed on the shoreline (*Endeodes basalis* LeConte, 1852 and *Endeodes blaisdelli* Moore, 1954), and under the rocks on the seashore (*A. elongatulus*). Moreover, genera *Attalus*, *Ifnidius* Escalera, 1940, and *Endeodes* LeConte, 1859 apparently share a remarkable attitude to speciation occurring in islands of the volcanically active marine areas: Tokara and Amami Islands in Japan (*Attalus*), Salvage, Canary, and Cape Verde Islands in Macaronesia (*Ifnidius*), and around the California peninsula on the north-American Pacific coasts (*Endeodes*) (Moore & Legner 1977, Lopez et al. 2014, Asano & Kojima 2017). Whether such speciation occurred just because of insularity, or whether it is possibly also supported by same effect of volcanic activity cannot be presently understood and, for the time being, must remain a guess.

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