

## ORIGINAL ARTICLE

Two new species of the genus *Carminator* Shaw from Japan, the northernmost record of extant Megalyridae (Hymenoptera)Toshiharu MITA<sup>1</sup>, Kazuhiko KONISHI<sup>2</sup>, Mamoru TERAYAMA<sup>3</sup> and Seiki YAMANE<sup>4</sup><sup>1</sup>Laboratory of Insect Resources, Faculty of Agriculture, Tokyo University of Agriculture, Kanagawa, <sup>2</sup>National Agricultural Research Center for Hokkaido Region, Hokkaido, <sup>3</sup>Laboratory of Applied Entomology, The University of Tokyo, Tokyo and<sup>4</sup>Department of Earth and Environmental Sciences, Faculty of Science, Kagoshima University, Kagoshima, Japan**Abstract**

The family Megalyridae is recorded from Japan for the first time on the basis of two new species, *Carminator helios* and *C. japonicus*. This is the northernmost record of living Megalyridae, although fossil species are known from regions of the Baltic Sea. *Carminator helios* can be distinguished from congeners of the Asian and Australian regions by the combination of a long head, deeply excavated frons with convex inner margins, entirely striated postgena, the number of fore tibial spines (more than 16), and a long R<sub>1</sub> vein. *Carminator japonicus* is distinguishable from other species by the combination of an orange-colored metasoma, a weakly excavated frons, and an elongate vertex. This species was collected from the canopy of *Acer pictum*. Additional characters that distinguish species of the genus *Carminator* are discussed.

**Key words:** *Carminator helios* sp. nov., *Carminator japonicus* sp. nov., distribution, taxonomy.

**INTRODUCTION**

The family Megalyridae is a group of parasitoid wasps that are mostly found in the Southern Hemisphere, and are uncommon in the Northern Hemisphere. It comprises eight living genera and displays a pantropical disjunctive distribution (Shaw 1988, 1990a). It is distinguishable from other families of parasitic Hymenoptera by the presence of subantennal grooves, 12-segmented flagella, reduced hindwing venation, and the position of pronotal spiracles (Shaw 1988, 1990a).

Most species are adapted to tropical forests, but some occur in moderate or arid conditions. A few of the better-known species are parasitizing wood-boring cerambycid larvae or mud-nesting sphecid wasp larvae, and host associations and host plant records have been recorded for Australian species (Shaw 1990b). However, most of the life history of members of this family remains unknown.

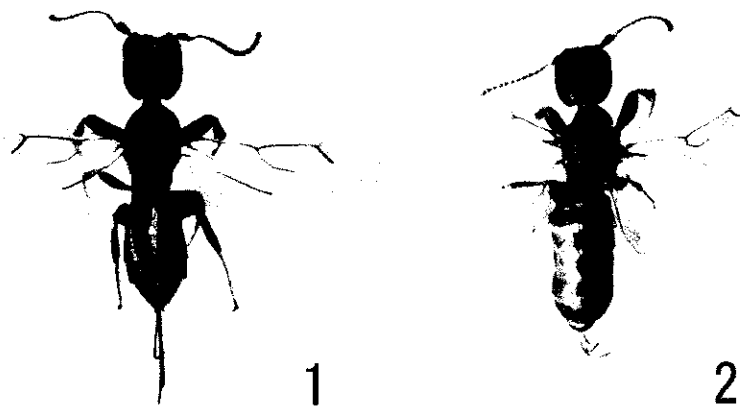
In the course of our study on the hymenopteran fauna of Japan, we obtained two specimens of the genus *Carminator* Shaw belonging to the family Megalyridae, one of which was collected from the Ryukyu Islands, in south-western Japan, and the other from Ibaraki Prefecture, located in central Japan. The latter species was collected from the canopy of *Acer pictum*.

After careful examination, we have concluded that these specimens undoubtedly represent a new record of the family from Japan and recognize them as separate new species, which are described and illustrated in this paper.

