

Studies on the morphology and biology of *Megastigmus aculeatus* (Swederus, 1795) (Hymenoptera: Megastigmidae), a new record for the fauna of Turkey

Hymenoptera is one of the largest insect orders, with over 150,000 identified species (Aguiar et al. 2013). Chalcidoidea, a superfamily of the order Hymenoptera, includes 22 families and two extinct families (Diversinitidae and Khutelchalcididae) (Grissell & Schauff 1990, Gibson et al. 1997, Aguiar et al. 2013, Heraty et al. 2013). Megastigmidae is a family of Chalcidoidea (Zerova et al. 2021). Megastigmidae was previously classified as subfamily Megastigminae of family Torymidae (Janšta et al. 2018, Noyes 2019). Megastigmidae consists of 214 species, and 12 genera worldwide (Noyes 2019, Zerova et al. 2021). Grissell (1999) reported 133 species and five subspecies of the genus *Megastigmus* worldwide. Besides, Noyes (2019) listed 154 species in the genus *Megastigmus*. Until now, nine species of the genus *Megastigmus* have been reported from Turkey (Novicky 1954, Hussey 1957, Lessmann 1962, Öncüer 1991, Fabre et al. 1994, Roques et al. 1999, Gencer 2003, Roques & Skrzypczynska 2003, Auger-Rozenberg et al. 2006, Daneshvar et al. 2009, Ayberk & Cebeci 2010, Doğanlar & Doğanlar 2010, Stojanova et al. 2012, Doğanlar & Zengin 2018). The genus *Megastigmus* includes only phytophagous species (without metallic reflections) and Bootanomyia, the entomophagous species (with metallic reflections) included in the past in *Megastigmus*. (Kamijo 1962). Phytophagous species are commonly known as seed chalcids because they attack plant seeds during the larvae period. The larvae of some species feed on the tissue of the fresh seeds of *Rosa canina* L. (Syrett 1990). Seed chalcids of *Megastigmus aculeatus* (Swederus 1795) (Hymenoptera: Megastigmidae) are the primary seed pests of *R. canina*.

Roses have been used in food, perfumery, and cosmetics industries for years (Uggla 2004). *R. canina*, known as dog rose, belonging to the family Rosaceae, is common in Turkey and the world. The family Rosaceae includes over 4,828 known species in 91 genera worldwide (Christenhusz & Byng 2016). This family is represented by 37 genera and 297 species in Turkey (Erik & Tarıkahya, 2004). In previous studies on rosehip (*Rosa* spp.) pests in Turkey, pest species belonging to Acarina, Heteroptera, Homoptera, Hymenoptera (Argidae, *Arge rosae*; Cynipidae, *Diplolepsi rosae*, *D. mayri*), Lepidoptera, and Thysanoptera orders were identified (Oğurlu et al. 1996, Özbek et al. 1996).

In this paper, *M. aculeatus*, recorded for the first time in Turkey, and it was investigated in morphology and biology on *R. canina*.

The eggs, larvae, and adult specimens of the new record of *M. aculeatus* were obtained from fresh and dry fruits of *R. canina* (Figure 1) in Bingöl province of Turkey in 2020-2021. The research was carried out in Beyaztoprak, Çeltiksuyu, and Kardeşler villages of central Bingöl, where *R. canina* grows naturally. In each village, plant controls were carried out three times in April and five times in June and July each year (16 times during the study). A total of 240 fruits per year, with an average of 10 whole fruit in each control, and 480 fruits

during the study were examined or cultured. The number of eggs and larvae found in these fruits was small, but we found a total of 13 adults. Adult specimens that emerged from the pupa were obtained from dry fruits in April (Figure 4c), while eggs and larvae were obtained from fresh fruits in June and July (Figure 4a). To obtain adult specimens, *R. canina* dry fruits were collected in April, brought to the laboratory in nylon bags and thermos, and cultured. Cultures were checked daily for a follow-up of the first adults' emergence. The adults emerging from the dry fruits cultured were killed with ethyl acetate, pinned, labeled, and prepared for identification. Fresh *R. canina* fruits were also collected in June and July and brought to the laboratory to obtain eggs and larvae. Fresh fruits were opened with tweezers and checked. The eggs and larvae found were removed and examined under a stereomicroscope. The used morphological terminology was based on identification keys by Roques & Skrzypczynska (2003), Doğanlar & Hassan (2010), and Doğanlar (2015). The identification was confirmed by Prof. Dr. Miktat Doğanlar and Dr. Irinel E. Popescu. Photographs of eggs, larvae, and diagnostic characters of adults of *M. aculeatus* were taken using a digital camera attached to a stereomicroscope. The material is deposited in the collection of the Department of Plant Protection, Faculty of Agriculture, Bingöl University, Bingöl, Turkey.

