PRINT ISSN 1302-0250
ONLINE ISSN 2651-3579

Journal of the Entomological Research Society

Volume: 22 Part: 2 2020

JOURNAL OF THE ENTOMOLOGICAL RESEARCH SOCIETY

Published by the Gazi Entomological Research Society

Subscription information

Published by GERS in single volumes three times (March, July, November) per year. The Journal is distributed to members only. Non-members are able to obtain the journal upon giving a donation to GERS.

Papers in *J. Entomol. Res. Soc.* are indexed and abstracted in Biological Abstract, Zoological Record, Entomology Abstracts, CAB Abstracts, Field Crop Abstracts, Organic Research Database, Wheat, Barley and Triticale Abstracts, Review of Medical and Veterinary Entomology, Veterinary Bulletin, Review of Agricultural Entomology, Forestry Abstracts, Agroforestry Abstracts, EBSCO Databases, Scopus and in the Science Citation Index Expanded.

Publication date: July 24, 2020

Printed by Hassoy Ofset
Tel:+90 3123415994 www.hassoy.com.tr

J. Entomol. Res. Soc., 22(2): 107-118, 2020
Print ISSN:1302-0250

Research Article
Online ISSN:2651-3579

A Study on the Biology of the Barred Fruit-tree Tortrix [*Pandemis cerasana* (Hübner, 1786) (Lepidoptera: Tortricidae)] be Detected in the Cherry Orchards in Turkey

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ABSTRACT

Pandemis cerasana (Hübner, 1786) (Lepidoptera: Tortricidae) causes economic damage by wrapping the leaves and bouquet of cherry fruit with the secreted silky strands and by gnawing the ripe fruits. This study was carried out in 2007-2009 to determine morphological characteristics and biology of *P. cerasana* in 0900 Ziraat variety cherry orchard in Sultandağı district of Afyonkarahisar province, Turkey and laboratory conditions. The relationship of *P. cerasana* biology with climate and cherry phenological features has been investigated. As a result of biological studies, adults were caught to pheromone trap in the cherry orchard in the third week of May in 2007-2008, reach to peak twice and continue to fly until October in both years. Adults laid eggs on the upper surface of the leaves in May-June for the first generation and in July-August for second generation. The larvae caused damage from April to October 2007-2008. Some second-generation larvae were overwintered as the first and second instar larva, and this pest has two generations per year. In the laboratory conditions, the average lifespan of *P. cerasana* was 8.48 days for males, 10.12 days for females, egg hatching time was 7.08 days, developmental time of larva was 32.58 days and developmental time of pupa was 7.21 days.

Key words: *Pandemis cerasana*, Totricidae, biology, morphology, cherry.

Özdem, A. (2020). A study on the biology of the barred fruit-tree tortrix [*Pandemis cerasana* (Hübner, 1786) (Lepidoptera: Tortricidae)] be detected in the cherry orchards in Turkey. *Journal of the Entomological Research Society,* 22(2), 107-118.

INTRODUCTION

Cherry [(*Prunus avium* L.) (Rosales: Rosaceae)] is an important fruit for Turkish pomiculture. It has an important position in the Turkish economy so that it matures in early season and it is produced for domestic market and as an export product. Turkey is one of the biggest cherry producing country in the world. According to 2018 data cherry production was 639.564 tonnes (Anonymous, 2019). Cherries are grown for export in Afyonkarahisar province and it is the most important source of income for local farmers. 80% of the cherry produced from Afyonkarahisar province, where was conducted this study, are exported. In Turkey, many insect species are harmful in the cherry orchards (Anonymous, 2017).

Family Tortricidae belongs to the order Lepidoptera and is one of the widest families in Microlepidoptera (Meijerman & Ulenberg, 2000). It includes 10,000 species andmost of them are considered as pests (Gilligan & Epstein, 2014). The barred fruit-tree tortrix, *Pandemis cerasana* (Hübner, 1786) (Lep.: Tortricidae) is a member of this family and lives in the Palearctic region from Western Europe to Asia. *P. cerasana*, a common leaf roller of deciduous trees in northern Eurasia, was found in North America for the first time at Victoria, B.C., in 1964 (Evans, 1970).

In Turkey, *P. cerasana* was detected in Afyonkarahisar, Ankara, Bolu, Bursa, Düzce (Özdemir, Özdemir, Seven, & Bozkurt, 2005), and Çanakkale (Ercan & Özpınar, 2014) provinces. The pest damages both leaves and fruit (Zangheri et al, 1992). Although its biology is very similar to the other members of the Tortricidae family, it causes much more economic damage. When its population increases, they damage complete of the fruits and the leaves in bouquet. They also negatively affect the quality of fruit with its silky strands and excreta (LaGasa, 1996). Gilligan & Epstein (2012) identified many plant variety belonging to 15 different families which were eaten by *P. cerasana* larvae. This species mainly causes damage by gnawing and eating ripen cherry fruits at the harvest time (Özdem, Bozkurt, & Özdemir, 2014). This leads to unnecessary usage of insecticide. Yet farmers usually fails to prevent the damage. *Pandemis cerasana* causes direct economic losses. Before 2004, this species was rarely seen in Turkish cherry orchards. But after 2004, its population dramatically increased and became an important pest for the cherry orchards of Turkey. In Turkey, nobody has conducted a detailed study on its biology. The aim of this study was determination of biology and morphological features of *P. cerasana* in cherry orchard and laboratory conditions in 2007-2009.

MATERIAL AND METHODS

The material of this study consisted of collected *Pandemis cerasana* samples, a cherry orchard planted with 0900 variety, Pherocon IC type pheromone traps, species-specific pheromone capsules, artificial bait (Southland Products Incorporated, U.S.A), climate-controlled cabinets, culture cages (40cm x 45m x 50cm), plastic glasses, and other laboratory equipments.

Morphological studies

Morphological studies of *P. cerasana* were performed on at least 20 individuals in adult, egg, larva and pupa stages. In morphological studies were taken of photos using Leica Z 16 Apo and assessed these pictures according to Razowski 2001.

Biological studies

Biological studies were conducted both in the cherry orchard and in the laboratory. In the orchard study, it was checked the cherry orchard twice a week in the critical weeks for pest control and once a week in other weeks. In this searched it was tried to determine of first adult, egg, larva and and their duration time, flight activity of adults and the number of generations. Studies were conducted in a cherry orchard in Sultandağı district of Afyonkarahisar. This orchard were consisted of 300 0900 Ziraat variety cherry tree. It was used Pherocon IC pheromone traps in order to determine the first *P. cerasana* adults appear and flight activity. It was also recorded the number of total adults caught to the traps. Sticky tables of traps were changed when dirty and pheromone capsules were renewed in every 4-6 weeks.

Egg stage

In order to determine the time egg clusters were laid and the length of period for *P. cerasana* eggs it was observed trunks, branches, leaves and fruits every week following the time when first adults were seen. It was determined that the length of incubation period by following the egg clusters after they were first seen for every generation. This process was repeated until the last egg cluster was seen.

Larva stage

In order to detect the time of finding for every generation of *P. cerasana* larvae, it was recorded the time when first and last larvae were seen. It was also placed grooved cardboards to the upper trunk and branches of 20 trees in 12th of September in order to determine the overwintering larvae.

Pupa stage

In order to observe the time of finding for every generation of *P. cerasana* pupae, it was recorded the time when first and last pupae were seen. This process was repeated until the last pupa was seen.

Number of generations

The number of generations in a year was obtained by following *P. cerasana* in the orchard and by determining its biological periods in the laboratory.

Meteorological data

Meteorological data was obtained with climate sensors placed in the orchard. Air temperature and relative humidity values were given as a pentad.

Phenological records

It was observed that the phenological periods of cherry trees during the study. Also it was recorded the necessary data for phenological periods

Laboratory studies

The different biological stages of *P. cerasana* were collected from the cherry orchard and kept until adult. Adults were released in 2 litre plastic container containing adult diets of honey soaked cotton and water supply from a piece of sponge inserted into a pot, polyethylene sheet on the bottom for oviposition and wet clothes for keeping moisture both side of the container. Eggs were laid on polyethylene sheets by adults. Plastic containers were controlled daily, and eggs are transferred to separate plastic container every 24 hours. Hatched larvae on polyethylene sheets were placed in separate plastic container and culture cages. Larvae were fed with fresh cherry leaves and artificial food. The larvae were placed on a roll of corrugated paper board of 5 cm in diameter for prepupal stage in the plastic container and kept until being adult. It was calculated the lifespan of male and female adults, the number of egg cluster laid by females, the average number of eggs in a cluster, the hatching time of eggs, and the duration of larva and pupa periods from the data collected from at least 20 individuals in every stage. Laboratory studies were carried out 25°C±1, 65%RH and 16:8 photoperiod conditions.

RESULTS AND DISCUSSION

Morphological features

Adult of *P. cerasana* frons and labial palpus light or dark brown or sometimes gray-white. Antennas of males slightly ribbed, notched in basaly, brownnish yellow in upper side. Basal of females not notched or notches are very slight. Ground color of forewings from light brownnish yellow to gray-brown, towards apically with reticulate stripes in light brown color. Markings browner or hazel color, outer sides of the basal fascia wavy and slightly crisscrossed. Median fascia is strongly crisscrossed, and outer margine slightly convex starting from the costa. The internal side of the preapical spot distinct but weak towards apically. Cilia is darker than the base color. Costal margine without costal fold, basal half convex. Dorsum strongly convex in basaly, slightly concave towards the tornus. Hindwings gray-brown, but cilia lighter, with subbasal stripes. Gilligan & Epstein (2012) states that *P. cerasana* can be distinguished from the other *Pandemis* spp. with the gray-brown pincers of males above the second abdominal sternite and with its darker scales. According to the measurements males have a wingspan of average 18.20±0.17 (16-19) mm (Fig. 1), whereas females have a wingspan of average 21.3±0.25 (18-22) mm (Fig. 2).

P. cerasana lays its eggs on the surface of leaves in clusters. Egg clusters have a very light green color when first laid, they take a darker green shade as time passes. When the hatching time comes, the eyes of larvae can be clearly seen. After hatching, eggs clusters take a milk-white color and transparent.

The last stage larvae of *P. cerasana* measures 20.15±0.26 (18-23) mm on average and their body has a translucent turquoise color (Fig. 3). Pinaculum light green, head light coloration like body with brownish dots. Thorax plate in light color and brown dots in the lower part. Thorax legs light brown. Pinaculum in color as body. Anal plate lighter brown. Anal scallop yellow, with 6-8 denticles.

In early stage pupa of *P. cerasana* light brown and green color but in later stages, they turn to dark brown. Pupa length is average 7.25±0.12 (6-8) mm.

Fig.1. Adult of *Pandemis cerasana* male (Photo by M. ÖZDEMİR).

Fig. 2. Adult of *Pandemis cerasana* female (Photo by M. ÖZDEMİR).

Fig. 3. Larvae of *Pandemis cerasana* (Photo by A. ÖZDEM).

Biology

Adult pheromone traps were hung up in the cherry orchard in April 26, 2007 and May 6, 2008 in order to observe the first flights of adult and adult flight activity of *P. cerasana* and the results in 2007 and 2008 are given in Fig. 4 and Fig. 5, respectively. As can be seen on the figures, first adults were caught in traps on May 21, 2007, and May 20, 2008. Temperature and humidity values in these days were respectively 17.5 and 18.8 °C, and 60.6% and 67.2% (Figs. 6-7). There was also rained 1.2 mm of in 2008 In this period, 80-85% of fruits early maturing cherry varieties turned into their color from raw green to yellow and 10-15% pink. Fruits of early maturing cherry varieties were at the size of a chickpea, whereas fruits of late maturing cherry varieties were green colour and at the size of lentil.

The adult population was reached to peak twice in both years. In 2007, the first peak was occured one week after the first flight on May 30, 2007. In that day, pentad temperature was 17.0 °C and relative humidity was 81.8%. In 2008, the first peak was occured on May 27, 2008. In that day, pentad temperature was 19.4 °C and relative humidity was 61%. It rained during the same week. In that period, 50-60% of Fruits of early maturing cherry varieties were became sweet and 40-50% of them were pinky yellow. But only 10-15% of fruits of late maturing cherry varieties had a pinky yellow color and 85-90% of them had a yellowish green color. In 2007, the second peak of adult population was reached on August 1, 2007. That day, pentad temperature was 25.3°C and relative humidity was 50.8%. In 2008, the second of adult population peak was reached on August 12, 2008. That day, the temperature was 19.4 °C and relative humidity was 51.4%. In both years, the second peak of adult population were occured after the cherry harvest. Flights ended on October 24, 2007, and October 21, 2008.

In the first year, the first generation started to fly on May 21, 2007, and flights ended on June 13, 2007. The second generation started to fly on July 18, 2007, and the flights ended on October 24, 2007 (Fig. 4). In the second year, the first generation started to fly on May 21, 2008, and flights ended on July 15, 2008. The second generation started to fly on July 21, 2008, and flights ended on October 21, 2008 (Fig. 5). In both years, the flying period of two generations differed and the first generation flew for a shorter period than the second generation. It is well known that *P. cerasana* had one or two generations in Europe and the first generation were seen in field in June and July, whereas the second generation were seen in August and September (Gilligan & Epstein, 2012). When we considered the results of this study together with our findings, we can conclude that the first generation adults start to fly late, and second generation complated flying a month earlier. Carter (1984) stated that *P. cerasana* was found in field between June and August and they fly at twilight. Alford (2012) stated that the adults of *P. cerasana* were found in field in June and August. Duration of adults stay in cherry orchard is longer in our findings compared to the findings of these researchers.

There was no significant difference between the years in terms of the length of the flying period. In general, adults flew between May and October in both years. Ercan & Özpınar (2014) studied the peach, apple and cherry orchards in the districts of Çanakkale

province and they concluded that *P. cerasana* does not damage apples and cherries, but only damages peaches. They also concluded that the adults of *P. cerasana* were active in orchard between May and August. It is thought that the difference between the adult flight time may be due to ecological and climate conditions as well as host differences.

It was determined that the number of adults that caught to pheromone traps differed between years. In 2007, average 16.1±7.58 (1-112) adults were caught on traps whereas in 2008, average 15.7±5.45 (0-94) adults were caught on traps.

Egg: In 2007, the first *P. cerasana* egg cluster was found on May 30, 2007, but subsequent year it was found on June 2, 2008. In that time, pentad temperature and relative humidity values in these two days were respectively 19.2°C-63.4% and 15.9°C-69.4% (Figs. 6-7). Egg cluster of the first generation were found between May 30 and June 13, 2007. And no new egg cluster was found in the following five weeks. Fig. 4 shows that adults were not caught in pheromone traps between June 20 and July 11. Thus, it is normal not to find any egg cluster. Gilligan & Epstein (2012) state that females lay their egg on leaves or branches in clusters and sometimes eggs hatch at the end of summer. But, contrary to this, it was not found egg cluster on branches in this study. It was determined that the egg cluster belonging to the second generation between July 25 and August 28. In that week pentad temperature and relative humidity values was 25.3 °C and 50.4%. As seen Fig. 4, shows that traps were started to caught adults on July 18.

In 2007, weekly records showed that the number of egg clusters of first generation of *P. cerasana* was average 5.13±0.54 (1-8) and the number of egg clusters of second generation was average 6.60± 0.60 (1-10). In 2008, eggs clusters of the first generation were seen between June 2 and 18.

The egg cluster belonging to the second generation were first observed on July 29 and pentad temperature and humidity values in that week were 20.6° C and 60.8% (Fig 7). The last egg cluster belonging to the second generation was seen on August 27. As examined Fig. 4 that the number of adults that caught to the pheromone traps in the cherry orchard, it is seen that this number drastically decreased between June 18 and July 21. It can be can explained this decrease with the start of the flying period. That is, it is understood that the absence of egg cluster occurred in parallel with the adult flight. Weekly records showed that, in 2008, the number of egg cluster belonging to the first generation was avarage 3.40±2.60 (1-7) and the number of egg cluster belonging to the second generation was avarage 4.16± 2.31 (1-7).

Egg cluster of *P. cerasana* stayed in orchard for 15 and 35 days, respectively for the first and second generation in 2007, whereas this was 17 and 30 days in 2008. In 2007, eggs cluster belonging to the first generation was seen in orchard between May and June and egg cluster belonging to the second generation was seen between July and August. In 2008, egg cluster belonging to the first generation was seen in orchard in June and egg cluster belonging to the second generation was seen between July and August (Figs. 8-9). Matthey (1967) observed the egg clusters of *P. cerasana* in orchard between June and July. Our study showed that egg clusters stay in orchard longer.

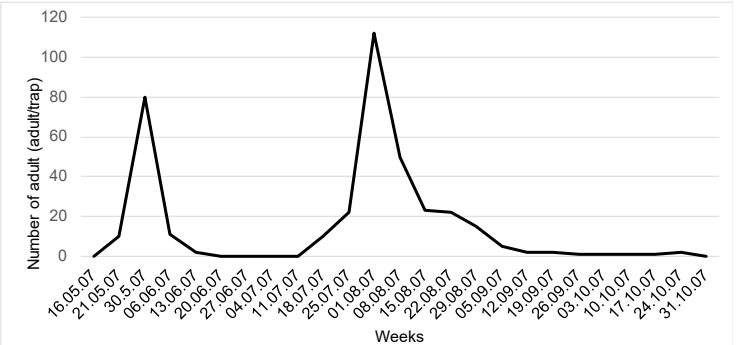

Fig. 4. Flight activity of *Pandemis cerasana* in 2007.

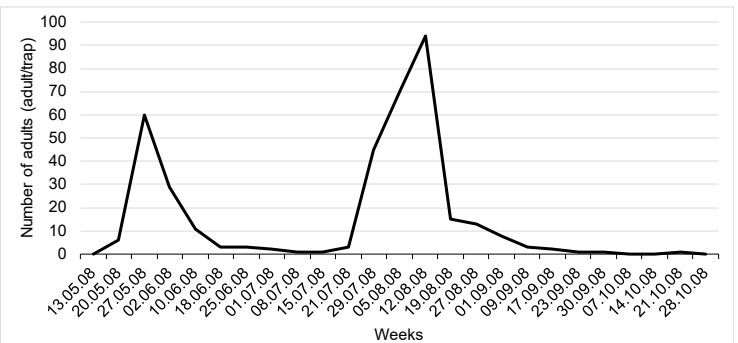

Fig. 5. Flight activity of *Pandemis cerasana* in 2008.

Overwintering larvae was searched on the trunk, branches and buds of trees from the last week of March to April in 2007 and 2008. It was found diapausing larvae at the first or second stage cocoon under the tree barks and inside bud scales. During this period, it is very hard to detect larvae since they are very small. Overwintering larvae began to actively feed when cherry trees were budding period. In 2007, larvae became active in 12th of April, whereas in 2008 they became active in 15th of April. In that week pentad temperature and relative humidity values were respectively 12.1°C-62.2% and 8.5 °C-65.8% and there was no rain in these days. Overwintering larvae of *P. cerasana* firstly feed on the buds. As a larva develops, it is easy to detect the location of the pest during this period. They consume the fruit inside this bouquet very quickly. They contaminate the fruits with their silky strings and excretions during feeding. The first generation larvae usually fed on the ripe or almost ripe fruits, whereas the second generation usually fed on the epidermis of leaves. Because cherry fruits were already harvested when the second generation larvae were active. Barbara, Faccioli, & Antropoli (1994) stated that the density of *P. cerasana* larvae varies from generation to generation and the second generation caused much more damage than the first generation. But our study showed that the first generation causes much more damage by directly affecting ripe fruits. Polat & Tozlu (2010) reported that *Arcips*

rosana L. winters over in Erzurum in form of an egg, the hatched larvae first feed on buds, then on leaves and cause great damage by wrapping leaves with silky strands. Besides, although they are from the same family, the damage form of *P. cerasana* is different from *A. rosanus*. *P. cerasana* generally causes serious damage on ripen fruits in addition to the damage to the leaf.

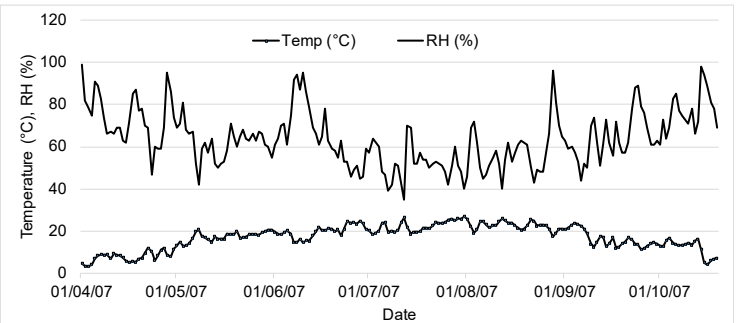

Fig. 6. Climate data in 2007 in Sultandağı district of Afyonkarahisar.

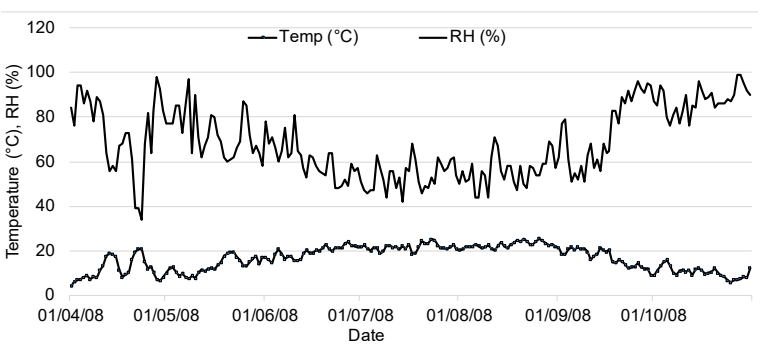

Fig. 7. Climate data in 2008 in Sultandağı district of Afyonkarahisar.

In 2007 and 2008, first generation larvae were active in the orchard between the end of June and the beginning of July, whereas second generation larvae were active at the end of October (Figs. 8-9). During the season weekly records showed that the number of *P. cerasana* larvae were avarage 15.73±3.60 (5-61) in 2007, and average 12.26±2.70 (1-47) in 2008. There were not seen any active larvae in orchard after October 10, 2007 and October 6, 2008.

It was observed that some of the second generation larvae became adults before the winter. But we also observed some of these second generation larvae wintered over as first or second stage larvae and became active in the April of next year. It was determined that some of the wintering larvae changed skin under the bark. Also, wintering larvae were either at the first or second stage. Approximately 80% of the wintering larvae were in second stage larva. Gilligan & Epstein (2012) stated that larvae winter over as second or third stage larvae, feed on leaves in spring, and turn

into pupae. Similarly, Carter (1984) stated that *P. cerasana* were overwinter as second and third stage larvae and start to feed in spring when trees start to bud. Contrary to our findings, the other researchers found that *P. cerasana* winters over in the form of second and third stage larvae. On the other hand, Alford (2012) states that this pest lays its eggs on tree branches and leaves, most of the eggs hatch in a couple of weeks, but some winter over as eggs. However, it was not found any evidence that *P. cerasana* spent in the egg period during winter. In order to follow the overwintering larvae, we examined the corrugated cardboards in November. But larvae didn't prefer cardboards to overwintering. However, larvae of another species belonging to the same family Codling moth, *Cydia pomonella* L. (Lep.: Tortricidae)] prefer to overwinter in corrugated cardboards (Anoymous, 2008).

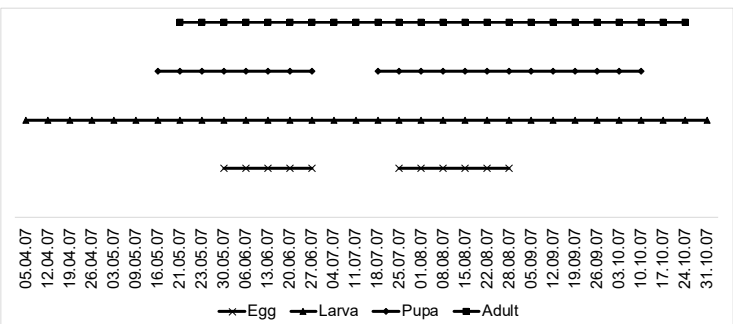

Fig. 8. Biological stages of *Pandemis cerasana* in 2007 in cherry orchard.

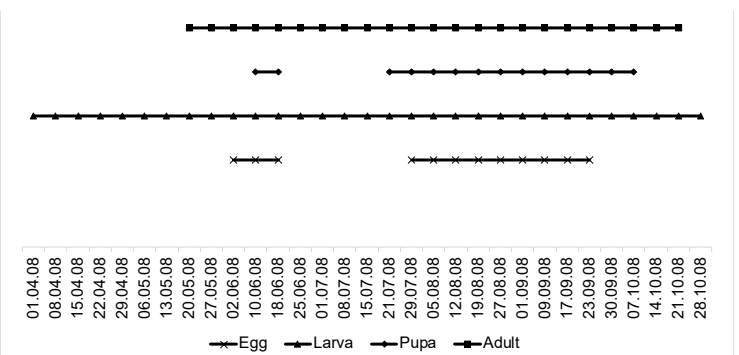

Fig. 9. Biological stages of *Pandemis cerasana* in 2008 in cherry orchard.

The first pupa was observed in orchard on May 16, 2007, and May 12, 2008. Pentad temperature and humidity values in these days were 18.4 °C-61.4% and 11.9 °C-72.4% respectively (Fig. 6 and Fig. 7). Pupae were active until June 27, 2007, and June 18, 2008. No pupae were observed in orchard two weeks after June 27, 2007, and four weeks after June 18, 2008. Pupae belonging to the second generation were first observed in orchard on July 1, 2007, and July 21, 2008. The last date they were seen in orchard was October 10, 2007, and October 14, 2008 (Figs. 8-9). In that

week pentad temperature and humidity values in 18th of June and 21st of July were respectively 21.0 °C-65.2% and 22.9 °C-53.8%. According to the weekly records, the number of *P. cerasana* pupae belonging to the first generation is 12.2±11.9 (1-32), and the number of pupae belonging to the second generation is 5.76±6.31 (1-21). Alford (1995) stated that *P. cerasana* larvae feed on leaves, spin cocoon and winter over, became active by spring, feed on offshoots and leaves, feed during May and June and turn into a cocoon inside leaf bouquet. Also, Carter (1984) and Alford (2012) stated that pest turns into a pupa inside a cocoon spun where they feed during May and June. I was determined that the last stage larvae of *P. cerasana* turn into pupa inside the leaf bouquets. Our findings are parallel with these studies.

Number of Generations: It was showed that the overwintering *P. cerasana* larvae become active by the third week of April, adults continue to fly until the third week of October and adult flights reach to peak twice a year. It was observed that some of second generation larvae were overwinter as the first and second stage larvae. It was determined that *P. cerasana* given two generations in a year.

Laboratory studies were carried out in 2009. According to laboratory studies; It was determined that adult males live 8.48±2.04 (5-13) days, and adult females live 10.12±2.36 (5-15) days on average. Egg hatching time for *P. cerasana* was average 7.08±1.16 (6-9) days, the number of eggs in a cluster was average 49.03±48.3 (6-230) and the number of egg cluster laid by a female was average 2.60±1.87 (0-7). Larva was developed in average 32.58±293 (30-39) days, and pupa was developed in average 7.21±1.34 (5-10) days.

There are still very few studies on *P. cerasana* in the global literature. This is the first comprehensive study on this insect which investigations the biological stages, phenology of the host and weather conditions.

ACKNOWLEDGEMENTS

I would like to thank to Dr. Mustafa ÖZDEMİR and Dr. Vildan BOZKURT for their contribution. I also thank the anonymous reviewers for their constructive comments on the manuscript.

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Received: May 16, 2019 *Accepted: September 08, 2019*

J. Entomol. Res. Soc., 22(2): 119-123, 2020
Print ISSN:1302-0250

Research Article
Online ISSN:2651-3579

Bald cypress (Cupressaceae) as an Unusual Host for the Exotic *Clepsis coriacana* (Rebel, 1894) (Lepidoptera: Tortricidae)

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ABSTRACT

Clepsis coriacana (Rebel, 1894), an exotic species expanding in the Iberian Peninsula, is reported causing severe defoliation on ornamental trees of *Taxodium distichum* for three consecutive years, this being a new host for this moth.

Key words: *Taxodium distichum*, *Clepsis coriacana*, Tortricidae, exotic insect, Portugal.

Naves, P., Nóbrega, F., & Gastón, J. (2020). Bald cypress (Cupressaceae) as an unusual host for the exotic *Clepsis coriacana* (Rebel, 1894) (Lepidoptera: Tortricidae). *Journal of the Entomological Research Society*, 22(2), 119-123.

INTRODUCTION

The bald cypress, *Taxodium distichum* (L.) Richard (Cupressaceae), native to North America, is one of the few deciduous conifers worldwide, and a versatile tree for timber production, ecological restoration of wetlands and ornamental use (Farjon, 2010). Clem (2015) reviewed 17 species of Lepidoptera, from nine families, associated with this conifer in the United States, with Heppner (2003) listing additional four species, including the pond apple leafroller moth, *Argyrotaenia amatana* (Dyar, 1901). The pond apple leafroller moth, and the bald cypress leafroller, *Archips goyerana* (Kruse, 2000) are the only Tortricidae species associated with *T. distichum* in its native range. *Archips goyerana* appears to be host-specific and the most damaging pest of bald cypress (Kruse, 2000).

Outside its native range, the bald cypress has been planted with commercial and ornamental purposes in many countries but reports of damages caused by insects appear to be very rare. Here, we report on an unusual severe defoliation observed on *T. distichum* young trees, outside its native range and caused by a Tortricid moth.