To date, the genus *Carminator* has been represented by four species from the Oriental and Australian regions: *C. affinis* Shaw from North Borneo, *C. ater* Shaw from Thailand, *C. cavus* Shaw from Taiwan, and *C. nooni* Shaw from New Britain in the Bismarck Archipelago (Shaw 1988, 1990a). All species are rare, and males have not been recorded. Three species are monotypic and *C. ater* is known by two specimens, the holotype and a paratype. The previously known species are distinctive, but these newly discovered Japanese specimens cannot be placed into any of the currently named species. In the present paper, we detail new characters that are useful for distinguishing

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Figures 1,2 *Carminator* spp. 1 *C. helios* sp. nov. 2 *C. japonicus* sp. nov.

*Carminator* species, and discuss their phylogenetic significance.

### MATERIALS AND METHODS

Two female wasps collected from Japan were examined; one was collected from Nakano-shima Island, a member of the Tokara Islands, which lie in the transition area between the Oriental and Palearctic regions, and the other was collected from Ibaraki Prefecture, central Japan, by a window trap placed in the canopy of *Acer pictum* approximately 20 m above the ground.

The trap comprised a clear sheet to interrupt the flight of insects, and a bucket to capture the trapped insects. The trap was in place from 28 April to 10 May 2002 during the flowering season of the *Acer* tree. The holotypes of *Carminator nooni* Shaw, 1988 and *C. cavus* Shaw, 1988 were also examined.

Terminology for morphological features follows that of Shaw (1987, 1988). The authorship of each species differs, and is indicated for each species. Photos and drawings were prepared by the first author.

### DESCRIPTIONS

#### *Carminator* Shaw, 1988

*Carminator* is a unique megalyrid genus that possesses the following characteristics: Prognathous head; shallow subantennal groove; five-toothed mandible; much-reduced wing venation; absence of pterostigma; mesonotal median sulcus not visible or weakly visible; comb of stout spines on fore tibia; strongly arched ovipositor. Most species have a black to brown body coloration, except for the following parts: mandible, antenna, leg, ovipositor and ovipositor sheath more or

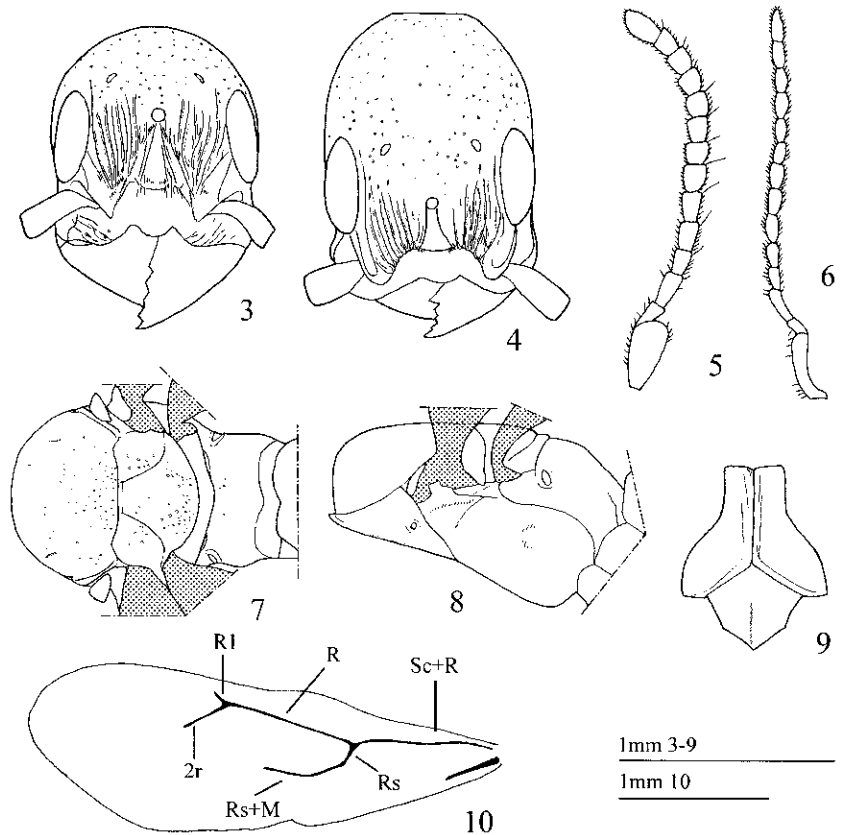
less lighter; wing slightly tinged with brown; metasoma rarely bright orange. The body is 4–9 mm in length, excluding the ovipositor.

