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Morphological diagnosis of Sunn pest, *Eurygaster integriceps* (Heteroptera: Scutelleridae) parasitized by *Hexameris eurygasteri* (Nematoda: Mermithidae)

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Abstract

Hexameris eurygasteri Tarla, Pinar and Tarla (Nematoda: Mermithidae) is an important natural enemy of Sunn pest (SP), *Eurygaster integriceps* Put. (Heteroptera: Scutelleridae) in overwintering areas. Adults of this pest become inactive during hibernation and aestivation about nine months in overwintering areas. These areas are very important for biological control of this pest. Because the overwintering adults with entomoparasitic nematodes can be easily collected from there and they can be sent to uninfected overwintering areas for inoculation. The success of this method depends on the morphological diagnosis of individuals infected with mermithids. It is necessary recognizing the individuals that infected with nematodes collected from overwintering areas to be used as biological control agent for the pest management. As a result of the studies carried out for this purpose, it was determined that the bodies of parasitized SP individuals have a wet and greasy appearance. The movement of infected SP is slowed when near nematodes leaving from the host body. Insect head extends forward, the neck is prolonged and nematodes are usually left the body from the cervix. Before leaving from the hosts, the mean distance between the head at eye level and the thorax was measured as $419.4 \pm 117.30 \mu\text{m}$ ($n = 11$).

Keywords: Eurygaster; Hexameris; Mermithidae; entomoparasitic nematode; Sunn pest

***Hexameris eurygasteri* (Nematoda: Mermithidae) tarafından parazitlenmiş *Eurygaster integriceps* (Heteroptera: Scutelleridae)'ın morfolojik teşhisini**

Özet

Hexameris eurygasteri Tarla, Pinar and Tarla (Nematoda: Mermithidae) kıslak alanlarda süne, *Eurygaster integriceps* Put. (Heteroptera: Scutelleridae)'nın önemli bir doğal düşmanıdır. Bu zararlıların erginleri kıslak alanlarda yaklaşık 9 ay süre ile kısıtlama ve yazılıma olarak aktif olmayan dönemde bulunurlar. Bu kıslak alanlar zararlıların biyolojik mücadelede oldukça önemlidir. Çünkü entomoparazitik nematodlar ile bulaşık kıslamakta olan ergin bireyler buralardan kolaylıkla toplanabilir ve bunlar bulaşık olmayan kıslak alanları bulaştırmak için gönderilebilir. Bu yöntemden başarısı mermithidlerle bulaşık bireylerin doğru morfolojik teşhisinin yapılmasına bağlıdır. Zararlı yönetimi için biyolojik kontrol etmeni olarak nematodlar ile bulaşık kıslak alanlarda toplanmış bireylerin tanınması gereklidir. Bu amaçla yürütülen çalışmalar sonucunda, nematod tarafından bulaşık süne bireylerinin vícutlarının ıslak ve yağlı bir görünüme sahip olduğu belirlenmiştir. Bulaşık sünenin hareketi konukçunun vücudundan nematodların çıkışmasına yakın zamanda yavaşlar. Nematod ile bulaşık böceği boyun ileri doğru uzamakta ve nematodlar genellikle konukçu vücudunu boyun kısmından terk etmektedir. Nematod konukçuya terk etmeden önce basın göz seviyesi ile göğüs arasındaki ortalama mesafe $419.4 \pm 117.30 \mu\text{m}$ ($n = 11$) olarak ölçülmüştür.

Anahtar Kelimeler: Eurygaster; Hexameris; Mermithidae; entomoparazitik nematod; süne

1. Introduction

Wheat, *Triticum aestivum* L. (Poales: Poaceae), is the most important crop as a strategic product with the total harvested weight and used in both human and animal nutrition in the world. One of the factors affecting quality and cost in wheat production areas is harmful insects. Among them, Sunn pest (SP), *Eurygaster integriceps* Put.