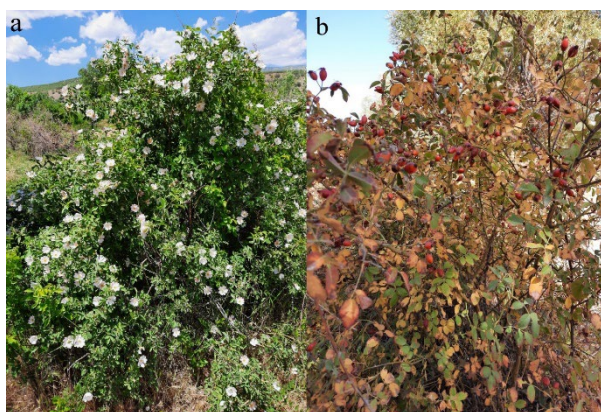


Figure 1. *Rosa canina* L. in Bingöl: 1a in spring; 1b in autumn.

Superfamily: **Chalcidoidea**

Family: **Megastigmidae**

Genus: ***Megastigmus*** Dalman, 1820

Species: ***Megastigmus aculeatus*** (Swederus, 1795)

Material examined. Bingöl: Beyaztoprak, 113 m, 13.V.2020, 2♀♀; 110 m, 22.V.2020, 3♀♀; Çeltiksuyu, 108 m, 06.V.2020, 5♀♀; Kardeşler, 115 m, 22.V.2021, 3♀♀.

Hostplant. *Rosa canina* L. (*R. canina* in Turkey).

Zoogeographic region. Afrotropical (Djibouti, South Africa), Australian, Nearctic, Neotropical & Palaearctic regions (Roques & Skrzypczynska 2003).

Distribution: Argentina, Armenia, Australia, Austria, Bosnia & Herzegovina, Bulgaria, China, Croatia, Czech Republic, Denmark, England, Ethiopia, Finland, France, Germany, Greece, Hungary, Iran, Iraq, Italy, Japan, Kazakhstan, Montenegro, Moldova, Morocco, Nearctic, Netherlands, New Zealand, Poland, Romania, Russia, Serbia,

Slovakia, South Africa, Somalia, Spain, Switzerland, Sweden, Tajikistan, Turkmenistan, Ukraine, USA, former USSR, former Yugoslavia (Zerova et al. 2021).

Remarks. This species is a new record for the fauna of Turkey.

Diagnosis (female)

Adult. Previous studies provided adult morphology of *M. aculeatus* in Roques & Skrzybczynska (2003). Here we provide a shorter description of the new record. The body length (except the ovipositor) is 3.9 mm (Figure 2a); the color is yellowish brown with black markings; the head is broader than the pronotum in dorsal view, light brownish yellow; the ocelli, occipital carina, and temple are black (Figure 2d); the antennal scape is 3x much longer than the pedicel; the scape and the pedicel are apically black basally yellow; the flagellum is completely dark brown (Figure 2c); the mandibles are apically black; the thorax is ventrally black; the mesoscutum, scutellum, and dorsellum are yellow; the propodeum is anteriorly black (Figure 2e); the legs are brownish yellow, except for the distal segments of other tarsi, which are brown; in the forewings costal, marginal, submarginal, postmarginal and stigmal veins are present (Figure 2f); the forewings' stigma are dark brown and roughly oval, not surrounded by distinct infuscated area; the stigmal vein is short (Figure 2g); terga are dark brown on dorsum and brownish yellow laterally; the ovipositor is black, with a 4.8 mm length; the exerted part of the ovipositor 1.2x longer than the body length, and 2.3x than the terga length (Figure 2a).

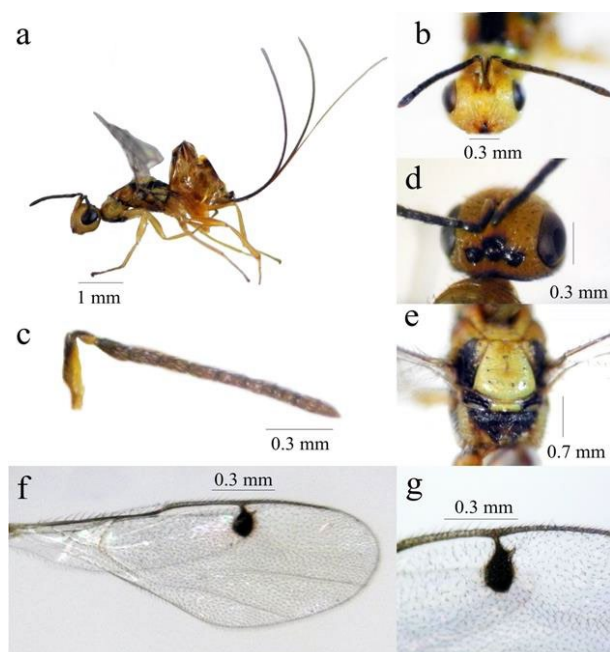


Figure 2. Adult of *Megastigmus aculeatus*: 2a lateral view; 2b frontal view; 2c Antenna; 2d dorsal view of ocelli; 2e dorsal view of thorax; 2f forewing; 2g stigma in the forewing.

Eggs. *M. aculeatus* eggs were described and photographed for the first time. The egg's length is approximately 1.1 mm with an oval shape; the color is yellowish white; the center of

the egg is wide, and the poles are narrow (Figure 3a, b).

