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Detection of an invasive serious pest: the Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae) from Iran

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ABSTRACT. *Mayetiola destructor* (Say, 1817) originated in the Fertile Crescent region of the Middle East and is one of the most serious pests of wheat, rye and barley and more than 16 Poaceae wild species. Here, we report the occurrence of this species as an invasive pest for the first time in Iran. It was detected in wheat fields and rye in Qūshchī Pass, Urmia environ, West Azarbaijan province (September 2020) as well as in wheat fields in Bil-e Savar, Ardabil province (July 2024). The diagnostic characters and its life history as well as the photographs of the adult male and female, larvae, puparium, male genitalia and wing venation are provided. This is the second species from the genus *Mayetiola* that has been reported from Iran. To prevent the spread of this destructive pest in Iran, suitable management practices are urgently needed.

Keywords: First record, gall midge, quarantine, rye, wheat

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INTRODUCTION

Wheat cultivation started in ancient times. It is one of the first domesticated food products and has been the main food of the great civilizations of Europe, West Asia and North Africa for the past 8000 years. Currently, the area of land used for wheat cultivation is more than that used for any other commercial crop, and it is still the most important grain food source for man (Curtis, 2024). Wheat has a global distribution and is affected by various stresses caused by living and non-living environmental factors all over the world. It has been reported that about 100 species of insects cause damage to wheat in wheat fields (Qayyum et al., 2021). The Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), is one of the most important pests of wheat and barley in many countries of the world (Makni et al., 2011;

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Sadeghi et al., 2021). Although the Hessian fly was originally collected from the Fertile Crescent region of the Middle East, it is now widespread in Europe and also known from North Africa, North America, northern Kazakhstan, northwestern China and New Zealand (Lhaloui et al., 2000; Stuart et al., 2012; Skuhravá & Skuhravý, 2021). It is one of the most serious pests of wheat, rye, barley and other Poaceae species. When a severe infestation occurs during the early growth stages of wheat it may result in the complete destruction of the crop (Buntin et al., 2007).

Hessian fly was included in the list of quarantine pests in Iran published by the Ministry of Jihad-e-Agriculture, Plant Protection Organization, Bureau of Plant Pest Surveillance and Pest Risk Analysis (Anonymous, 2015). In a Guide to Identifying and Tracking the Foreign Quarantine Pest/Hessian fly, Cheraghian (2019) already warned about the possibility of this pest entering Iran.

MATERIAL AND METHODS

To study the gall midges (Cecidomyiidae) in the northwest of Iran in 2020 and 2024, rye and wheat plants infested by the larvae of the Hessian fly were collected and transferred to the laboratory. The infested plants were kept in a glass box (50 × 40 × 80 cm) covered with muslin, fixed with a rubber band, until the emergence of adults. The bottom of the box was covered by a 3 cm thick layer of soft sand for the pupation of the larvae. The boxes were checked daily to collect emerged gall midge adults for 25–30 days. The adults were moved into the vials with 75% ethanol. To study the male genitalia, the specimen was heated at 85 °C in a 10% KOH solution for 10 minutes. It was later washed in distilled water and shortly put in glacial acetic acid. Then, it was placed in a microvial containing glycerin as a preservative, and pinned below the source specimen. Digital images of the male genitalia were taken using a Canon® 650D camera and edited using Adobe® Photoshop CS2. The specimens were identified by morphological characters such as the male genitalia and wing venation, using the keys by McAlpine et al. (1981) and Skuhravá (1997). The terminology of morphological characters of adults follows the terminology given in Skuhravá (1997). The voucher specimens are deposited in the collection of Marcela Skuhravá, Prague, Bítovská, Czech Republic and Hayk Mirzayans Insect Museum (HMIM), Tehran, Iran.