MATERIAL AND METHODS

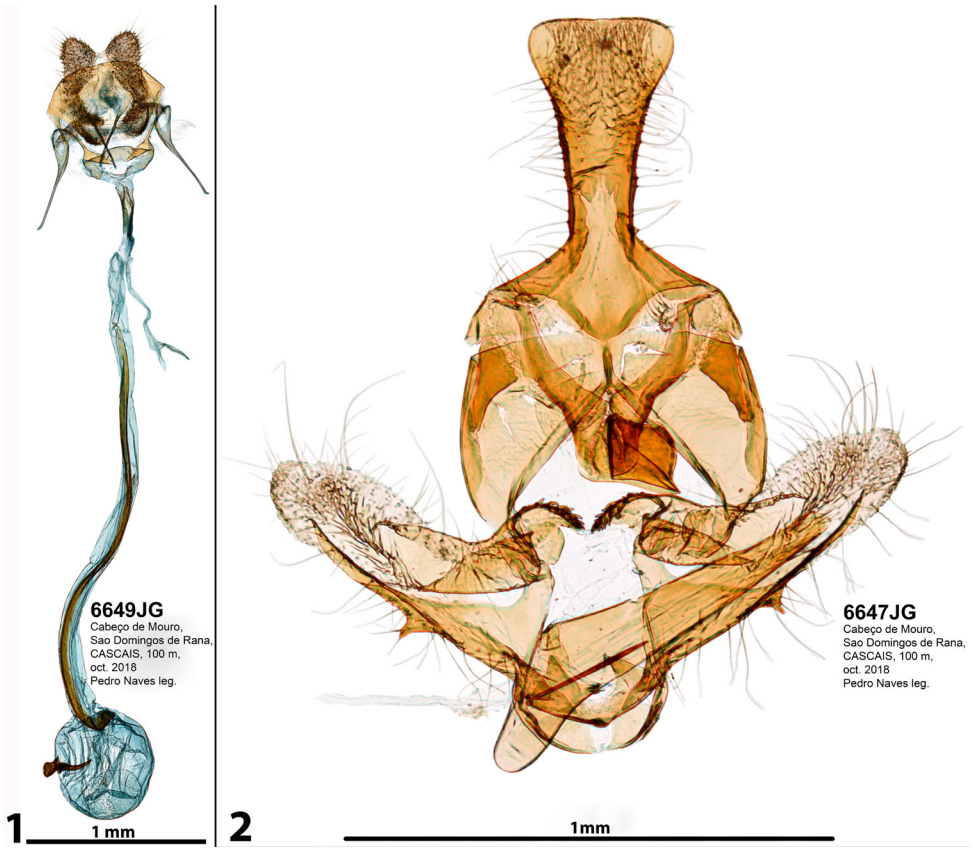
Larvae, pupae and adults of a Tortricid moth were collected from young (≈10 years old) bald cypress trees (which had been obtained from seeds) from a private garden in São Domingos de Rana, Cascais, Portugal (altitude 98 m, UTM 10x10 coordinate MC78). Eggs, larvae, pupae and moths were detected from May to early December, when leaves were present, with several consecutive generations throughout the year.

Immature insects were reared to adult under controlled conditions (≈24ºC), and five adult moths were prepared for genitalia observation, including three male (references 5783JG, 6647JG and 6648JG) and two female specimens (references 6649JG and 6650JG, in J. Gastón coll.). The preparations followed Robinson (1976) with minor adaptations. Observations were made using a NIKON Eclipse E400 microscope, and a NIKON D3100 and SONY α100 DSLR-A100K digital cameras, with AF 100 MACRO 1:2,8 (32) objective, and the photos enhanced with Adobe Photoshop © software.

To support the morphological identification, adult moths were submitted to molecular analysis performed by sequencing the partial cytochrome c oxidase subunit I gene (COI), as described in detail in Catry et al, (2017).

RESULTS

Adults were identified, by examining the genitalia, as *Clepsis coriacana* (Rebel, 1894) (Tortricidae), which is also frequently (and erroneously) named *C. coriacanus*. *Clepsis coriacana* is morphologically close to *Clepsis neglectana* (Herrich-Schäffer, 1851), *Clepsis consimilana* (Hübner, 1817) and *Clepsis eatoniana* (Ragonot, 1881) [synonym *Clepsis razowskii* Gastón, Vives & Revilla, 2017 (Zlatkov & Huemer, 2019)], which are also found in the Iberian peninsula but can be distinguished by characters of the genitalia, with a more developed uncus of trapezoidal shape and a bigger lenght of the colliculum, and by a stronger sclerotization (Figs. 1-2).



Figs. 1-2.Genitalia of *Clepsis coriacana*.

The morphological identification was fully supported by the molecular analysis; sequences were compared with the sequences registered in the public databases, and the 650 bp-long regions of the COI revealed 99.84 % similarity with one sequence of *C. coriacana* (registered as *Clepsis coriacanus* in BOLDSystems database) from the Canary Islands. Our sequences are now publicly available in GenBank database (NCBI) under accession number MK371069.

Extensive defoliation was observed on the young trees for three consecutive years (2017, 2018 and 2019), causing the wilting and dieback of small branches late in the season.

DISCUSSION AND CONCLUSIONS

Clepsis coriacana is native to the Canary Islands (Islands of Tenerife, Gran Canaria, La Gomera and La Palma) and Morocco (Klmesch, 1987), and was reported for the first time in continental Europe in 2006, in Gibraltar (Clifton, 2007). It was later found

in other locations in mainland Spain, namely in Catalunya in 2007 (Dantart & Jubany, 2010). It has also been located by one of the authors in Getxo and Berango (Vizcaya) during all the months of the year (Gastón, personal observation). In Portugal, this species is present at least since 2014 (Corley et al, 2018, reported as *C. coriacanus*), with no mention to its hosts. All records from Iberian Peninsula (Fig. 3) are in locations very close to the sea, suggesting *C. coriacana* prefers regions with mild oceanic climates, similarly to its native range in the Canary archipelago and Morocco.

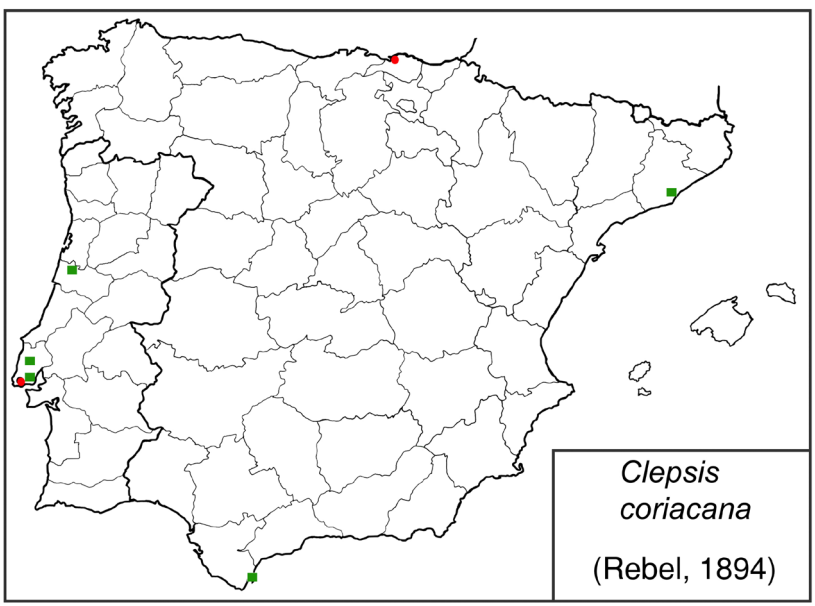


Fig. 3. Distribution of *Clepsis coriacana* in the Iberian Peninsula, including published references (Clifton, 2007; Dantart & Jubany, 2010; Corley et al, 2018 - green squares) and author´s observations (red circles).

The genus *Clepsis* Guenée, 1845 comprises more than 100 species worldwide (Wang, Li, & Wang, 2003), including a few pests of cultivated plants. *Clepsis coriacana* is quite polyphagous, feeding on multiple hosts from various plant families (Razowski, 1979; Klimesch, 1987). However, this is apparently the first report of a *Clepsis* species feeding on a member of the Cupressaceae family (Brown, Robinson, & Powell, 2008). In its native range, *C. coriacana* is commonly known as “palomilla del peral” (pear orchard moth), being considered a minor pest of apple and pear orchards (Hernández, 2012), and locally listed as a harmful pest (Carrillo & Lana, 2002).

In addition to *T. distichum*, no other hosts were locally recorded for *C. coriacana* in São Domingos de Rana, but this moth appears to be a generalist herbivore with a capacity to feed on multiple hosts, including native and exotic plant species, and should therefore be monitored as one more alien species which may, eventually, affect host plants of ornamental and/or agricultural importance in the Iberian Peninsula.

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Received: May 17, 2019 *Accepted: April 10, 2020*

J. Entomol. Res. Soc., 22(2): 125-129, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

New Records of the Giant Dung Beetle Genus *Heliocopris* Hope, 1837 (Coleoptera, Scarabaeidae, Scarabaeinae)

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ABSTRACT

Some new country records of dung beetles belonging to the genus *Heliocopris* Hope, 1837 are given: *H. marshalli* Péringuey, 1901 is recorded for the first time for Zambia; *H. hamadryas* (Fabricius, 1775) is recorded for the first time for the Lubombo region (Swaziland); the first exact locality for Gabon is reported for *H. haroldi* Kolbe, 1893; finally the occurrence of *H. antenor* (Olivier, 1789) is confirmed for Uganda.

Key words: Scarabaeidae, *Heliocopris antenor*, *Heliocopris hamadryas*, *Heliocopris marshalli*, *Heliocopris haroldi*, new record.

Ceccolini, F. & Cianferoni, F. (2020). New records of the giant dung beetle genus *Heliocopris* Hope, 1837 (Coleoptera, Scarabaeidae, Scarabaeinae). *Journal of the Entomological Research Society,* 22(2), 125-129.

INTRODUCTION

Heliocopris Hope, 1837 is a genus of dung beetle including night-flying, tunneling species which feed preferentially upon elephant dung, although some of them use also other dung types of herbivores and sometimes even of human (Davis, Frolov, & Scholtz, 2008). This genus comprises 55 large-to very large body species, 50 of which are endemic to Africa, four endemic to Asia, and one occurring in both continents (Schoolmeesters, 2020). The Asian species occur in the southern part of the continent: from Iran to China, although records are quite scattered; one species occurs in north east Africa and Arabian Peninsula; finally African species are present in all the sub-Saharan region, even if some countries (Chad, Mali, and Mauritania) have not records (Pokorný, Zidek, & Werner, 2009), probably due to lacking of research. Despite the impressiveness of these beetles, knowledge about their distribution is still poor and fragmented and even new species have been collected and described in recent years (Moretto & Minetti, 2013; Moretto, 2014, 2017) after the genus revision by Pokorný et al (*op. cit.*). The present work provides new country records for some species of these dung beetles.

MATERIAL AND METHODS

The examined material consists of collected or photographed specimens from the naturalistic online platform "iNaturalist" (www.inaturalist.org) (see abbreviations). For each site, the following information is provided: locality, date, collector or photographer, number of specimens, sex, repository or source. Geographical coordinates are in decimal degrees (datum WGS84). The uncertainty (in metres) of data from the online source is indicated according to the point-radius method (Wieczorek, Guo, & Hijmans, 2004). Each record was identified or confirmed by the authors.

Abbreviations: CFC = Filippo Ceccolini collection, Rassina (Arezzo), Italy. MZUF = Natural History Museum of the University of Florence, Italy. IN = www.inaturalist.org

leg. = legit

RESULTS

List of species

Heliocopris antenor (Olivier, 1789)

Material examined. UGANDA: Kuchumbala, Kumi district, Teso sub-region, Eastern Region, 14.04.2016, P.-D. Svoboda legit, 1 ♂, CFC.

Biology: This species seems to be attracted by light (Pokorný, et al, 2009; De Jong & Krell, 2011); some specimens are found in burrows under cattle pads (Pokorný, Zidek, & Werner, *op. cit.*) and human dung is also reported as trophic source (Davis, Frolov, & Scholtz, 2008).

General distribution: The species is known for almost all central Africa, from Senegal to Ethiopia and Zimbabwe as southern limit (Pokorný, Zidek, & Werner, *op. cit.*). Few

records are reported from large areas of oriental Africa. The species is reported in Ethiopia (Pokorný, Zidek, & Werner, *op. cit.*), but no data are recorded from Kenya, while in Tanzania a single record was reported by Kolbe (1898) in XIX century; also in Uganda the distribution knowledge of this species is very poor: only one record is known from literature, recently quoted by De Jong & Krell (2011).

Remarks. The present record is the second one from Uganda; the occurrence of *H. antenor* is confirmed in this poorly investigated country.

Heliocopris hamadryas (Fabricius, 1775)

Material examined. SWAZILAND: Mlawula Nature Reserve, Magadzavane Lodge area, Lugongolweni, Lubombo region, -26.316652° N 31.989698° E (uncertainty = 1 m), 19.02.2016, 1 ♂ (Fig. 1), photo by Kate Braun, IN.

Biology: This dung beetle can be attracted at light (Pokorný, et al, 2009). During nesting behaviour, in the tunnel the dung cake is relocated piecemeal to a deeper chamber before brood construction (Davis, Frolov, & Scholtz, 2008). Besides elephant dung, *H. hamadryas* can use as trophic source also cattle dung (Pokorný, Zidek, & Werner, *op. cit.*) and this adaptation has allowed this species to thrive in regions where elephants no longer exist (Stronkhorst & Stronkhorst, 2013).

General distribution: The species is documented in almost all countries of Africa south to equator (Pokorný, Zidek, & Werner, *op. cit.*; Stronkhorst & Stronkhorst, *op. cit.*).

Remarks: The record for the Mlawula Nature Reserve is the first one for the Lubombo region and only the second one from Swaziland, after that which Stronkhorst & Stronkhorst (*op. cit.*) cited on a website.

Fig. 1. Male specimen of *Heliocopris hamadryas* (Fabricius, 1775) from Swaziland in two different positions (photos by Kate Braun).

Heliocopris haroldi Kolbe, 1893

Material examined. GABON: Ivindo National Park, Makokou, Ivindo Department, Ogooué-Ivindo Province, 05.2009, A. Susini leg., 1 ♀, MZUF; *idem*, 01-15.03.2010, 4 ♂♂, 4 ♀♀, MZUF.

Biology. It seems to be a mainly rainforest species (Moretto, 2014).

General distribution. It is known for almost all central-eastern Africa, while in many countries of western Africa its occurrence needs confirmation (see Pokorný, Zidek, &

Werner, 2009; Moretto, 2014).

Remarks. So far, the only record of this species for Gabon was reported by Moretto (2014), but without precise locality.

Heliocopris marshalli Péringuey, 1901

Material examined. ZAMBIA: Kasanka National Park, Serenje district, Central Province, -12.502312° N 30.131646° E (uncertainty = 21 m), 13.12.2013, 1 ♂ (Fig. 2), photo by Jakob Fahr, IN.

Biology: Little known species, a few specimens were found from underneath cattle dung (Pokorný,et al 2009).

General distribution: Very few data are known for this species, which is rarely encountered in the field, and was recorded so far only for two countries: Tanzania and Zimbabwe (Pokorný, Zidek, & Werner, op. cit.)

Remarks: First record for Zambia.

Fig. 2. Male specimen of *Heliocopris marshalli* Péringuey, 1901 from Zambia in two different positions (photos by Jakob Fahr).

DISCUSSION

New records for this relatively little investigated genus of dung beetles are added by this contribution. The record of *H. marshalli* is particularly interesting, since still scarce is the distribution knowledge of this species: Zambia is only the third country in which this beetle is found. Further research could help to verify if the species occurs also in other neighboring countries, like Malawi or Mozambique.

Uganda and especially Swaziland are relatively uninvestigated countries for *Heliocopris* fauna. *Heliocopris antenor* was not reported by Pokorný,et al (2009) in Uganda, where the species was documented for the first time only in recent years (De Jong & Krell, 2011), bringing to seven the number of *Heliocopris* species occurring in this country (see Pokorný, Zidek, & Werner, *op. cit.*).

Even less investigated is Swaziland. No records from this country are reported by Pokorný, Zidek, & Werner (*op. cit.*) and the only records from this state can be found in Gillet & Barr (2018), as well as in a privately published online article by Stronkhorst & Stronkhorst (1997) and in website of the same authors (Stronkhorst & Stronkhorst, 2013), for a total of five species.

Then, in Pokorný, Zidek, & Werner (*op. cit.*) only three species were reported from Gabon; one of which, *H. haroldi*, was generically recorded by Moretto (2014) for the country. Herein, a first exact locality for Gabon is given for this scarab beetle.

Further research is certainly needed to better define the distribution of many species of these dung beetles.

ACKNOWLEDGEMENTS

We thank Luca Bartolozzi (Museo di Storia Naturale dell'Università degli Studi di Firenze, Florence, Italy) who allowed us to study the material under his care and Philippe Moretto (Toulon, France) for providing some useful papers.

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Received: June 01, 2019 *Accepted: May 17, 2020*

J. Entomol. Res. Soc., 22(2): 131-135, 2020
Print ISSN:1302-0250

Research Article
Online ISSN:2651-3579

New Record of *Ionympha* Graham (Chalcidoidea: Eulophidae) from India with Description of a New Species

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ABSTRACT

Genus *Ionympha* Graham (Hymenoptera: Eulophidae) is recorded first time from India and Oriental region. A new species, *I. lenis* sp. nov. is described from Uttar Pradesh, India.

Key words: Hymenoptera, Entedoninae, new record, Oriental region.

Jamali, M. M.(2020). New record of *Ionympha* Graham (Chalcidoidea: Eulophidae) from India with Description of a new species. *Journal of the Entomological Research Society*, 22(2), 131-135.

INTRODUCTION

Ionympha Graham (Eulophidae: Entedoninae) is little-known genus, containing only two species *I. carne* (Walker, 1839) and *I. ochus* (Walker, 1839) (Noyes, 2019). Both species are recorded in Europe (Boucek & Askew 1968) and the Nearctic and Neotropical regions (Hansson 1988).

In this paper, genus *Ionympha* Graham is recorded first time from India as well as Oriental region with description of a new species *I. lenis* sp. nov. An identification key to species is also provided.

MATERIAL AND METHODS

The body colour was noted from card mounted specimens before clearing and mounting the specimens on slides in Canada balsam. Body length is given in millimetres. All other relative measurements are taken from the divisions of a linear scale of a micrometer placed in the eye piece of a compound microscope. These measurements were taken at 100× magnification of the microscope.

The photographs of slide mounted body parts were taken with a digital camera (Nikon DS-Fi1c) attached to a compound microscope (Nikon Eclipse Ci).

The following abbreviations are used in the text:

F1-4 = Funicle segment 1 to 4

ZDAMU = Insect collections, Department of Zoology, Aligarh Muslim University, Aligarh, India.

RESULTS AND DISCUSSION

Genus *Ionympha* Graham

Ionympha Graham, 1959: 199. Type species *Entedon ochus* Walker, 1839: 21, by original designation.

Diagnosis

Female: Head with frontal grooves V-shaped; scrobal grooves ending separately on frontal grooves, extending below toruli (Fig. 1); clypeus not delimited by suture; gena with strong incision below each eye to fit the base of mandibles when open. Antenna (Fig. 2) with 5 well-separated flagellomeres in male, the last two united in female. Mesosoma with pronotum reduced dorsally; propodeum smooth and shiny, without median carina. Fore wing with postmarginal vein subequal or shorter than stigmal vein; stigma petiolate. Petiole reduced to a narrow dorsal band. Ovipositor very short.

Male: Similar to female except sexual dimorphism and antenna with setae.

Key to world species of *Ionympha* Graham, females

1. Antenna with pedicel mainly white in colour..... *I. carne* (Walker)

-Antenna with pedicel dark brown in colour.....2

2. Mesoscutum dull with strongly reticulation. Fore wing with postmarginal vein as long as stigmal vein (Fig. 9)..... *I. ochus* (Walker)

-Mesoscutum shiny and smooth. Postmarginal vein indistinct or rudimentary (Fig. 5) ..... *I. lenis* sp. nov.

***Ionympha lenis* sp. nov. (Figs 1-8)**

Holotype Female: Body length: 1.23 mm. Head metallic dark brown to black. Antenna dark brown. Mesosoma metallic dark brown to black. Wings (Figs 5, 6) hyaline. Legs including coxae dark brown except tarsomeres 1-3 pale brown, 4th tarsomere brown. Gaster metallic dark brown.

Head (Fig. 1) in frontal view, 1.26× as broad as high; eye height 1.7× as long as malar space; antennal toruli situated slightly above the lower eye margin. Antenna (Fig. 2) with scape 4.25× as long as broad, 2.8× as long as pedicel; pedicel 1.57× as long as broad; pedicel + flagellum slightly longer than head width; flagellum with 2 anelli; F1 1.4× as long as broad, subequal in length to F2 (in one antenna F1 distinctly longer than F2 as in figure 3; F3 subequal to F4; clava 2.4× as long as broad, shorter than all funicle segments individually.

Mesosoma (Fig. 4) smooth, 1.44× as long as broad; pronotum narrow, hardly visible in dorsal view; mesoscutum shorter than scutellum; notauli almost complete; mid lobe of mesoscutum with 4 setae; axillae elongate, reaching more than half length of scutellum; scutellum longer than broad with 2 setae, one seta near each lateral margin; dorsellum 2.7× as broad as long; propodeum 1.5× as long as dorsellum; propodeal callus with 3 setae. Fore wing (Fig. 5) densely setose, 2.08× as long as broad, without any row of setae radiating from stigmal knob; speculum closed; radial cell setose; marginal vein + parastigma 1.84× submarginal vein, 10.2× as long as stigmal vein; postmarginal vein 0.3× stigmal vein length; longest marginal seta 0.16× maximum wing width. Hind wing (Fig. 6) 5.6× as long as broad with apex pointed; longest marginal seta 0.5× maximum wing width.

Metasoma (Fig. 7). Petiole 2.76× as broad as long; gaster longer than mesosoma; ovipositor occupying more than half length of gaster, not exserted beyond apex of gaster; ovipositor 1.3× as long as hind tibia.

Relative measurements (holotype slide). Head height: width, 30: 38; eye height, 18; malar space, 10.5. Antennal segments length: width- scape, 17: 4; pedicel, 6: 3.75; F1, 6.5: 4; F2, 6.5: 4; F3, 5.75: 3.5; F4, 5.5: 3.5; clava, 5: 2.5; spicula, 2. Mesosoma length: width, 49: 34. Fore wing length: width, 104: 50; longest marginal seta, 8; submarginal vein length, 25; parastigma length, 6; marginal vein length, 40; postmarginal vein length, 1.5; stigmal vein length, 4.5. Hind wing length: width, 90: 16; longest marginal seta, 8. Hind tibia length, 30. Metasoma. Petiole length: width, 3.25: 9; gaster length, 55; ovipositor length, 39.

Male: Similar to female except sexual diamorphism. Antenna (Fig. 8) with scape 2.5× as long as broad, 3.45× as long as pedicel; pedicel 1.22× as long as broad; F1 2× as long as broad, slightly longer than F2; clava 2.3× as long as broad, subequal to F4.

Relative measurements (paratype slide): Antennal segments length: width- scape, 19: 7.5; pedicel, 5.5: 4.5; F1, 9.5: 4.75; F2, 9: 4.25; F3, 8: 3.5; F4, 7.5: 3.5; clava, 7.5: 3.25; spicula, 3. Genitalia length, 26; phallobase length, 19.

Material examined: Holotype (ZDAMU), female (on slide under four coverslips, slide No. EUL.218), INDIA: UTTAR PRADESH: Aligarh, Dhadda, 19.iii.2016, Coll. M.T. Khan.

Paratypes, 1 female, 1 male. 1 female (on card); 1 male (on slide, slide No. EUL.235), with same data as for holotype. (ZDAMU).

Host: Unknown.

Etymology: This species name is derived from its smooth body (in *Latin, lenis* = smooth).

Distribution: India: Uttar Pradesh.

Comments

Ionympha lenis sp. nov. comes close to *I. ochus* (Walker) (Fig. 9) by having more or less similar body colour, but it differs from the later by the characters given under key to species.

Figs. 1-9. *Ionympha lenis* sp. nov. (1-8), holotype: 1, head, frontal view; 2, antenna; 3, antenna with enlarge F1; 4, mesosoma; 5, fore wing; 6, hind wing; 7, metasoma. Paratype, male: 8, antenna. *Ionympha ochus* (Walker), lectotype: 9, habitus in dorsal view.

ACKNOWLEDGEMENTS

Thanks to Dr Shahid Bin Zeya, Department of Zoology, Aligarh Muslim University, Aligarh, for constant help and encouragements. Thanks also to Dr Christer Hansson for the confirmation of the genus and Natalie Dale-Skey, Curator, Hymenoptera section, BMNH London, for providing the photographs of card-mounted Lectotype of *Ionympha ochus* (Walker).

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Received: August 07, 2019 *Accepted: February 19, 2020*

J. Entomol. Res. Soc., 22(2): 137-152, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

Ethology of *Prolepsis tristis* (Walker, 1851) (Diptera: Asilidae) in Northeastern Florida, U.S.A.

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ABSTRACT

Prolepsis tristis (Walker, 1851) foraged from vegetation, capturing prey in flight and immobilizing them in flight or at the feeding site. Seven of the 10 prey were instances of cannibalism with females preying on other females and one male. Mating occurs in the tail to tail position. Female oviposition is in the soil. Feeding and mating peaks are from 10:00-11:00 AM, with two smaller peaks in the afternoon from 1:00-3:00 PM and 3:00-4:00 PM, respectively. Grooming behavior did not occur often and was brief, but resembles that of other species of Asilidae. Morphology, habitat, flight patterns, resting behavior, and predators and parasites also are discussed.

Key words: Behavior, robber flies, Diptera, Asilidae.

Dennis, D.S. (2020). Ethology of *Prolepsis tristis* (Walker, 1851) (Diptera: Asilidae) in Northeastern Florida, U.S.A. J*ournal of the Entomological Research Society*, 22(2), 137-152.

INTRODUCTION

Prolepsis is predominantly a genus of Neotropical robber flies with 17 species (Geller-Grimm, 2019). *Prolepsis tristis* (Walker, 1851) is the only Nearctic species and is found in about the southern half of the United States from California to Missouri and North Carolina south to Texas and Florida, as well as in Mexico (Fisher & Wilcox, 1997; Geller-Grimm, 2019). Despite the relatively widespread distribution of *P. tristis*, limited information has been published on this species.

This paper provides information on the ethology of *P. tristis* in the Moses Creek Conservation Area (MCCA) in St. Augustine in northeastern Florida. The main behaviors described are flight patterns, resting, foraging and feeding, courtship and mating, oviposition, grooming, and daily rhythm of activity. Male and female morphology, prey, and predators and parasites are also discussed.

MATERIALS AND METHODS

Prolepsis tristis is a widely distributed species in Florida, generally occurring from May into October. In the MCCA observations were made over nine field seasons: 01-14.09.2011; 16-31.08.2012; 12.09.2013; 28.07.2014-09.10.2014; 19.08.2015-04.09.2015; 13-17.05.2016; 15-30.08.2017; 05-07.09.2018; and 21.05.2019-04.10.2019. Some years had shorter periods of study because of inclement weather and low populations of flies.

Prolepsis tristis was studied when it was most abundant in the Moses Creek floodplain marsh and mesic flatwoods vegetation communities. Observations involved an average of 3 individuals per day, each for up to 89 minutes. Total number of hours of observations equaled approximately 97, not including the many hours searching for individuals or populations of *P. tristis* to observe.

Prolepsis tristis was studied by the author sitting or standing and observing single flies for as long as possible in order to collect information on their various behaviors and diurnal activities. The author also slowly walked through a study area and observed the activities of a number of flies, primarily to collect prey and to locate mating pairs and ovipositing females.

Collected prey was placed in glass vials with a label indicating the sex of the predator, date, time, and location. The author sent prey that he could not identify to the U. S. Department of Agriculture, Agricultural Research Service, Systematic Entomology Laboratory (SEL), Beltsville, Maryland, U.S.A. for identification. Prior to shipment, prey was measured with a clear, plastic ruler to the nearest 0.5 mm.

While in the field, a hand-held Taylor thermometer and/or a Cooper-Atkins DPP400W Digital Thermometer were used to take air, surface and subsurface ground temperatures. A Dwyer Hand-Held Wind Meter measured wind speed and a UYIGAO Digital Light Meter (UA-962) measured light levels.

RESULTS AND DISCUSSION

Morphology

Prolepsis tristis is 14-28 mm long and is dimorphic with the male and female differently colored (Fig. 1). In the MCCA the overall color of males is black to dark reddish brown with four variations in color observed on the abdominal segments as follows, (1) all black abdomen; (2) segments 2 and 3 with circular faint white to triangular bright white spots laterally; (3) in the bright white forms, the dorsal apex of the base of the triangle runs toward the mid-dorsal line, often coalescing there; (4) segments 4 or 5-7 mostly dorsally and laterally orangish to reddish brown with similar dorsal lighter spots on segments 2 or 3; (5) mesonotum of thorax reddish brown and an abdomen that is entirely black except the sides of segment 2 and the lateral posterior margins of segment 3, which are dark reddish brown.

Fig. 1. Mating pair of *Prolepsis tristis* in the tail-to-tail position with the female left and male right (Photograph: D.S. Dennis, 25 August 2015, 11:48 AM).