#### Key to Japanese species

- 1 a Metasoma brown-black (Fig. 1)
  - b Frons with deep triangular depression between antennal insertions and anterior ocellus (Figs 3,4). . . . . *C. helios* sp. nov.
- 2 aa Metasoma testaceous (Fig. 2)
  - bb Frons without deep triangular depression between antennal insertions and anterior ocellus (Figs 11,12). *C. japonicus* sp. nov.

#### *Carminator helios* Mita, Terayama & Yamane sp. nov. (Figs 1,3–10)

**Diagnosis.** Female (holotype). Head (Figs 3,4) long, 1.30 times as long as wide, sparsely scattered with small, deep punctures, with smooth surface among punctures; frons with approximately 20 longitudinal striae, and without punctures among striae, deeply and triangularly excavated between antennal insertions and median ocellus; excavated area shiny, largely smooth, with a narrow transversely wrinkled step between the area and clypeus; punctures on gena much sparser, as large as on vertex, much smaller than pronotal spiracle; temple smooth, with sparsely located punctures; postgena entirely obliquely striated; vertex elongate, posterior margin flat in full face view; length of vertex 0.43 times as long as head; occipital ridge strongly arching; occiput excavated inside of the head. Clypeus smooth, flat, anterior margin rounded. Inner orbit of eye with an irregular puncto-striated row; punctures near antennal scrobe closely positioned, posteriorly much sparser. Maximum diameter of eye 0.48 mm; anterior ocellus 0.04 mm in diameter; ocelli forming a large obtuse triangle; OTW/



Figures 3–10 *Carminator helios* sp. nov. 3,4 Head: 3 frontal view, 4 dorsal view. 5,6 Antenna: 5 dorsal view, 6 lateral view. 7,8 Mesosoma: 7 dorsal view, 8 lateral view. 9 Propleuron and prosternum in ventral view. 10 Forewing.

OED: 4.3; OTW/OTL: 1.3; posterior margin of posterior ocelli at an approximate level represented by the posterior 0.25 length of eyes in full face view. Mandible with an acutely triangular apical tooth followed by four blunt subtriangular teeth; basal part humped, with acute ridge. Antenna (Figs 5,6) with scape flat, subsequent segments weakly flat; 8th–13th segments with length equal to width; 14th segment oval. Length/width ratio of antennal segments: 6.5/3.0, 2.0/1.5, 3.5/1.75, 2.25/1.5, 2.5/1.75, 2.5/2.0, 2.25/2.0, 2.0/2.0, 2.0/2.0, 2.0/2.0, 2.0/2.0, 2.0/2.0 and 3.25/2.0.

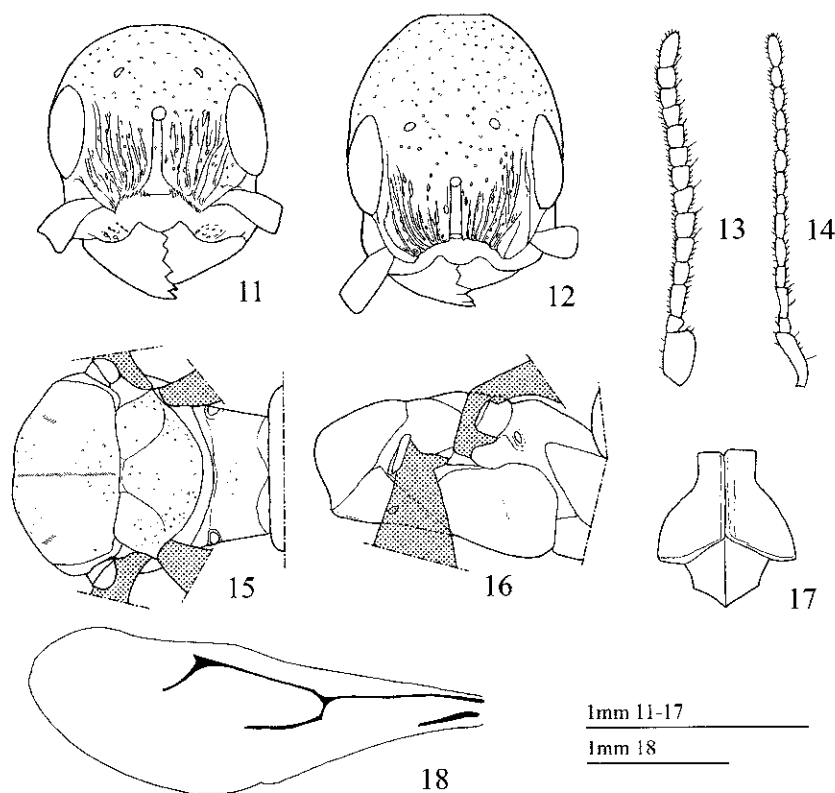
Pronotum strongly shagreened, forming strongly obtuse triangle (Fig. 7). Propleuron dorsally strongly shagreened, ventrally smooth, elongate, anterior half forming a “neck” (Fig. 9). Prosternum with a weak median furrow: anterior 3/10 not visible, posterior 4/10 faintly deeper (Fig. 9). Scutum shagreened, sparsely punctate, near scutellum denser, with a pair of short “scratches” of notauli visible on shoulders; disc 0.65 times as long as wide, with broadly convex anterior margin in dorsal view. Scutellum 0.50 times as long as wide. Mesopleuron with an epicnemial suture obscure,