(Heteroptera: Scutelleridae) is the most important pest in Turkey and in some other countries. Both nymphs and adults of the SP cause damage plants by feeding on leaves, stems, and grains of cereals [1]. The economic loss can reach up to 100% if control measures are not applied [2]. *Eurygaster integriceps* has a single generation per year. The adults spend at least nine months of their life in the soil (at about 0 - 5 cm depth) and usually under dead leaves of plants on mountains around wheat fields during hibernation and aestivation. When the soil surface temperature reaches 15

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°C, overwintering adults begin to migrate towards the fields of wheat. Then, the SP passes through a further inactive period at overwintering areas from mid-October until late March or April [3]. During this period, various natural enemies and entomopathogenic diseases could play an important role in reducing populations of SP. The Mermithidae is a family of nematodes that parasitizes several species of insects, spiders, leeches, crustaceans, nematodes, and other invertebrates throughout the world [4]. This family has the potential to reduce populations of many agricultural insect pests. Species of the genera *Agameris*, *Geomeris*, *Hexamermis*, *Limnimermis*, *Mermis*, *Ovameris*, *Pentatomermis*, and *Romanomeris* have been found parasitizing a wide range of economically important insects [5]. There are many studies about the nematodes parasitizing some insect species in literature. Earlier reports of mermithids attacking SP were made by Memişoğlu and Özer [6] in Turkey; however, the determined mermithids were not identified at that time. Entomoparasitic nematodes have a great potential to be used as biological control agents against agricultural insect pests [7, 8, 4, 9, 10].

There are many studies dealt with the mermithids and SP relationship in overwintering areas. Many mermithids have been reported from species of the closely related hemipteran. Examples of these were included *Mermis* sp. (Nematoda: Mermithidae) and *Hexamermis* sp. (Nematoda: Mermithidae) parasitising *Aelia rostrata* Boh. (Heteroptera: Pentatomidae) and *Eurygaster maura* (L.) (Heteroptera: Scutelleridae) in Turkey [11, 6, 12, 13, 14, 15] and *Hexamermis* sp. parasitising *Rhaphigaster nebulosa* Poda (Heteroptera: Pentatomidae) in Italy [16]. And also *Pentatomimermis pentatomiae* (Rubtzov) (Nematoda: Mermithidae) was reported from *Elasmostethus interstinctus* (L.) (Acanthosomatidae) in Novosibirsk, Russia [17]. In recent past, one species was obtained from *E. integriceps* in Turkey and named as *Hexamermis eurygasteri* Tarla, Poinar and Tarla [13]. In addition, some mermithid species were reported on other some insects' species in Turkey [18, 19, 20].

The *Hexamermis* is a significant factor in the death of SP and has an important role to reduce their populations in natural conditions. Adults of SP become inactive during hibernation and aestivation about nine months in overwintering areas. These areas are very important for biological control of this pest by using *Hexamermis* because infected adults can be easily collected from there and they can be sent to uninfected overwintering areas for inoculation. The success of this method depends on the morphological diagnosis of individuals infected with mermithids. It is necessary recognizing the individuals that infected with nematodes collected from overwintering areas to be used as biological control agent for the pest management.

The purpose of this study is to determine the morphological diagnosis of *E. integriceps* parasitized by nematodes.

2. Material and Method

Before *E. integriceps* migration to cereal fields, overwintering adults were collected by hand under dead leaves of *Quercus* from overwintering areas in Gaziantep Province on March 01, 2016. The insects were brought to the laboratory in transparent plastic bags where they were sexed. After then, a pair of them was released onto wheat plants in plastic petri - dishes (90 mm diameter) lined with blotting paper. The dishes were placed in a chamber maintained at 29 ± 2 °C, $65 \pm 10\%$ relative humidity (RH), and under a light: dark (L: D) cycle of 16: 8 hours (hrs). Once every 2 - 3 days, wheat plants were replaced by fresh

ones. The blotting paper was moistened with distilled water to provide humidity once every two days. Thus, morphological differences were observed on adult individuals to determine the diagnosis of *E. integriceps* parasitized by *H. eurygasteri* species until all males and females died.

The experiments were carried out in laboratory of Department of Organic Agriculture Program (Uşak University, Vocational High School, Uşak, Turkey). Taxonomic distinction of *E. integriceps* species was completed according to characteristics reported by [21]. *Eurygaster integriceps* and *E. maura* are very difficult to separate taxonomically without dissection or examination of genitalia [3-1]. Therefore, taxonomic distinction of *E. integriceps* species was completed according to characteristics of the male aedeagus, which has 4 internal spines (Figure 1). The nematode species identification was made by the first author. The photographs were acquired by using Olympus SZX10 microscope with an integrated Olympus SC30 camera. The specimen materials for this record were deposited in the collection of the Insect Museum of the Plant Protection Department, Faculty of Agriculture and Natural Sciences, Uşak University, Uşak, Turkey.

