



Original article (Orijinal araştırma)

Evaluation of spermatheca morphology and systematics of some *Terellia* Robineau-Desvoidy, 1830 (Diptera: Tephritidae) species¹

Bazı *Terellia* Robineau-Desvoidy, 1830 (Diptera: Tephritidae) türlerinin spermateka morfolojisi ve sistematik açıdan değerlendirilmesi

Murat KÜTÜK^{2*}

Esra DOĞAN³

Mehmet YARAN⁴

Summary

Spermatheca structures of four species, *Terellia colon* (Meigen, 1826), *Terellia gynaecochroma* (Hering, 1937), *Terellia quadratula* (Loew, 1869) and *Terellia ruficauda* (Fabricius, 1794), belonging to the genus *Terellia* Robineau-Desvoidy, 1830 (Diptera: Tephritidae) were examined with scanning electron microscopy (SEM). The specimens were collected from various provinces in Turkey between 1999 and 2013. The samples were coated by gold/palladium with the Emitech SC 7620 Sputter Coater and examined with a Jeol 6390 LV SEM operated at 10 kV. The ultrastructure of the spermatheca for each of the studied species was described and differences between species were identified. The results add to the morphological variations recorded among these species.

Keywords: Fruit flies, SEM, spermatheca, Tephritidae, *Terellia*

Özet

Terellia Robineau-Desvoidy, 1830 (Diptera: Tephritidae) cinsine ait *Terellia colon* (Meigen, 1826), *Terellia gynaecochroma* (Hering, 1937), *Terellia quadratula* (Loew, 1869) ve *Terellia ruficauda* (Fabricius, 1794) dört türün spermateka yapıları taramalı elektron mikroskobu (SEM) ile incelenmiştir. Türler 1999-2013 yılları arasında Türkiye'nin çeşitli illerinden toplanmıştır. Örnekler Emitech SC 7620 Sputter Coater ile örneklere altın/paladyum kaplaması yapılarak Jeol 6390 LV SEM ile 10 kV' da incelendi. Her bir tür için ince spermateka yapıların tanımlamaları türler arasındaki morfolojik farklılıklar belirlendi. Sonuçlar, bu türler arasında kaydedilen morfolojik varyasyonlara katkıda bulunmaktadır.

Anahtar sözcükler: Meyve sinekleri, SEM, spermateka, Tephritidae, *Terellia*

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² Gaziantep University, Art and Sciences Faculty, Biology Departments, Şehitkamil, 27310, Gaziantep, Turkey

³ Gaziantep University, Art and Sciences Faculty, Biology Departments, Şehitkamil, 27310, Gaziantep, Turkey

⁴ Gaziantep University, İslahiye Vocational Schools, Plant and Animal Breeding Departments, İslahiye, 27800, Gaziantep, Turkey

* Corresponding author (Sorumlu yazar) e-mail: mkutuk@gantep.edu.tr

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Introduction

The spermatheca is an accessory female reproductive organ that occurs in all orders of insects with the exception of the Protura and Collembola (Matsuda, 1976). It is a complex organ of the female reproductive system, and it varies greatly in shape and histology (Pendergrast, 1957). It serves for uptake and storage of the sperm from the time of mating until the time to fertilize the eggs (Lay et al., 1999).

The spermatheca (receptaculum seminis) is an ectodermal gland which opens to the anterior portion of the female oviduct. It has a significant role in sperm storage and egg fertilization (Kocorek & Danielczok-Demska, 2002). After mating, the spermatheca provides energy and nutrients to keep the sperm alive until a suitable time for egg fertilization and oviposition occurs (Pabalan et al., 1996). The period of sperm storage can range from hours to months in different insects, and for years in exceptional cases, such as honey bees (Candan et al., 2014).

The female genitalia tract in *Terellia* Robineau-Desvoidy, 1830 species (ovarian, spermatheca and auxiliary glands) extends over the entire abdomen and comprises two spermatheca, located within the fourth or fifth abdominal segments. Each spermatheca consists of three different parts: spermathecal bulb (reservoir), pumping region (intermediate part), spermathecal duct (ductus receptaculi) (Pluot-Sigwalt & Lis, 2008).