RESULTS

Taxonomic hierarchy

Class Insecta Linnaeus, 1758

Order Diptera Linnaeus, 1758

Suborder Nematocera Duméril, 1805

Family Cecidomyiidae Newman, 1835

Genus *Mayetiola* Kieffer, 1896

***Mayetiola destructor* (May, 1817)**

Material examined. IRAN; 11♂♂ 6♀♀, West Azarbaijan (Azarbaijan-e Gharbi) province, Urmia 61 km north of Urmia—the northwestern slope of Qūshchī Pass, 38°03'10"N, 044°54'53"E, 1820 m, ex. *Secale cereale*, 15–23. ix. 2020, leg.: Y. Karimpour; deposited in the collection of Marcela Skuhravá, Prague; 4♂♂ 7♀♀, Ardabil province, Bil-e Savar, Jaafar Abad; 39°25'53.8"N, 048°04'43.8"E, 201 m, ex. *Triticum aestivum* Lam., 15–22.vii.2024, leg.: A. Alijani; deposited in HMIM.

Morphology. Adults of HF (Fig. 1A–B) are midge-like and about 3 mm long. The females (Fig. 1A) are brown or black though the abdomen may be reddish brown owing to the presence of orange eggs developing inside. The males (Fig. 1B) are slightly smaller. The wings are slightly darkened (Fig. 1C) and the legs are as long as or longer than the body (VanDuyn et al. 2003, Foster & Hein, 2009). The male genitalia in dorsal and lateral views are as in Figure 1D–E. The bead-like antennae are well-developed with a basal scapus and pedicellus, and 14 flagellomeres. The scapus and pedicellus are the largest segments and globular in shape. The antennae are different in males and females: male antennae are longer and the flagellomeres obviously consist of a wider proximal part and a narrow distal part, the neck (Harris, 1964; Schneeberg et al., 2013).