Females are yellowish brown to reddish brown with color variation on the abdominal segments mostly consisting of dorsal and lateral bands that become lighter ventrally or are missing as follows, (1) segments 2-5 with combination of reddish brown, yellow, orangish, and black bands, (2) segments 2 and 3 with combination of orangish to reddish brown, yellow, and black bands and segments 4-7 black; and (3) segments 2 and 3 with yellow and reddish brown bands with mid-dorsal black spot, segment 4 black with dorsal posterior reddish brown stripe, and segments 5-7 dorsally and laterally reddish brown.

Bromley (1934, 1950) indicated that *P. tristis* is a wasp mimic with the males mimicking Pompilidae or Sphecidae and the females resembling *Polistes* (Vespidae). In the Moses Creek floodplain marsh habitat discussed below, black pompilid wasps (e.g., *Anoplius* sp.) and *Polistes* metricus Say, 1831 are often seen.

Habitat

Prolepsis tristis was found in the Moses Creek floodplain marsh (Fig. 2), and mowed and roller-chopped mesic flatwoods vegetation communities shown in Table 1. At the times this species was studied the dominant plants in the floodplain marsh were pickerelweed (Pontideriaceae, *Pontederia cordata* L.), saltmarsh fingergrass (Poaceae, *Eustachys glauca* Chapm.), danglepod (Fabaceae, *Sesbania herbacea* (Mill.) McVaugh), and pond cypress (Cupressaceae, *Taxodium ascendens* Brongn.). In the mesic flat woods the dominant plants were staggerbush (Ericaceae, *Lyonia* spp.)

and saw palmetto (Arecaceae, *Serenoa repens* (W. Bartram) Small). The dominant plants in the roads passing through the study areas were grasses (Poaceae) and sedges (Cyperaceae), and soft rush (Juncaceae, *Juncus effuses* L. subsp. *solutus* (Fernald & Wiegand) Hämet-Ahti) in the floodplain marsh.

Table 1. Vegetation communities in which *Prolepsis tristis* was studied in the Moses Creek Conservation Area.

Vegetation Type	**Vegetation Community**	
Family/Genus/Species/Common Name	**Moses Creek Floodplain Marsh**	**Mowed and Roller Chopped Mesic Flatwoods**
Altingiaceae		
Liquidambar styraciflua L./Sweetgum	X[1]	-[2]
Annonaceae		
Asimina sp./Pawpaw	-	X
Apiaceae		
Cicuta maculata L./Spotted water hemlock	X	-
Apocynaceae		
Asclepias perennis Walter/ Swamp milkweed	X	-
Aquifoliaceae		
Ilex glabra (L.) A. Gray/ Gallberry	-	X
Arecaceae		
Sabal palmetto (Walter) Lodd. ex Shult. & Shult. f./Cabbage palm	X	-
Serenoa repens (W. Bartram) Small/Saw palmetto	X	X
Asteraceae		
Carphephorus corymbosus (Nutt.) Torr. & A. Gray/Coastalplain chaffhead (Florida paintbrush)	-	X
Carphephorus odoratissimus (J. F. Hamel) H. Hebert/Vanillaleaf (deer's tongue)	-	X
Coreopsis leavenworthii Torr. & A. Gray/ Leavenworth's tickseed	X	-
Elephantopus elatus Bertol./Tall elephantsfoot	X	-
Erechtites hieraciifolius (L.) Raf. Ex DC./American burnweed	X	X
Eupatorium sp./Fennel	X	X
Pityopsis graminifolia (Michx.) Nutt./Narrowleaf silkgrass	-	X
Pluchea sp./Camphorweed	X	-
Senecio vulgaris L./Common groundsel	-	X
Solidago sp./Goldenrod	-	X
Liatris tenuifolia Nutt./Shortleaf gayfeather	-	X

Table 1. Continued.

Vegetation Type	Vegetation Community	
Family/Genus/Species/Common Name	**Moses Creek Floodplain Marsh**	**Mowed and Roller Chopped Mesic Flatwoods**
Convolvulaceae		
Ipomoea sp./Morning-glory	X	-
Cupressaceae		
Taxodium ascendens Brongn./Pond-cypress	X	-
Cyperaceae		
Cyperus spp./Flatsedges	X	X
Cyperus surinamensis Rottb./ Tropical flatsedge	-	X
Juncus megacephalus M.A. Curtis/Bighead rush	X	-
Rhynchospora spp./Beaksedges	X	X
Scirpus sp./Bulrush	X	-
Dennstaedtiaceae		
Pteridium aquilinum L. (Kuhn) var. *pseudocaudatum* (Clute) Clute ex. A. Heller/ Tailed bracken	X	X
Ericaceae		
Bejaria racemosa Vent./Tar flower (flyweed)	-	X
Lyonia ferruginea (Walter) Nutt./ Rusty lyonia	-	X
Lyonia lucida (Lam.) K. Koch/ Fetterbush	-	X
Vaccinium arboreum Marshall/Sparkleberry	-	X
Vaccinium corymbosum L./ Highbush blueberry	-	X
Vaccinium myrsinitas Lam./ Shinyblueberry	-	X
Fabaceae		
Chamaecrista sp./Sensitive pea or Partridge pea	X	-
Galactia elliottii Nutt./Elliott's (white) milkpea	-	X
Lupinus diffuses Nutt./Sky-blue lupine	X	-
Mimosa sp./Sensitive plant	-	X
Sesbania herbacea (Mill.) McVaugh/Danglepod	X	-
Sesbania sericea (Wild.) Link/Silky sesban	X	-
Fagaceae		
Quercus laurifolia Michx./Laurel oak	X	-
Quercus myrtifolia Willd./Myrtle oak	-	X
Quercus virginiana (P. Mill)/Live oak tree	X	X
Quercus sp./Scrub oaks	X	X

Table 1. Continued.

Vegetation Type	Vegetation Community	
Family/Genus/Species/Common Name	**Moses Creek Floodplain Marsh**	**Mowed and Roller Chopped Mesic Flatwoods**
Hypoxidaceae		
Hypoxis juncea Sm./Fringed yellow stargrass	-	X
Juncaceae		
Juncus effusus L. subsp. *solutus* (Fernald & Wiegand) Hämet-Ahti/Soft rush	X	-
Lamiaceae		
Agalinis fasciculata (Elliott) Raf./Beach false foxglove	-	X
Onagraceae		
Ludwigia sp./Primrosewillow	X	-
Osmundaceae		
Osmunda cinnamomea L./ Cinnamon fern	?	X?
Pinaceae		
Pinus clausa (Chapm. Ex Engelm.) Vasey ex Sarg./Sand pine	-	X
Pinus elliottii Engelm./Slash pine	-	X
Poaceae		
Andropogon glomeratus (Walter) Britton et al./Bushy bluestem	-	X
Andropogon virginicus L./Broomsedge bluestem	-	X
Andropogon virginicus L. var. *glaucus* Hack./Chalky bluestem	X (northern edge)	-
Aristida stricta Michx. Var. beyrichiana (Trin. & Rupr.) D. B. Ward/Wiregrass	-	X
Dactyloctenium aegyptium (L.) Willd. Ex Asch. & Schweinf/Durban crowfootgrass	-	X
Digitaria sp./Crabgrass	X	-
Eustachys distichophylla (Lag.) Nees/Weeping fingergrass	X	-
Eustachys glauca Chapm./Saltmarsh fingergrass	X	-
Panicum virgatum L./Switchgrass	X	-
Setaria sp./Foxtail	X	X
Other grasses	X	X
Polygalaceae		
Polygala lutea L./Orange Milkwort	-	X

Table 1. Continued.

Vegetation Type	Vegetation Community	
Family/Genus/Species/Common Name	Moses Creek Floodplain Marsh	Mowed and Roller Chopped Mesic Flatwoods
Polygonaceae		
Persicaria glabra (Wild.) M. Gómez/Denseflower knotweed	X	-
Pontideriaceae		
Pontederia cordata L./Pickerelweed	X	-
Rubiaceae		
Oldenlandia corymbosa L./Flattop clustered mille	X	-
Sapindaceae		
Acer rubrum L./Red maple	X	-
Saururaceae		
Saururus cernuus L./Lizard's tail	X	X
Smilaceae		
Smilax auriculata Walter/Earleaf greenbrier vine	-	X
Smilax bona-nox L./Saw greenbrier vine	-	X
Vitaceae		
Vitis rotundifolia Michx./ Muscadine	X	X
Xyridaceae		
Xyris sp./Yelloweyed grass	-	X

1 = present; 2 = not present. There are no 1 or 2 is it correct.

Fig. 2. *Prolepsis tristis* habitat along road in Moses Creek floodplain marsh (Photograph: D.S. Dennis, 24 August 2012, 9:27 AM).

The vegetation in the floodplain marsh community is thick, approximate 83 m long and 35.7 m wide, and is mostly along a "U" shaped road in an electrical transmission

line corridor. As part of vegetation height management, some plants in the corridor are periodically sprayed with herbicide. Thus, when *P. tristis* was initially studied in 2011, there was more danglepod, pickerelweed, and pond cypress than in subsequent years.

Bromley (1934) said that *P. tristis* is "Found along water courses or cultivated fields where vegetation is rank." Lavers (2011) and Raney (2019) both found this species near or along sandy beaches near rivers.

Flight patterns

Dennis & Lavigne (1975) classified robber fly flight patterns as, orientation flights; investigatory flights; foraging flights; and searching flights. Orientation flights are short flights around a robber fly's location to change its field of vision and are not directed towards potential prey. Investigatory flights are directed toward potential prey without the asilid making contact. Foraging flights are when an asilid makes contact with potential prey. Searching flights are, "Vertical undulating flight patterns or weaving in and out of the vegetation by male asilids in their search for receptive females with which to mate."

After making an orientation flight, many asilids return to or within a few cm of their original foraging location. *Prolepsis tristis* sometimes return to within 15 cm to 1 m of their original foraging position, but usually move to a new location 1.8-18.9 m away, flying up to 4.6 m above the ground or up to 3.4 m above the vegetation. The flights are relatively straight and take from 3-65 seconds. It is believed that these flights allow the asilids to survey the habitat and to select new resting and foraging locations. Some flights spanned Moses Creek (up to 8.1 m wide) to other parts of the habitat

During the longer flights the asilids slowly fly with the femora of the fore- and mid-legs held up against the thorax, and the tibiae and tarsi hanging down at about a 30-45º angle or the tibiae and tarsi are held closer to the thorax and extend forward. The hind legs also hang below the asilid at about a 45º angle. Sometimes the abdomen is gently curved up. Wasps flying slowly in the habitat held their legs in similar positions.

Diogmites crudelis Bromley, 1936 also made long orientation flights within 3-8 m of its foraging position (Dennis, 2015). Lavigne (1992) assumed that the long orientation flights (in excess of 10 m) that *Colepia abludo* (Daniels, 1983) made were in response to the lack of potential prey in the vicinity of its foraging location or were males relocating when no females had been seen. This also may be true for *P. tristis.*

Prolepsis tristis investigatory and foraging flights are discussed below under Foraging and Feeding Behavior. Searching flights are discussed under Courtship and Mating Behavior.

Resting behavior

Prolepsis tristis rests on and forages from vegetation, primarily on grass stems and blades. When they initially land on a grass blade, the blade generally bends over so that it is parallel to the ground. As the grass blade bends over the asilids balance themselves by spreading their wings for up to 44 seconds and curving their abdomen

over the edge of the blade. When having trouble balancing on a grass blade, some asilids buzz their wings. If an asilid lands on the edge of a grass blade, they usually keep their body at a 30-45º angle. One female rested on the side of a foxtail (Poaceae, *Setaria* sp.) spike vertical to the ground.

While resting, *P. tristis* are mostly still, but may make brief, quick movements of their head and abdomen, in particular when other insects fly over 45 cm to 1.2 m above their location. One female also reacted to a bird flying over 3 m above her. Individuals rest for up to 24 minutes before resuming other activities.

Most *P. tristis* rest 20 cm to 1.5 m above the ground with their sides to the sun. One asilid rested 6.1 m above the ground on scrub oak on the western side of the Moses Creek floodplain marsh habitat. However, when air temperature in the sun reached 36.5ºC, some individuals move down to the shade of vegetation, 5-30 cm above the ground, where it is slightly cooler, 34.5-35ºC. Many species of robber flies maintain their body temperature by changing their position in relation to the sun and/or rest on the shady side of vegetation (Dennis, 2018; Dennis & Lavigne, 1975; Lavigne & Holland, 1969).

While resting, one male *P. tristis* excreted a white drop from its anus. When resting and feeding, other species of robber flies in the MCCA have expelled a drop of creamy-white to brownish liquid from their anuses including: *Proctacanthus brevipennis* (Wiedemann, 1828) (Dennis, 2012), *P. longus* (Wiedemann, 1821) (Dennis, 2019), *Stichopogon trifasciatus* (Say, 1823) (Dennis, 2013), *Holopogon phaeonotus* Loew, 1874 (Dennis, 2014), *H. snowi* Back, 1909 (Dennis, 2018), *Diogmites crudelis* Bromley, 1936 (Dennis, 2015), and *Promachus bastardii* (Macquart, 1838) (Dennis, 2016). Lehr (1958) observed that the expulsion of liquid from the anal opening is quite common in robber flies.

Prolepsis tristis spent the night on vegetation, generally 30-60 cm above the ground, in either a horizontal or vertical position with their head up. One female was observed in a horizontal position with early morning dew on her thorax (Fig. 3).

Fig. 3. Female *Prolepsis tristis* with early morning dew on thorax (Photograph: D.S. Dennis, 24 August 2012, 8:13 AM).

Foraging and feeding behavior

Prolepsis tristis forage from vegetation 15 cm-1.5 m above the ground. Investigatory flights are made within 15 cm-1.5 m and generally above an asilid's foraging position. Flights are for distances up to 1.5 m. One investigatory flight involved a female chasing a male, and three other flights were both female and male *P. tristis* chasing *Polistes metricus* wasps. Following investigatory flights, the asilids land at least 1 m from their original foraging location.

Foraging flights, when *P. tristis* capture and release potential prey, are made within 30 cm-1 m of an asilid's foraging position. Prey is generally released in flight, but one male captured a potential prey, fell to the ground, and then released it. Two males captured and released *P. metricus* while in flight. Like the investigatory flights, *P. tristis* did not return to its original foraging position after foraging flights.

Male and female *P. tristis* have modified foraging flights when they weave in and out of vegetation and then hover in front of and briefly hit grass stems and foxtail spikes. Males did not exhibit this behavior as much as females.

Only three prey captures were observed and all involved cannibalism when females captured other females. All prey were captured approximately 1 m from a female's foraging position and then the predator and prey fell into the vegetation where feeding ensued. Also, one male captured a female in flight and when the pair fell to the ground, the female inserted her proboscis in the venter of the male's head.

During feeding small prey hang free from the asilid's proboscis without being held by the tarsi and are not manipulated. Larger prey (i.e., other *P. tristis*) are held against the vegetation and the asilid crawls on the prey and manipulates the prey with a number of tarsi or holds onto vegetation with one or both fore tarsi and mid-tarsi and manipulates the prey with the other tarsi prior to reinserting its proboscis. As feeding progresses, prey is manipulated up to six times.

Only one complete feeding was observed and involved a female *P. tristis* feeding on another female. When the female captured the other female (prey), she inserted her proboscis in the venter of the prey's head, which indicates that the prey was attacked from below. The feeding took 129.5 minutes during which the prey was manipulated six times. Following the first manipulation the female reinserted her proboscis in the anteroventral part of the other female's abdomen. This was followed by manipulation and reinsertion of the proboscis in the female's ventral tip of the abdomen, right anterolateral part of the thorax, dorsal tip of the abdomen (two times in a row), and then the dorsal surface of the thorax. Following feeding the female dropped her prey at the feeding site and the author lost her as she flew to another location in the habitat.

During feeding some robber flies pump the first one to three segments of their abdomen. This abdominal pumping (or contractions) has been associated with the injection of proteolytic enzymes into prey and the ingestion of liquefied food from prey (Musso, 1968; Lavigne & Holland, 1969), as well as thermoregulation (Morgan, Shelly, & Kimsey, 1985; Morgan & Shelly, 1988). *Prolepsis tristis* did not exhibit abdominal pumping.

Prey

Very few *P. tristis* were found with prey. The following is a list of prey taken by *P. tristis* with the number and sex of the predator following the date.

COLEOPTERA, Chrysomelidae: *Lema daturaphila* Kogan & Goeden, 1970, 25.09.19 (1 ♀). Meloidae: *Epicauta* sp. prob. *torsa* LeConte, 1853, 08.09.2014 (1 female). DIPTERA, Asilidae: female *P. tristis*, 17.08.2012 (1 ♀), 20.08.2012 (3 ♀♀) 21.08.2015 (1 ♀), male *P. tristis*, 17.08.2012 (1 ♀), 26.08.2015 (1 ♀). LEPIDOPTERA, Crambidae: *Herpetogramma bipunctalis* (Fabricius, 1794), 24.08.2015 (1 ♀).

As shown in the list of prey, the largest number of prey is from females preying upon both male and female *P. tristis*. Raney (2019) photographed a male *P. tristis* feeding on another male.

The records of cannibalism reported here occurred during periods of good weather without rain or high winds. Lehr (1961) observed that female *Stenopogon heteroneurus* (Macquart, 1838) preyed on males and cannibalism enabled the asilids to survive a shortage of food after a long period of inclement weather.

Bromley (1934) observed a female *P. tristis* (as *Dizonias tristis*) with *Epicauta* sp. (Coleoptera, Meloidae) as prey. Bromley (1950) also said that they (as *D. tristis*) feed on slow flying beetles and observed a female feeding on *Epicaerus formidolosus* Boheman, 1842 (Coleoptera, Curculionidae). Fattig (1945) reported *P. tristis* (as *D. tristis)* preying on *Eristalis dimidiata* (Wiedemann, 1830) (as *Tubifera dimidiatus*; Diptera, Syrphidae), *Apis mellifera* L., 1758 (Hymenoptera, Apidae), and *Epicauta trichrus* (Pallas, 1798).

Courtship and mating behavior

Some of the previously mentioned orientation flights, in particular when the male weaves during flight (30-120 cm above the vegetation), may have been searching flights for receptive females with which to mate. However, most male searching flights involve the male slowly weaving in-and-out of vegetation, generally 30-90 cm above the ground, often hovering in front of vegetation.

Male and female *P. tristis* would fly up to investigate and briefly hover or oscillate back and forth within 7.5-10 cm in front of each other and up to 3 m above the ground. Some also hovered in a half circle in front of each other. A few came into contact with each other and one male grasped a female and the pair fell to the ground where they separated. One male also captured another male and the pair separated when they fell into vegetation.

Males initiate mating by flying from vegetation, 1.0-1.2 m above the ground, grasp the female and straighten out in the tail-to-tail position (Fig. 1) while still in flight, or alternately the pair falls into vegetation and then they straighten out in the tail-to-tail position. One pair when they fell into vegetation were facing and pushing each other with their tarsi before straightening out in the tail-to-tail position.

While mating, the asilids were easily disturbed, even by wind blowing vegetation, and they would often fly to other nearby vegetation. Mating pairs generally moved two

to four times, depending on the length of the mating. One pair after the initiation of mating, was unable to find vegetation that could support their weight. So they moved eight times before finding vegetation that was sturdy enough to support them.

If after moving the male or female could not immediately grasp vegetation, they would hang free until they were able to reach and hold onto vegetation. Females usually took the lead when flying and were most frequently head up when on vegetation and the male was head down.

Between flights to other vegetation, the mating pair would generally remain motionless except for grooming of the fore tarsi. However, during the longest mating (91 minutes), after 41 minutes of its initiation, the male arched or flexed up his abdomen twice, and then opened and closed his wings seven times over a 12 minute period. The male left his wings open at approximately a 45º angle, for five to 47 seconds with an average of 30 seconds.

The author observed seven complete and 11 partial matings. The complete matings lasted 30-91 minutes with an average of 48 minutes 42 seconds. At the completion of mating, males usually released the female and both flew off. Only one mating pair separated in flight.

Prolepsis tristis matings occurred when the air temperature ranged from 26-36.5ºC at the height where the mating pair rested on vegetation, with an average of 31.5ºC.

Oviposition Behavior

One oviposition was observed in the soil. The female flew 12-15 cm above the ground, 6 m from her previous location in thick vegetation, and landed on the soil in a small opening in the vegetation. The female's body was at a 45º angle to the soil, with her wings closed, and her ovipositor was barely inserted in the soil, which was moist from recent rains. She remained in this position for 33 seconds, then briefly swept the soil with the tip of her ovipositor, and flew off. Soil was recovered and examined for eggs, but none were found.

The air temperature above the oviposition site was 31ºC; both at the surface and just below the surface, soil temperature was 33ºC.

Grooming

Robber fly grooming behavior is often associated with other behaviors such as following the completion of feeding, mating, and oviposition. However, this was not observed for *P. tristis*. This species, like *Holopogon phaeonotus* (Dennis, 2014) and *H. snowi* (Dennis, 2018), did not frequently groom themselves. Dennis (2018) commented that for *H. phaenotus* and *H. snowi*, "This may be because the asilids occupy various heights on vegetation and do not land on the ground." The same may be true for *P. tristis*.

When *P. tristis* did groom it was in much the same way as reported for other species of robber flies (Dennis, 2014). They always use the fore legs to groom their heads, and the hind legs to groom their wings, abdomen, and genitalia while resting and during feeding and mating.

Some robber flies groom for extended periods of time (e.g., *Diogmites crudelis* Bromley, 1936) (Dennis, 2015). However, *P. tristis* grooming is brief, lasting for seven seconds or less.

Prolepsis tristis often groom only the fore tarsi by placing the tarsi together and then moving them back and forth along their length. They also groom the fore tarsi and then groom their eyes and the sides of their face with their fore tibiae. They did not groom their proboscis, even after feeding.

When they groom their wings and abdomen, they would often briefly groom the hind tarsi and tibiae, and then groom the posterior half of the abdomen and wings from anterior to posterior with the hind tibiae and tarsi. The abdomen is often slightly curved down during grooming. When the wings are closed, only the top surface is groomed; when the wings are spread at a 30-45° angle to the body, both the tops and bottoms of the wings are groomed outward for about 3/4 of their length.

Daily rhythm of activity

Prolepsis tristis had one peak period for both feeding (40.0%) and mating (33.3%) between 10:00-11:00 AM (Fig. 4). Feeding had a second peak (22.2%) between 1:00-3:00 PM. A smaller mating peak (5.9%) occurred in the afternoon between 3:00-4:00 PM. Only one oviposition was observed, at 12:10 PM.

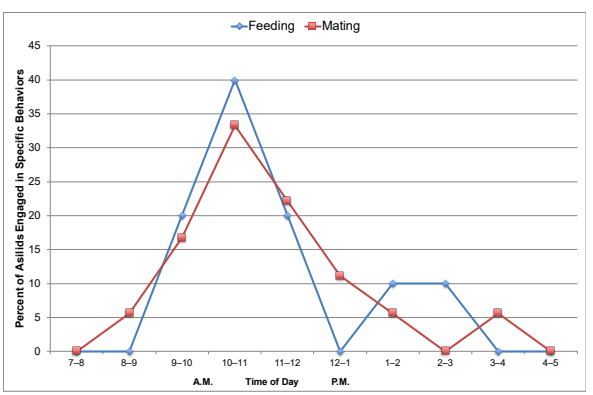

Fig. 4. Daily rhythm of activity of *Prolepsis tristis* based on 9 and 18 observations for feeding and mating, respectively.

The observations of daily rhythm of activity were made in the Moses Creek floodplain marsh habitat. This habitat has live oak, red maple, sweet gum and cabbage palm trees on both the eastern and western sides so that the habitat is in shade until about 8:17 AM when sun shines on some of the western side. By 10:40 AM about half the habitat is in sunshine and it is in full sun by about 12:00 noon. As the day progresses the western area starts to be in shade about 3:47 PM and the habitat is completely in shade by 5:00 PM.

The peak period of feeding and mating for *Prolepsis tristis* appears to be coordinated with when a large part of the habitat is in the sun, when light levels are

86,510-87,730 lux. However, even when the sky is overcast and the author can see a dim shadow with light levels ranging from 10,090-10,710 lux, *P. tristis* continues to forage and mate. Resting and some flying takes place in the shade with light levels of 1,619-1,754 lux.

Predators and parasites

As indicated above, female *P. tristis* prey upon both males and other females. According to Lavigne, Dennis, & Gowen (2000) cannibalism is common among robber flies.

Both male and female *P. tristis* were caught in the webs of the black-and-yellow orb weaver (*Argiope aurantia* Lucas, 1833; Araneae, Araneidae) orb weaver webs. Once caught in the webs, the robber flies were wrapped by the spiders in a cocoon of silk for later consumption.One male *P. tristis*, when resting on a grass stalk, was captured by a regal jumping spider (*Phidippus regius* C.L. Koch, 1846; Araneae, Salticidae) (Fig. 5).

Mites are often found on robber flies, in particular on the thorax. However, none were found on P. tristis.

Fig. 5. Regal jumping spider (*Phidippus regius*) with male *Prolepsis tristis* as prey (Photograph: D.S. Dennis, 20 August 2012, 11:25 AM).

CONCLUSIONS

Prolepsis tristis rests on and forages from vegetation. All prey were captured in flight and consisted of seven Diptera (70.0%), two Coleoptera (20.0%), and one Lepidoptera (10.0%). All of the Diptera were instances of cannibalism when females preyed on other females and males. During feeding small prey were not manipulated and larger prey (i.e., other *P. tristis*) were crawled on and manipulated with a number of tarsi. Mating occurred in the tail-to-tail position and oviposition was in the ground. This species exhibited a daily rhythm of activity with peak feeding and mating from 10:00-11:00 AM, with smaller peaks from 1:00-3:00 PM and 3:00-4:00 PM, respectively. The one oviposition observed was at 12:10 PM. Grooming behavior did not occur often and was brief, but resembles that of other species of Asilidae. Male and female *P.*

tristis were caught in the webs of the black and yellow orb weaver, *Argiope aurantia*. A regal jumping spider, *Phidippus regius*, captured one male.

ACKNOWLEDGMENTS

The author thanks the staff of the St. Johns River Water Management District for the issuance of the Special Use Authorization that allows the study of robber flies in the Moses Creek Conservation Area (MCCA) and for their interest in the research.

With gratitude, the author acknowledges Alma Solis (SEL) for her identification of the Lepidoptera (Crambidae) prey and Alexey Tishechkin (Department of Entomology, Louisiana State Arthropod Museum, Baton Rouge) for his identification of the Coleoptera (Meloidae) prey. The author also would like to thank the SEL's Michele Touchet for handling of the prey and the prompt Identification Reports.

I also thank the anonymous reviewers for their constructive comments on the manuscript.

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Received: August 12, 2019 *Accepted: June 26, 2020*

J. Entomol. Res. Soc., 22(2): 153-162, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

New Records for the Caddisfly Fauna (Insecta: Trichoptera) of the Karadak Mountains, Western Balkans

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ABSTRACT

We collected adult caddisfly specimens occasionally during 2017 at the Karadak Mountains, which remains one of the least explored mountainous areas in the Western Balkans. Here we report 15 species, three of which are first records for the Karadak Mountains and Republic of North Macedonia: *Rhyacophila bosnica* Schmid, 1960, *Tinodes kimminsi* Sykora, 1962 and *Stenophylax permistus* McLachlan, 1895.

In addition to this, new localities of *R. bosnica* from Kosovo are reported. We discuss the distribution and ecology of this rare endemic species, including the first noted winter activity of the adult stage.

Key words: Trichoptera, Kosovo, R. North Macedonia, *Rhyacophila bosnica*, *Tinodes kimminsi, Stenophylax permistus*, new records.

Musliu, M., Ibrahimi, H., Bilalli, B., Stamenković, V.S., Hinić, J., & Bozdoğan, H. (2020). New records for the caddisfly fauna (Insecta: Trichoptera) of the Karadak Mountains, Western Balkans. J*ournal of the Entomological Research Society,* 22(2), 153-162.

INTRODUCTION

The Balkan Peninsula is one of the most important hotspots of caddisfly diversity in Europe. However, data about this group of aquatic insects in this region are still incomplete. Faunistic data for the caddisfly fauna of this area date back over a century ago (e.g. Radovanović, 1931, 1935, 1953; Klapálek, 1899,1902). Extensive investigations of caddisfly fauna of the Balkan Peninsula have taken place recently regarding geographic distribution patterns (e.g. Kučinić, 2002; Živić, Marković, & Brajković, 2006; Ćuk & Vučković, 2009; Stanič-Koštroman, 2009; Previšić & Popijač, 2010; Oláh, 2010; Ibrahimi, Kučinić, Gashi, & Grapci-Kotori, 2012a; Ibrahimi et al, 2012b, 2014a; Ibrahimi, Kučinić, Gashi, & Grapci-Kotori, 2014b; Ibrahimi et al, 2015a, 2015b), description of new taxa (e.g. Kučinić & Malicky, 2002; Malicky, Previšić, & Kučinić, 2007; Oláh, 2010, Ibrahimi et al. 2015a; 2016), description of larval stage of known species (e.g. Kučinić et al, 2008; 2013; Graf et al, 2008; Waringer et al, 2009), and ecological preferences, as well as phylogenetic and phylogeographic studies for several species (e.g. Pauls, Lumbsch, & Haase, 2006; Pauls, Graf, Haase, Lumbsch, & Waringer, 2008; Previšić et al, 2014).

Caddisfly fauna of the Republic of Kosovo has been intensively investigated during the past years (Gashi et al, 2015; Ibrahimi et al, 2012a, 2012b, 2013, 2014a, 2014b, 2015a, 2015b, 2016), while in Republic of North Macedonia this order of aquatic insects was only partially investigated (Oláh, 2010, 2011; Oláh & Kovács, 2013; 2014; Rimcheska et al, 2015; Slavevska-Stamenković et al, 2016; Bilalli, Ibrahimi, & Musliu, 2018).

