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Pupal Parasitoids of the Hessian Fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae) in Cereal Fields in Northern Cyprus

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Abstract

The Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), is the primary pest insect affecting barley and wheat fields in Northern Cyprus. This research aimed to identify the pupal parasitoids of *M. destructor*. Field studies were conducted in three locations representing Lefkoşa, Girne, Güzelyurt, Gazimağusa, and İskele during the cereal production seasons of 2012-2013. In each field, 100 plants were uprooted and placed in plastic bags, then kept in boxes covered with nets in the laboratory at 25±1°C and 65±5% relative humidity during the spring season. As a result of the studies revealed *Arthrolytus maculipennis* (Walker), *Meraporus graminicola* Walker (Pteromalidae), and *Eupelmus microzonus* Folster (Eupelmidae) species from the Hymenoptera order (Chalcidoidea). *A. maculipennis*, with a prevalence rate of 59.6%, was found to be widespread and predominant, followed by *M. graminicola* at 22.8% and *E. microzonus* at 17.6%. While *E. microzonus* was newly recorded in the fauna of Cyprus, both *A. maculipennis* and *M. graminicola* were documented for the first time in this study in the Cyprus fauna.

Keywords: Hessian fly, *Mayetiola destructor*, pupal parasitoid, Northern Cyprus

INTRODUCTION

The cereal cultivation has an important share in agricultural areas in Northern Cyprus. Of the 880,446 decares of arable land, 660,380 decares consist of cereal (Anonymous, 2019). Among cereals, barley ranks first with a share of 82.5%, followed by wheat with 17%. Known as the Hesse fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae) is one of the most significant pests in cereal fields in Cyprus.

The Hessian fly is considered a serious pest in all areas where barley and wheat grow. If this pest is not controlled, it can cause significant yield losses in both barley and wheat (Painter, 1951; Lafever et al., 1980; Wellso et al., 1987; Chapin et al., 1989; Lhaloui et al., 1992; Buntin, 1999). Therefore, the population of the Hessian fly is regularly monitored in North America and Western Mediterranean countries. Especially, in Morocco, losses attributed to *M. destructor* have been recorded at 42% in bread wheat (*Triticum aestivum* sub. sp. *aestivum* L.) and 32% in durum wheat (*T. turgidum* sub. sp. *durum* L.) (Lhaloui et al., 1992a; Lhaloui et al., 1992b). Although the biological development of the Hessian fly varies from region to region, the pest produces 2-3 generation per year (Lhaloui, 1995; Konuksal et al., 2016). The females of *M. destructor* live for 1-4 days (Bergh et al., 1990; Harris and Rose, 1990). Larvae, hatched from approximately 250-300 elliptical, red-orange-colored eggs laid on the upper surface of cereal leaves, begin feeding within leaf sheaths within 12-24 hours (Hamilton, 1966).

There are three larval stages, during which the first and second stage larvae feed, and these two stages last approximately 2-3 weeks (Foster and Hein, 2009). The mature larval (third instar) and pupal stages vary between 7 and 35 days, depending on environmental factors. Damaged plants become dark green and remain stunted, causing them to dry out in the future.

The lack of sufficient knowledge about the biology of the insect and uncertainty about the timing of spraying reduce the success of chemical applications. Therefore, methods such as cultivating resistant varieties, late sowing, and controlling weeds should be preferred.

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Alongside these, biological control agents are also important in suppressing the population of the fly. So far, 55 species belonging to the families Aphelinidae (3), Encyrtidae (1), Eulophidae (9), Eupelmidae (6), Eurytomidae (3), Pteromalidae (25), and Torymidae (8) of the order Hymenoptera, superfamily Chalcidoidea, have been identified as egg, larval, and pupal parasitoids of the Hessian fly, which is found in many parts of the world.

This study was carried out to determine the pupal parasitoids of *M. destructor*, which was the main pest in Northern Cyprus cereal fields during the 2012-2013 cereal production season.

MATERIALS and METHODS

The studies were conducted three each fields representing the districts of Lefkoşa, Girne, Güzelyurt, Gazimağusa, and İskele between February and March during the 2012-2013 cereals production season. Samples were collected from 10 different parts of each field with 10 infected plants with their roots. Plants with pupae were distinguished under stereo-microscope. Then, the upper part of these plants was by cut (15 cm above the root collar), only root section was cultured in plastic jars with mesh-covered openings, maintained at a temperature of 25°C and a relative humidity of 60±10% in the laboratory. The obtained adult parasitoids were preserved in 70% ethyl alcohol for diagnostic purposes.

