

Original article (Orijinal araştırma)

Tachinid (Diptera: Tachinidae) parasitoids of the lucerne beetle, *Gonioctena fornicata* (Brüggemann, 1873) (Coleoptera: Chrysomelidae), with a new parasitoid record and their parasitism rates

Yonca yaprak böceği, *Gonioctena fornicata* (Brüggemann, 1873) (Coleoptera: Chrysomelidae)'nın yeni bir parazitoit kaydı ile Tachinid (Diptera: Tachinidae) parazitoitleri ve parazitlenme oranları

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Abstract

The lucerne beetle, *Gonioctena fornicata* (Brüggemann, 1873) (Coleoptera: Chrysomelidae), is a serious pest of lucerne. In this study, tachinid (Diptera: Tachinidae) parasitoids of *G. fornicata*, and their parasitism rates were investigated at one location in Tokat Province, Turkey during 2016 and 2017. For this purpose, the lucerne beetle larvae were collected from an lucerne field and reared in the laboratory. Two tachinid species were obtained from the reared larvae. The species were *Meigenia mutabilis* (Fallén, 1810) and *Macquartia tenebricosa* (Meigen, 1824) (Diptera: Tachinidae). *Macquartia tenebricosa* was recorded first time as parasitoid of *G. fornicata*. The number and sex of the emerged parasitoids were recorded daily. The parasitism rates were 3.61% and 1.07% during 2016, and 3.69% and 0.50% in 2017, for *M. mutabilis* and *M. tenebricosa*, respectively. Based on these data, it was concluded that *M. mutabilis* is more effective parasitoid of *G. fornicata*. This paper reports for the first time detailed information on the natural enemies of *G. fornicata* and their effectiveness both on Turkey and worldwide.

Keywords: *Gonioctena fornicata*, lucerne, parasitoids, Tachinidae, Turkey

Öz

Yonca yaprak böceği, [*Gonioctena fornicata* (Brüggemann, 1873) (Coleoptera: Chrysomelidae)], yoncanın önemli bir zararlısıdır. 2016-2017 yıllarında gerçekleştirilen bu çalışmada, Tokat ilinde belirlenen bir lokasyonda yonca yaprak böceği (*G. fornicata*)'nın Tachinid (Diptera: Tachinidae) parazitotleri ve parazitlenme oranları araştırılmıştır. Bu maksat için yonca yaprak böceğinin larvaları yonca arazisinden toplanarak laboratuvarında kültüre alınmıştır. Tachinidae familyasına ait iki tür tespit edilmiş olup bunlar, *Meigenia mutabilis* (Fallén, 1810) ve *Macquartia tenebricosa* (Meigen, 1824) (Diptera: Tachinidae)'dır. *Macquartia tenebricosa*'nın *G. fornicata*'nın parazitoiti olduğu ilk kez bu çalışma ile bildirilmiştir. Çıkan parazitoitlerin sayısı ve cinsiyetleri günlük olarak kaydedilmiştir. *Meigenia mutabilis* ve *M. tenebricosa* için 2016 yılındaki parazitlenme oranları, sırasıyla %3.61 ve %1.07; 2017 için ise %3.69 ve %0.50 olarak belirlenmiştir. Elde edilen sonuçlara göre *M. mutabilis*'in *G. fornicata* üzerinde daha etkili bir parazitoit olduğu saptanmıştır. Bu çalışma, *G. fornicata*'nın doğal düşmanlarının ve etkinliklerinin belirlenmesi bakımından hem dünya hem de Türkiye'de gerçekleştirilen ilk detaylı çalışma niteliğindedir.

Anahtar sözcükler: *Gonioctena fornicata*, yonca, parazitoitler, Tachinidae, Türkiye