The goal of this paper was to contribute to the knowledge of caddisflies of the Karadak Mountains (Kosovo, Republic of North Macedonia) including ecological knowledge of some rare species found during this investigation.

MATERIAL AND METHODS

Data sampling and processing

Adult caddisfly specimens were collected with entomological nets (EN) and ultraviolet light traps (UV) during 2016 and 2017. Collected specimens were preserved in 80 % ethanol. Ultraviolet light traps were left to operate from dusk to the next morning nearby the streambanks. The specimens were identified under a stereomicroscope with determination keys of Kumanski (1985; 1988) and Malicky (2004).

The collection is deposited at the Laboratory of Zoology of the Faculty of Natural and Mathematical Sciences, University of Prishtina, Republic of Kosovo. Systematic follows Morse (2017).

Study area

The sampling was carried out at six localities: three in Kosovo (S4 Lugu i Kopilaqës, S5 Lumbardhi i Pejës River and S6 Stream in Sharr Mountains) and three in the Republic of North Macedonia (S1 Tanushë, S2 bove Brodec and S3 Brodec) (Table 1). Karadak/Skopska Crna Gora is a mountain range located mainly in the Republic

of North Macedonia and Kosovo, while a smaller part of it is in Serbia. It lies between the cities of Kaçanik (in southern Kosovo) and Skopje (Republic of North Macedonia) until Anamorava (Kosovo) in the north-east and Preshevë (Serbia) in the south-east. The highest peak is Ramno (1,651 m asl) in the Republic of North Macedonia. Four localities are located in Karadak/Skopska Crna Gora Mountains, while the last two ones are outside this area and are taken into consideration because of the distribution of *Rhyacophila bosnica*.

Table 1. Locality data for the 6 sampling stations of caddisflies

Code	Sampling Stations	Latitude °N	Longitude °E	Altitude m
S1	Tanushë, North Macedonia	42.23356	21.42733	1358
S2	Above Brodec, North Macedonia	42.160165	21.448974	1350
S3	Brodec, North Macedonia	42.14192	21.4403	912
S4	Lugu i Kopilaqës, Kosovo	42.24605	21.43110	1160
S5	Lumbardhi i Pejës River, Kosovo	42.661901	20.249348	580
S6	Stream in Sharr Mountains, Kosovo	42.17506°	20.97593°	1410

RESULTS

During this investigation, we found 15 species belonging to seven families and 10 genera. The distribution of species within families is as following: Rhyacophilidae (5), Limnephilidae (4), Philopotamidae (2), Polycentropodidae (1), Psychomyiidae (1), Leptoceridae (1) and Beraeidae (1).

The highest number of specimens belongs to the following species: *Rhyacophila bosnica* (85 specimens), *Stenophylax permistus* (25 specimens) and *S. meridiorientalis* Malicky, 1982 (23 specimens), while all other species were found with less than twenty specimens. The following four species were found with one specimen only during the whole investigation period: *Rhyacophila obtusa* Klapalek, 1894, *Plectrocnemia conspersa* (Curtis, 1834), *Potamophylax pallidus* (Klapalek, 1899) and *Adicella filicornis* (Pictet, 1834). Eleven species were found each in one locality only (*Rhyacophila fasciata* Hagen, 1859, *R. polonica* McLachlan, 1879, *R. obtusa* Klapalek, 1894, *Wormaldia occipitalis* (Pictet, 1834), *Plectrocnemia conspersa* (Curtis, 1834), *Tinodes kimminsi*, *Potamophylax pallidus*, *Micropterna sequax* McLachlan, 1875, *Adicella filicornis* and *Beraea pullata* (Curtis, 1834).

Seasonal dynamics of *Rhyacophila bosnica* based on the number of adult specimens caught during this investigation and based on literature records (Gashi et al, 2015; Ibrahimi et al, 2014b) (Fig. 1) reveals its activity from early February to late July. Based on this, the highest activity of adults of this species was observed during March and May, while the lowest activity during February and June.

Systematic list of caddisflies collected at six stations in the Karadak Mountains (Kosovo and Republic of North Macedonia) and Lumbardhi i Pejës and Lepenc rivers (Kosovo) during the period February-August 2017. Details about sampling stations are given in Table 1. EN -Entomological net, UV-Ultraviolet light trap.

Family: Rhyacophilidae

Rhyacophila bosnica Schmid, 1970*

S1 Tanushë, Republic of North Macedonia: (EN) 04.02.2017. 1 ♂; (EN) 25.03.2017. 52 ♂♂, 1♀. S2 Above Brodec, Republic of North Macedonia: (EN) 04.02.2017. 2 ♂♂; 25.03.2017. 2 ♂♂, 20 ♀♀; S5 Lumbardhi i Pejës River 11.05.2019 (EN) 5 ♂♂, 2 ♀♀; S6 Stream in Sharr Mountains, Kosovo: 11.03.2019 (EN) 3 ♂♂, 5 ♀♀; 13.04.2019 (EN) 2 ♂♂, 3 ♀♀.

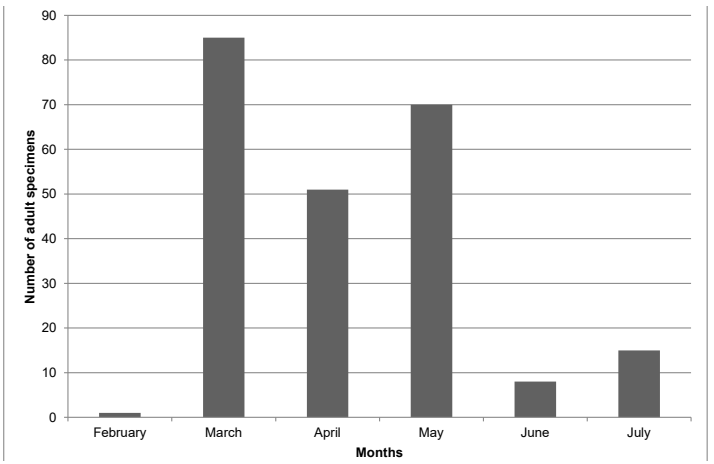

Fig. 1. Seasonal dynamics of the adult stage of *Rhyacophila bosnica.*

Rhyacophila fasciata Hagen, 1859

S4 Lugu i Kopilaqës, Kosovo: (EN) 30.08.2017. 6 ♂♂, 2 ♀♀.

Rhyacophila polonica McLachlan, 1879

S4 Lugu i Kopilaqës, Kosovo: (EN) 20.06.2017. 5 ♂♂.

Rhyacophila obtusa Klapalek, 1894

S3 Brodec, Republic of North Macedonia: (EN) 04.06.2017. 1 ♂.

Rhyacophila tristis Pictet, 1834

S2 Above Brodec, Republic of North Macedonia: (EN) 03.06.2017. 6 ♂♂, 1 ♀; S4 Lugu i Kopilaqës, Kosovo: (EN) 20.06.2017. 1 ♂, 2 ♀♀.

Family: Philoptamidae

Philopotamus montanus (Donovan, 1813)

S3 Brodec, Republic of North Macedonia: (EN) 04.06.2017. 3 ♂♂, (UV) 23.06.2017. 4 ♂♂, 2 ♀♀; S2 Above Brodec, Republic of North Macedonia: (EN) 03.06.2017. 1 ♂; (UV) 23.06.2017. 1 ♂; S4 Lugu i Kopilaqës, Kosovo: (EN) 20.06.2017. 1 ♂, 2 ♀♀.

***Wormaldia occipitalis* (Pictet, 1834)**

S2 Above Brodec, Republic of North Macedonia: (EN) 03.06.2017. 4 ♂♂; (UV) 23.06.2017. 3 ♂♂.

Family: Polycentropodidae

***Plectrocnemia conspersa* (Curtis, 1834)**

S3 Brodec, Republic of North Macedonia: (UV) 23.06.2017. 1 ♂.

Family: Psychomyiidae

Tinodes kimminsi* Sykora, 1962

S2 Above Brodec, Republic of North Macedonia: (EN) 03.06.2017. 3 ♂♂, 1 ♀.

Family: Limnephilidae

***Potamophylax pallidus* (Klapalek, 1899)**

S2 Above Brodec, Republic of North Macedonia: (UV) 06.08.2017. 1 ♂.

***Micropterna sequax* McLachlan, 1875**

S3 Brodec, Republic of North Macedonia (UV) 23.06.2017. 2 ♂♂, 1 ♀.

***Stenophylax meridiorientalis* Malicky, 1982**

S2 Above Brodec, Republic of North Macedonia: (UV) 04.06.2017. 9 ♂♂, 9 ♀♀; S3 Brodec, Republic of North Macedonia: (UV) 23.06.2017. 2 ♂♂, 3 ♀♀.

Stenophylax permistus* McLachlan, 1895

S2 Above Brodec, Republic of North Macedonia: (UV) 04.06.2017. 7 ♂♂, 5 ♀♀. S1 Tanushë, Republic of North Macedonia: (UV) 04.06.2017. 7 ♂♂, 6 ♀♀.

Family: Leptoceridae

***Adicella filicornis* (Pictet, 1834)**

S2 Above Brodec, Republic of North Macedonia: (UV) 23.06.2017. 1 ♂.

Family: Beraeidae

***Beraea pullata* (Curtis, 1834)**

S3 Brodec, Republic of North Macedonia: (EN) 04.06.2017. 2 ♂♂.

DISCUSSION

In this investigation, we found three species which are rare in the Balkan Peninsula based on the number of known localities, according to the current knowledge (e.g. Malicky, 2015, 2019; Neu, Malicky, Graf, & Schmidt-Kloiber, 2018): *Rhyacophila bosnica, Tinodes kimminsi* and *Stenophylax permistus*.

Species of the genus *Rhyacophila* Pictet, 1834 are widespread in the holarctic region (Schmid, 1970) and are found frequently at the different river and stream segments in the Balkan Peninsula. *Rhyacophila bosnica* is an endemic species of Ecoregion 5 and 6 (Ibrahimi et al, 2012b; Graf, Kučinič, Previšič, Vučkovič, & Waringer, 2008). Previously this species was reported from epirhithral, metarhithral and hyporhithral zones (Graf et al, 2008) but during this investigation was also found in eucrenal and hypocrenal segments at S1 - Tanushë and S3 - Brodec. The microhabitat/substrate preferences for larvae of this species include macro-/megalithal and hygropetric habitats (Graf et al, 2008). It was recently reported for the first time from Kosovo (Ibrahimi et al, 2012b, 2014b). According to Fauna Europea (Malicky, 2019), it is also present in the Republic of North Macedonia, even though detailed revision of the literature data did not confirm this conclusion. Hence, in this study, *R.bosnica* is reported from the Republic of North Macedonia for the first time. During this study, we found new localities of this Balkan endemic species from Kosovo. It was only known from few localities in Albania, Kosovo, Bosnia and Herzegovina and Serbia previously (Marinković-Gospodnetić, 1980; Ibrahimi et al, 2012b, 2014a; Oláh, 2010) and thus, our study greatly expands its known distribution area. During this investigation, we noted for the first time a winter activity of the adult stage of *Rhyacophila bosnica*. Adults of this species were observed walking on the snow throughout early March at station S6 in Sharr Mountains, and most surprisingly during the beginning of February at station S2 Above Brodec. Several ripe pupae and one adult were noted at the beginning of February at station S1 Tanushë as well. Based on literature records, this species was known to emerge from March to July (Marinković-Gospodnetić, 1980; Oláh, 2010; Ibrahimi et al, 2012b, 2014b; Gashi, Ibrahimi, Grapci-Kotori, Sejdiu, & Bislimi, 2015). The peak of adult activity is during March and May, although significant adult activity was noted during the late spring and beginning of summer as well (Fig. 1). This makes *R. bosnica* one of the earliest emerging caddisfly species at the Balkans, based on several years' long observations and literature records as well (e.g. Radovanović, 1931; Marinković-Gospodnetić, 1980; Kumanski 1985; Kučinić, 2002; Wiberg-Larsen, 2008; Stanić-Koštroman, 2009; Vučkovič et al, 2011; Ibrahimi et al, 2012a, 2014b). This is apparently one of the rarest, if not the only, species of the genus *Rhyacophila* to be active during the cold months of the year, at least in Balkans. We are not aware of any other such literature record. Most of the winter active species of caddisflies in the area belong to the family Limnephilidae. In this study, we registered the lowest altitude for this species in its entire range (580 m in station S5). Previously the species was found exclusively at altitudes higher than 1000 m asl. This species seems to prefer cold and fast-flowing streams. Although located lower, station S5 resembles the other sampling stations of higher altitudes, since the river flow is very fast and

the water temperature is low. A side-spring located nearby station S5 contributes to the lower water temperature of this river segment as compared to the other parts of Lumbardhi i Pejës River in this area of low altitude. A similar case was noted earlier with *Drusus krusniki* Malicky, 1981, which is a typical high altitude species, but was found at the altitude of 580 m asl at station S5 (Ibrahimi et al, 2014b).

Stenophylax permistus is a widespread species in Europe, present in almost all ecoregions and usually found in hypocrenal, epirhithral and metarhithral zones (Graf et al, 2008). It was found in two localities in the Republic of North Macedonia during spring. Adults of this species can be found throughout the most of the year. It is quite frequent in some parts of Europe, while the number of localities is still low in the Western Balkans and especially in the area surrounding Kosovo and North Macedonia, according to the current knowledge (e.g. Neu et al, 2018). It is known from a single locality in Kosovo and was reported only a few years ago (Ibrahimi et al, 2016b).

The species of the family Psychomyiidae, *Tinodes kimminsi* was found with only a few specimens in one locality only in the Republic of North Macedonia (S2 Above Brodec) and is reported for the first time for this country. This species is present in the following countries: Albania, Austria, Bulgaria, Czech Republic, Germany, Greece, Poland, Slovakia, and Turkey (Malicky, 2019). Most of the occurrence records in Balkans, according to the current knowledge, are from Bulgaria (Neu et al, 2018).

This investigation contributes to the knowledge about the caddisfly fauna composition of the Karadak Mountains in Kosovo and the Republic of North Macedonia. With several first findings for the area, it proves that this mountainous massive is still under-investigated. The presented data could be useful for selecting the high conservation areas of the Karadak/Skopska Crna Gora Mountains where effective protection measures should be applied.

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Received: August 28, 2019 *Accepted: January 19, 2020*

J. Entomol. Res. Soc., 22(2): 163-190, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

Checklist of Turkish Tachinidae (Insecta, Diptera) with New Records

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ABSTRACT

A checklist of the Turkish Tachinidae, with a total of 341 species is presented for the first time. The subfamiliy Exoristinae, with 139 species, has the highest representativeness, while the other subfamilies, Tachininae, Phasiinae and Dexiinae, with 91, 63 and 48 species, respectively. Among them, eight species are newly recorded for the Turkish Tachinidae fauna. These species are *Exorista deligata* Pandellé, 1896, *Lecanipa leucomelas* (Meigen, 1824), *Lomachantha rufitarsis* Villeneuve, 1912, *Nowickia ferox* (Panzer, 1809), *Germaria ruficeps* (Fallén, 1820), *Solieria vacua* (Rondani, 1861), *Eriothrix argyreata* (Meigen, 1824) and *Opesia grandis* (Egger, 1860). The informative label data of newly recorded species was also provided.

Key words: Diptera, Tachinidae, checklist, new records, Turkey

Kara, K., Tschorsnig, H.-P., & Atay, T. (2020). Checklist of Turkish Tachinidae (Insecta, Diptera) with new records. *Journal of the Entomological Research Society*, 22(2), 163-190.

INTRODUCTION

The Tachinidae are among the largest families of Diptera with currently about 8540 known valid species worldwide and more than 2100 described species in the Palaearctic region (O'Hara, Henderson, & Wood, 2019). The family Tachinidae, comprising important biological control agents, has ecologic and economic importance in agriculture and forestry because all the species in this family act as parasitoids of insects and several other arthropods (Mellini, 1990; Stireman, O'Hara, & Wood, 2006). The most common hosts are larvae of Lepidoptera that feed on foliage, but tachinids also attack a range of other insect orders, especially Heteroptera (adults and nymphs), Coleoptera (larvae and adults) and Hymenoptera (Symphyta larvae) (Wood, 1987). However, the hosts of many tachinid species are still unknown. Herting (1960) provided details on the biology of West Palaearctic species. Other detailed information on West Palaearctic hosts can be found in Tschorsnig and Herting (1994), Kara & Tschorsnig (2003), Vaňhara, Tschorsnig, Herting, Mückstein, & Michalková (2009), and Cerretti and Tschorsnig (2010). Recently, the most comprehensive catalogue about Palaearctic hosts was prepared by Tschorsnig (2017). It comprises 827 tachinid species reared from 2672 arthropod hosts belonging to eleven insect orders and one chilopod order.

A few detailed researches have been carried out on determining hosts of tachinids in Turkey. The studies which have the largest scope are Doğanlar (1975), Kara (1998) and Atay (2011). In addition, Öncüer (1991) has prepared a parasite and predator catalogue of plant pests in Turkey and gives a separate chapter for tachinids. Kara & Tschorsnig (2003) and Kara, Atay, & Balkan (2014) have prepared a comprehensive catalogue containing tachinid/hosts couples identified in Turkey.

The Turkish tachinid fauna is not known in detail. The majority of the regions have not yet been studied. However, some important studies were provided (Doğanlar, 1982a; 1982b; Kara, 1999a; 1999b; 2001a; 2001b; Kara, 2002; Kara & Alaoğlu, 2002; Korkmaz, 2007; Kara, Korkmaz, & Kırıkoğlu, 2010; Atay & Kara 2014; Balkan, Kara, & Atay, 2015; Lekin, Kara, & Atay, 2016b; Atay, 2017). Finally, Lutovinovas et al (2018) listed 139 tachinid species from southwestern Turkey, 52 of them being the first new records for Turkey. Further investigations are necessary to understand the species diversity in Turkey. This checklist was compiled to provide a reference for future studies.

MATERIAL AND METHODS

This checklist of Turkish Tachinidae is based on records of both old and recent literature. All relevant papers from 1930 to 2019 have been examined. The arrangement and (mostly) the nomenclature of tachinids follows Herting & Dely-Draskovits (1993). For some records, O'Hara, Henderson, & Wood (2019) was taken as reference. Several errors in previous papers have been corrected. Particular emphasis is given to species whose type locality is Turkey. The new records were identified using the keys of Mesnil (1944-1965), Mesnil (1980), Tschorsnig and Herting (1994) and Tschorsnig and Richter (1998).

RESULTS

Subfamily Exoristinae (139 species)

Exorista amoena Mesnil, 1960: Özbek & Çoruh 2012.

Exorista larvarum (Linnaeus, 1758): Doğanlar, 1982a; Herting, 1983b; Kansu, Kılınçer, Uğur, & Gürkan, 1986; Çobanoğlu, 1994; Tuncer & Ecevit, 1996; Tschorsnig & Herting, 1997; Kara, 1998; Anay, 2000; Kara & Özdemir, 2000; Tschorsnig, 2005; Kara, Gözüaçık, & Mart, 2007; Korkmaz 2007; Kaya & Kornoşor, 2008; Gözüaçık, Mart, & Kara, 2009; Özbek & Çoruh, 2012; Lutovinovas et al, 2018.

Exorista rossica Mesnil, 1960: Doğanlar, 1975; 1982a; Herting, 1983b; Herting & Dely-Draskovits, 1993; Kılıç & Alaoğlu, 1996; Kara & Alaoğlu, 2001; Sertkaya & Bayram, 2005.

Exorista segregata (Rondani, 1859): Schimitschek, 1944; Herting, 1960; 1983b; Gürses, 1975; Doğanlar, 1982a; Herting, 1983b; Kılıç & Alaoğlu, 1996; Kansu et al, 1986; Kara & Alaoğlu, 2001; Avcı & Kara, 2002; Avcı & Oğurlu, 2002; Mückstein, Tschorsnig, & Vaňhara, 2004; Tschorsnig, 2005; Avcı, 2009; Akdağcık, 2010; Bartsch & Tschorsnig, 2010; Atay, 2011; Özbek & Çoruh, 2012; Atay & Kara, 2014; Lutovinovas et al, 2018.

Exorista sorbillans (Wiedemann, 1830): Çobanoğlu, 1994.

Exorista nova (Rondani, 1859): Herting, 1989; Mückstein et al, 2004; Kara, 2001a; Lutovinovas et al, 2018.

Exorista civilis (Rondani, 1859): Balkan et al, 2015; Lutovinovas et al, 2018.

Exorista deligata Pandellé, 1896

Material examined: Bartın: Amasra-Merkez, 41°44'01"N, 32°25'14"E, 266 m, 19.07. 2012, 1♂, leg. T.ATAY, **Kastamonu**: Cide - Koçlar, 41°56'14"N, 33°06'49"E, 295 m, 19.07. 2012, 1♂, leg. T.ATAY.

This tachinid is recorded for the first time from Turkey.

Exorista kugleri Mesnil, 1960: Lutovinovas et al, 2018.

Exorista xanthaspis (Wiedemann, 1830): Steiner, 1937; Kansu, 1955; Doğanlar, 1975; Efil & Kara, 2004; Gözüaçık & Mart, 2009; Gözüaçık et al, 2009.

Exorista mimula (Meigen, 1824): Kara & Alaoğlu, 2002; Balkan et al, 2015.

Exorista rendina Herting, 1975: Aydın, 1997.

Exorista rustica (Fallén, 1810): Steiner, 1937; Kara, 2001b; Kara & Alaoğlu, 2002; Korkmaz, 2007; Lutovinovas et al, 2018.

Chetogena acuminata Rondani, 1859: Kara, 1998; Kara & Özdemir, 2000; Kara & Alaoğlu, 2001; Aksu, 2005; Lutovinovas et al, 2018.

Chetogena nigrofasciata (Strobl, 1902): Herting, 1987.

Chetogena obliquata (Fallén, 1810): Kara, 2001a; Robertson & Shaw, 2012.

Diplostichus janitrix (Hartig, 1837): Tunca, Kara, & Özkan, 2009.

Phorocera assimilis (Fallén, 1810): Lutovinovas et al, 2018.

Phorocera grandis (Rondani, 1859): Kara, 2001a; Lutovinovas et al, 2018.

Bessa parallela (Meigen, 1824): Kansu et al, 1986; Erol & Yaşar, 1996; Kara, 1998; Kara & Özdemir, 2000.

Bessa selecta (Meigen, 1824): Robertson & Shaw, 2012.

Belida angelicae (Meigen, 1824): Atay, Kara, & Özdemir, 2015; Lutovinovas et al, 2018.

Meigenia dorsalis (Meigen, 1824): Lutovinovas et al, 2018.

Meigenia incana (Fallén, 1810): Balkan, 2014; Balkan et al, 2015.

Meigenia mutabilis (Fallén, 1810): Doğanlar, 1982a; Kara, 1998; Kara, 2001b; Atay, 2018; Lutovinovas et al, 2018.

Meigenia simplex Tschorsnig & Herting, 1998: Tschorsnig & Herting, 1998; Atay, 2011; Atay & Kara, 2014; Balkan, 2014; Balkan et al, 2015; Kara & Atay, 2015.

Conogaster pruinosa (Meigen, 1824): Doğanlar, 1982a.

Zaira cinerea (Fallén, 1810): Doğanlar, 1982a; Lutovinovas et al, 2018.

Medina luctosa (Meigen, 1824): Lutovinovas et al, 2018.

Medina melania (Meigen, 1824): Kara et al, 2010.

Medina separata (Meigen, 1824): Çoruh & Kara, 2011.

Istocheta longicornis (Fallén, 1810): Lutovinovas et al, 2018.

Lecanipa leucomelas (Meigen, 1824)

Material examined: Kastamonu: Azdavay - Alacık, 41°44'48"N, 33°28'07"E, 806 m, 18.07.2012, 3♂, leg. T.ATAY.

This tachinid is recorded for the first time from Turkey.

Oswaldia muscaria (Fallén, 1810): Lekin, 2014; Lekin, Atay, & Kara, 2016a.

Lomachantha rufitarsis Villeneuve, 1912

Material examined: Van: Çatak, 16.07. 2002, 1♂, leg. K.KARA.

This tachinid is recorded for the first time from Turkey.

Ligeria angusticornis (Loew, 1847): Lutovinovas et al, 2018.

Blondelia nigripes (Fallén, 1810): Doğanlar, 1982a; Herting, 1983b; Atay, 2011; Atay & Kara, 2014; Lutovinovas et al, 2018.

Blondelia pinivorae (Ratzeburg, 1844): Bergström & Bystrowski, 2011.

Remarks: Turkish specimens reared from the cedar processionary moth *Thaumetopoea* [=*Traumatocampa*] *ispartaensis* Doğanlar & Avcı, 2001, published as *Blondelia nigripes* by Avcı & Kara (2002), turned out to be *B. pinivorae* after revision of Bergström & Bystrowski (2011).

Blondelia angusticornis Herting, 1987: Herting 1987. - Type locality: Hakkari-Sat Mountain.

Compsilura concinnata (Meigen, 1824): Tuatay, Kalkandelen, & Aysev Çağatay, 1972; Öncüer, Yalçın, & Erkin, 1977; Doğanlar, 1982a; Kansu et al, 1986; Eroğlu, 1995; Kılıç & Alaoğlu, 1996; Tuncer & Ecevit, 1996; Tschorsnig & Herting, 1997; Kara, 1998; Kovancı, Gencer, & Kaya, 1999; Kara & Özdemir, 2000; Oğurlu, 2000; Kara, 2001b; Kara & Alaoğlu, 2001; Avcı & Oğurlu, 2002; Avcı & Kara, 2002; Aksu, 2005; Tschorsnig, 2005; Kaya & Kornoşor, 2008; Avcı, 2009; Akdağcık, 2010; Atay, 2011; Sullivan & Ozman-Sulllivan, 2012; Sullivan, Karaca, Ozman-Sulllivan, & Kara, 2012; Atay & Kara, 2014; Balkan, 2014; Balkan et al, 2015; Kaya, Cengiz, Çalışkan, & Çalışkan, 2016; Lutovinovas et al, 2018; Tek & Okyar, 2018.

Vibrissina turrita (Meigen, 1824): (Yıldız, 2018).

Acemya acuticornis (Meigen, 1824): Kara et al, 2010; Atay, 2017.

Acemya fishelsoni Kugler, 1968: Herting, 1985.

Acemya rufitibia (Von Roser, 1840): Lutovinovas et al, 2018.

Ceracia mucronifera Rondani, 1865: Lutovinovas et al, 2018.

Metacemyia calloti (Séguy, 1936): Öncüer, 1991; Lutovinovas et al, 2018.

Paratryphera barbatula (Rondani, 1859): Özdemir, 1981; Çanakçıoğlu, 1993; Kara, 1998; Melan & Kara, 2004; Lutovinovas et al, 2018.

Atylomyia loewii Brauer, 1898: Lutovinovas et al, 2018.

Smidtia amoena (Meigen, 1824): Lutovinovas et al, 2018.

Winthemia cruentata (Rondani, 1859): Lutovinovas et a, 2018.

Winthemia pilosa (Villeneuve, 1910): Kara, 2001a.

Winthemia quadripustulata (Fabricius, 1794): Atay et al, 2015; Lutovinovas et al, 2018.

Nemorilla floralis (Fallén, 1820): Zeki, Özdem, & Bozkurt, 1999; Kara & Alaoğlu, 2002; Lutovinovas et al, 2018; Tek & Okyar, 2018.

Nemorilla maculosa (Meigen, 1824): Kavut, Dinçer, & Karman, 1974; Doğanlar, 1982a; Herting, 1983b; Yabaş & Zeren, 1987; Avcı & Özbek, 1990; Çanakçıoğlu, 1993; Aydın, 1997; Kara & Özdemir, 2000; Kara, 2001b; Efil & Kara, 2004; Lutovinovas et al, 2018.

Aplomya confinis (Fallén, 1820): Kara & Alaoğlu, 2002; Bolu & Çınar, 2005; Bolu & Kara, 2006; Kara & Aksu, 2007; Korkmaz, 2007; Lutovinovas et al, 2018.

Phebellia nigripalpis (Robineau-Desvoidy, 1847): Lutovinovas et al, 2018.

Nilea anatolica Mesnil, 1954: Doğanlar, 1975, 1982a; Herting & Dely-Draskovits, 1993. - Type locality: Akşehir-Konya.

Epicampocera succincta (Meigen, 1824): Kara, 2001b; Kara & Alaoğlu, 2002; Aksu, 2005; Korkmaz, 2007; Atay, 2017.

Buquetia musca Robineau-Desvoidy, 1847: Kara & Tschorsnig, 2003.

Phryxe caudata (Rondani, 1859): Tosun, 1977; Soydanbay, 1978; Herting, 1983b; Avcı & Kara, 2002; Avcı & Oğurlu, 2002; Kanat & Türk, 2002; Özdal, 2002; Özçankaya

& Can, 2004; Atay, 2011; Atay & Kara, 2014; Battisti et al, 2015; Lutovinovas et al, 2018.

Phryxe magnicornis (Zetterstedt, 1838): Kara & Özdemir, 2000; Kara, 2001b; Kaya & Kornoşor, 2008.

Phryxe prima (Brauer et Bergenstamm, 1889): Ford, Shaw, & Robertson, 2000; Korkmaz, 2007.