not forming distinct margin; episternal scrobe forming a weak depression; pleural suture complete, posterior half weak. Metanotum strongly shagreened and moderately punctate. Anterior lobe of metapleuron entirely weakly swollen, with densely located long silver setae. Propodeum 0.35 times as long as wide, with parallel sides, swollen; transverse carina complete, dorsally weak; dorsal area (anterior to propodeal carina) : posterior area (posterior to propodeal carina) = 8:3 in dorsal view; posterior area weakly convex in median part.

Fore tibia flat, with a row of stout spines forming a U-shape; spines of row complete and no missing spines observed, but the number of spines differs between right and left legs: right tibia with 17 spines, left with 20. Fore tarsal segments with the following ratio: 5.25:1.75:1.5:1.0:3.0. Hind tarsal segments with the following ratio: 7.25:2.25:2.0:1.0:4.0.

Forewing with Sc + R branching into R and Rs;  $R_1/2r = 0.3$ ; branch point between  $R_1$  and 2r small (Fig. 10).

Metasoma subspindle-shaped, weakly flattened; smooth and opaque dorsally, and weakly shagreened



Figures 11–18 *Carminator japonicus* sp. nov. 11,12 Head: 11 frontal view, 12 dorsal view. 13,14 Antenna: 13 dorsal view, 14 lateral view. 15,16 Mesosoma: 15 dorsal view, 16 lateral view. 17 Propleuron and prosternum in ventral view. 18 Forewing.

1mm 11-17  
1mm 18

ventro-laterally; seventh abdominal tergite strongly shagreened; first tergite not compressed, 0.59 times as long as wide. Ovipositor sheath with long suberect setae longer than the maximum diameter of ovipositor, 0.74 times as long as ovipositor, 1.08 times as long as mesosoma.

**Color.** Head and mesosoma black; metasoma reddish black; mandible reddish black; scape basal 2/3 dark brown, apical 1/3 brown; pedicel and first segment of flagellum brown, subsequent segments brown; legs brown with hind coxa brown-black; basal 1/3 of forewing hyaline, distal 2/3 subhyaline, tinged with brown; hindwing hyaline; wing vein brown; ovipositor and ovipositor sheath brown.

**Measurements.** Head 1.20 mm long, 0.93 mm wide; mesosoma 1.30 mm long; scutum in dorsal view 0.75 mm wide; propodeal disc 0.25 mm long, 0.63 mm wide; metasoma 1.83 mm long, 0.98 mm wide; forewing 3.6 mm long; ovipositor 1.9 mm, ovipositor sheath 1.4 mm long in full length; total body length excluding ovipositor, 4.3 mm.

**Holotype.** ♀, Japan: Nakano-shima Island (Tokara Islands), Nanatsu-yama, 29°85' N, 129°87' E, 4.vi.2004, T. Mita leg.

**Type depositary.** The holotype is deposited in the Laboratory of Insect Resources, Tokyo University of Agriculture, Kanagawa, Japan.