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Introduction

Forage crops have a very important place in agriculture, and particularly for animal production (Yolcu & Tan, 2008). Lucerne is the most favored forage crop worldwide due to its high adaptability to different climatic and environmental conditions, high feed efficiency and good feed quality (Özyazıcı et al., 2013). The lucerne beetle, *Gonioctena fornicata* (Brüggemann, 1873) (Coleoptera: Chrysomelidae) causes significant damage to lucerne and other species in the Fabaceae. Adults and larvae feed on lucerne leaves, causing significant yield losses depending on their density in the field. Alkan (1946) was the first to record the presence and damage of *G. fornicata* in Turkey. Later, many researchers have published information about the damage, spread and biology of *G. fornicata* in the country (Medvedev, 1970; Kismalı, 1973; Kovancı, 1982; Kasap, 1988; Yıldırım et al., 1996; Aslan & Özbek, 1999; Efe & Özgökçe, 2014). Coşkun & Genç (2006) reported that the first adults were observed in Bursa at the end of March, and damage was observed in the lucerne fields until end of July. Furthermore, it was reported that the insect has one generation per year. Çam & Atay (2006) also reported that larvae and adults cause heavy damage to lucerne leaves in Tokat Province, Turkey. Grigorov (1976) reported that the larvae and adults feed on leaves, shoots and leaf buds of the plants causing severe losses which may exceed 60% for vegetative mass and 100% for seeds in Central and Southeastern Europe.

Collection of larvae and adults is recommended for control this pest in small areas. Early and frequent cutting or flooding of lucerne stands may lead to mortality of the pest. There have also been some biological control studies. Particularly, entomopathogenic fungi contribute to regulation of its population. Atay et al. (2015) found that 36% of *G. fornicata* overwintered adults in lucerne growing areas of Tokat Province were naturally infested with an entomopathogenic fungus *Beauveria* sp. Despite the significant damage, an effective control strategy against these pests is yet to be developed.

Lucerne is a perennial plant having an average life of 5 years. Many different organisms can establish in lucerne growing areas as it creates habitat for them. Lucerne fields provide a temporary equilibrium in terms of flora and fauna among field crops. In this way, lucerne cultivation contributes to the natural balance in agroecosystems. Therefore, the development of eco-friendly and appropriate methods of control against *G. fornicata* will allow for the provision of production, as well as the protection of this natural balance. All over the world natural enemies, biological control agents, are regarded as important repressive elements to achieve this goal. In this framework, the efficacy of the tachinid species against *G. fornicata* was investigated.

The Tachinidae is a family of parasitoids, which are very important biological control agents. Many of their hosts are significant pests of cultivated crops. Most species parasitize lepidopteran larvae, other hosts are ranged as the orders Coleoptera, Hemiptera, Hymenoptera, Orthoptera and Diptera according to their importance (Grenier, 1988; Stireman et al., 2006). Kara & Tschorsnig (2003) prepared a detailed catalog containing tachinid hosts identified in Turkey. The most recent and comprehensive catalog of Palearctic hosts was prepared by Tschorsnig (2017). No records of Tachinidae in lucerne beetle have been published for Turkey.

Material and Methods

This study was conducted to determine the tachinid parasitoids of *G. fornicata* and parasitism rates at one location in Tokat Province, Turkey during 2016-2017.

Study area: a lucerne field in Ballıdere, Tokat - Merkez (40°21'03" N, 36°38'05" E, 606 m, 0.3 ha).

Lucerne beetle larvae were collected (1200 larvae in each year) from the lucerne field through mid-May to early June in both 2016 and 2017. The larvae were brought to the laboratory with their host plants, which were replaced with new ones every day, transferred to separate cages, kept at 25±2°C and 60-70% RH, and inspected daily for emergence of the parasitoids. The number and sex of the parasitoids obtained were recorded daily. Parasitism rates for each species were calculated using the following formula (Keçeci et al., 2008).

Parasitism rate (%) = [Number of adult parasitoids / (Number of lucerne beetle larvae + Number of adult parasitoids)] x 100

After adult emergence, the flies were pinned and processed for identification. They were identified using the keys of Mesnil (1962), Tschorsnig & Herting (1994) and Tschorsnig & Richter (1998). Nomenclature and arrangement of tachinids followed Herting & Dely-Draskovits (1993). The specimens were deposited at the Plant Protection Museum in Gaziosmanpaşa University, Agricultural Faculty, Plant Protection Department, Tokat, Turkey.

Results and Discussion

Two tachinids, *Meigenia mutabilis* (Fallén, 1810) and *Macquartia tenebricosa* (Meigen, 1824) (Diptera: Tachinidae), were obtained and their parasitic efficiencies determined. *Macquartia tenebricosa* was recorded for the first time as parasitoid of *G. fornicata*. No hymenopteran parasitoids were encountered during the study. The distribution and some additional information related to tachinid species is as follows.

Subfamily: Exoristinae

Tribe: Blondeliini

Meigenia mutabilis (Fallén, 1810)

Distribution in Turkey: Erzurum (Doğanlar, 1982), Tokat (Kara, 1998), Amasya (Kara, 2001).