Phryxe vulgaris (Fallén, 1810): Tuatay et al, 1972; Öncüer et al, 1977; Tosun, 1977; Uzun, 1987; Avcı & Özbek, 1990; Tschorsnig & Herting, 1997; Kara, 1998; Atay, 2011; Atay & Kara, 2014; Kara & Özdemir, 2000; Lutovinovas et al, 2018.

Gymnophryxe inconspicua (Villeneuve, 1924): Rauther, 1930; Herting, 1983b; Herting & Dely-Draskovits, 1993.

Periarchiclops scutellaris (Fallén, 1820): Kara, 2001a.

Pseudoperichaeta nigrolineata (Walker, 1853): Çanakcıoğlu, 1959; Özdemir, 1981; Herting, 1985; Herting & Tschorsnig, 1993; Kara, 1998; Melan & Kara, 2004; Lutovinovas et al, 2018.

Pseudoperichaeta palesioidea (Robineau-Desvoidy, 1830): Zeki et al, 1999; Kara & Alaoğlu, 2002; Özbek, 2008; Tozlu & Çoruh, 2011; Atay, 2017; Lutovinovas et al, 2018.

Lydella grisescens Robineau-Desvoidy, 1830: Kara & Alaoğlu, 2002.

Lydella thompsoni Herting, 1959: Özdemir, 1981; Kayapınar & Kornoşor, 1992; Herting & Tschorsnig, 1993; Kara & Özdemir, 2000; Melan & Kara, 2004; Lutovinovas et al, 2018.

Amphicestonia dispar Villeneuve, 1939: Kara, 2001a; Lutovinovas et al, 2018.

Chetina setigena (Rondani, 1861): Kara, 2001a; Korkmaz, 2007; Lutovinovas et al, 2018.

Cadurciella tritaeniata (Rondani, 1859): Kara, 2001b; Lutovinovas et al, 2018.

Drino atropivora (Robineau-Desvoidy, 1830): Bolu, Kara, Zirek, & Özaslan, 2015; Lutovinovas et al, 2018.

Drino galii (Brauer et Bergenstamm, 1891): Herting, 1984; Herting & Dely-Draskovits, 1993; Bayram, 1999; Lutovinovas et al, 2018.

Drino gilva (Hartig, 1837): Doğanlar, 1982a; Tunca et al, 2009.

Drino imberbis (Wiedemann, 1830): Doğanlar, 1975, 1982a; Herting, 1983b; Avcı & Özbek, 1990; Herting & Dely-Draskovits, 1993; Kara & Özdemir, 2000; Kara & Alaoğlu, 2001; Efil & Kara, 2004; Gözüaçık et al, 2009.

Drino inconspicua (Meigen, 1830): Steiner, 1937; Schimitschek, 1944; Doğanlar, 1975; 1982a; Herting, 1983b; Tschorsnig, 2005; Korkmaz, 2007; Avcı, 2009; Akıncı & Avcı, 2016; Lutovinovas et al, 2018.

Drino triplaca Herting, 1979: Herting, 1979.

Drino vicina (Zetterstedt, 1849): Doğanlar, 1982a; Aksu, 2005.

Carcelia bombylans Robineau-Desvoidy, 1830: Lutovinovas et al, 2018.

Carcelia dubia (Brauer et Bergenstamm, 1891): Herting, 1984; Herting & Dely-Draskovits, 1993; Lutovinovas et al, 2018. - Type locality: Bursa

Carcelia gnava (Meigen, 1824): Kara & Alaoğlu, 2002.

Carcelia iliaca (Ratzeburg, 1840): Avcı & Kara, 2002.

Carcelia laxifrons Villeneuve, 1912: Kara & Özdemir, 2000.

Carcelia lucorum (Meigen, 1824): Lutovinovas et al, 2018.

Senometopia separata (Rondani, 1859): Kansu, 1955; Doğanlar, 1975, 1982a; Herting, 1983b; Kara, 1998; Atay, 2011; Atay & Kara, 2014.

Thecocarcelia acutangulata (Macquart, 1850): Lutovinovas et al, 2018.

Erycia fasciata Villeneuve, 1924: Bayram & Kara, 1998; Aksu, 2005; Atay, 2017; Lutovinovas et al, 2018.

Erycia festinans (Meigen, 1924): Tek & Okyar, 2017.

Erycesta caudigera (Rondani, 1861): Lutovinovas et al, 2018.

Alsomyia olfaciens (Pandellé, 1896): Ford et al, 2000.

Townsendiellomyia nidicola (Townsend,1908): Kansu, 1955; Gürses, 1975; Öncüer et al, 1977; Öncüer, Yalçın, & Erkin, 1978; Doğanlar, 1982a; Herting, 1983b, 1984; Kansu et al, 1986; Herting & Dely-Draskovits, 1993; Kara, 1998; Tschorsnig & Herting, 1997; Tschorsnig, 2005; Atay, 2011; Atay & Kara, 2014; Lutovinovas et al, 2018.

Platymya antennata (Brauer et Bergenstamm, 1891): Lutovinovas et al, 2018.

Platymya fimbriata (Meigen, 1824): Lutovinovas et al, 2018.

Eumea linearicornis (Zetterstedt, 1844): Aydoğdu, 2014.

Myxexoristops blondeli (Robineau-Desvoidy, 1830): Doğanlar, 1982a.

Zenillia dolosa (Meigen, 1824): Kara, 2002.

Zenillia libatrix (Panzer, 1798): Soydanbay, 1976; Öncüer et al, 1978; Kansu et al, 1986; Tschorsnig & Herting, 1997; Kara, 1998; Lutovinovas et al, 2018.

Clemelis pullata (Meigen, 1824): Kara & Alaoğlu, 2002; Aksu, 2005; Atay, 2017; Lutovinovas et al, 2018.

Ceratochaetops triseta (Villeneuve, 1922): Kara, 2001a.

Pales pavida (Meigen, 1824): Acatay, 1959a; Doğanlar, 1975, 1982a; Herting 1983b; Çanakçıoğlu, 1993; Tuncer & Ecevit, 1996; Tschorsnig & Herting, 1997; Kara, 1998; Kara & Özdemir, 2000; Kara, 2001b; Cerretti, 2005; Tschorsnig, 2005; Avcı, 2009; Özbek & Çalmaşur, 2010; Atay, 2011; Özbek & Çoruh, 2012; Robertson & Shaw, 2012; Atay & Kara, 2014; Balkan, 2014; Balkan et al, 2015; Lekin, 2014; Lekin et al, 2016b; Lutovinovas et al, 2018.

Pales processioneae Ratzeburg, 1840: Herting & Dely-Draskovits, 1993; Avcı & Kara, 2002; Cerretti, 2005.

Phryno vetula (Meigen, 1824): Doğanlar, 1982a; Aksu, 2005; Lutovinovas et al, 2018.

Ceromasia rubrifrons (Macquart, 1834): Kara & Alaoğlu, 2002.

Allophorocera ferruginea (Meigen, 1824): Kara et al, 2010.

Ocytata pallipes (Fallén, 1820): Lutovinovas et al, 2018.

Pexopsis aprica (Meigen, 1824): Lutovinovas et al, 2018.

Erythrocera nigripes (Robineau-Desvoidy, 1830): Kara, 2001b; Aksu, 2005.

Cadurcia casta (Rondani, 1861): Özdemir, 1981; Ulu, 1983; Herting & Dely-Draskovits, 1993.

Ramonella mesnili (Kugler, 1980): Herting & Dely-Draskovits, 1993.

Eurysthaea scutellaris (Robineau-Desvoidy, 1848): Gençer & Doğanlar, 1996; Kara, 1998; Gençer, 2003.

Erynnia ocypterata (Fallén, 1810): Herting, 1983b.

Elodia morio (Fallén, 1810): Kansu et al, 1986; Çanakçıoğlu, 1993.

Elodia atricans (Herting, 1975): Herting & Tschorsnig, 1986.

Sturmia bella (Meigen, 1824): Herting, 1960; Doğanlar, 1975; Atak & Atak, 1984; Kara, 1998; Balkan, 2014; Balkan et al, 2015; Lutovinovas et al, 2018.

Blepharipa pratensis (Meigen, 1824): Doğanlar, 1982a; Kara, 2001a; Korkmaz, 2007; Lutovinovas et al, 2018.

Blepharipa schineri (Mesnil, 1939): Lutovinovas et al, 2018.

Masicera pavoniae (Robineau-Desvoidy, 1830): Schimitschek, 1944; Herting & Dely-Draskovits, 1993.

Masicera sphingivora (Robineau-Desvoidy, 1830): Tuatay et al, 1972; Doğanlar, 1975, 1982a; Gürses, 1975; Herting, 1984; Herting & Dely-Draskovits, 1993; Tschorsnig & Herting, 1997; Kara, 1998; Bayram, 1999; Kara & Özdemir, 2000; Tschorsnig, 2005; Bartsch & Tschorsnig, 2010; Atay, 2011; Özbek & Çoruh, 2012; Atay & Kara, 2014; Lutovinovas et al, 2018.

Dolichocolon paradoxum Brauer et Bergenstamm, 1889: Lutovinovas et al, 2018.

Palesisa maculosa (Villeneuve, 1936): Efil & Kara, 2004.

Palesisa nudioculata Villeneuve, 1929: Gürses, 1975; Öncüer et al, 1977, 1978; Soydanbay, 1976; Doğanlar, 1982a; Herting, 1983b; 1984; Herting & Dely-Draskovits, 1993; Kara & Özdemir, 2000; Tschorsnig, 2005; Atay, 2011; Özbek & Çoruh, 2012; Atay & Kara, 2014; Lutovinovas et al, 2018.

Hebia flavipes Robineau-Desvoidy, 1851: Lutovinovas et al, 2018.

Thelymorpha marmorata (Fabricius, 1805): Doğanlar, 1975, 1982a; Herting, 1983b; Atay, 2011; Atay & Kara, 2014.

Brachychaeta petiolata Mesnil, 1953: Lutovinovas et al, 2018.

Gonia asiatica (Rohdendorf, 1928): Herting & Dely-Draskovits, 1993.

Gonia atrata Bischof, 1906: Herting & Dely-Draskovits, 1993. - Type locality: Erciyes Mountain-Kayseri.

Gonia bimaculata Widemann, 1819: Tuatay et al, 1972; Kavut et al, 1974; Doğanlar, 1982a; Gözüaçık et al, 2009; Lutovinovas et al, 2018.

Gonia maculipennis Egger, 1862: Doğanlar, 1982a; Herting & Dely-Draskovits, 1993. - Type localities: Hungary and Turkey.

Gonia olgae (Rohdendorf, 1927): Herting & Dely-Draskovits, 1993.

Gonia ornata Meigen, 1826: Tuatay et al, 1972; Doğanlar, 1982a; Herting & Dely-Draskovits, 1993; Aksu, 2005.

Gonia picea (Robineau-Desvoidy, 1830): Kara & Bayram, 1999; Sertkaya & Bayram, 2005; Lutovinovas et al, 2018.

Pseudogonia rufifrons (Wiedemann, 1830): Kara, 2001a; Sertkaya & Bayram, 2005; Gözüaçık et al, 2009; Atay, 2017.

Pseudogonia parisiaca (Robineau-Desvoidy, 1851): Aksu, 2005.

Spallanzania hebes (Fallén, 1820): Doğanlar, 1982a; Balkan, 2014; Balkan et al, 2015; Lutovinovas et al, 2018.

Spallanzania multisetosa (Rondani, 1859): Aksu, 2005.

Spallanzania quadrimaculata Herting, 1967: Aksu, 2005.

Spallanzania griseiventris Herting, 1967: Kara & Aksu, 2007.

Spallanzania rectistylum (Macquart, 1847): Lutovinovas et al, 2018.

Subfamily: Tachininae (91 species)

Tachina grossa (Linnaeus, 1758): Kara & Aksu, 2008.

Tachina corsicana (Villeneuve, 1931): Herting & Dely-Draskovits, 1993.

Tachina fera (Linnaeus, 1761): Doğanlar, 1982b; Kara, 1999a; Korkmaz, 2007; Lekin, 2014; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Tachina magnicornis (Zetterstedt, 1844): Steiner, 1937; Bodenheimer, 1958; Kavut et al, 1974; Doğanlar, 1975, 1982b; Kara, 1999a; Kara & Özdemir, 2000; Kaya & Kovancı, 2000; Gürkan, 2010; Korkmaz, 2007; Lekin, 2014; Balkan, 2014; Balkan et al, 2015; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Tachina nupta (Rondani, 1859): Kara, 1999a.

Tachina lurida (Fabricius, 1781): Lutovinovas et al, 2018.

Tachina praeceps Meigen, 1824: Doğanlar, 1975, 1982b; Gürses, 1975; Öncüer et al, 1977; Herting, 1983b; Kansu et al, 1986; Kara, 1999a; Kara & Özdemir, 2000; Mückstein et al, 2004; Özbek & Çoruh, 2012; Lutovinovas et al, 2018.

Nowickia atripalpis (Robineau-Desvoidy, 1863): Doğanlar, 1975.

Nowickia ferox (Panzer, 1809)

Material examined: Eskişehir: Sarıcakaya, 09.07. 2003, 2♂♂, leg. S.AKSU.

This tachinid is recorded for the first time from Turkey.

Nowickia rondanii (Giglio-Tos, 1890): Atay et al, 2015.

Tachina danilewskyi (Portschinsky, 1882) (Portschinsky, 1882): Herting & Dely-Draskovits, 1993; Kara & Aksu, 2007.

Peleteria abdominalis (Robineau-Desvoidy, 1830): Mesnil, 1944-1975.

Peleteria rubescens (Robineau-Desvoidy, 1830): Doğanlar, 1975; Kara, 1999a; Khan & Özer, 1984; Kansu et al, 1986; Kara & Özdemir, 2000; Korkmaz, 2007; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b.

Peleteria iavana (Wiedemann, 1819): Kara, 2001b; Lekin, 2014; Lekin et al, 2016b.

[***Copecrypta ruficauda*** (Van der Wulp, 1867): Herting & Dely-Draskovits, 1993.]

Remark: Herting 1984: 94 states “locality probably wrong” because this species is Nearctic. Unfortunately Herting’s note was not included again by Dely-Draskovits when she rewrote Herting’s 1984 paper.

Germaria hermonensis Kugler, 1980: Kara, 1999a.

Germaria nudinerva (Mesnil, 1963): Ziegler, 2015.

Germaria ruficeps (Fallén, 1820)

Material examined: Eskişehir: Tepebaşı (Gökçekısık), 12.09.2003, 2♀♀, leg. S.AKSU.

This tachinid is recorded for the first time from Turkey.

Germaria obscuripennis Tschorsnig, 2000: Tschorsnig, 2000. - Type locality: Ilgaz-Çankiri, reared from *Bembecia scopigera* Scopoli (Lepidoptera, Sesiidae).

Germaria graeca (Brauer & Bergenstamm, 1889): Ziegler, 2010.

Nemoraea pellucida (Meigen, 1824): Doğanlar, 1982b; Herting, 1985; Tschorsnig, 2005; Tuncer & Ecevit, 1996; Sullivan et al, 2012; Sullivan & Ozman-Sulllivan, 2012; Balkan, 2014; Balkan et al, 2015; Lutovinovas et al, 2018.

Linnaemya comta (Fallén, 1810): Kavut et al, 1974; Doğanlar, 1982b; Kara, 1999a; Balkan, 2014; Balkan et al, 2015; Atay, 2017; Lutovinovas et al, 2018.

Linnaemya neavei Curran, 1934: Kara et al, 2007; Gözüaçık et al, 2009; Lutovinovas et al, 2018.

Linnaemyia vulpina (Fallén, 1810): Sertkaya & Bayram, 2005; Kara & Aksu, 2007; Korkmaz, 2007; Lutovinovas et al, 2018.

Linnaemya impudica (Rondani, 1859): Doğanlar, 1982b; Lekin, 2014; Lekin et al, 2016b.

Linnaemya fissiglobula Pandellé, 1895: Kara, 2001a.

Linnaemya olsufjevi Zimin, 1954: Kansu et al, 1986; Kara & Özdemir, 2000.

Linnaemya pentheri (Bischof, 1906): Herting & Dely-Draskovits, 1993. - Type locality: Erciyes Mountain-Kayseri.

Lydina aenea (Meigen, 1824): Lutovinovas et al, 2018.

Lypha dubia (Fallén, 1810): Lutovinovas et al, 2018.

Petagnia occlusa Rondani, 1856: Herting & Dely-Draskovits, 1993.

Panzeria fucosa (Mesnil, 1975): Herting & Dely-Draskovits, 1993.

Zophomyia temula (Scopoli, 1763): Kara, 1999a.

Sonaca moderata (Herting, 1979): Herting, 1979.

Cleonice callida (Meigen, 1824): Kara, 1999a.

Loewia brevifrons (Rondani, 1856): Herting, 1984; Herting & Dely-Draskovits, 1993; Kara, 1999a; Lutovinovas et al, 2018.

Loewia crassipes (Mesnil, 1953): Bystrowski, 2011; Lutovinovas et al, 2018.

Loewia phaeoptera (Meigen, 1824): Kara, 2001b.

Loewia papei Cerretti, Giudice & O'Hara, 2014: Cerretti, Giudice, & O'Hara, 2014; Lutovinovas et al, 2018. – Type locality: Kovada Gölü-Isparta.

Macquartia praefica (Meigen, 1824): Kara, 1999a.

Macquartia tenebricosa (Meigen, 1824): Kara, 1999a, 2001b; Anay, 2000; Korkmaz, 2007; Atay, 2018; Lutovinovas et al, 2018.

Macquartia tessellum (Meigen, 1824): Doğanlar, 1982b; Kara, 1999a; Lutovinovas et al, 2018.

Macquartia chalconota (Meigen, 1824): Kara, 2001b; Sahebari, Khaghaninia, & Ziegler, 2013; Lekin, 2014; Lekin et al, 2016b; Atay, 2017.

Anthomyiopsis plagioderae (Mesnil, 1972): Atay, 2011; Kara & Atay, 2015.

Triarthria setipennis (Fallén, 1810): Lutovinovas et al, 2018.

Trichactia pictiventris (Zetterstedt, 1855): Lutovinovas et al, 2018.

Trichactia meridiana Ziegler & Gilasian, 2018: Gilasian et al, 2018.

Neaera atra Robineau-Desvoidy, 1850: Herting & Dely-Draskovits, 1993.

Neaera laticornis (Meigen, 1824): Kara, 1999a.

Neoplectops pomonellae (Schnabl et Mokrzecki, 1903): İren, 1952; Çakıllar & Nizamlioğlu, 1953; Bodenheimer, 1958; Acatay, 1959b; Tuatay et al, 1972; Herting & Dely-Draskovits, 1993.

Phytomyptera nigrina (Meigen, 1824): Çakıllar, 1959; Önçağ, 1975; Doğanlar & Döken, 1985.

Phytomyptera cingulata (Robineau-Desvoidy, 1830): Lutovinovas et al, 2018.

Graphogaster vestita Rondani, 1868: Kara et al, 2010; Lutovinovas et al, 2018.

Ceromya bicolor (Meigen, 1824): Lutovinovas et al, 2018.

Ceromya dorsigera Herting 1967: Lutovinovas et al, 2018.

Actia crassicornis (Meigen, 1824): Çanakcıoğlu, 1993.

Actia infantula (Zetterstedt, 1844): Lutovinovas et al, 2018.

Actia pilipennis (Fallén, 1810): Çanakcıoğlu, 1993.

Actia resinellae (Schrank, 1781): Çanakcıoğlu, 1993.

Peribaea apicalis Robineau-Desvoidy, 1863: Lutovinovas et al, 2018.

Peribaea tibialis (Robineau-Desvoidy, 1851): Anay, 2000; Kara, 2001b; Korkmaz, 2007; Lekin, 2014; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Ceranthia impropria Herting, 1987: Herting, 1987. - Type locality: Sat Mountain-Hakkari.

Siphona pauciseta Rondani, 1865: Lutovinovas et al, 2018.

Siphona rossica Mesnil, 1961: Andersen, 1996.

Siphona pilistyla Andersen, 1996: Andersen, 1996.

Aphria longirostris (Meigen, 1824): Atay et al, 2015.

Prodemoticus orientalis Villeneuve, 1919: Herting & Dely-Draskovits, 1993.

Bithia acanthophora (Rondani, 1861): Herting & Dely-Draskovits, 1993.

Bithia ancyrensis (Villeneuve, 1942): Herting & Dely-Draskovits, 1993. - Type locality: Ankara.

Bithia demotica (Egger, 1861): Kara & Aksu, 2007.

Bithia immaculata (Herting, 1971): Doğanlar, 1982b; Kara, 1999a; Korkmaz, 2007.

Bithia modesta (Meigen, 1824): Doğanlar, 1982b; Korkmaz, 2007; Atay, 2017; Lutovinovas et al, 2018.

Bithia maculifacies Tschorsnig & Kara 2002: Tschorsnig & Kara, 2002. – Type locality: Çamlıbel-Tokat.

Leskia aurea (Fallén, 1820): Kara & Özdemir, 2000; Kara, 2001a.

Leskia erevanica Richter, 1974: Kara & Aksu, 2008.

Solieria fenestrata (Meigen, 1824): Kara, 1999b.

Solieria vacua (Rondani, 1861)

Material examined: Kastamonu: Şenpazar - Dağlı, 41°46'59"N, 33°08'20"E, 678 m, 20.09.2012, 1♂, leg.T.ATAY.

This tachinid is recorded for the first time from Turkey.

Clausicella puella (Rondani, 1861): Kara 2002; Lutovinovas et al, 2018.

Clausicella suturata Rondani, 1859: Lutovinovas et al, 2018.

Mintho rufiventris (Fallén, 1817): Ertürk, 1963; Doğanlar, 1982b; Herting, 1983b; Herting & Tschorsnig, 1993; Kara, 1999a; Lutovinovas et al, 2018.

Minthodes brevipennis Brauer et Bergenstamm, 1889: Herting & Dely-Draskovits, 1993; Kara & Aksu, 2007. - Type locality: Amasya.

Minthodes diversipes (Strobl, 1899): Herting, 1984; Herting & Dely-Draskovits, 1993; Lutovinovas et al, 2018.

Minthodes pictipennis Brauer et Bergenstamm, 1889: Herting & Dely-Draskovits, 1993. - Type locality: Bursa.

Minthodes atra (Kugler, 1971): Gilasian, Ziegler, & Araghi, 2016.

Minthodes latifacies Herting, 1983: Gilasian et al, 2016; Lutovinovas et al, 2018.

Minthodes transiens Herting, 1987: Herting, 1987. - Type locality: Sat Mountain-Hakkari.

Minthodes simulans Herting, 1987: Herting, 1987. - Type locality: Sat Mountain-Hakkari.

Palmonia hermonensis Kugler, 1972: Lutovinovas et al, 2018.

Ziminia masiceraeformis (Portschinsky, 1881): Doğanlar ,1982b.

Microphthalma europaea Egger, 1860: Karagöz, Aksu, Gözüaçık, & Kara, 2011; Balkan, 2014; Balkan et al, 2015; Lutovinovas et al, 2018.

Melisoneura leucoptera (Meigen, 1824): Lutovinovas et al, 2018.

Therobia leonidei (Mesnil, 1965): Lehmann, 1998.

Subfamily: Dexiinae (48 species)

Billaea adelpha (Loew, 1873): Kara, 2001a.

Billaea irrorata (Meigen, 1826): Özbek, Tozlu, & Çoruh, 2009.

Dinera carinifrons (Fallén, 1817): Doğanlar, 1982b; Ziegler, Lutovinovas, & Zhang, 2016.

Dinera ferina (Fallén, 1817): Lekin, 2014; Lekin et al, 2016a.

Dinera fuscata occidentalis Ziegler, 2016: Ziegler et al, 2016.

Estheria acuta (Portschinsky, 1881): Herting & Dely-Draskovits, 1993; Cerretti & Tschorsnig, 2012; Atay, 2017.

Estheria nigripes (Villeneuve, 1920): Herting, 1984; Öncüer, 1991; Herting & Dely-Draskovits, 1993; Cerretti & Tschorsnig, 2012; Lutovinovas et al, 2018.

Estheria pallicornis (Loew, 1873): Herting & Dely-Draskovits, 1993; Cerretti & Tschorsnig, 2012.

Estheria picta (Meigen, 1826): Doğanlar, 1982b.

Dexia rustica (Fabricius, 1775): Lekin, 2014; Sahebari, Khaghaninia, & Ziegler, 2014; Lekin et al, 2016a; Lutovinovas et al, 2018.

Prosena siberita (Fabricius, 1775): Kara, 2001a; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b.

Zeuxia cinerea Meigen, 1826: Kara, 1999b; Richter, Gültekin, & Korotyaev, 2002; Kara & Aksu, 2007; Korkmaz, 2007; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Zeuxia erythraea (Egger, 1856): Doğanlar, 1982b.

Zeuxia roederi (Villeneuve, 1932): Herting & Dely-Draskovits, 1993.

Zeuxia subapennina Rondani, 1862: Kara, 1999b; Lutovinovas et al, 2018.

Zeuxia tricolor (Portschinsky, 1881): Herting, 1984; Herting & Dely-Draskovits, 1993; Kara, 1999b; 2001b; Kara & Aksu, 2007; Lekin, 2014; Lekin et al, 2016b.

Zeuxia zejana Kolomiets, 1971: Herting & Dely-Draskovits, 1993; Tozlu & Kara, 2007.

Eriothrix apennina (Rondani, 1862): Doğanlar, 1982b; Kara, 2001b.

Eriothrix argyreata (Meigen, 1824)

Material examined: Van: Çatak, 16.07. 2002, 2♂♂, leg. K.KARA.

This tachinid is recorded for the first time from Turkey.

Eriothrix prolixa (Meigen, 1824): Kara, 1999b; Lutovinovas et al, 2018.

Eriothrix rufomaculata (De Geer, 1776): Doğanlar, 1982b; Kara, 1999b; Korkmaz, 2007; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b; Lutovinovas et al, 2018.

Campylocheta inepta (Meigen, 1824): Lutovinovas et al, 2018.

Campylocheta latigena Mesnil, 1974: Lutovinovas et al, 2018.

Campylocheta praecox (Meigen, 1824): Lutovinovas et al, 2018.

Blepharomyia pagana (Meigen, 1824): Lutovinovas et al, 2018.

Periscepsia carbonaria (Panzer, 1798): Kavut et al, 1974; Khan & Özer, 1984; Kansu et al, 1986; Bayram, 1987; Bayram & Kılınçer, 1987, 1991; Kara & Özdemir, 2000; Kara & Aksu, 2007; Lekin, 2014; Lekin et al, 2016b.

Wagneria cunctans (Meigen, 1824): Lutovinovas et al, 2018.

Wagneria micropyga Herting, 1987: Herting, 1987; Lutovinovas et al, 2018. – Type locality: Beytüşşebap-Şırnak.

Athrycia impressa (Van der Wulp, 1869): Doğanlar, 1982b; Kara, 1999b; Lekin, 2014; Lekin et al, 2016b.

Athrycia trepida (Meigen, 1824): Sahebari et al, 2014; Lutovinovas et al, 2018.

Voria ruralis (Fallén, 1810): Steiner, 1937; Bodenheimer, 1958; Kavut et al, 1974; Avcı & Özbek, 1990; Kara, 1999b; Anay, 2000; Kara & Özdemir ,2000; Kara, 2001b; Korkmaz, 2007; Kaya & Kornoşor, 2008; Lekin, 2014; Lekin et al, 2016b; Lutovinovas et al, 2018.

Cyrtophloeba ruricola (Meigen, 1824): Sahebari et al, 2014; Lutovinovas et al, 2018.

Klugia marginata (Meigen, 1824): Kara, 1999b.

Hypovoria hilaris Villeneuve, 1912: Sahebari et al, 2014; Lutovinovas et al, 2018.

Hypovoria pilibasis (Villeneuve, 1922): Mückstein at al, 2004.

Nanoplagia hilfi (Strobl, 1902): Cerretti, 2009.

Uclesia simyrae Herting, 1966: Herting, 1966; Herting & Dely-Draskovits, 1993. - Type locality: Konya.

Uclesia fumipennis Girschner, 1901: Doğanlar, 1982b.

Thelaira solivaga (Harris, 1780): Sahebari et al, 2014.

Stomina angustifrons Kugler, 1968: Herting & Dely-Draskovits, 1993.

Stomina iners (Meigen, 1838): Doğanlar, 1982b; Herting & Dely-Draskovits, 1993; Kara & Aksu, 2007.

Stomina tachinoides (Fallén, 1817): Kara, 2001a.

Dufouria nigrita (Fallén, 1810): Kara, 1999b.

Dufouria occlusa (Robineau-Desvoidy, 1863): Kara, 1999b.

Rondania cucullata Robineau-Desvoidy, 1850: Doğanlar, 1982b.

Microsoma exiguum (Meigen, 1824): Aeschlimann, 1990; Lutovinovas et al, 2018.

Euthera fascipennis (Loew, 1854): Herting & Dely-Draskovits, 1993.

Mitannia insueta Herting, 1987: Herting, 1987. - Type locality: Sat Mountain-Hakkari.

Subfamily: Phasiinae (63 species)

Eliozeta helluo (Fabricius, 1805): Lodos, 1961, 1986; Brown, 1962; Dupuis, 1963; Yüksel, 1968; Tuatay et al, 1972; Herting, 1984, 1985; Herting & Dely-Draskovits, 1993; Memişoğlu & Özer, 1994; Şimşek, Güllü, & Yaşarbaş, 1994; Öncüer & Kıvan, 1995; Kıvan, 1996; Kara, 1998; İslamoğlu & Kornoşor, 2003, 2007; Korkmaz, 2007; Gözüaçık et al, 2010; Gün, 2010; Duman & Sertkaya, 2015; Lutovinovas et al, 2018.