**Etymology.** This species is named after the sun over Mount Otake on Nakano-shima Island.

**Remarks.** This species is very similar to the Taiwanese *C. cavus* Shaw, 1988, in having a long head and deeply excavated frons, but is distinguished from the latter by a wrinkled step of a triangular area and rather shallow concavity on the frons, posteriorly very sparse punctures in a row on the inner orbit of the eye, entirely striated postgena, short antennal segments, and a long R<sub>1</sub> vein (see latter discussion). The holotype was found by chance: it settled on a hand net along a path on a ridge in a broad-leaved forest at an altitude of 320 m a.s.l.

***Carminator japonicus* Mita & Konishi**  
sp. nov. (Figs 2,11–18)

**Diagnosis.** Female (holotype). Head (Figs 11,12) long, 1.15 times as long as wide in dorsal view, sparsely scattered with small, deep punctures, with smooth surface among punctures; frons with approximately 20 longitudinal striae, moderately excavated to form a furrow below the anterior ocellus in full face view, with small

punctures among striae; furrow deeper and smooth, separated from the clypeus by a step and striae; punctures on gena slightly larger than on vertex, smaller than pronotal spiracle; temple scattered with punctures slightly sparser than on vertex; vertex elongate, posterior margin flat in full face view; length of vertex 0.43 times as long as head; occipital ridge strongly arching; occiput excavated inside of the head. Clypeus smooth, with apical margin rounded. Inner orbit of eye with a regular row of elongate punctures, moderately closely positioned. Maximum diameter of eye 0.41 mm; median ocellus 0.05 mm in diameter; ocelli forming a large obtuse triangle; OTW/OED: 3.2; OTW/OTL: 1.2; posterior margin of posterior ocellus at an approximate level represented by the posterior 0.16 length of eyes in full face view. Mandible with an acutely triangular apical tooth followed by four blunt subtriangular teeth; basal part humped, without acute ridge, dull. Antenna (Figs 13,14) with scape flat, subsequent segments weakly flat; last half segments long, at least 1.14 times as long as wide; 14th segment oval. Length/width ratios of antennal segments: 6.0/3.0, 1.5/1.5, 3.0/1.75, 2.0/1.5, 2.25/1.75, 2.75/1.75, 2.5/1.75, 2.5/1.75, 2.25/1.75, 2.0/1.75, 2.0/1.75, 2.25/1.75, 2.25/1.75 and 3.25/1.75.

Pronotum shagreened, forming almost a right-angled triangle in lateral view (Fig. 16). Propleuron dorsally strongly shagreened, ventrally smooth or faintly shagreened, elongate, forming a "neck" (Fig. 17). Prosternum with a median furrow distinct and complete. Scutum weakly shagreened, sparsely punctate, near scutellum denser, with a trace of mesoscutal sulcus, a pair of short "scratches" of notauli visible on shoulders; disc 0.58 times as long as wide, with broadly convex anterior margin in dorsal view. Scutellum shagreened and punctuated as scutum on dorsal region, much denser on lateral region, 0.42 times as long as wide. Mesopleuron with an epicnemial suture forming a clear margin; episternal scrobe forming a weak depression; anterior half of pleural suture distinct, posterior half weak but clearly visible. Metanotum narrow, shagreened. Anterior lobe of metapleuron entirely strongly swollen, with sparsely located short silver setae. Propodeum 0.30 times as long as wide, with parallel sides, swollen; pronotal carina complete, dorsally weak, with median part convex; dorsal area (anterior to propodeal carina): posterior area (posterior to propodeal carina) = 3:1 in dorsal view; posterior area weakly convex in median part.

Fore tibia flat with a row of stout spines forming a U-shape; spines of row complete and no missing spines observed, but the number of spines differs between

right and left legs: right tibia with 15 spines, left with 16. Fore tarsal segments with the following ratio: 5.0:1.75:1.75:1.0:3.0. Hind tarsal segments with the following ratio: 7.0:2.5:2.25:1.0:4.0.