Distribution elsewhere: Caucasus, Soviet Middle Asia, East Siberia, Asia (Herting & Dely-Draskovits, 1993), Europe (Tschorsnig et al., 2004).

Remarks: From the middle of April to the middle of October, it has several generations in Central Europe. It can be observed on flowers and leaves. *Meigenia mutabilis* has many Chrysomelidae hosts, rarely Curculionidae and Tenthredinidae (Tschorsnig & Herting, 1994; Tschorsnig, 2017). No host of *M. mutabilis* has previously been reported in Turkey. Tschorsnig (2017) mentions a few old records of *M. mutabilis* being obtained from *G. fornicata*. This parasitoid kills the host and then emerges from the host and turns into pupae (Figure 1a).

Subfamily: Tachininae

Tribe: Macquartiini

Macquartia tenebricosa (Meigen, 1824)

Distribution in Turkey: Tokat (Kara, 1999), Amasya (Kara, 2001), Bartın (Korkmaz, 2007).

Distribution elsewhere: Caucasus, Soviet Middle Asia, East and West Siberia, Asia (Herting & Dely-Draskovits, 1993), Europe (Tschorsnig et al., 2004). Remarks: From the middle of April to the early October, the species has several generations in Central Europe. Only Chrysomelidae are known as reliable hosts (Tschorsnig & Herting, 1994; Tschorsnig, 2017). No hosts of *M. tenebricosa* have been reported in Turkey until this report. *Gonioctena fornicata* is a new host species for this tachinid. This parasitoid kills the host and then turns into pupae inside the host larval skin (Figure 1b).

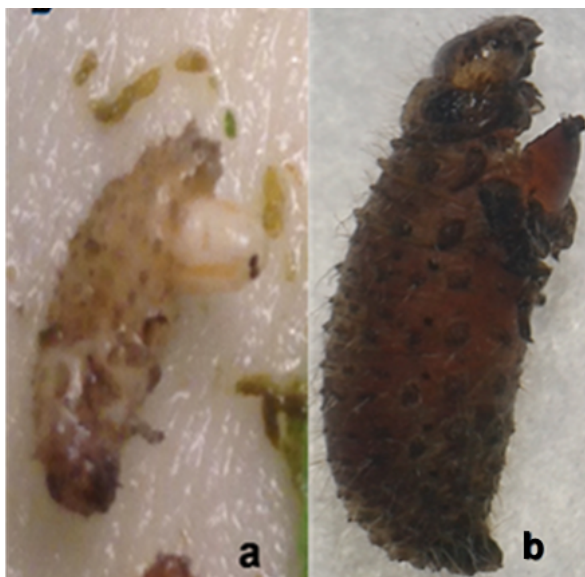


Figure 1. a) *Meigenia mutabilis* larvae emerging from *Gonioctena fornicata* larvae; and b) the puparium of *Macquartia tenebricosa* inside the host larval skin.

Data collected on the parasitoids are presented in Table 1. The parasitism rates were 3.61 and 3.69% for *M. mutabilis*, and 1.07 and 0.50% for *M. tenebricosa* during 2016 and 2017, respectively. The parasitism rate of *M. mutabilis* was higher than *M. tenebricosa* in both years of the study. The total parasitism rate of the two parasitoids was 4.68% in 2016 and 4.19% in 2017 (Table 1).

Table 1. Numbers and parasitism rates of *Meigenia mutabilis* and *Macquartia tenebricosa*

Year	<i>M. mutabilis</i>				<i>M. tenebricosa</i>			
	Male	Female	Total	Parasitism Rate (%)	Male	Female	Total	Parasitism Rate (%)
2016	26	19	45	3.61	7	6	13	1.07
2017	19	27	46	3.69	0	6	6	0.50

The number and sex of emerged parasitoids were recorded daily. Overall higher number of emerging individuals of *M. mutabilis* than *M. tenebricosa* was recorded during both years of the study (Table 1). Notably, individuals of *M. mutabilis* emerged earlier than those of *M. tenebricosa*, regardless of the year and sex (Figure 2). Early emergence of parasitoids from their hosts increases the impact of the parasitoid on the host population. The emergence of males of *M. tenebricosa* was only recorded in 2016. Both parasitoids yielded higher number of males than females in 2016, while more number of females was recorded during the second year of the study (Table 1 and Figure 2). The total number of males of *M. mutabilis* and *M. tenebricosa* were 45 and seven, respectively, in both years of the study, while the total female numbers were 46 and 12, respectively (Table 1). Consistently female-biased parasitoid sex ratios may benefit biological control because successful parasitization can result from lone females (Heimpel & Lundgren, 2000).