3. Results

Some important differences were recognized as a result of morphological observations on adult individuals of *E. integriceps* which parasitized by mermithids. The movement of the parasitized SP is slowed when near nematodes leaving from the host body. Their bodies have wet and greasy appearance. The head of infected SP extends forward. The neck is prolonged and nematodes are usually left the body from the cervix of *E. integriceps* (Figure 2). Similar symptoms on the *E. maura* parasitized with *Agameris* sp. were reported by Memişoğlu and Özer [6].

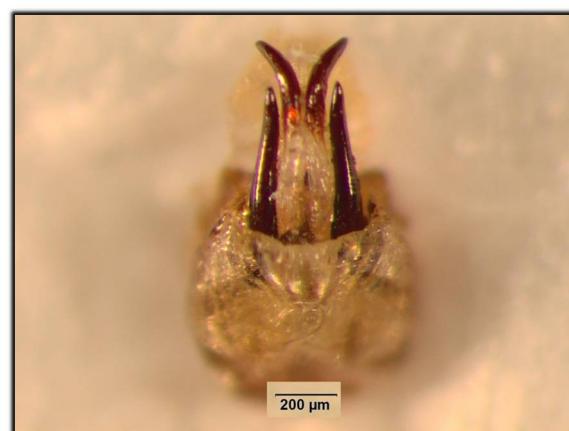


Figure 1. Male aedeagus of *Eurygaster integriceps* with 4 internal spines

The mean distance between the head to begin at eye level and the thorax (Figure 3 B) was measured as 419.4 ± 117.30 µm ($n = 11$) just before the mermithids left the hosts. There is no distance of not parasitized insect (Figure 3 A). Sometimes nematode can also be seen in the abdomen of infected individuals.

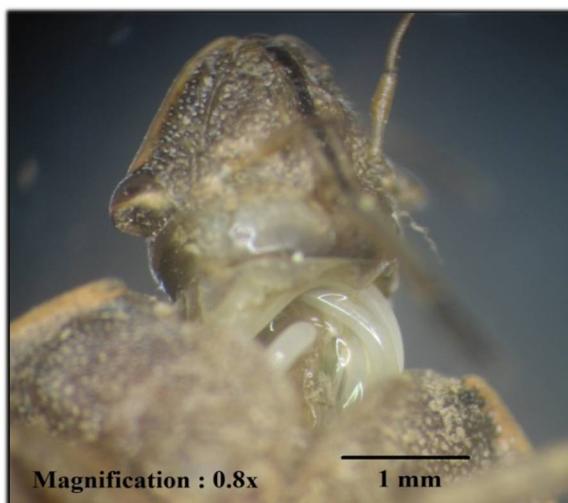


Figure 2. Prolonged head and cervix of infected *Eurygaster integriceps*

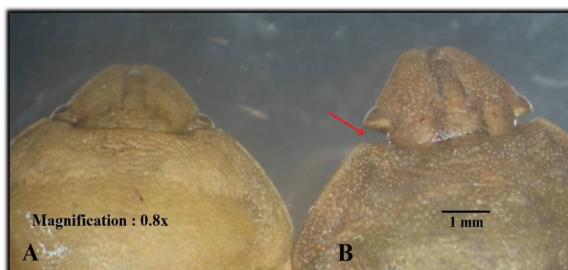


Figure 3. Distance between eye level and the thorax of uninfected (A) and infected (B)

4. Discussion and Conclusion

Adults of SP become inactive in summer and enter a diapause for about nine months in overwintering areas. These areas are very important because overwintering adults can be easily collected from there and nematodes can be sent to uninfected overwintering areas for inoculation. The success of this method depends on the morphological diagnosis of individuals parasitized with mermithids. Overwintering adults collected in the field is important to be used as biological control agent and it is necessary to know which of the individuals were infected.

In conclusion, *Hexameris* is one of the most important parasites of SP. The parasitism rate of the mermithids attacking female of *E. integriceps* was reached to 16.0% in overwintering areas in Gaziantep Province of Turkey [14]. The levels of parasitism of *E. maura* were recorded as 20.0% for females and 31.6% for males in the overwintering areas in Ankara Province in 2014 [15]. It was needed detailed studies on the biology of this nematode. Understanding the ecological and biological behavioral relationships between the nematode and SP could result the proper use of biological control agents in providing an integrated approach to SP management. This mermithid may be a candidate to use in biological control program of SP in the future.

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