Forewing with Sc + R branching into R and Rs;  $R_1/2r = 0.25$ ; branch point between  $R_1$  and  $2r$  large (Fig. 18).

Metasoma subcylindrical, mostly smooth and opaque, weakly granulated; latero-posterior portions of tergites weakly shagreened; seventh tergite weakly shagreened, effaced; first tergite strongly anteriorly compressed, 0.30 times as long as wide.

Ovipositor sheath with long suberect setae, longer than the maximum diameter of ovipositor, 0.85 times as long as ovipositor, 0.79 times as long as mesosoma.

*Color.* Head black; antenna testaceous, with scape dark brown; mandible light brown, with teeth reddish brown; mesosoma reddish brown; legs testaceous, with coxa reddish brown, fore femur and tibia brownish; metasoma bright orange, apical half of each tergite semicircularly and sixth tergite ovably whitish; forewing and hindwing tinged with brown; wing vein testaceous.

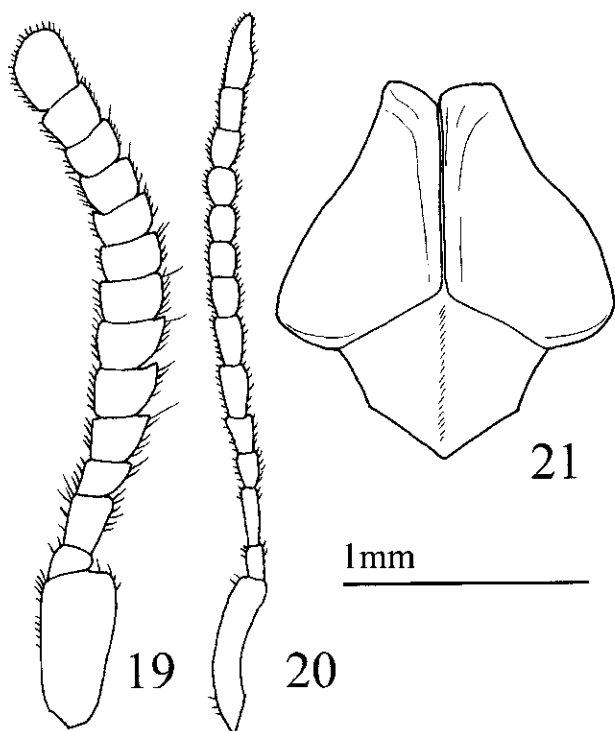
*Measurements.* Head 1.10 mm long, 0.96 mm wide; mesosoma 1.45 mm long; scutum in dorsal view 0.52 mm long, 0.89 mm wide; metanotum 0.05 mm long; propodeal disc 0.20 mm long, 0.67 mm wide; forewing 3.35 mm long; metasoma 2.41 mm long, 1.03 mm wide; ovipositor 1.35 mm, ovipositor sheath 1.15 mm long in full length; total body length excluding ovipositor, 5.0 mm.

*Holotype.* ♀, Japan: Ogawa, Kitaibaraki, Ibaraki Prefecture, Honshu, 36°55' N, 140°34' E, 3–5.v.2002, caught in a window trap in the canopy of *Acer pictum*, M. Shibata leg.

*Type depository.* Laboratory of Insect Systematics, National Institute for Agro-Environmental Sciences, Tsukuba, Japan.

*Etymology.* The name refers to the type locality in the country of Japan.

*Remarks.* In the key to the species of *Carminator* Shaw, 1988, *japonicus* runs to *nooni*, but this species is easily distinguished from the latter by the small body size (5.0 mm, excluding ovipositor), moderately excavated frons in full face view, elongate vertex and flat posterior margin, much smaller punctures than pronotal spiracle, and slender antennae (Figs 13,14). Examination of the holotype of *C. nooni* revealed a large body size (8.5 mm, excluding ovipositor), a flat frons in full face view, a vertex that was wide and round, and antennae that were short and broadened (Figs 19,20; see Discussion). The holotype was collected in a



Figures 19–21 *Carminator nooni*, holotype. 19,20 Antennae: 19 dorsal view, 20 lateral view. 21 Propleuron and prosternum in ventral view.

temperate deciduous broad-leaved forest at an altitude of 610–660 m a.s.l.