Eliozeta pellucens (Fallén, 1820): Kara & Bayram, 1999; Korkmaz, 2007.

Clytiomyia continua (Panzer, 1798): Kara, 1998; Aksu, 2005; Atay, 2011; Atay & Kara, 2014; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b; Atay, 2017.

Clytiomya dupuisi Kugler, 1971: Kara, 1998; Kara & Alaoğlu, 1999; Karsavuran & Kara, 2003; Lutovinovas et al, 2018.

Clytiomya sola (Rondani, 1861): Mesnil, 1971; Tuatay et al, 1972; Karsavuran & Kara, 2003; Tschorsnig, 2005; Lutovinovas et al, 2018.

Ectophasia crassipennis (Fabricius, 1794): Zwölfer, 1932; Lodos, 1953, 1961, 1986; Yüksel, 1968; Şimşek et al, 1994; Atay, 2011; Atay & Kara, 2014; Lekin, 2014; Duman & Sertkaya, 2015; Duman, Güz, & Sertkaya, 2015; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Ectophasia leucoptera (Rondani, 1865): Herting & Dely-Draskovits, 1993.

Ectophasia oblonga (Robineau-Desvoidy, 1830): Dupuis, 1963; Herting, 1984; Herting & Dely-Draskovits, 1993; Herting & Tschorsnig, 1993; Memişoğlu & Özer, 1994; Öncüer & Kıvan, 1995; Kıvan, 1996; Kara, 1998; İslamoğlu & Kornoşor, 2003, 2007; Aksu, 2005; Tschorsnig, 2005; Korkmaz, 2007; Gözüaçık et al, 2010; Atay, 2011; Atay & Kara, 2014; Lekin, 2014; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Gymnosoma clavata (Rohdendorf, 1947): Doğanlar, 1982b; Karsavuran, 1986; Herting & Tschorsnig, 1993; Kara, 1998; Karsavuran & Kara, 2003; Aksu, 2005; Korkmaz, 2007; Atay, 2011; Atay & Kara, 2014; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Gymnosoma desertorum (Rohdendorf, 1947): Brown, 1962; Lodos, 1986; Kara & Alaoğlu, 1999; Atay, 2011; Atay & Kara, 2014; Balkan, 2014; Balkan et al, 2015.

Gymnosoma dolycoridis Dupuis, 1961: Karsavuran, 1986; Kara, 1998; Aksu, 2005.

Gymnosoma iranica (Zimin, 1966): Kara, 2001a.

Gymnosoma nitens Meigen, 1824: Kara, 2001a; Korkmaz, 2007; Atay, 2017; Lutovinovas et al, 2018.

Gymnosoma rotundata (Linnaeus, 1758): Kurt, 1975; Dikyar, 1981; Kara, 1998; Korkmaz, 2007; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b; Atay, 2017.

Gymnosoma rungsi (Mesnil, 1952): Zimin, 1966; Mesnil, 1971; Tuatay et al, 1972; Dikyar, 1981; Herting & Dely-Draskovits, 1993; Herting, 1984; Herting & Tschorsnig, 1993; Memişoğlu, Özkan, & Melan, 1994; Lutovinovas et al, 2018.

Cistogaster mesnili (Zimin, 1966): Memişoğlu et al, 1994.

Opesia grandis (Egger, 1860)

Material examined: Eskişehir: Alpu, 11.07. 2003, 1♂, leg. S.AKSU.

This tachinid is recorded for the first time from Turkey.

Elomya lateralis (Meigen, 1824): Lodos, 1961, 1986; Brown, 1962; Dupuis, 1963; Yüksel, 1968; Mesnil, 1971; Dikyar, 1981; Herting & Tschorsnig, 1993; Memişoğlu & Özer, 1994; Memişoğlu et al, 1994; Öncüer & Kıvan, 1995; Kıvan, 1996; İslamoğlu & Kornoşor, 2003, 2007; Korkmaz, 2007; Kara & Alaoğlu, 1999; Tschorsnig, 2005; Gözüaçık et al, 2010; Atay, 2011; Atay & Kara, 2014; Duman & Sertkaya, 2015; Atay, 2017; Lutovinovas et al, 2018.

Phasia aurigera (Egger, 1860): Ziegler, 2011

Phasia hemiptera (Fabricius, 1794): Lekin, 2014; Lekin et al, 2016a.

Phasia obesa (Fabricius, 1798): Kara, 1998; Kara & Alaoğlu, 1999; Lekin, 2014; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Phasia subcoleoptrata (Linnaeus, 1767): Lodos, 1952, 1953, 1961, 1986; Brown, 1962; Dupuis, 1963; Yüksel, 1968; Tuatay et al, 1972; Soydanbay, 1978; Herting, 1984, 1985; Herting & Dely-Draskovits, 1993; Herting & Tschorsnig, 1993; Memişoğlu & Özer, 1994; Şimşek et al, 1994; Öncüer & Kıvan, 1995; Kıvan, 1996; İslamoğlu & Kornoşor, 2003, 2007; Sun & Marshall, 2003; Keçeci, Tekşam, Topuz, & Öztop, 2007; Gözüaçık et al, 2010; Gün, 2010; Atay, 2011; Atay & Kara, 2014; Duman & Sertkaya, 2015; Duman et al, 2015; Lutovinovas et al, 2018.

Phasia mesnili (Draber-Monko, 1965): Kara, 1998; Kara & Alaoğlu, 1999; Sun & Marshall, 2003; Korkmaz, 2007; Atay, 2017; Lutovinovas et al, 2018.

Phasia pandellei (Dupuis, 1957): Kara et al, 2010; Atay, 2017.

Phasia pusilla Meigen, 1824: Kara, 1998; Kara & Alaoğlu, 1999; Korkmaz, 2007; Atay, 2017; Lutovinovas et al, 2018.

Phasia venturii (Draber-Monko, 1965): Lutovinovas et al, 2018.

Xysta holosericea (Fabricius, 1805): Kara et al, 2010; Lutovinovas et al, 2018.

Catharosia albisquama (Villeneuve, 1932): Lutovinovas et al, 2018.

Catharosia claripennis Kugler, 1977: Lutovinovas et al, 2018.

Catharosia pygmaea (Fallén, 1815): Atay, 2017; Lutovinovas et al, 2018.

Eulabidogaster setifacies (Rondani, 1861): Kara, 1998; Kara & Alaoğlu, 1999; Korkmaz, 2007; Atay, 2011; Atay & Kara, 2014; Atay, 2017; Lutovinovas et al, 2018.

Leucostoma abbreviatum Herting, 1971: Kara & Alaoğlu, 1999; Korkmaz, 2007; Balkan, 2014; Balkan et al, 2015.

Leucostoma anthracinum (Meigen, 1824): Kara, 1998; Atay, 2017; Lutovinovas et al, 2018.

Leucostoma crassa Kugler, 1966: Herting & Dely-Draskovits, 1993; Kara & Alaoğlu, 1999.

Leucostoma engeddense Kugler, 1966: Kara, 2002; Lutovinovas et al, 2018.

Leucostoma simplex (Fallén, 1815): Kara & Alaoğlu, 1999; Korkmaz, 2007; Atay, 2011; Lutovinovas et al, 2018.

Leucostoma tetraptera (Meigen, 1824): Kara et al, 2010.

Leucostoma nudifacies Tschorsnig, 1991: Kara & Bayram, 1999.

Clairvilla biguttata (Meigen, 1824): Kara, 1998; Kara & Alaoğlu, 1999; Aksu, 2005; Lutovinovas et al, 2018.

Clairvillia pninae Kugler, 1971: Kara, 2001a; Kara & Aksu, 2007; Lutovinovas et al, 2018.

Psalidoxena transsylvanica (Villeneuve, 1929): Kara, 2002.

Labigastera nitidula (Meigen, 1824): Kara, 2002.

Labigastera pauciseta (Rondani, 1861): Kara & Alaoğlu, 1999; Korkmaz, 2007.

Weberia digramma (Meigen, 1824): Lutovinovas et al, 2018.

Cylindromyia rufifrons (Loew, 1844): Lutovinovas et al, 2018.

Cylindromyia rubida (Loew, 1854): Çerçi, 2017.

Cylindromyia theodori Kugler, 1974: Gilasian, Talebi, Ziegler, Manzari, & Araghi, 2013.

Cylindromyia bicolor (Olivier, 1812): Herting, 1983a; Işık, Ecevit, Kurt, & Yücetin, 1987; Kara, 1998; Kara & Alaoğlu, 1999; Korkmaz, 2007; Lekin, 2014; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Cylindromyia brassicaria (Fabricius, 1775): Doğanlar, 1982b; Karsavuran, 1986; Kara, 1998; Kara & Alaoğlu, 1999; Aksu, 2005; Atay, 2011; Atay & Kara, 2014; Lekin, 2014; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Cylindromyia brevicornis (Loew, 1844): Kara & Alaoğlu, 1999.

Cylindromyia montana Kugler, 1974: Doğanlar, 1982b.

Cylindromyia pilipes (Loew, 1844): Herting 1984; Herting & Dely-Draskovits, 1993; Atay, 2017; Lutovinovas et al, 2018. - Type localities: İstanbul and Bursa.

Cylindromyia pusilla (Meigen, 1824): Herting, 1984; Herting & Dely-Draskovits, 1993; Korkmaz, 2007; Atay, 2017; Lutovinovas et al, 2018.

Cylindromyia rufipes (Meigen, 1824): Kara, 2001a; Korkmaz, 2007; Atay, 2017; Lutovinovas et al, 2018.

Cylindromyia crassa (Loew, 1845): Lutovinovas et al, 2018.

Cylindromyia intermedia (Meigen, 1824): Doğanlar, 1982b; Atay, 2017.

Cylindromyia auriceps (Meigen, 1838): Kara, 1998; Kara & Alaoğlu, 1999; Aksu, 2005; Korkmaz, 2007; Balkan, 2014; Lekin, 2014; Balkan et al, 2015; Lekin et al, 2016b; Atay, 2017; Lutovinovas et al, 2018.

Cylindromyia hermonensis Kugler, 1974: Lutovinovas et al, 2018.

Cylindromyia interrupta (Meigen, 1824): Kara et al, 2010.

Cylindromyia persica Tschorsnig, 2000: Gilasian et al, 2013.

Besseria lateritia (Meigen, 1824): Kara et al, 2010; Lutovinovas et al, 2018.

Besseria zonaria (Loew, 1847): Herting & Dely-Draskovits, 1993; Korkmaz, 2007.

Phania albisquama (Villeneuve, 1924): Kara, 2002.

DISCUSSION

In this paper, a total of 341 tachinid species are listed from Turkey. The subfamily Exoristinae is dominant with 139 species, followed by the subfamilies Tachininae, Phasiinae and Dexiinae, respectively. The number of species known to each Turkish province varies widely, depending mainly on areas of research of the most active researchers: 156 species (47%) are recorded from Southwestern Tukey including Muğla, Aydın, Burdur, Denizli, Antalya, 145 species (43%) from Central Black Sea including Tokat and Amasya, 66 species (20%) from Western Black Sea including Kastamonu, Karabük, Bolu, Bartın, 71 species (21%) from Northwest Central Anatolia including Ankara and Eskişehir, 57 species (17%) from North of Eastern Anatoloia including Erzurum and 24 species (7%) from Eastern Marmara.

The type locality of 19 species (5.6%) is Turkey and 11 of them are at present endemic species. These are *Blondelia angusticornis* Herting, 1987, *Germaria obscuripennis* Tschorsnig, 2000, *Linnaemya pentheri* (Bischof, 1906), *Loewia papei* Cerretti, Lo Giudice & O'Hara, 2014, *Ceranthia impropria* Herting, 1987, *Bithia ancyrensis* (Villeneuve, 1942), *Minthodes brevipennis* Brauer et Bergenstamm, 1889, *Minthodes transiens* Herting, 1987, *Minthodes simulans* Herting, 1987, *Mitannia insueta* Herting, 1987 and *Wagneria micropyga* Herting, 1987.

The present publication includes all relevant papers on Turkish Tachinidae known to the authors. Further studies involving different habitats would certainly reveal additional species. The total number of species in the large and diverse country Turkey will surely exceed the listed 341 species. Fauna Europaea (http:// www.faunaeur.org/) gives an impression how many species can be recorded in even much smaller European countries.

ACKNOWLEDGEMENTS

We are grateful to all the researchers who contributed to the detection of the species diversity of the Tachinidae family in Turkey.

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Received: November 14, 2019 *Accepted: July 07, 2020*

J. Entomol. Res. Soc., 22(2): 191-201, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

Some New Records on Aphid (Hemiptera, Aphididae) Fauna of Turkey and Aphid Host Plant Interactions

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ABSTRACT

This study was carried out in Kayseri province and its districts between 2015 and 2018. Aphids were collected from different regions of Kayseri province. Three aphid species; **Drepanosiphum aceris* Koch, **Subsaltusaphis (Subsaltusaphis) picta* (Hille Ris Lambers), ***Trama (Trama) troglodytes* von Heyden are new records for the Turkish aphid fauna, while seven species *Aphis (Aphis) spiraephaga* F.P. Müller, *Acyrthosiphon (Acyrthosiphon) cyparissiae* (Koch), *Acyrthosiphon kondoi* Shinji, *Macrosiphoniella staegeri* Hille Ris Lambers, *Phloeomyzus passerinii* (Signoret), *Pleotrichophorus persimilis* Börner, *Uroleucon (Uromelan*) *rapunculoidis* (Börner) were recorded for the first time in Kayseri province.

Information on biology and geographical distribution for each species is also provided. Besides, seven (*Epilobium angustifolium* L., *Euphorbia cyparissias* L., *Astragalus melanophrurius* Boiss., *Acer cinerascens* Boiss., *Centaurea maculosa* Lam., *Populus alba* L., *Artemisia campestris* L.) host plant species and one new endemic host plant (*Campanula rapunculoides* L.) species are recorded for eight of the aphid species for the first time. *Acyrthosiphon (Acyrthosiphon) kondoi* Shinji was found for the first time on the *Astragalus melanophrurius*. This plant is not included in the Holman catalog (2009). It is the new host plant registration for the World Aphid-Host plant catalog.

Key words: New record, Aphididae, Kayseri, Turkey, new host plant.

Özdemir, I. (2020). Some new records on aphid (Hemiptera, Aphididae) fauna of Turkey and aphid plant interactions. *Journal of the Entomological Research Society,* 22(2), 191-201.

INTRODUCTION

Turkey has a high number of endemic species which make up about 31% of the total flora, the largest in Europe (Davis, 1988). Turkey is also a bridge between Asia and Europe and it has a geographically very large area with different kinds of climate zones favourable for aphid breeding. Turkey can be divided to seven distinct geographic areas and each with different climatic conditions and flora. Steppe climate is dominant in many parts of Kayseri. Here summers are hot and dry, winters are cold and snowy. However, since there are mountainous places and plains and boats between them, some climatic characteristics of height are also effective. In the lands of Kayseri, steppe vegetation is dominant in the mountains and hilly areas as in the plains. Although forest cover is seen in high parts of the province, soils are generally covered with degraded forests and shrubs (Anonim, 2019).

Aphididae (Hemiptera) species, known as aphids, contain important pests that can cause economic loss in cultivated plants. As a result of the feeding of aphids on the flowers, shoots, fruits, leaves, trunk and roots of the plants; folds in the leaves, stunting in the plant, deformations in the plant organs occur. When Aphidoidea is fed to the upper family, saprophyte fungus is released on the egg they secrete, causing the formation of fumagine and thus the leaves cannot perform the assimilation task. The Aphids can cause direct damage to the plant plants by indirectly destroying the plant physiology and vectoring them to virus and virus-like organisms.

More than 5600 valid species of Aphidomorpha have been described worldwide (Blackman & Eastop, 2020; Favret, 2020). Aphids are a predominantly northern temperate group and more than 75 % of the species are known from the Palaearctic region (Holman, 2009). During last two decades aphid fauna of Turkey has been studed intensively by different authors (Remaudière, Toros, & Özdemir, 2006; Görür, Akyıldırım, Olcabey, & Akyürek, 2012; Barjadze, Japoshvili, & Bakhtadze, 2010; Barjadze, 2011; Barjadze, Karaca, Yaşar, & Gratiashvili, 2011; Barjadze, Özdemir, & Blackman, 2014a; Barjadze, Japoshvili, Karaca, & Özdemir, 2014b; Barjadze, Blackman, & Özdemir, 2015; Barjadze & Özdemir 2014, 2018; Özdemir & Barjadze 2015; Kanturski, Barjadze, Jensen, & Wieczorek, 2018; Akyürek, Zeybekoğlu, Görür, & Karavin, 2019). At present 555 aphid species are known from Turkey (Akyürek et al, 2019). Knowledges on the aphid fauna of Kayseri are very limited. In present study, were evaluated aphid specimens collected from Kayseri province, were presented new records for Turkish fauna. In addition, new information about the host plants of the species is included. New information about the hospitality of aphids on endemic plants is given.

MATERIAL AND METHODS

Aphids were collected in the field from their host plant with a small soft brush and put in to a tube which contained 70 percent ethyl alcohol. The slide mounting technique was mainly based on the method of Hille Ris Lambers (1950). The specimens were studied using a LEICA DM LB2 compound light microscope and morphological characters

were measured using LAS 4.1 version software. Measurements of morphological characters were made according to Blackman and Eastop (2006, 2020). The species determination was done using Heie (1992, 1995), Blackman and Eastop (1994, 2000, 2006, 2020) and Wieczorek et al (2016). Aphids' host plants were identified according to Davis (1967, 1970, 1972, 1975, 1978, 1982, 1984, 1985) and Davis, Mill, & Tan, (1988) by Ufuk ÖZBEK (Gazi University, Faculty of Science, Department of Biology). Slides of the aphid species have been deposited in the Department of Agricultural Fauna and Microflora, Plant Protection Central Research Institute, Ministry of Agriculture, Ankara, Turkey.

RESULTS

List of investigated aphids and new aphid-plant interactions

Aphis (Aphis) spiraephaga F.P. Müller, 1961 (Aphidinae: Aphidini)

Comments: Çanakçıoğlu (1966) was given on *Spireae thunbergii* in the literature such as new records from Turkey. However, It was found in this study from the *Epilobium angustifolium* L. This species is a new record for the province of Kayseri. Host plant is a new record for Turkey.

Material examined: One apterous viviparous and three alatae females on *Epilobium angustifolium* L. (Onagraceae), Kayseri, Yahyalı (38°18'33" N, 35°54'52" E), altitude 1356 m, 08.07.2015, leg. M. Özdemir

Apterous viviparous females are dark brownish, greyish brown, with transverse dorsal bands of wax. Alatae have secondary rhinaria distributed on antennal III segment: 5-18. Both apterae and alate have a very variably developed pattern of dorsal sclerotisation (Fig. 1).

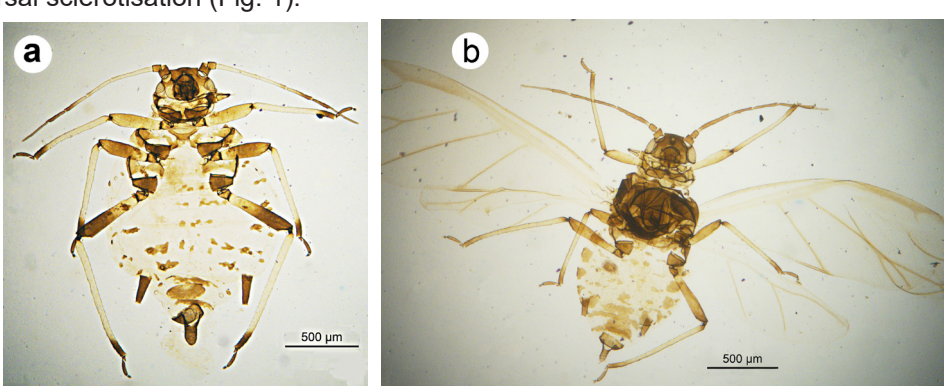

Fig. 1. *Aphis spiraephaga* F.P. Müller. a. Apterous viviparous female; b. Alata viviparous female.

Biology: In dense ant-attended colonies on young shoots of *Spiraea* spp. However this species seems to be rather polyphagous, with records from *Epilobium* spp. (Holman, 2009), and other genera in several plant families (*Arabis*, *Carum*, *Centranthus*, *Erica*, *Filipendula*, *Helipterum*, *Symphoricarpus*, *Trinia* and *Valeriana*)

Distribution: This species is distributed in Europe (but not UK), west Siberia, Kazakhstan, Mongolia

***Acyrthosiphon (Acyrthosiphon) cyparissiae* (Koch, 1855) (Aphidinae: Macrosiphini)**

Synonymy: *Siphonophora cyparissiae* Koch, 1855

Comments: It was reported in Tuatay & Remaudiere, 1964. This is a newly recorded species from Kayseri province and new host plant record for the aphid fauna of Turkey (Fig. 2).

Material examined: One apterous viviparous and three alatae females on *Euphorbia cyparissias* L. (Euphorbiaceae), Kayseri, Yahyalı (38°01'24" N, 35°29'47" E), altitude 1322 m, 28.05.2015, leg. I. Özdemir

This species are greenish with brownish black front part of head and brownish-brown.

Biology: It lives on *Euphorbia* spp., feeding on upper sides of upper leaves.

Distribution: This species is distributed in In Europe, Middle East, Central Asia and China.

***Acyrthosiphon (Acyrthosiphon) kondoi* Shinji, 1938 (Aphidinae: Macrosiphini)**

Synonymy: *Siphonophora lactucae* Passerini, 1860

Comments: It was reported in Akyıldırım, 2010. This is a newly recorded species from Kayseri province and new host plant record for the aphid fauna of Turkey and World (Fig. 3). This aphid species was found for the first time on the *Astragalus melanophrurius*. This plant is not included in the Holman catalog (2009). It is the new host plant registration for the World Aphid-Host plant catalog.

Material examined: Two apterous viviparous females, on shoots and flower stems of *Astragalus melanophrurius* Boiss. (Asteraceae), Kayseri, Yahyalı, Avlak (37°58'46" N, 35°32'27" E), altitude 1400 m, 06.05.2018, leg. M. Özdemir.

Apterae are bluish greenish and brownish.

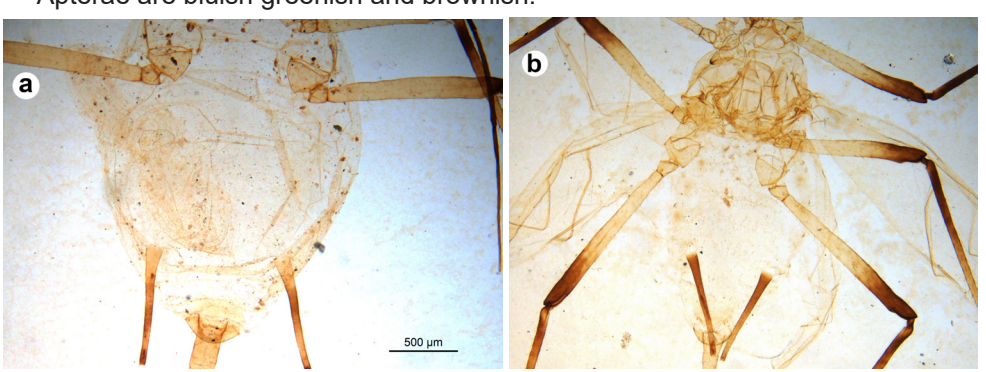

Fig. 2. *Acyrthosiphon cyparissiae* (Koch). a. Apterous viviparous female; b. Alata viviparous female.

Fig. 3. *Acyrthosiphon kondoi* Shinji. Apterous viviparous female.

Biology: On stems and leaves of Leguminosae/Fabaceae, mainly of tribes Trifoleae (*Medicago*, *Melilotus*, *Trifolium*) and Loteae (*Dorycnium*, *Lotus*) but also on Galegeae (*Astragalus*), and also recorded from *Pisum*, *Vicia* and *Lens* (Vicieae). An important pest of alfalfa (Blackman & Eastop, 2000; 2020).

Distribution: This species is distributed from Afro-tropical region, Australian region, Corsica, East Palaearctic, Near East, Nearctic region, Neotropical region, Oriental region (Anonymous, 2019), Asia, North and South America, South Africa, Australia and New Zealand (Blackman & Eastop, 2020).

******Drepanosiphum aceris* **Koch, 1855 (Aphidinae: Aphidini)**

Comments: This is a new species and new host plant record for the aphid fauna of Turkey from Kayseri.

Material examined: Two alatae viviparous females, on shoots *Acer cinerascens* Boiss. (Aceraceae), Kayseri, Felahiye, Mollahacı (38°57'38" N, 35°32'46" E), altitude 1275 m, 21.09.2018, leg. M. Özdemir.

Alate viviparous females are whitish-greenish or yellowish, with thoracic lobes darker, a conspicuous brown-black spot in front of the base of each siphunculus, siphunculi distally dark, and a short brown bar on abdominal tergites 4-5 only (Fig. 4).

Fig. 4. *Drepanosiphum aceris* Koch. Alata viviparous female.

Biology: On *Acer pseudoplatanus*, under lower leaves, usually in shade. (Holman, 2009; Blackman & Eastop, 2020).

Distribution. This species is distributed from Europe and east to the Caucasus and Georgia (Barjadze et al, 2010).

***Macrosiphoniella (Macrosiphoniella) staegeri* Hille Ris Lambers, 1947 (Aphidinae: Macrosiphini)**

Comments: It was reported in Tuatay & Remaudiere, 1964 on *Centaurea* spp. This is a new record from Kayseri province (Fig. 5) and new record host plant.

Material examined: Two apterous viviparous females, on *Centaurea maculosa* LAM. (Asteraceae), Kayseri, Bünyan, Süksün (38°45'50" N, 35°56'01" E), altitude 1601 m, 08.08.2015, leg. I. Özdemir.

Apterae are brownish, brown to black, dusted with dirty whitish wax.

Fig. 5. *Macrosiphoniella staegeri* Hille Ris Lambers. Apterous viviparous female.

Biology: It lives on underside of leaves of *Centaurea* spp. (Blackman & Eastop, 2020). Oviparae and alate males were found in Turkey in October (Tuatay & Remaudière, 1964).

Distribution: This species was recorded from southern Europe, Turkey, Armenia, Tajikistan and Kazakhstan (Kadyrbekov, 2014).

***Phloeomyzus passerinii* (Signoret, 1875) (Phyloeomyzinae: Phyloeomyzini)**

Synonymy: S*chizoneura passerinii* Signoret; *Lovia passerini* Signoret

Comments: *P. passerini* collected on *Populus alba* L. (Salicaceae) is a new species record for Kayseri province (Fig. 6). This aphid species is a new record for Kayseri province. Bodenheimer and Swirskii (1957) given record from Turkey. However, the host plant and its locality have not been given. Detailed registration is given for the first time in this paper.

Material examined: Three apterous viviparous females, on *Populus alba* L. (Salicaceae), Kayseri, Talas, Alidağ (38°39'59" N, 35°32'59" E), altitude 1727m, 13.09.2017, leg. M. Özdemir.

Apterae are greenish-yellow to yellow, covered with dirty white wax wool.

Biology: On bark and in crevices on trunks of *Populus* spp.

Distribution: *P. passerini* is widely distributed in Europe, and is also found in Belarus, Britain, Bulgaria, Central European Russia, Czech Republic, East Palaearctic, French mainland, Germany, Egypt.

Fig. 6. *Phloeomyzus passerinii* (Signoret). Apterous viviparous female.

Pleotrichophorus persimilis Börner, 1950 (Aphidinae: Macrosiphini)

Comments: It was reported in Tuatay & Remaudiere, 1964. This is a newly recorded species for Kayseri province and new host plant record for the aphid fauna of Turkey (Fig. 7).

Material examined: Two apterous viviparous females, *Artemisia campestris* L. (Asteraceae), Kayseri, Kocasinan, Himmetdede (38°54'36" N, 35°05'18" E), altitude 1250 m, 30.09.2016, leg. I. Özdemir.

Apterae are pale yellowish red to brownish, appearing wax-powdered.

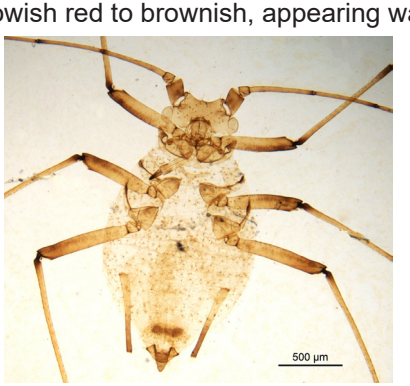

Fig. 7. *Pleotrichophorus persimilis* Börner. Apterous viviparous female.

Biology: Its colonies live on On *Artemisia* spp., especially *A. campestris* and *A. scoparia* (Blackman & Eastop, 2020). Life cycle is unknown.

Distribution: This species is distributed in Belgium, Britain, Bulgaria, Czech Republic, East Palaearctic, Finland, Germany, Hungary (Holman, 2009; Blackman & Eastop 2020).

***Subsaltusaphis (Subsaltusaphis) picta* (Hille Ris Lambers, 1939) (Saltusaphidinae: Thripsaphidini)**

Comments: This is a newly recorded aphid species for the aphid fauna of Turkey (Fig. 8).

Material examined: Four apterous viviparous females and one alate on *Carex* sp. (Cyperaceae), Kayseri, Province, (38°46'09" N, 35°17'08" E), altitude 1065 m, 26.06.2017, leg. M. Özdemir.