Spermathecal structure of *Terellia* has been examined using light microscope. Korneyev et al. (2013) has presented light microscope images of *Terellia virens* (Loew, 1846) group species and Zarghani et al. (2017) light microscope images of *Terellia amberboae* Korneyev & Merz, 1996 group species. In this study, the ultrastructure of the spermatheca in *Terellia* species (Tephritidae) is described for the first time using scanning electron microscopy (SEM).

Four species, *Terellia (Terellia) colon* (Meigen, 1826), *Terellia gynaecochroma* Hering, 1937, *Terellia quadratula* (Loew, 1869) and *Terellia ruficauda* (Fabricius, 1794), with similar wing pattern were selected for this study. Spermathecal structures, aspect ratio spermathecal bulb and spermathecal duct and the spicules on spermathecal bulb surface were defined. Also, similarities and differences between these species were determined. The structure of the spermatheca varies between species of Diptera and is useful as a systematic character.

Material and Methods

The terminology used for the spermathecal morphology was that of McAlpine (1981). Spermathecal structure consists of spermathecal bulb, valve, pumping region and spermathecal duct. In addition, during the designation process, the aspect ratio was also used as a distinctive property.

Specimens examined: *Terellia* species which were collected between 1999 and 2014 from different regions of Turkey and preserved as museum material (Zoological Museum, Gaziantep University, Turkey).

Dissection of specimens: Specimens were treated with 10% potassium hydroxide solution for 3-4 days, then placed in Petri dishes containing 96% ethanol. Genital structures, other than the spermathecal structures, were removed using fine-tipped forceps. The isolated spermatheca were placed in glycerin. The preparation of the specimens followed Candan & Erbey, 2006. Observations were made using a stereomicroscope (Olympus SZX12, Olympus Optical Co. Ltd., Tokyo, Japan).

Preparing of specimens: For SEM. For SEM observation, spermathecal structures were dried with air for about 10 min and placed on SEM stubs. These samples were coated by gold/palladium with the Emitech SC7620 Sputter Coater (Quorum Technologies, Laughton, UK) and examined with a Jeol 6390LV SEM (JOEL Ltd., Tokyo, Japan) operated at 10 kV, in Gaziantep University Entomology Laboratory and Electron Microscopy unit.

Results and Discussion

Results

The ultrastructure of the spermatheca of *T. colon*, *T. gynaeochroma*, *T. quadratula* and *T. ruficauda* is shown in Figures 1-4, respectively.

Terellia colon (Meigen, 1826)

Spermathecal bulb: width 62 μm , height 236 μm , aspect ratio 0.26; distinct corncob shaped (Figure 1a); apex swollen compared to base point; small fingerlike spicules on the bulb surface (Figures 1b, c); a cavity made by inward in the region close to apex; pores present both at the end of the fingerlike spicules and on the surface (Figure 1d); gland canaliculus stretched out from pores on the fingerlike spicules. Spermathecal duct: width 76 μm , height 257 μm , aspect ratio 0.29; distinctive; wide at apex, narrow at base; transverse muscle fibers densely present (Figure 1e).