## DISCUSSION

Extant species of the family Megalyridae are distributed mainly in the Southern Hemisphere, without any record from the Holarctic region. Megalyrid species show their greatest diversity in Australia, with the next-most diverse area occurring in the Afrotropical region, particularly in Madagascar, and there are approximately 18 species of undescribed *Dinapsis* species (Shaw 2006; S.R. Shaw, pers. comm., 2006). In the Oriental region, *Megalyra*, *Ettchellsia* and *Carminator* have been recorded. *Carminator cavus* and an unidentified male specimen belonging to *Ettchellsia* have been recorded from Taiwan, which previously represented the northernmost records of Megalyridae (Shaw 1988, 2003).

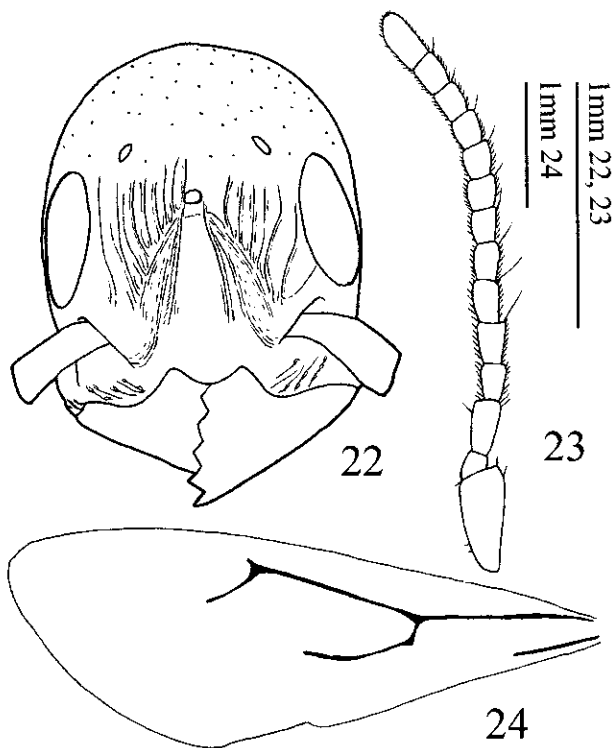
*Carminator helios* was collected from Nakano-shima Island, in the Tokara Islands, which is regarded as a transition area of fauna between the Oriental and Palearctic regions. This species is considered to be closely

related to the Taiwanese *C. cavus* in having a long head, a deeply excavated frons and a smooth triangular furrow below the anterior ocellus. *Carminator japonicus* was collected from Ibaraki Prefecture, which is located in central Japan in the Palearctic region. This species was collected from the canopy of *Acer pictum* using a window trap. This is the first record of a *Carminator* species collected from a particular tree. This might indicate that the wasp attacks hosts in the *Acer* tree. On the other hand, since the wasp was caught while the tree was in flower, the wasp might have merely been visiting the blossom. Our discovery of this new species represents the northernmost record for the Megalyridae.

Shaw (1988) established the genus *Carminator* and described four new species. In that paper, comparison and description were chiefly focused on head structure, with other characters, especially those of the mesosoma, being neglected. Comparing the holotypes of *C. nooni*, *C. cavus* and the two Japanese species discovered in the present study, we will now detail the characters we consider important for distinguishing species and possibly for phylogenetic analysis.

## Head

Shaw (1988) mentioned several key characters for recognition of *Carminator* species: relative length of head; excavation (present or absent) and striae (entirely or partly) of the frons; puncture size, especially on gena; puncture row along inner orbit of eye (continuous or discontinuous); and position of ocelli. However, it is difficult to distinguish *Carminator helios* and *C. cavus* on the basis of these key characters. The following additional characters are needed to distinguish *Carminator* species: punctures on head are sparser and deep (*helios*, *japonicus*) or denser and shallow (*cavus*); basal part of mandible forms an acute ridge (*cavus*, *helios*) or hump (*japonicus*); median furrow under anterior ocellus forms a wide triangular area (*cavus*, *helios*), simple narrow furrow (*japonicus*) or is without a distinct furrow (*nooni*); frons deeply excavated (*cavus*, *helios*), weakly excavated (*japonicus*) or not excavated (*nooni*); a margin between clypeus and median furrow is visible (*nooni*, *helios*, *japonicus*) or not visible (*cavus*; Fig. 22); postgena is entirely striated (*helios*, *japonicus*) or partly striated, medially smooth (*cavus*); vertex is elongate (*cavus*, *helios*, *japonicus*) or round (*nooni*); occipital ridge is strongly arched (*cavus*, *helios*, *japonicus*) or weakly arched (*nooni*); flagellum is flat (*nooni*) or otherwise (*cavus*, *helios*, *japonicus*); relative length of flagellomere is longer than wide (*cavus* (Fig. 23), *japoni-*