Adult apterae of *S. picta* are whitish yellowish, with dark tranverse intersegmental muscle sclerites. The antenna are black beyond the basal half of the third segment.

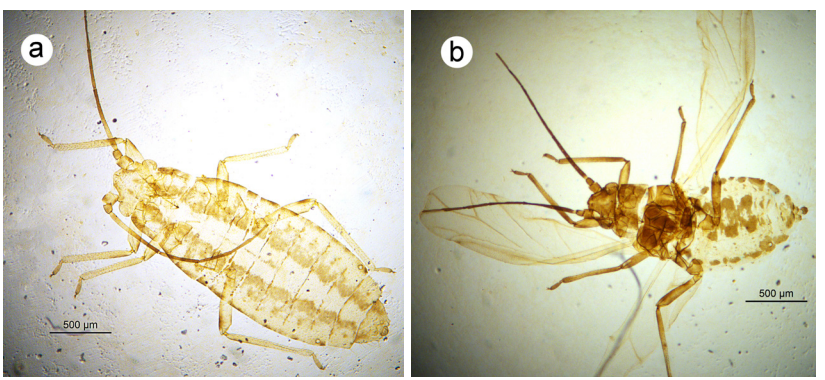

Fig. 8. *Subsaltusaphis picta* (Hille Ris Lambers). a. Apterous viviparous female; b. Alata viviparous female.

Biology: The painted sedge aphid lives on sedge (*Carex* sp.).

Distribution: *S. picta* is widely distributed in Europe, and is also found in Austria, Belgium, Britain I., Czech Republic, East Palaearctic, Finland, French mainland, Germany, Hungary, Poland, Kazakhstan and east Siberia (Blackman & Eastop, 2020).

****Trama (Trama) troglodytes* von Heyden, 1837 (Lachninae: Tramini)**

Comments: This a new record from the Turkish aphid fauna (Fig. 9).

Material examined: Three apterous viviparous females, *Helianthus tuberosus* L. (Asteraceae), Kayseri, Hacılar (38°35'39" N, 35°29'50" E), altitude 1863 m, 21.09.2015, leg. M. Özdemir.

Fig. 9. *Trama (Trama) troglodytes* von Heyden. Apterous viviparous female.

Apterae are white or yellowish white or grey.

Biology. Various names have been applied to populations on different host plants (*Achillea*, *Artemisia*, *Centaurea*, *Cichorium*, *Cirsium*, *Cynara*, *Helianthus*, *Lactuca*, *Lapsana*, *Sonchus*, *Taraxacum*) (Blackman & Eastop, 2020).

Distribution. This species was recorded from Europe, west Siberia, Central Asia, and Japan, England.

***Uroleucon (Uromelan) rapunculoidis* (Börner, 1939) (Aphidinae: Macrosiphini)**

Comments: It was first reported in Tuatay & Remaudiere, 1964. This is a newly recorded species from Kayseri province and new endemic host plant record for the aphid fauna of Turkey (Fig.10).

Material examined: Two apterous viviparous females and two alatae on *Campanula rapunculoides* L. (Campanulaceae), Kayseri, Yeşilhisar (38°20'41" N, 35°05'35" E), altitude 1125 m, 22.09.2016, leg. I. Özdemir.

Apterae are shiny dark brown with black antennae, siphunculi and cauda.

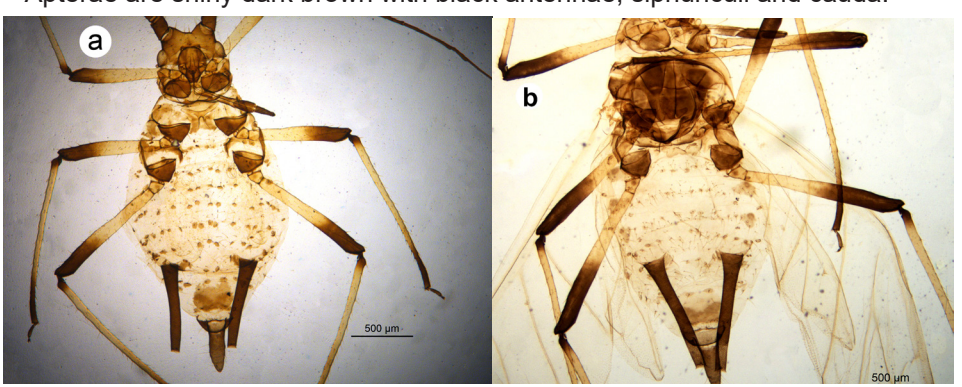

Fig. 10. *Uroleucon (Uromelan) rapunculoidis* (Börner). a. Apterous viviparous female; b. Alata viviparous female.

Biology: On stems and flowers of *Campanula rapunculoides* in Europe (Blackman & Eastop, 2019).

Distribution: This species is recorded from *C. glomerata* and *C. sibirica* in south-west and central Asia. Oviparae were found in October in the Netherlands (Holman, 2009; Blackman & Eastop, 2020).

ACKNOWLEDGEMENTS

I would like to thank Mustafa ÖZDEMİR (Plant Protection Central Research Institute, Ankara) for collection of some samples and Ufuk ÖZBEK (Gazi University, Faculty of Science, Department of Biology) for identification of host plants and two anonymous reviewers for the constructive comments on the manuscript. This study was supported by the General Directorate of Agricultural Research and Policies (TAGEM-BS-13/01-06/01-18) of The Ministry of Agriculture and Forestry.

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Received: December 18, 2019 *Accepted: March 10, 2020*

J. Entomol. Res. Soc., 22(2): 203-210, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

Which Factors Predict Stem Weevils Appearance in Rapeseed Crops?

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ABSTRACT

Stem weevils are the first pests that invade oilseed rape crops after winter period of hibernation. Rape and cabbage stem weevils are considered as a pest complex although their biological and ecological characteristics are different. The most important moment in their control is to determine optimal time of insecticide application to prevent oviposition and larvae development inside the plants. The aim of this research was to determine which climatic factors have the greatest impact on appearance of adult forms. During four growing seasons flight of adults forms were monitored by yellow water traps. Abundance and climatic factor from each location were correlated and for each species a regression tree was created. The most important factors that determine the appearance of adult forms of stem weevils are growth stage of the crop, daily sunshine hours, mean daily air temperature and mean daily precipitation. These results represent a starting point for the new prediction model within moderate climatic zone.

Key words: Oilseed rape, *Ceutorhynchus napi*, *Ceutorhynchus pallidactylus*, prediction, climatic factors.

Juran, I., Grubišić, D., Štivičić, A., & Čuljak, T.G. (2020). Which factors predict stem weevils appearance in rapeseed crops?. *Journal of the Entomological Research Society,* 22(2), 203-210.

INTRODUCTION

Biological and ecological features of rape (*Ceutorhynchus napi* Gyllenhal, 1837) and cabbage (*Ceutorhynchus pallidactylus* Marsham, 1802) stem weevil are similar and they are often presented as a pest complex although life cycles are different and demand different approaches in their control. Adult forms of rape stem weevil hibernate between -2 and +2 °C and emerge from the soil during February and March. Activity of adult forms of rape stem weevil begins between soil temperature of 4 and 6 °C (Broschewitz, 1985) or when temperature 5 cm below soil surface exceeds 6 °C (Büchs, 1998). Flight of adult forms starts when air temperature exceeds 9 °C (Nuss, 2004) with increased activity between 12 and 15 °C when they move onto oilseed rape fields. According to Šedivy & Kocourek (1994) mass flight of rape stem weevil starts between 12 and 20 °C or when daily air temperature reaches 12.2 °C. Nuss (2004) states that highest number of adult forms of rape stem weevil was recorded when temperature threshold exceeds 12 °C and mean daily temperature was between 8 and 9 °C. According to Eickermann, Beyer, Georgen, Hoffman, & Junk (2014) flight of adult forms starts when air temperatures reach 0 °C and cumulative temperature sum form January 1st reach 74 °C. Flight activity of adult forms of cabbage stem weevil starts when air temperature reach 6 °C and cumulative temperature sum from January 1st reach 86 °C (Gratina, Apenite, & Turka, 2011). According to Johnen & Meier (2000) adult forms fly between air temperature of 12 and 14 °C and when wind speed is lower than 3 m/s. Active migration of adult forms of cabbage stem weevils occurs at average weekly temperature of 7.2 °C (Vaitelyté, Brazauskiené, & Petraitiené, 2013). Mass flight of adults occurs between 10 and 18 °C (Šedivy & Kocourek, 1994). When maximum daily air temperatures reach 15 °C and mean daily air temperatures reach 9 °C the highest number of adults can be found in yellow water traps (Nuss, 2004), which is partially confirmed by Debouzie & Ballanger (1993) and Johnen & Meier (2000). Insecticides applications are still common practice for control of stem mining weevils in oilseed rape. Thus, it is crucial to individuate the best period for insecticides treatment which should be applied before start of oviposition (Lerin, 1993). To fulfil this task various phonological forecasting systems were developed and help producers to predict the date of pest immigration to crops (Johnen et al, 2010). Critical point is to determine the optimal time of stem mining weevils migration into winter oilseed rape crops (Eickermann et al, 2014). As pest migration into fields is influenced by meteorological data, forecasting systems utilize long-term field studies and weather datasets, e.g. air temperature, soil temperature, precipitation, wind speed and sunshine hours (Johnen et al, 2010; Williams, 2010). The decision support system “proPlant expert” provides weather-based risk forecast for several oilseed rape pests (Frahm, Volk, & Johnen, 1996; Johnen et al, 2010). A series of “if-then” rules are used to provide prompt information about optimal time for insecticides application. This system relies on growth stage of the crop, on density of pest population and on climatic variables. The main precondition for utilization of the “proPlant” is to determine pest phenology at the local level. Thus, the objective of this study was to determine key climatic factors which are valuable in prediction of flight activity of rape and cabbage stem weevil in

oilseed rape crops and might help to be incorporated into decision support system and validate on a local level.

MATERIALS AND METHODS

During four growing seasons (2015-2019) adult forms of rape and cabbage stem weevil were trapped at six locations within five counties presenting areas of intensive oilseed rape production (Table 1). During research period rapeseed crops were at the same growth stage at all locations. Sampling period started immediately after sowing (autumn period) and lasted till the end of senescence (BBCH 99) of the crop including fallow period between harvest and sowing in the next season.

Table 1. Counties, locations and GPS coordinate for each location during four years growing seasons where adult forms of stem mining weevils were sampled

Growing season	County	Location	GPS
1	Sisak-moslavina	Popovača	N 45°32'33.66'' E 16°34'38.87''
	Sisak-moslavina	Lipovljani	N 45°23'12.34'' E 16°51'52.66''
	Varaždin	Varaždin	N 46°21'11.19'' E 16°18'52.24''
	Požega-slavonia	Lipik	N 45°24'38.5'' E 17°08'18.96''
2	Sisak-moslavina	Popovača	N 45°31'59.41'' E 16°39'28.56''
	Sisak-moslavina	Lipovljani	N 45°24'18.54'' E 16°51'21.96''
	Varaždin	Varaždin	N 46°21'25.65'' E 16°12'46.94''
	Koprivnica-Križevci	Koprivnički Bregi	N 46°07'35.2'' E 16°53'42.79''
3	Sisak-moslavina	Popovača	N 45°34'17.99'' E 16°35'26.61''
	Zagreb	Šašinovec	N 45°50'45.45'' E 16°11'50.95''
4	Sisak-moslavina	Popovača	N 45°34'13.03'' E 16°32'56.91''
	Zagreb	Šašinovec	N 45°51'04.11'' E 16°10'58.88''

Monitoring of appearance and flight dynamics of adult forms of both species at each site was conducted by yellow water traps (34x26x7 cm) as standardized method (Williams, 2010). Four traps were installed in oilseed rape fields on metal, height - adjustable holders. Each rapeseed field was 3 ha and traps very placed diagonally through the field, from the lower left to the upper right edge, at the same distance between traps. This scheme enabled to have the representative sample of the whole field. Traps were filled with water with few drops of detergent to prevent surface tension of water. Due to height of oilseed rape plants traps were raised to be in line with the crop during to the growing period. The content of each trap was emptied once a week and collected fauna was placed into plastic bottles with 96 % ethanol. Growth stage of oilseed rape was recorded using BBCH-identification keys (Weber & Bleiholder, 1990; Lancashire et al, 1991) for every activity in the field. For both species trapping occurred from January 1st of each year to two weeks after harvest of oilseed rape.

Climatic data (minimum, maximum and mean daily air temperature, soil temperature at 5 and 20 cm depth, daily precipitation and number of daily sunshine hours) were obtained from Croatian Meteorological and Hydrological Service for each year of investigation and for each location. The maximum distance between the meteorological stations and trial locations was 20 km. Correlation between climatic factors, which have impact on appearance of adult forms of stem weevils, was determined with Pearson`s correlation coefficient. Based on determined coefficient connection between oilseed rape growth stage, daily number of sunshine hours, minimum, mean and maximum daily air temperature, daily precipitation and soil temperature on 5 and 20 cm depth were determined. To determine which factor best explains the greater abundance of each species the regression tree model was used. To predict pest abundance for each species (*C. napi* and *C. pallidactylus*) regression tree was created. Statistical analysis was performed in R software (version 3.1.2., 2014).

RESULTS AND DISCUSSION

In total, 13 832 adult forms of stem mining weevils were collected; 1 868 individuals were *C. napi* and 11 964 individuals were *C. pallidactylus*. Climatic factors that can help in prediction of appearance and abundance of *C. napi* are growth stage of oilseed rape plants, daily sunshine hours and mean daily air temperature and for prediction of *C. pallidactylus* additional important factor is mean daily precipitation. For both species wind speed was not key climatic factor in prediction of their appearance and abundance as it was proposed by Johnen et al. (2010). These factors can be utilized in decision support tools which are commercially available based on computer system (Frahm et al, 1996; Johnen & Meier, 2000; Newe, Meier, Johnen & Volk, 2003; Johnen et al, 2010), but for our area of investigation has to be adapted to local climatic conditions. Variables most influential in predicting *C. napi* abundance are present in Fig. 1 and variables most influential in predicting *C. pallidactylus* abundance are present in Fig. 2.

According to *Regression TREE* procedure the best predictor for the occurrence of *C. napi* was the growth stage of oilseed rape (Fig. 1) which is in contrast to Broschewitz (1985) who states that mean and maximum daily air temperatures and soil temperatures on 5 cm depth have the highest impact on appearance and flight activity of *C. napi*. When oilseed rape plants have more than seven leaves visible (>BBCH 27) the first *C. napi* individuals can be found. If oilseed rape plants have less than seven visible leaves (<BBCH 27) there is no possibility in appearance of adult forms in higher density, although single individuals can be found within the crop. This population size is not significant and is still under the economic threshold (Büchs, 1998; EPPO, 2014). The highest density, marked as the peak of the flight, of *C. napi* adults (36 individuals) were predicted when oilseed rape is in growth stage between seven side shoots detectable (BBCH 27) and flower buds are free and level with the youngest leaves (BBCH 52) and if daily sunshine hours are between 6.3 and 6.6. These results are partly confirmed by Broschewitz (1985) but only with respect to the relationship between growth stages of oilseed rape and number of adult forms, while

literature data dealing with the effect of daily sunshine hours on number of adult forms of *C. napi* do not exist. Higher number of adult forms (16 individuals in yellow water traps) can be expected if daily sunshine hours are higher than 6.6 and if mean daily air temperatures are less than 7 °C which is in contrast to Šedivy & Kocourek (1994) and Nuss (2004) and indicate different ecological features of both species due to different climate conditions in experimental areas. If oilseed rape is between growth stages of free flower buds levelled with the youngest leaves (BBCH 52) and full flowering (BBCH 65) and if sunshine hours are above 9.7 adult forms of *C. napi* would reach control threshold of 10 adults in yellow water trap (Büchs, 1998; Williams, 2010; EPPO, 2014).

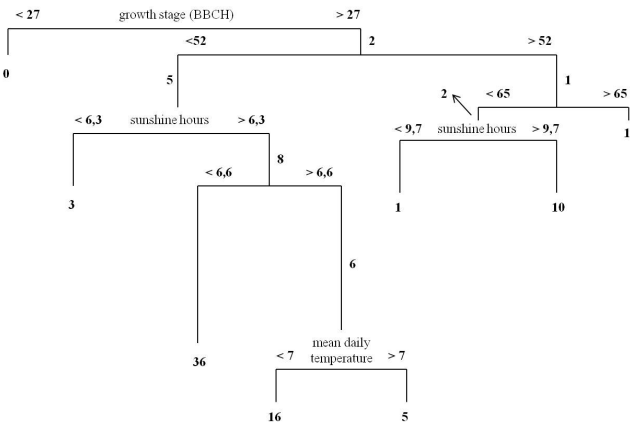

Fig. 1. Variables most influential in predicting *C. napi* abundance using the *Regression TREE* procedure.

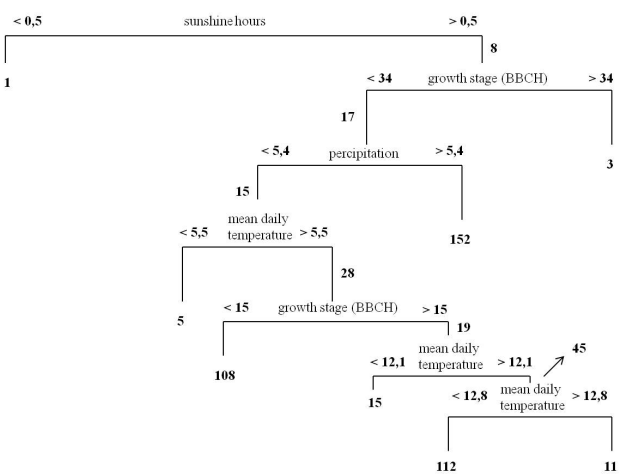

Fig. 2. Variables most influential in predicting *C. pallidactylus* abundance using the *Regression TREE* procedure.

The most important climatic factor that influences appearance of adult forms of *C. pallidactylus* is daily sunshine hours (Fig. 2). It is enough less than half an hour

during the day for the appearance of the first *C. pallidactylus* individuals in yellow water traps. However, this population is not high and is below the economic threshold (Büchs, 1998; EPPO, 2014). If sunshine hours exceed half an hour per day, the next factor is growth stage of oilseed rape plants. The highest abundance of adult forms of *C. pallidactylus* (152 individuals in yellow water traps) can be expected if plants have four visible extended internodes (BBCH 34) and if mean daily precipitation exceeds 5.4 mm which is in accordance with Nolte (1957) but opposite to Šedivý & Vašak (2002) who states that activity of stem mining weevils is lower when higher amount of precipitation is present. Higher insect activity at higher amount of precipitation shows other insect species as western corn rootworm (Kozina, 2012). If mean daily precipitation is less than 5.4 mm, mean daily air temperature is below 5.5 °C and plants have less than five leaves unfolded (<BBCH 15) higher number of adult forms can be expected (108 individuals in yellow water traps) and coincides with the peak of the flight of *C. pallidactylus*. Adults can appear in greater numbers (112 individuals in yellow water traps) when oilseed rape plants are between five leaves unfolded and four visibly extended internodes (BBCH 15 - 34) and if mean daily precipitation is less than 5.4 mm and mean daily air temperature is between 12.1 and 12.8 °C.

As our results suggest climatic factors are very important for migration of stem mining weevils from the hibernation places to oilseed rape fields and together with growth stage of crop are very useful in prediction of appearance of adult forms. The time of the first appearance of adult forms in oilseed rape fields is the most critical point in their control because they have to be controlled before oviposition to prevent damages from larvae feeding inside the stems (Lerin, 1993, Eickermann et al, 2014).

CONCLUSIONS

The most important factors that determine the appearance of adult forms of *C. napi* are the growth stage of oilseed rape, daily sunshine hours and mean daily air temperature. The most important factors affecting the emergence of adult forms of *C. pallidactylus* are the daily sunshine hours, the growth stage of oilseed rape, the mean daily precipitation and the mean daily air temperature. Based on the obtained results of regression trees, the basis for the creation of new or the use of existing forecast models adapted to our climatic conditions has been developed. It will provide more accurate and timely information on the occurrence of a certain stage of stem weevils in the oilseed rape crops.

ACKNOWLEDGEMENTS

We would like to express our special thanks to Dr. Katarina Mikac (University of Wollongong, NSW, Australia) for her help in statistical analysis.

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Received: January 14, 2020 *Accepted: May 05, 2020*

J. Entomol. Res. Soc., 22(2): 211-218, 2020
Print ISSN:1302-0250

Research Article
Online ISSN:2651-3579

Three New Species of *Hilara* Meigen (Diptera: Empididae) from Central and Northeastern Turkey

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ABSTRACT

Three new species, *Hilara elifae* Çiftçi & D. Çiftçi sp. nov. (*Hilara interstincta*-group), *Hilara ardahanensis* Çiftçi & Can sp. nov. (*Hilara abdominalis*-group) and *Hilara hasbenlii* Çiftçi sp. nov. (*Hilara maura*-group) are described from central (Sivas province) and northeastern (Ardahan province) Turkey. Male and female specimens of new species are described and male genitalia and forelegs are illustrated. The relationships between the new species and related species are compared.

Key words: Taxonomy, distribution, dance flies, new species, Turkey.

Çiftçi, M.C., Çiftçi, D., & Can, Ş.B. (2020). Three new species of *Hilara* Meigen (Diptera: Empididae) from central and northeastern Turkey. *Journal of the Entomological Research Society*, 22(2), 211-218.

INTRODUCTION

Hilara Meigen is a complex and the most difficult Palaearctic genus of Empididae to distinguish and identify species because of the large number of described species and the lack of distinctive differential characters and uniform appearance (Chvála, 2005; Chvála & Merz, 2009). By the absence of metapleural bristles, long and acute radial fork (R_{4+5}) and swollen fore basitarsus, the genus *Hilara* may easily be recognized (Chvála, 1994).

A few researchers have tried to make species groups for easier identification of this difficult genus (Strobl, 1892; Collin, 1961; Chvála, 2005). As a result, Chvála divided the genus *Hilara* into 14 species groups with his studies (Chvála, 2005, 2008; Chvála & Merz, 2009). In this study, three new species are described and are assigned to the following three species groups: *Hilara interstincta*-group, *Hilara abdominalis*-group and *Hilara maura*-group.

MATERIAL AND METHODS

This study is based on 23 male and 15 female dried and pinned specimens collected from central (Sivas province) and northeastern (Ardahan province) Turkey in 2013 and 2019. For illustration, the male genitalia and fore legs were dissected and cleared in 10% KOH for 24 h at 30 °C. All figures were drawn using a binocular microscope with an ocular grid. After drawing, all parts were stored in small capsules with glycerol and pinned beneath the specimens. In this study, the morphological nomenclature of McAlpine (1981), Stuckenberg (1999) and Sinclair (2000) were followed.

The specimens were collected by A. Hasbenli, D. Çiftçi, M.C. Çiftçi and Ş.B. Can during field studies within the scope of baseline data collection studies (2013) for the environmental impact assessment and post-construction monitoring (2019) for the Trans Anatolian Natural Gas Pipeline Project (TANAP) and are stored in the Zoological Museum of Gazi University (ZMGU).

RESULTS

Hilara ardahanensis Çiftçi and Can sp. nov.

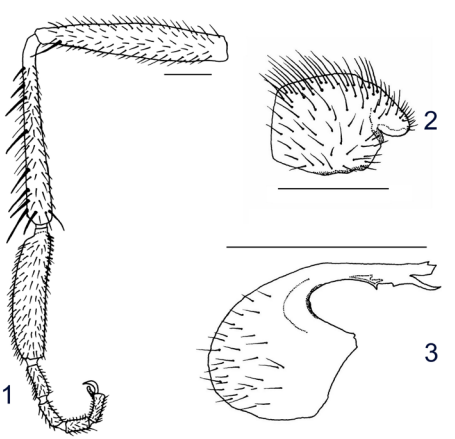
Diagnosis. Large, yellowish species of *H. abdominalis*-group with dense grey dusting. Body about 5.5-6.1 mm long, legs mostly yellow colored. Scape and pedicel yellow, postpedicel black. Palpus yellow with 1 long preapical bristle. Halter completely yellow. Male fore basitarsus slightly thickened, slightly broader than tip of the fore tibia. Basal segments of abdomen yellowish.

Description. *Male*. Face and frons black with grey dusting. Frons almost as wide as postpedicel, face slightly wider than frons. Ocellar bristles long, frontal bristles shorter than ocellar pair. Occiput densely grey dusted, occipital bristles black. Scape and pedicel yellow, postpedicel black. Stylus as long as postpedicel. Palpus yellow, ventrally with black hairs and 1 long preapical bristle. Labrum shiny black and longer than half length of head.

Thorax black with densely grey dusting. Humeral area lower part of postalar area and pleural stur yellow. Hairs and bristles on thorax black. Scutum with 2 black stripes between acrostichal and dorsocentral bristles in frontal view. Acrostichal and dorsocentral bristles short, hair-like, becoming longer and thicker posteriorly. Acrostichal bristles 4-serial, longer dorsocentral bristles uniserial and ending with 2 rather long prescutellar pairs. Large marginal bristles long: 1 fine humeral, 2 fine intrahumerals, 1 posthumeral anteriorly with 2-3 short hairs, 3 notopleurals, 3-4 fine supra-alars, 1 postalar and 3 pairs of scutellar bristles. Prothoracic collar with black bristle on each side, between them with row of small spine-like black hairs. Proepisternum and sides of prosternum with fine, very short black hairs.

Wing almost clear, slightly brownish, veins brownish lighter colored on basal half. Anal vein only distinct at base. Pterostigma long, slightly brownish, basal costal bristle long and strong. Squamae and margin yellow, fringes long and yellow, black on basal half. Halter completely yellow.

Legs long, yellow; apical half of tibiae and tarsal segments brownish. Coxae slightly grey dusted. All hairs and bristles on legs black, only fore coxa with pale hairs on basal half. All femora with short hairs, anterior row on mid femur and anteroventral row and dorsal hairs on hind femur slightly longer and thicker. All tibiae with short hairs and preapical circlet of bristles long and distinct. Fore tibia dorsally with 1 row of bristles. Mid tibia posterodorsally with 1 row of thin bristles. Hind tibia dorsally and anteroventrally with long bristle-like hairs. All tarsal segments with dense short hairs. All basitarsi ventrally with short spine-like bristles. Fore basitarsus (Fig. 1) clearly shorter than fore tibia, parallel-sided and slightly broader than tip of fore tibia.



Figs. 1-3. *Hilara ardahanensis* 1. Fore leg (scale: 0,3 mm); 2. Epandrial lamella (scale: 0,5 mm); 3. Hypandrium (scale: 1 mm).

Abdomen densely grey dusted; terga brownish yellow, first three sterna completely yellow, other sterna at margins yellow with middle parts blackish. Hairs on terga black, hairs on sterna short and yellow. Hind marginal bristles short but distinct. Hypandrium

(Fig. 3) small, shiny black and forked at tip. Epandrial lamella (Fig. 2) large apically with dense hairs and wide finger-like apical process.

Holotype male body length: 6 mm, wing length: 6.9 mm. Paratypes body length: male 5.8-6.1 mm; wing length: male 6.7-6.9 mm.

Female. Unknown.

Type material. Holotype: Turkey, ♂, Ardahan, Posof, SW of Yeniköy, 2075m, 41° 26' N / 42° 47' E, 24.07.2013, leg. A. Hasbenli and D. Çiftçi, det. M.C. Çiftçi (ZMGU). Paratypes: 2♂♂, same locality and date as holotype (ZMGU).

Derivatio nominis. This species is named after Ardahan Province, where the type material was collected.

Remarks. When Chvála's (2005, 2008) keys are used for the diagnosis of the species, *Hilara ardahanensis* leads to the species *Hilara comes* Collin and *Hilara cypriana* Chvála in the 2008 key and using the 2005 key, the species runs to *Hilara abdominalis* Zetterstedt and *Hilara allogastra* Chvála. The presence of a row of small spine-like black hairs between black bristles on each side of the prothoracic collar and the absence of long dorsal hairs or bristles of the male fore basitarsus clearly differentiate *H. ardahanensis* from *H. comes* and *H. cypriana*. When we look at the genitalia (epandrial lamella and the tip of hypandrium) and the above mentioned properties, *H. ardahanensis* is more similar to *H. abdominalis* and *H. allogastra*. *Hilara ardahanensis* is clearly differentiated from *H. abdominalis* with characters such as the male fore basitarsus clearly shorter than the fore tibia, tarsomere 2 of fore leg is not larger than the other tarsomeres and the scape and pedicel are yellow. *Hilara ardahanensis* is differentiated from *H. allogastra* by these characters: frontal bristles shorter than ocellar bristles, halteres completely yellow, male fore basitarsus shorter and less swollen, hind femur with row of anterodorsal bristles and differences in genitalia structure.

***Hilara elifae* Çiftçi and D. Çiftçi sp. nov.**

Diagnosis. Large species of *H. interstincta*-group, body about 4.8-5.9 mm long and completely dull black with slightly brownish dusting species. Antenna blackish brown with slightly grey dusting, stylus nearly as long as postpedicel. Palpus covered with dense black hairs and ventrally with 4-5 long black bristles. Halter, palpus and all legs completely black. Male fore basitarsus swollen, dorsally with 1-2 fine bristles.

Description. *Male*. Frons black with slightly greyish brown dusting, as wide as half-length of postpedicel. Face wider than frons and lower edge slightly shiny. Pair of ocellar bristles as long as postpedicel with stylus, frontal bristles slightly shorter than ocellar pair. Occiput dull black, occipital bristles black. Antenna black, stylus nearly as long as postpedicel, postpedicel slightly grey dusted. Palpus with dense black hairs and ventrally with 4-5 long bristles. Labrum shiny black, scarcely shorter than height of head.