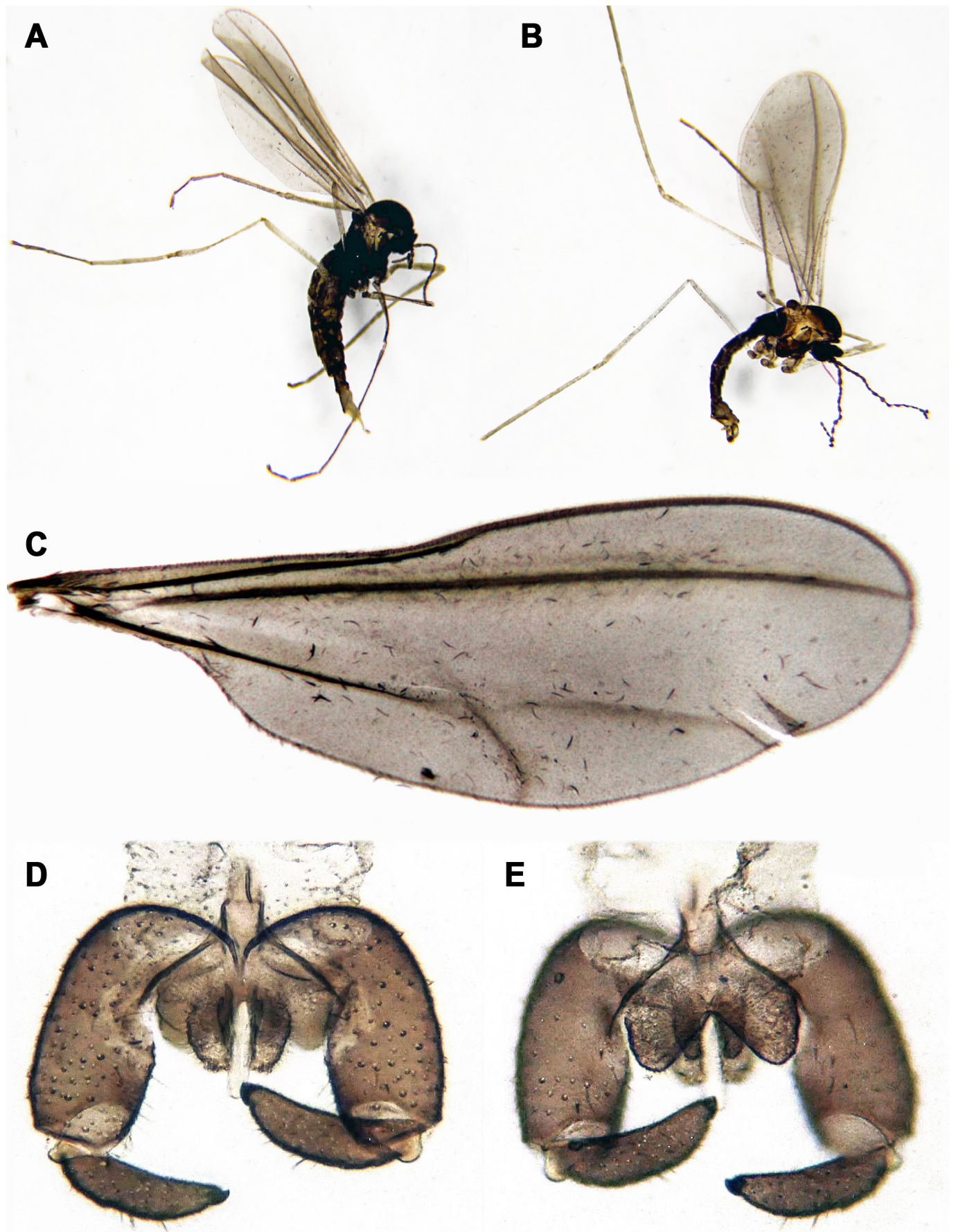


Figure 1. *Mayetiola destructor* (May, 1817). **A.** Female Lateral view; **B.** Male Lateral view; **C.** Wing venation; **D.** Male genitalia, dorsal view; **E.** Male genitalia, Ventral view.