Figures 22–24 *Carminator cavus*, holotype. Head: 22 frontal view. Antenna: 23 dorsal view. 24 Forewing.

*cus*), as long as the width (*helios*) or shorter (*nooni*); shape of 12th flagellomere is oval (*cavus*, *helios*, *japonicus*) or truncate (*nooni*).

The vertex of the Japanese species and Taiwanese *C. cavus* is not precisely elongate; the ratio of the length of the vertex to head length is almost the same (*helios*, 0.43; *japonicus*, 0.43; *cavus*, 0.43; *nooni*, 0.40), although the position of ocelli differs to some extent. As a consequence, the vertex becomes comparatively longer or wider according to the ratio of the head length. The same applies for the arc of the occipital ridge.

### Mesosoma

Shaw (1988) mentioned that “There is little variation in the form of the mesosoma or metasoma except for very subtle differences in microsculpture.” Only the propodeal carina was investigated in his description. Although details of notaulices were not presented, a short scratch of notaulices is visible on the shoulder in each species. Shaw also indicated that a mesoscutal sulcus was not observed in *Carminator* species, which an apomorphic character state in the Megalyridae; however, a trace of mesoscutal sulcus is observed in

*C. japonicus*. Another difference for *C. japonicus* involves the scutellum: the ratio of the length of the scutellum to the width is smallest, whereas it is larger and the same in other species (*japonicus*, 0.42; *helios*, 0.50; *cavus*, 0.50; *nooni*, 0.51). Though species recognition based on the notal region is very difficult, as acknowledged by Shaw (1988), several well-defined characters among species are found in the pleural region. The most noticeable character is the shape of the propleuron: the propleuron of *C. nooni* is not elongate (Fig. 21), but the anterior half of the propleuron forms a “neck” in the other three species. It is believed that the length of the “neck” is closely related to the shape of the head, especially the length of the vertex. The following characters are also considered useful for distinguishing species: pronotum forming a right-angled triangle (*cavus*, *helios*) or obtuse triangle (*nooni*, *japonicus*); prosternum suture is weak and incomplete (*nooni*, *cavus*, *helios*) or distinct and complete (*japonicus*); epicnemial suture is weak (*cavus*, *helios*) or strong (*nooni*, *japonicus*); episternal scrobe is weak (*helios*, *japonicus*) or strong (*nooni*, *cavus*); anterior lobe of metapleuron is entirely swollen (*cavus*, *helios*, *japonicus*) or partly swollen (*nooni*); setae on lobe short and sparser (*nooni*, *japonicus*) or long and denser (*cavus*, *helios*).

### Leg

The number of fore tarsal spines varies to some extent between individuals, but each species shows a distinct cline. Fore tarsal segments have a different ratio between species. The second segment is as long as wide, and at most slightly longer than the third segment (*helios*, *japonicus*) or more than 1.5 times longer (*nooni*, *cavus*).

### Wing

Shaw (1988) referred to the length of the  $R_1$  vein and presented the ratio of  $R_1$  length/2r length. The shape of the branching point between both veins also differs between species: the branching point can be normal (*helios*, *nooni*) or large (*cavus* (Fig. 24), *japonicus*).

### Metasoma

As mentioned by Shaw (1988), there is little difference between all examined species, except for color, although the seventh tergite can be strongly shagreened (*cavus*, *helios*) or weakly shagreened (*nooni*, *japonicus*). Each species exhibits a different ratio of the full length of the ovipositor sheath relative to the length of the mesosoma.

## ACKNOWLEDGMENTS

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