Thorax black, slightly shiny, pleura with grey and scutum slightly brownish dusted. Hairs and bristles on thorax black. Scutum slightly brownish dusted in frontal view, dull black in dorsal view. Acrostichal bristles widely spaced, 4-serial, almost as long as stylus. Dorsocentral bristles uniserial, distinctly longer than acrostichal bristles

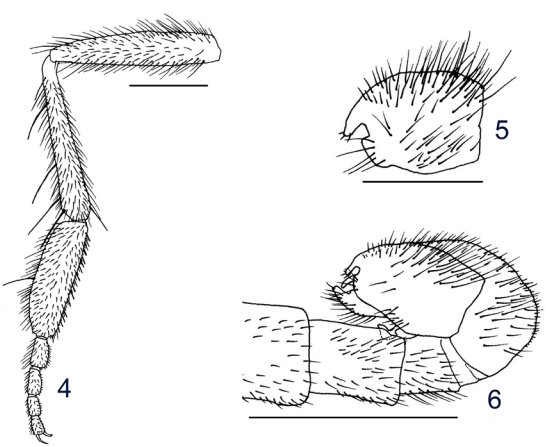
and ending with 2 long prescutellar pairs. Large marginal bristles long: 1 humeral, 1 intrahumeral, 3 posthumerals, 3 notopleurals, 2 supra-alars, 1 postalar and 2 pairs of scutellar bristles. Notopleural depression anteriorly with fine, short black hairs. Prothoracic collar with black bristle on each side between them with row of small black hairs. Proepisternum and prosternum with fine, short black hairs.

Wing brownish with distinct black veins. Pterostigma long and brownish black, basal costal bristle long and strong. Anal vein only distinct at base. Squamae brownish with dark blackish margin and fringes black. Halter completely black.

Legs long and black, slightly grey dusted, only base of tibiae brownish. All hairs and bristles black. Femora with short black hairs, fore and mid femora dorsally with slightly longer hairs, fore femur posteroventrally with 1 long, fine preapical hair. Mid femur with 5 long anterior bristles and 2 longer and fine anteroventral bristles on apical part. Hind femur anteroventrally and posteroventrally with 1 long and fine bristles. All tibiae with short hairs and distinct preapical circlet of bristles. Fore tibia dorsally with 4 long bristles, mid tibia ventrally with 2 bristles on basal half and dorsally on apical half with 3 long, strong bristles. Hind tibia with row of dorsal and anteroventral long bristles. Tarsal segments with dense short hairs. Fore basitarsus (Fig. 4) thickened, slightly broader than the apex of fore tibia and shorter than fore tibia, dorsally with 1-2 long bristles.

Abdomen brownish black. Abdominal hairs black, only marginal hairs on terga fine and brownish. Sterna with very short hair. Hind marginal bristles distinct but not very long. Genitalia (Figs. 5-6) large and densely covered with hairs. Hypandrium small but epandrial lamella very large and convex.

Holotype male body length: 5.8 mm, wing length: 6.1 mm. Paratypes body length: male 5-5.9 mm; female 4.8-5.5 mm, wing length: male 5.8-6.2 mm; female 5.3-5.8 mm.



Figs. 4-6. *Hilara elifae* 4. Fore leg (scale: 0,5 mm); 5. Epandrial lamella (scale: 0,5 mm); 6. Post abdomen (scale: 1 mm).

Female. General appearance as in male, only hairs and bristles on legs shorter than in male. Wings slightly shorter, squamae lighter colored with pale fringes. Acrostichal

and dorsocentral bristles equally long. Hind tibia slender and simple. Abdominal hairs shorter and lighter colored, hind marginal bristles shorter than in male.

Type material. Holotype: Turkey, ♂, Ardahan, Posof, SW of Yeniköy, 2075m, 41° 26' N / 42° 47' E, 24.07.2013, leg. A. Hasbenli and D. Çiftçi, det. M.C. Çiftçi (ZMGU). Paratypes: 9♂♂, 12 ♀♀, same locality and date as holotype (ZMGU). 2 ♂♂, 1♀, Ardahan, Posof, SW of Yeniköy, 2075m, 41° 26' N / 42° 47' E, 06.08.2019, leg. A. Hasbenli and Ş.B. Can, det. M.C. Çiftçi (ZMGU).

Derivatio nominis. This species named after Dr. Elif Manav (ÇINAR Engineering Consulting Inc., Ankara) who worked as the ecology coordinator in Trans Anatolian Natural Gas Pipeline Project (TANAP) Environmental Impact Assessment Study.

Remarks. Considering the completely black and large body, unstriped greyish dusted scutum, widely spaced and 4-serial acrostichals and male fore basitarsus shorter than fore tibia, *Hilara elifae* is very similar to *H. anglodanica* Lundbeck in *H. interstincta*-group. *Hilara elifae* leads to *H. anglodanica* in Chvála's (2008) identification key. *H. elifae* is clearly separated from *H. anglodanica* by the following characters: labrum longer (nearly as long as height of head), posterior four tibiae without spine-like anterior bristles, clearly shorter fore basitarsus in male and the shape of male genitalia.

***Hilara hasbenlii* Çiftçi sp. nov.**

Diagnosis. Medium-sized species of *H. maura*-group, body 3.5-3.9 mm long. Legs short and robust, brownish black. Body subglossy with slightly grey dusting, bristles on body very reduced. Halter black, antennal stylus short and stout. Scutum subglossy, slightly brownish dusted without stripes. Acrostichal and dorsocentral bristles rather short, acrostichals biserial, dorsocentrals uniserial. Abdominal hairs short and black.

Description. *Male*. Face and frons wide, dull black with grey dusting, except edges of frons shiny. Ocellar bristles almost as long as postpedicel with stylus, frontal bristles little shorter than ocellar bristles. Occiput dull black from any point of view, occipital hairs black, upper postocular bristles little shorter than frontal bristles, lower part of occiput below neck with shorter and finer pale hairs. Antenna black, postpedicel long, stylus stout and half length of postpedicel. Palpus black, slightly grey dusted with 2 preapical bristles as long as frontal bristles, palpus ventrally with yellowish hairs on basal half and black hairs on apical half. Labrum short, shorter than half-length of height of head.

Thorax black, pleura densely grey dusted, scutum slightly shiny with grey and brownish dusted, without stripes and slightly shinier in frontal and dorsal views. Acrostichal and dorsocentral bristles rather short and hair-like, acrostichal bristles narrowly spaced, biserial, dorsocentral bristles uniserial, and ending with pair of somewhat long prescutellar bristles. Large marginal bristles short and fine: 1 very fine humeral, intrahumeral and posthumeral bristles absent, 3 notopleural, 1 supra-alar, 1 postalar and 2 pairs of scutellar (inner pair longer) bristles. Notopleural depression with short fine yellowish hairs. Prothoracic collar, prosternum and prothoracic episterna with yellowish hairs, prothoracic collar without bristles at sides, sensory pit below prothoracic spiracle guarded by long white hairs.

Wing almost clear, slightly brownish, more brownish on costal area. Veins dark brown, anal vein only distinct at base, not reaching wing margin. Pterostigma long

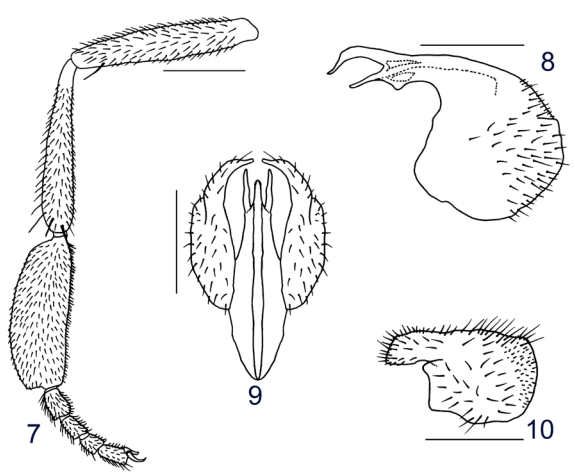
and brownish, basal costal bristle shorter than prescutellar pair. Squama brownish black with yellowish fringes. Halter completely black.

Legs stout and simple, brown to brownish black with lighter colored “knees”. Coxae greyish dusted, especially fore coxa lighter brown. Coxae with yellowish hairs and lower parts with longer hair. Legs with black and yellow rather short hairs. Bristles almost absent. Femora with short hairs, mid femur anteriorly with row of fine and short hairs, only 1 basal bristle distinct and bristle-like. Hind femur not thickened. Tibiae with short hairs, preapical circlet of bristles short and hair-like, only dorsal pair on fore tibia long and bristle-like. Hind tibia dorsally with row of bristle-like hairs slightly longer than depth of hind tibia. Tarsal segments with short pubescent-like hairs. Fore basitarsus (Fig. 7) swollen, twice as wide as tip of fore tibia and almost as long as fore tibia.

Abdomen blackish brown colored, slightly shiny and dusting considerably reduced. Abdominal hairs brown and black, very short, first two segments with longer hairs. Hairs on sterna yellow and quite reduced. Hind marginal bristles absent. Genitalia (Figs. 8-10) covered with thin black hairs. Tip of hypandrium (Figs. 8-9) at middle with two hooked shaped processes bent upwards, ventrally slightly enlarged and tip simple and pointed. Apical projection of epandrial lamella (Fig. 10) long and broad.

Female. General appearance as in male, hairs and bristles on head much shorter than in male, legs darker colored, anterior row of hairs on mid femur more distinct Hind tibia slender and simple. Abdominal hairs yellowish and shorter.

Holotype male body length: 3.8 mm, wing length: 3.9 mm. Paratypes body length: male 3.6-3.9 mm; female 3.6 mm, wing length: male 3.6-4 mm; female 3.7 mm.



Figs. 7-10. *Hilara hasbenlii* 7. Fore leg; 8. Hypandrium; 9. Hypandrium and Epandrial lamella in dorsal view; 10. Epandrial lamella. Scale: 0.3 mm.

Type material. Holotype: Turkey, ♂, Sivas, Yıldızeli, Belcik village, 1260 m, 39° 49’ N / 36° 15’ E, 17.06.2013, leg. A. Hasbenli and D. Çiftçi, det. M.C. Çiftçi (ZMGU). Paratypes: 4 ♂♂, 1♀, same locality and date as holotype (ZMGU). 3 ♂♂, 1♀, Sivas, Yıldızeli, Belcik village, 1260 m, 39° 49’ N / 36° 15’ E, 24.05.2019, leg. A. Hasbenli and M.C. Çiftçi, det. M.C. Çiftçi (ZMGU).

Derivatio nominis. The species is named after the collector of the type specimens, Turkish dipterist and the authors mentor, Prof. Dr. Abdullah Hasbenli.

Remarks. When Chvala's (2005) key is used for the diagnosis, *Hilara hasbenlii* leads to *H. discalis*. While it is similar to *H. discalis* with biserial acrostichal bristles, uniserial dorsocentral bristles, yellowish fore coxa and the hind tibia in females slender and simple, it differs from this species with its dull black, partly grey dusted frons, narrow spaced biserial acrostichals, a pair of prescutellar bristles more distinct, longer fore basitarsus and differences in genitalia structure. Tip of hypandrium of *H. hasbenlii* similarly shape with *H. brevistyle*, but this species is in the *Hilara chorica*-group of species and morphologically very different with *H. hasbenlii*.

ACKNOWLEDGEMENTS

These findings were obtained from field studies carried out within the TANAP Project. The authors wish to thank the TANAP Natural Gas Transmission Inc. for their financial support and ÇINAR Engineering Consulting Inc. for conducting Environmental Impact Assessment studies and ENVY Energy and Environmental Investments Inc. for conducting post-construction monitoring. Also we thank Prof. Dr. Abdullah Hasbenli for collecting specimens.

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Received: March 31, 2020 *Accepted: June 26, 2020*

J. Entomol. Res. Soc., 22(2): 219-225, 2020 *Research Article*
Print ISSN:1302-0250 *Online ISSN:2651-3579*

A New Species of *Tipula*, Subgenus *Lunatipula* From Turkey (Diptera, Tipulidae)

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ABSTRACT

The specimens in this study were obtained in the Environmental Impact Assessment study (EIA) in 2013 and post-construction monitoring study in 2019 within the scope of the Trans Anatolian Natural Gas Pipeline (TANAP) project. As a result of the studies *Tipula* (*Lunatipula*) *tanap* sp. n. Koç & Can is described and diagnostic characters are illustrated. The distributions of new species are mapped. It distinguished from related congeners by the difference of ovipositor and sternite 8 shape of the ventral process of the aedeagus.

Key words: Diptera, TANAP, *Tipula*, *Lunatipula*, Crane flies, Palearctic, Turkey.

Çağlar, Ü., Çİftçİ, D., Can, Ş.B., & Koç, H. (2020). A new species of *Tipula*, Subgenus *Lunatipula* from Turkey (Diptera, Tipulidae). *Journal of the Entomological Research Society*, 22(2), 219-225

INTRODUCTION

Tipulidae family are known as the crane flies. Adults are short-lived and found in moist and shady areas such as meadows, shrubs or forests where they feed on plant sap and nectar. Larval periods can be one year or longer. They generally live in semi-aquatic or terrestrial environments (Oosterbroek & Theowald, 1992).

Tipulidae, which includes mosquitoes of medium and large body size, is one of the well-known Diptera families in the world. In adults, rostrum often developed with nasus. Ocel eyes are absent. Antennae have 13 segments; some species may have more segments. The V-shaped mesonotal stur located in the dorsal of the thorax and the 2 anal veins on the wings are its outstanding features (Oosterbroek, 2006).

The family Tipulidae is represented in the world by 4321 taxa. There are more than 30% of these species (1360 species and subspecies) in the Palearctic region. Also, 521 taxa are recorded from Europe (Oosterbroek, 2020). The number of species known from Turkey has been increased significantly in recent years. So, the number of known Tipulidae taxa from Turkey are rise to 161 (Koç, Özgül & Hasbenli, 2015).

MATERIAL AND METHODS

Specimens of new species were collected from provinces of Ardahan, Gümüşhane and Sivas during the studies on the Trans Anatolian Natural Gas Pipeline (TANAP, passing through 20 provinces and having 1805 km line) in 2013 and 2019.

The adults in the study area were collected usually by sweeping method with the help of 40 cm in diameter swep net. Genital preparations of some of the specimens brought to the laboratory for diagnosis were made. These genitals were then placed in small capsules filled with glycerin and attached to the needles of the specimens.

The genital structures were drawn under a stereoscopic microscope (Olympus SZX-7) with the aid of a drawing tube. Photographs of the habitus and some part of aedeagus were taken at different depths with a digital camera Olympus E330. All photographs were edited with Helicon Focus v. 3.1. The map was created in ArcGIS 10.1 program.

Terminology of morphological features follows that of McAlpine (1981) and H. De Jong (1997). The materials referred to in this study are stored at Muğla Sıtkı Koçman University, Faculty of Science, Department of Biology, Zoology Research Laboratory.

RESULTS

Tipula (*Lunatipula*) *tanap* sp. n. Koç & Can (Figs. 1-12)

Material examined: Holotype**:** Turkey: Ardahan, Hanak, Baştoklu Village, 1996 m, 38T 314332 E/ 4562989 N, 23.07.2013, leg. Koç, 1 ♂; Holotypus, *Tipula* (*Lunatipula*) *tanap* sp. n. det. Koç (Muğla Sıtkı Koçman University, Faculty of Science, Department of Biology, Zoology Research Laboratory) 1 ♂.

Paratypes**:** Ardahan, Hanak, Baştoklu Village, 1996 m, 38T 314332 E/ 4562989 N, 23.07.2013, leg. Hasbenli, 8 ♂♂, 2 ♀♀; Ardahan, Baştoklu Village, 1958 m, 38T 313279 E/ 4562538 N, 23.07.2013, leg.

Çağlar, 3 ♂♂, 1 ♀; Ardahan, Alaçam, 2026 m, 38T 314356.94 E/ 4563169.14 N 27.07.2019, leg. Can 5 ♂♂, 1 ♀; Ardahan, Posof, Çamyazı Village, 2453 m, 38T 314397 E/ 4590645 N, 24.07.2013, leg. Koç, 4 ♂♂; Ardahan, Yeniköy, 1975 m, 38T 315805 E/ 4592457 N, 24.07.2013, leg. Koç, 3 ♂♂, 2 ♀♀; Ardahan, Derinsu, 1419 m, 38T 316595 E/ 4601085 N, 24.07.2013, leg. Çağlar, 2 ♂♂; Ardahan, Yeniköy, 2088 m, 38T 315759 E/ 4591741 N, 24.07.2013, leg. Hasbenli, 1 ♂; Sivas, İmranlı, Beğendik Village, 1635 m, 37S 416407 E/ 4415399 N, 19.06.2013, leg. Çağlar, 4 ♂♂; Sivas, Kapumahmut, 1690 m, 37S 430415 E/ 4418174 N, 20.06.2013, leg. Koç, 4 ♂♂, 2 ♀♀; Sivas, Kapumahmut, 1675 m, 37S 430507 E/ 4418198 N, 20.06.2013, leg. Çiftçi, 4 ♂♂; Sivas, Imranli, Kılıçköy Village, 1672 m, 37S 412446.28 E/ 4414439.15 N, 29.06.2019, leg. Koç, 1 ♂; Gümüşhane, Kelkit, Belenli Village, 2100 m, 37S 540966 E/ 4422098 N, 17.07.2013, leg. Koç. 1♂.

Male description: Habitus as in Fig. 1. Body length: 9-11 mm, antennal length: 4,5-5 mm, wing length: 12-14 mm.

Rostrum well-developed, yellowish brown. The behind of the eyes, forehead and vertex greyish brown. Basal segments of the antennas yellowish brown, flagellar segments yellowish brown to brown, but in some specimens the 1st flagellar segment yellowish brown. Flagellar segments cylindrical with the base slightly thickened. Circlet setae on flagellar segments shorter than the segments. Palp segments brown, the last one blackish brown. Nasus small.

Thorax usually greyish brown. Catepisternum and anepisternum gray to brown, dorsal parts darker. Prescutum stripes uncertain. Coxae, trochanters and femora basally greyish brown. The other leg parts brown to brownish black towards the tip. Spurs distinct, spur formula 1.2.2. Wing membrane greyish white and anterior parts light yellowish. Veins are brown, pterostigma indistinct, light yellowish brown. Discal cells small as in *Mediotipula* species and its length approximately 1,5 times its width. Petiole of veins M_{1+2} longer than m-cu. Squama with several short bristle. A_2 and Cu veins ends with curved, not straight.

Abdomen yellowish brown, dorsally somewhat darker in the middle of tergites. Hypopygium slightly wider than abdomen (Fig. 2). Sternite 8 appendages developed with pair of apical thorns that bend strongly against each other. Between these appendages, as in the *peliostigma*-group, covered with 3-4 setae transversely standing. Hind margin of sternite 8 have a bundle of yellow brown setae (Fig. 3).

Appendages of sternite 9 pillow-shaped, narrowed towards to apically, covered with setae, fleshy and two-lobed (Fig. 4). Hind margin of tergite 9 slightly indentation in the middle with a small thorn, laterally with developed lobes that extending awards (Figs. 5).

Fig. 1. Habitus of *Tipula* (*Lunatipula*) *tanap* sp. n. Koç & Can

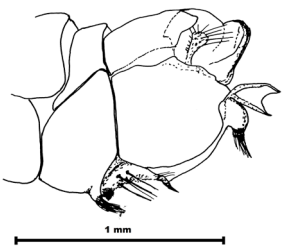


Fig. 2. Hypopyg (lateral view).

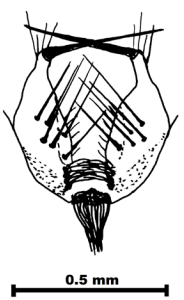


Fig. 3. Hind margin of sternite 8 and appendages (posterior view).

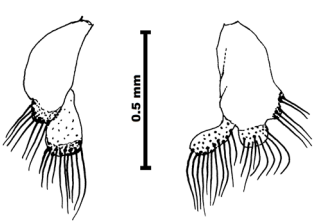


Fig. 4. Appendages of sternite 9 (posterior view).

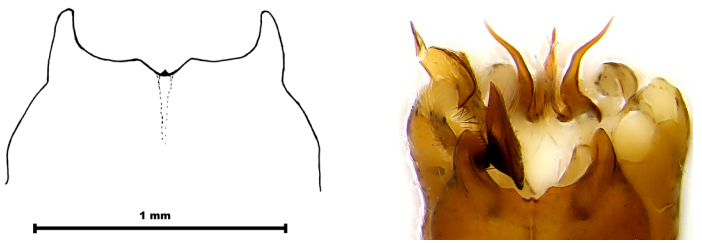
Outer gonostylus ax-shaped, leathery, anteriorly and dorsally covered with long prickly setae. Also, outer gonostylus a little protruding towards anterodorsally. Inner gonostylus wide, apically blunt, posteriorly notched and curved (Fig. 6). Adminiculum structures similar to *lunata* species group (Fig. 7).

Female Description: Body length: 9-10 mm, antennal length: 3,5-4 mm, wing length: 11-12 mm.

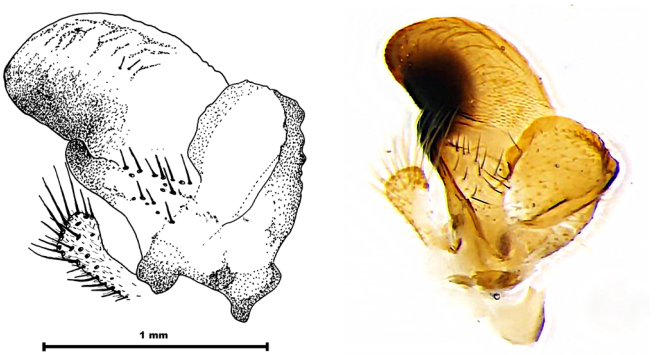
General coloration and appearance of female as in male but a little smaller than male. Female wing as in male, without folding or reduction. Ovipositor with long cerci, gradually tapering towards tip, and end of hypovalve blunt (Fig. 8).

Etymology: This species is named after the Trans Anatolian Natural Gas Pipeline (TANAP), the environmental baseline field studies for which provided the opportunity and financial support for the collection of the type materials.

Habitat: Specimens of the new species were collected from underneath bushy plants like wild pear, rose and berberis in meadows and forest areas.



Figs. 5. Tergite 9 (dorsal view). a. Drawing b. Photo of tergit and adminiculum



Figs. 6. Internal and external gonostylus (lateral view). a. Drawing b Photo

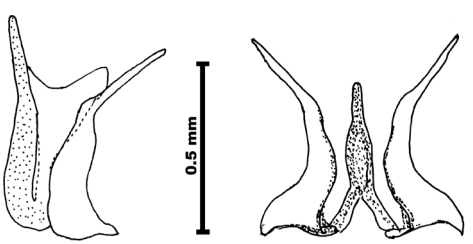
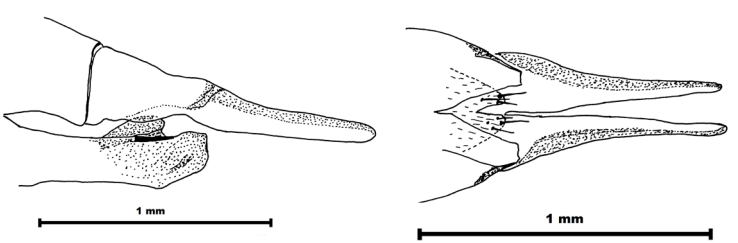


Fig. 7. Adminiculum (posterior and lateral view).



Figs. 8 . Ovipositor a. lateral view b ventral view

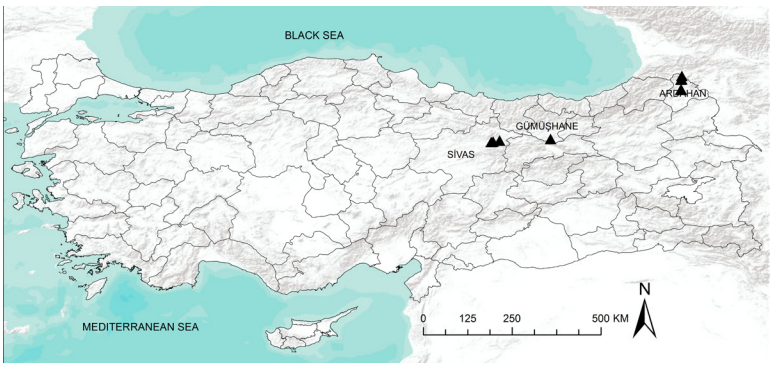


Fig. 9. Provinces in which *Tipula* (*Lunatipula*) *tanap* sp. n. Koç & Can was determined.

CONCLUSIONS AND DISCUSSION

The new species *Tipula* (*Lunatipula*) *tanap* sp. n. Koç & Can belongs to the *phaidra* species group of the subgenus *Lunatipula*. Today, 6 species are known from the western Palearctic region belonging to this group: *T*.(*L*.) *bulbosa*, *T*.(*L*.) *phaidra*, *T*.(*L*.) *cressa*, *T*.(*L*.) *circe*, *T*.(*L*.) *sciurus* and *T*.(*L*.) *lyrion* (Mannheims, 1965; Theischinger, 1977, 1987).

Tipula (*Lunatipula*) *tanap* sp. n. Koç & Can is included in this group because hind margin of sternite 8 with bristle bundle, sternite 8 appendages inter closes as a form of basket and sternite 9 appendages pillow-shaped. The other similarities with the species of the group are that wing squama thorny, spur formula 1.2.2 and secondary teeth of claws in male.

T. (*L*.) *tanap* sp. n. is distinguished from the *peliostigma* group species with a bunch of bristle in the middle of hind margin of sternite 8. In addition, this new species is easily separated from the *acuminata* group species by appendages of sternite 9 pillow-shaped and narrowed towards to apically. It is similar to the *peliostigma* group species due to the fact that it's the sternite 8 appendages inter is similar to a form of a basket.

The new species is similar to *Tipula* (*Lunatipula*) *cressa* from the *phaidra* group in terms of bristel bundles and inter of appendages on the hind margin of tergite 9 and sternite 8.

However, the females of new species are easily separated from *Tipula* (*Lunatipula*) *cressa* with their normal wings and ovipositor structure. In addition, there are fewer spiky setae (3, rarely 4) that cover the gap of sternite 8 appendages.

The new species is included in the *phaidra* species group. Thus, with the addition of the new species, the number of taxa defined in this group became two in Turkish fauna. On Hasan Mountain, located in the Central Taurus Mountains, *T.* (*L*.) *sciurus* has been previously described (Theischinger, 1977). The number of Tipulidae taxa in with the new species has risen to 162 in Turkey. This situation shows that Turkey is rich in fauna and reveals other new species in Tipulidae family in later times can be identified.

ACKNOWLEDGMENTS

The specimens belonging to the new species identified in this study were collected during the field studies conducted within the scope of the Trans Anatolian Natural Gas Pipeline Project. Therefore, we would like to thank TANAP Inc. for its financial support and for this opportunity. We would also like to thank ÇINAR Engineering Consulting Inc. (2013) for conducting EIA studies and ENVY Energy and Environmental Investments Inc. (2019) for conducting post-construction monitoring. We also would like to thank Professor Dr. Abdullah HASBENLI (Ankara, Turkey) for collecting specimens of the new species during the studies.

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Theischinger, G. (1987). Neue Taxa von *Lunatipul 1987* Edwards aus der mediterranen Subregion der Palaearktis (Diptera, Tipulidae, *Tipula* Linnaeus). V. Fortsetzung, *Beaufortia*, 37, 99-120.

Received: April 05, 2020 *Accepted: May 26, 2020*

AUTHOR GUIDELINES

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The manuscripts should be written in Arial with 12 type size with double spacing in Microsoft Office Word. The paragraphs should not be indented. The Manuscripts in general should not exceed 30 pages.

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For faunistic research follow this order, Distribution:., Material examined:…, Host plant:….etc.

Example:
Sphex oxianus Gussakovskij, 1928
Distribution: Central and South West Asia, Afghanistan, Iran, Israel, Turkey (Bohart and Menke, 1976; Menke and Pulawski, 2000; Kazenas, 2001), Turkey: Artvin (De Beaumont, 1967).
Material examined: Ankara, Altındağ, Çubuk Dam Lake, 900 m, 29.06.1998, 1 ♂; Kalecik, 600 m, 24. 07. 2001, 2 ♀♀, Kalecik, 800 m, 25. 07. 2001, 3 ♀♀
Host plant: Echinophora sp.
Please use ♀, ♂ symbols. Please write upper genus categories with capital letters.

Illustrations: Illustrations, graphs, their caption or legends should form a separate, and a self-explanatory unit. Abbreviations in the legends should be explained but if there are too many, they should be included into a separate list. The original drawing and photographs should not be more than twice as large as when printed.

Morphological illustrations should include a scale bar. Photographs and electron micrographs should be in high-resolution JPEG file format (300 dpi). Drawings (black and white type) should be in TIFF format and their size should be no more than 10 MB. Graphs should also be in black and white and submitted in excel file format. Tables should include headings and explanations, and should be numbered consecutively. Their approximate position in the text should be indicated in the margin. Legends and titles of the graphs and tables should be in Arial with 12 type size. Please do not embed the figures, graphs and table into the text, and send them as supplementary files. In the text attribution to the figures should be given in parenthesis and must be abbreviate like this; (Fig.1).Figs. 1-10. A. marriotti sp. n.. 1. Male (holotype), dorsal. 2. Female (paratype)

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Book

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Edited Book

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