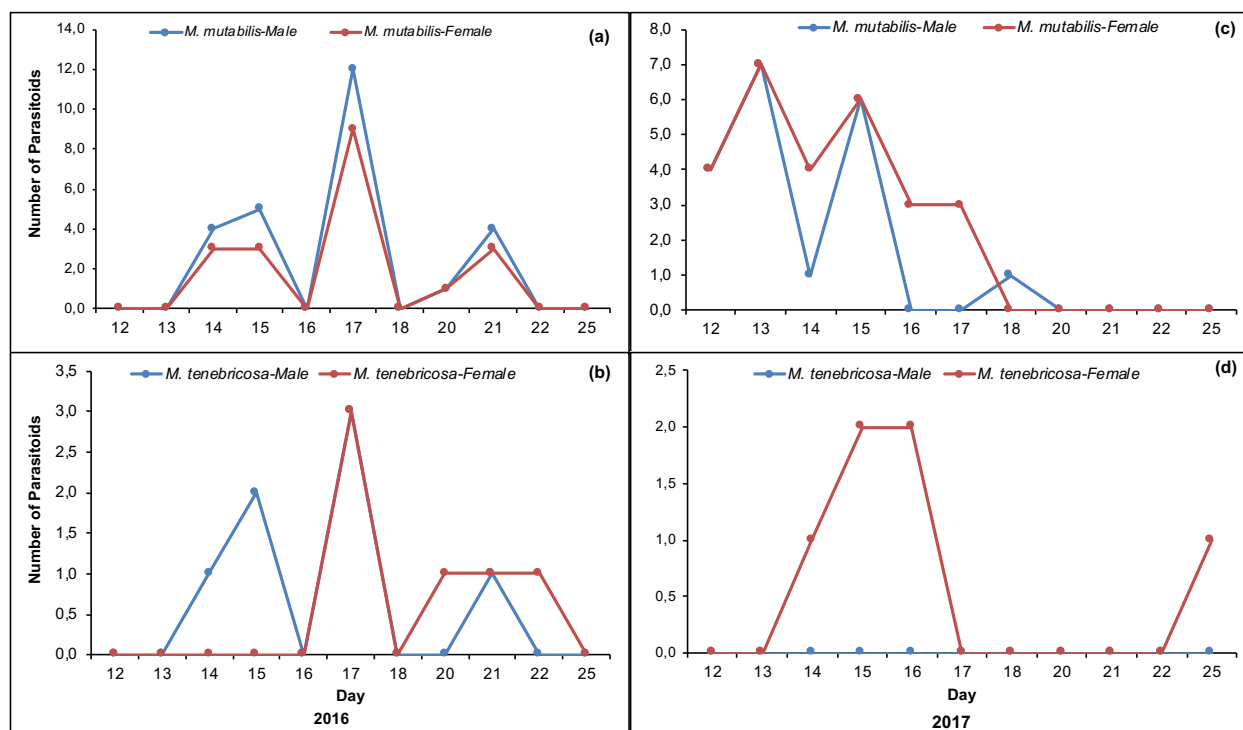


Figure 2. Emergence time of males and females of *Meigenia mutabilis* and *Macquartia tenebricosa* in 2016 (a and b, respectively) and 2017 (c and d, respectively) from the host.

There is limited literature on the natural enemies of *G. fornicata*. This paper reports the first detailed information in terms of determination of natural enemies of *G. fornicata* and their effectiveness. No there are published records of Tachinidae reared from lucerne beetles in Turkey. Elsewhere, it is only known to be parasitized by *M. mutabilis* (Mellini, 1954; Michieli, 1957; Tschorsnig, 2017). Brovdii (1976) considered that the natural enemies of this pest in the Ukraine are insufficiently known, while the larvae are parasitized by *M. mutabilis* in southern Europe.

Meigenia mutabilis was found to be a more effective parasitoid of *G. fornicata*. Tachinids have been used both in agricultural and forest areas in more than 100 biological control programs over the last century (Grenier, 1988). Getting benefit from tachinids within the framework of biological control programs requires determination of natural habitats of species, explaining their biology, illuminating host-parasitoid relations and determining their effectiveness in nature.

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