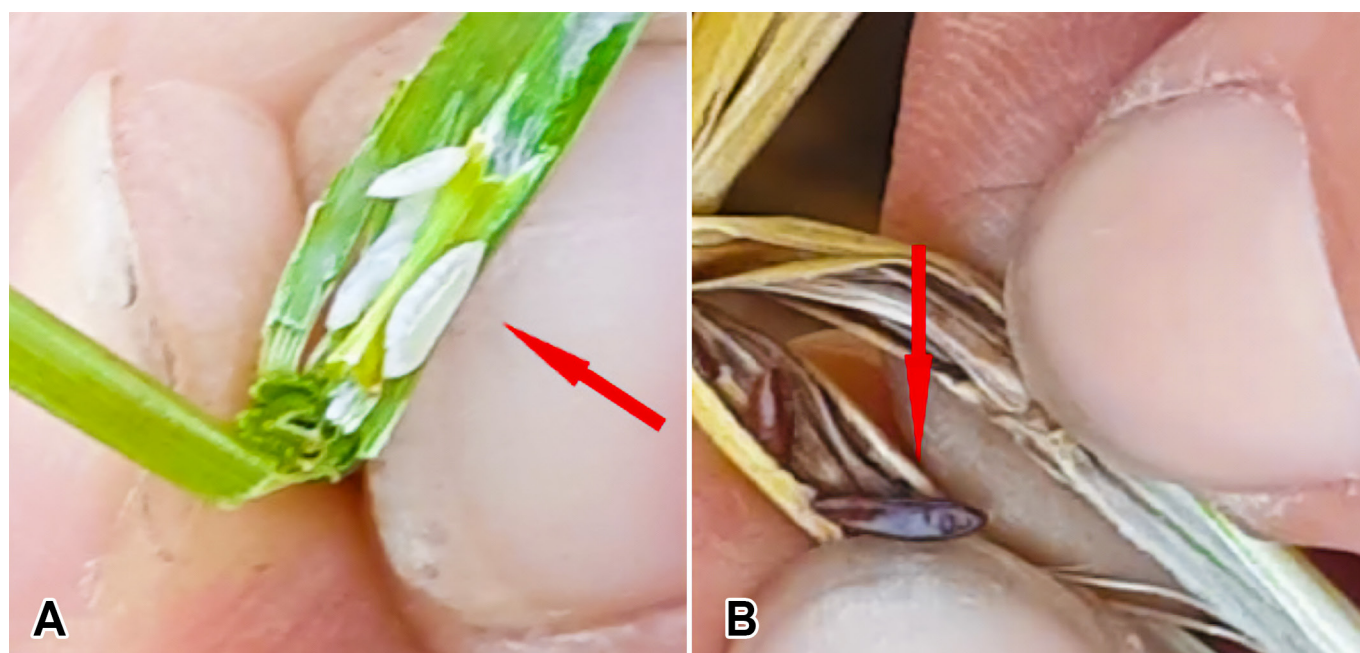


Figure 2. *Mayetiola destructor* (May, 1817). **A.** Third instar Larvae; **B.** Flaxseed shape puparium.

Life History. *Mayetiola destructor* is a polyphagous species and attacks many species of the family Poaceae. Although it is a minor pest of wheat in Europe, there are many records of its serious damage to cereals in North America, Ukraine, Hungary and Poland (Skuhravá & Skuhravý, 2021). The duration of entire life cycle of the Hessian fly (HF), depending on the weather conditions takes between 20 to 61 days (Painter, 1951) and according to the findings of Stuart et al. (2012), HF completes its life cycle in 28 days, but with temperature changing and during periods of diapause and summer dormancy, the completion of the life cycle is delayed. The life cycle was described by several authors (Hamilton, 1966; Ratcliffe & Hatchett, 1997; Froster & Hein, 2009; Makni et al., 2011; Stuart et al., 2012; Flanders et al., 2013; Schmid et al., 2018). The adult females of *M. destructor* live 1 to 2 days and lay 250 to 300 eggs in the grooves of the upper surface of cereal leaves. Eggs are oval, reddish-orange or cream in colour, 0.5 mm long. Larvae go through three stages to complete development. The first instar larvae (Fig. 2A) are legless, spindle-shaped, yellowish white to light green and 0.56 to 1.70 mm long. Second and third instar larvae grow between 1.70 to 4.00 mm and approximately 4.00 to 5.00 mm, respectively (Gagne & Hatchett 1989; Schmid et al., 2018). The third larval stage and the pupa grow inside the cuticle of the second larval stage, which is known as the puparium. This stage is generally called as flaxseed stage (Fig. 2B) due to its hardness and sclerotization, dark brown color and shape of the cuticle. Because puparium is very similar to flax, *Linum usitatissimum* L. (Malpighiales: Linaceae) seeds. In fact, flaxseed is a protective structure for puparia. The aestivation and diapause of HF depend on the temperature and humidity of the environment. Therefore, the number of generations is different across the world. In various published documents, it has been reported that HF produces 2 to 6 generations annually (Lidell & Schuster, 1990; Flanders et al., 2013).

DISCUSSION

The genus *Mayetiola* comprises 29 species that are distributed in the Palaearctic region. Only one species, *M. ammophila* Gagné, 1975, naturally occurs in North America on American beach grass, *Ammophila breviligulata* Fern. (Poaceae) (Gagné, 1975). *Mayetiola destructor* is an immigrant species in North America and New Zealand (Gagné & Jaschhof, 2021). All known species of *Mayetiola* are associated with the various genera of Poaceae (Gagné & Jaschhof, 2021). The bread wheat, *Triticum aestivum* var. *aestivum* is the best-known host plant for HF. But many other grass species including cultivated and wild grasses in 16 different genera have been identified as hosts for the U.S. populations of Hessian fly (Zeiss et al., 1993).