Larvae. A previous study provided larvae morphology for *M. aculeatus* (Nieves-Aldrey et al. 2008). Here, a shorter description is given of the new record. The length of young larvae is 2.9 mm, and the width of 1.3 mm; the head is brownish, the thorax whitish, and the abdomen light brownish white; there are visible anterodorsal protuberances and spiracles in the integument; mandibles, maxillae, and labrum are well visible, they are not divided into parts or lobes; mandibles have four teeth (Figure 3c). The mature larvae length was 3.2 mm, and the width 1.4 mm; the head is reddish-white, the thorax is blackish white, and the abdomen is white; the integument is entirely smooth; mandibles, maxillae, and labrum are relatively small, not divided into parts or lobes. (Figure 3d).

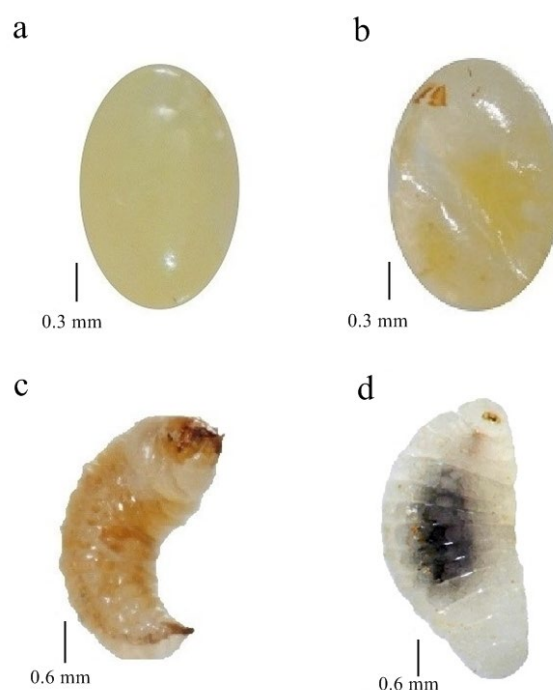


Figure 3. *Megastigmus aculeatus*: 3a The first period of the egg; 3b The last period of the egg; 3c Young larvae; 3d Mature larvae.

Biology

The first emergence of adults from the *Rosa canina* dry fruits collected from Bingöl province in the spring of 2020-2021 was observed in the first week of May. In addition, eggs of *M. aculeatus* found in fresh fruits of *R. canina* were cultured to observe larvae hatching (Figure 4b). Five days after the eggs were cultured, the heads of larvae (mandible and eyes) began to be seen in eggs; after six days the eggs shriveled up and after seven days the first larvae hatched in June. Hatched larvae were cultured in the seeds and fruits of *R. canina* (Figure 4e). The larval development was examined under the stereomicroscope, and larvae were left in a culture dish with fresh *R. canina* seeds for feeding. Larvae probably have five instars (Cuda et al. 2002). Larvae develop completely within a single seed, with winter diapause that may extend to a few years (Turgeon et al., 1994). In addition, some species can

thrive in unfertilized seeds (Niwa & Overhulser 1992, Rappaport et al. 1993, Rouault 1998).

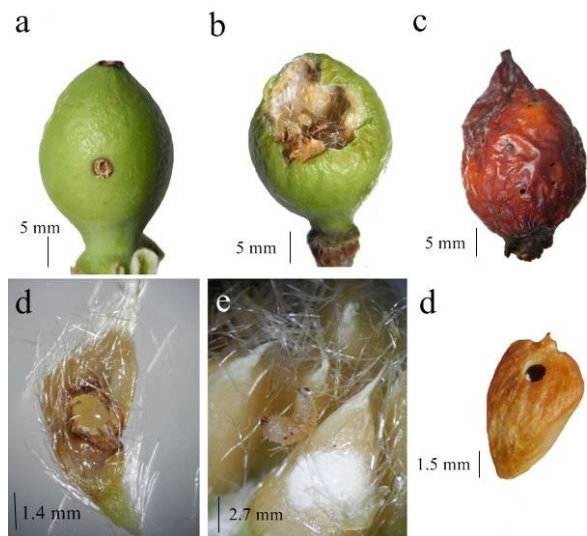


Figure 4. *Megastigmus aculeatus* in *R. canina* L. fruit and seed: 4a Ovipositor hole of an adult female in fresh fruit; 4b Egg cultured in fresh fruit; 4c Adult exit hole in dry fruit; 4d Egg in the seed; 4e Larvae cultured in fresh fruit; 4f Adult exit hole in the seed.

Adult females make holes in the fruits with their ovipositor and put their eggs inside the seeds of *R. canina* (Figure 4a, d). The ovipositor holes with a diameter of 1.6 mm were counted from 1 to 4 in each fruit. The main damage in *R. canina* occurs when the hatched larvae feed inside the seeds (Figure 4f). However, the hole made by adult females with ovipositor turns black, and microorganisms enter the fruit from this part, causing the blackening and decay of the fruit (Figure 4a).

In the present study, *M. aculeatus* is newly recorded from Turkey. Consequently, the number of species of the genus *Megastigmus* reported from Turkey is increased to 10 by the current study. Also, data on the morphology and biology of seed chalcid *M. aculeatus* were demonstrated for the first time.

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