RESULTS and DISCUSSION

A total of 57 parasitoids were reared from pupae of Mayetiola destructor (Say) (Diptera: Cecidomyiidae) from barley fields of Northern Cyprus (Lefkoşa, Girne, Güzelyurt, Gazimağusa, and İskele) in the 2012-2013 cereals production season. The species obtained were *Arthrolytus maculipennis* (Walk.), *Meraporus graminicola* Walker (Pteromalidae), and *Eupelmus microzonus* Folster (Eupelmidae) species of the superfamily Chalcidoidea of Hymenoptera order. *Arthrolytus maculipennis* (Walk.) is known as a parasitoid of both *M. destructor* and *M. avenae* (Marchal) (Graham, 1969). When examining the distribution of this parasitoid worldwide, it is observed to be distributed in Bulgaria (Thuroczy, 1990), the Czech Republic (Kalina, 1989), France (Graham, 1969), Germany (Vidal, 2001), Hungary (Herting, 1978), Italy (Vidal, 1997), Moldova (Boucek, 1965), the Netherlands (Gijswijt, 2003), Russia (Tselikh, 2011), Spain (Garrido & Nieves Aldrey, 1999), Sweden (Hansson, 1991; Hedqvist, 2003), the United Kingdom (Boucek & Graham, 1978), and England (Thomson, 1958).

Hosts identified for the parasitoid include *Phorbia genitalis* (Schnabl, 1911) (Diptera, Anthomyiidae), *Clinodiplosis piceae* Kieffer, 1920, *Mayetiola destructor*, *M. avenae* (Marchal, 1895) (Diptera, Cecidomyiidae), and *Elachista klimeschi* Parenti, 1981 (Lepidoptera, Elachistidae) (Noyes, 2012). *A. maculipennis* was added to the insect fauna of the island for the first time in this study.

Meraporus graminicola was recorded in the Palearctic region, including Belgium, the Canary Islands, the Czech Republic, Denmark, the Faeroe Islands, Iran, Germany, Hungary, Iceland, Moldova, Morocco, the Netherlands, North Africa, Norway, Romania, Russia, Serbia, Slovakia, Spain, the Balearics, Sweden, Switzerland, the Transcaucasus, Ukraine, the UK, and the former Yugoslavia (Ghahari et al., 2015). This species has been reported as a parasite of *Mayetiola* sp. (Askew et al., 2001). *M. graminicola* was added to the insect fauna of Cyprus island for the first time through this study.

Eupelmus microzonus was found in the Nearctic (Canada) and Palaearctic regions (Gibson, 2011). Additionally, Noyes (2014) listed over 25 countries across the Palaearctic, including North Africa (Morocco) and the Middle East (Iran).

Noyes (2014) listed over 20 species of Cynipidae as well as five species of Eurytomidae (Hymenoptera), plus one or more species in Apionidae, Bruchidae, and Curculionidae (Coleoptera), Cecidomyiidae, Chloropidae, and Tephritidae (Diptera), and Lasiocampidae, Psychidae, and Pyralidae

(Lepidoptera). This species was reported in Cyprus (Anonymous, 2024). The number and relative abundance of pupal parasitoids obtained in the studies are shown in Table 1.

Table 1. *Pupal parasitoids species of Mayetiola destructor (Say) and their relative abundance*

Parasitoids	Number of species	Relative abundance
Arthrolytus maculipennis (Walk.)	34	59,6
Meraporus graminicola Walker	13	22,8
Eupelmus microzonus Folster	9	17,6

Among these species, *A. maculipennis* was identified as the most abundant and widespread, followed by *M. graminicola* and *E. microzonus*. Many species of Chalcidoidea (Hymenoptera) are known to attack the pupae of the Hessian fly. Morrill (1982) and Pike et al. (1983) reported that these parasitoids caused Hesse fly population reductions of 55%, 87%, and 98% in Georgia, Texas, and Washington cereal fields, respectively. Schuster and Lidell (1990) also recorded that parasitism rates in Texas wheat fields ranged from 0% to 87%. Larvae of the Hessian fly feeding on cereal roots cause the main damage. Since parasitization during the pupal stage mostly occurs in the spring population, it does not have a significant impact on preventing damage. However, it possesses biotic potential that can affect the decline of Hessian fly populations in the following season. Schuster and Lidell (1990) stated that parasitoids active in late spring do not protect the current crop but reduce the numbers of Hessian flies entering the summer season.

CONCLUSION

Arthrolytus maculipennis, *Meraporus graminicola* and *Eupelmus microzonus* species were identified as pupal parasitoids of *Mayetiola destructor* in Northern Cyprus. Among these specimens, *A. maculipennis* emerged as the most prevalent and abundant species. These parasitoids play a crucial role as effective biological adversaries in decreasing the Hessian fly population in subsequent growing seasons. Furthermore, it is evident that the cultivation of resistant varieties, post-harvest soil cultivation, combating with alternate host plants, and adjusting the timing of planting, along with reducing chemical usage, would be more effective in reducing the population of the Hessian fly and protecting the crop. The winters are short and rainy in Cyprus and this climate is quite suitable for Hessian fly development. Therefore, it is thought that it would be useful to evaluate these parasitoids in IPM in order to increase their effectiveness in future studies.

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AUTHOR CONTRIBUTIONS

The authors have contributed equally to this study**.**

CONFLICT of INTEREST

The authors declare there is no conflict of interest**.**

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