A total of 41 genera and 80 species of gall midge have been reported from Iran of which 9 genera and 19 species are associated with Poaceae. Only *Mayetiola poae* (Bosc, 1817) had been reported from Iran (Karimpour et al., 2024). With this new record of *M. destructor* the number of known species of the genus *Mayetiola* increases to two and the total number of known gall midge species in Iran reaches 81. It should be noted that *Contarinia tritici* (Kirby, 1798) was reported from Iran as a serious pest of wheat previously by Farahbakhsh (1961). With the current report of HF from Iran, the number of harmful gall midges associated with wheat in the country has now increased to a total of two species.

Till now *M. destructor* had been reported from North Africa (Algeria, Morocco, Tunisia) and Europe (Austria, Belarus, Belgium, Bulgaria, Canada, China (Northwestern parts), Cyprus, Czech Republic, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Kazakhstan (Northern parts), Italy, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia (European part), Spain, Sweden, Switzerland, Türkiye, Ukraine, United Kingdom, former Yugoslavia) and United States of America (Lhaloui et al., 2000; Stuart et al. 2012; Skuhrová & Skuhrový, 2021). Now Iran has also added to the list of countries where HF is distributed. Türkiye is the country nearest to Iran where HF is widespread. It has been reported from Antalya, Ankara, Bursa (Karacabey), Konya, Yalova, Thrace and from Aegean and Mediterranean regions of Türkiye (Skuhrová et al., 2005). Therefore, it seems likely that HF entered northwestern Iran from eastern Türkiye.

Considering the potential risks of *M. destructor* to wheat production, it is adamant to take necessary and urgent measures to prevent the spread of this quarantine pest to other parts of the country.

AUTHOR'S CONTRIBUTION

The authors confirm their contribution to the paper as follows: Y. Karimpour: Collecting specimens from Urmia, preparing the manuscript; M. Skuhrová: Identifying the specimens, preparing the manuscript; E. Gilasian: Preparing the male genitalia, providing the photographs for the figure 1, preparing the manuscript; M. Razmi: Collecting the specimens; A. Cheraghian: Collecting the specimens from Ardabil; A. Alijani: Collecting the specimens from Ardabil, providing the photographs for figure 2. The authors read and approved the final version of the manuscript.

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This research received no specific grant from any funding agencies.

AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in the collection of Marcela Skuhrová, Prague, Bítovská, Czech Republic and Hayk Mirzayans Insect Museum (HMIM), Tehran, Iran, and are available from the curator, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study only included plants and arthropod material, and all required ethical guidelines for the treatment and use of animals were strictly adhered to in accordance with international, national, and institutional regulations. No human participants were involved in any studies conducted by the authors for this article.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

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گزارش آفت مهاجم و خطرناک از ایران: پشه‌ی گندم (*Mayetiola destructor* (Say) (Diptera: Cecidomyiidae)

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چکیده: پشه (*Mayetiola destructor* (Say, 1817) با خاستگاه منطقه هلال حاصل‌خیز خاورمیانه یکی از مخرب‌ترین آفات گندم، جو و چاودار و بیش از ۱۶ گونه از گندمیان وحشی است. در اینجا ما برای اولین بار حضور پشه (*Mayetiola destructor* (Say) را به عنوان یک آفت مهاجم از ایران گزارش می‌کنیم. نمونه‌ها از مزارع آلوده گندم و چاودار واقع در گردنه قوشچی، اطراف ارومیه، آذربایجان غربی (شهریور و مهر ۱۳۹۹) و مزارع گندم شهرستان بيله‌سوار استان اردبیل (تیر و مرداد ۱۴۰۳) جمع‌آوری شدند. برخی ویژگی‌های افتراقی و چرخه زیستی پشه همراه با تصاویری از حشرات کامل نر، ماده، لارو، شفیره، اندام جنسی نر و رگ‌بندی بال ارائه شد. این دومین گونه از جنس *Mayetiola* است که از ایران گزارش می‌شود. برای جلوگیری از گسترش این آفت مخرب در ایران، اقدامات مدیریتی مناسب و فوری لازم است.

واژگان کلیدی: اولین گزارش، پشه گال‌زا، قرنطینه، چاودار، گندم