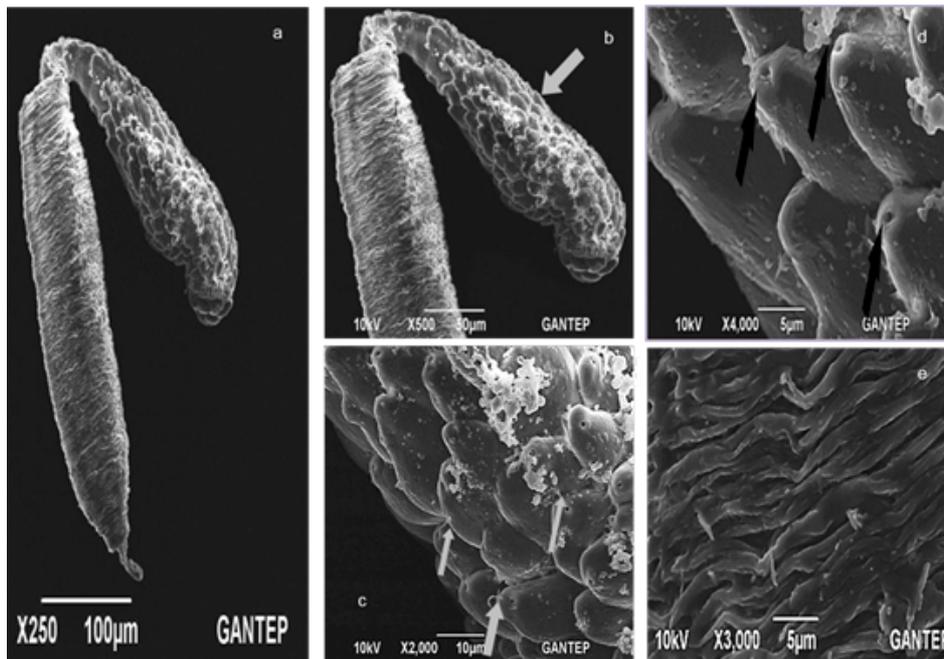


Figure 1. Spermatheca structures of *Terellia colon* (Meigen, 1826) a) general view of spermatheca, b) spermathecal bulb, c) pores, d) gland canaliculus, and e) muscle fibers.

Terellia gynaeochroma (Hering, 1937)

Spermathecal bulb: width 24 μm , height 96 μm , aspect ratio 0.24; flattened and spatulate (Figure 2a); thick thorn-shaped spicules on the bulb surface; long and thick, directed upward spicules present densely at apex (Figure 2b); fewer on base; spicules directed upward on apex; point-shaped and fewer spicules present on the base; no pores and gland canaliculus present on bulb surface; pores in different sizes on base (Figure 2c). Spermathecal duct: width 37 μm , height 201 μm , aspect ratio 0.18; transverse muscle fibers densely present (Figure 2e); pumping region encloses apex of the duct like a cap.

Terellia quadratula (Loew, 1869)

Spermathecal bulb: width 137 μm , height 279 μm , aspect ratio 0.49; elliptic; spicules thorn-shaped (Figure 3b); apex blunt; spicules directed upward on apex; fewer spicules present and towards duct on the base; fewer, almost none, small pores (Figure 3d); gland canaliculus present. Spermathecal duct: width 119 μm , height 217 μm , aspect ratio 0.55; transverse muscle fibers aligned regularly (Figure 3f); muscles in groove-shaped; pores present (Figure 3f); valve present on apex.

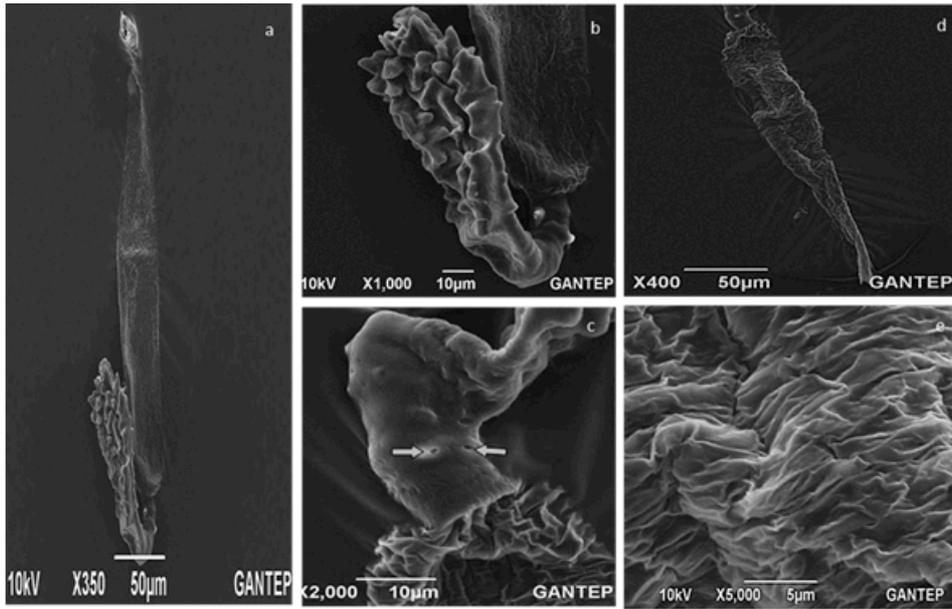


Figure 2. Spermatheca structures of *Terellia gynaecochroma* Hering, 1937 a) general view of spermatheca, b) spermathecal bulb, c) pores, d) spermathecal channel, and e) muscle fibers.

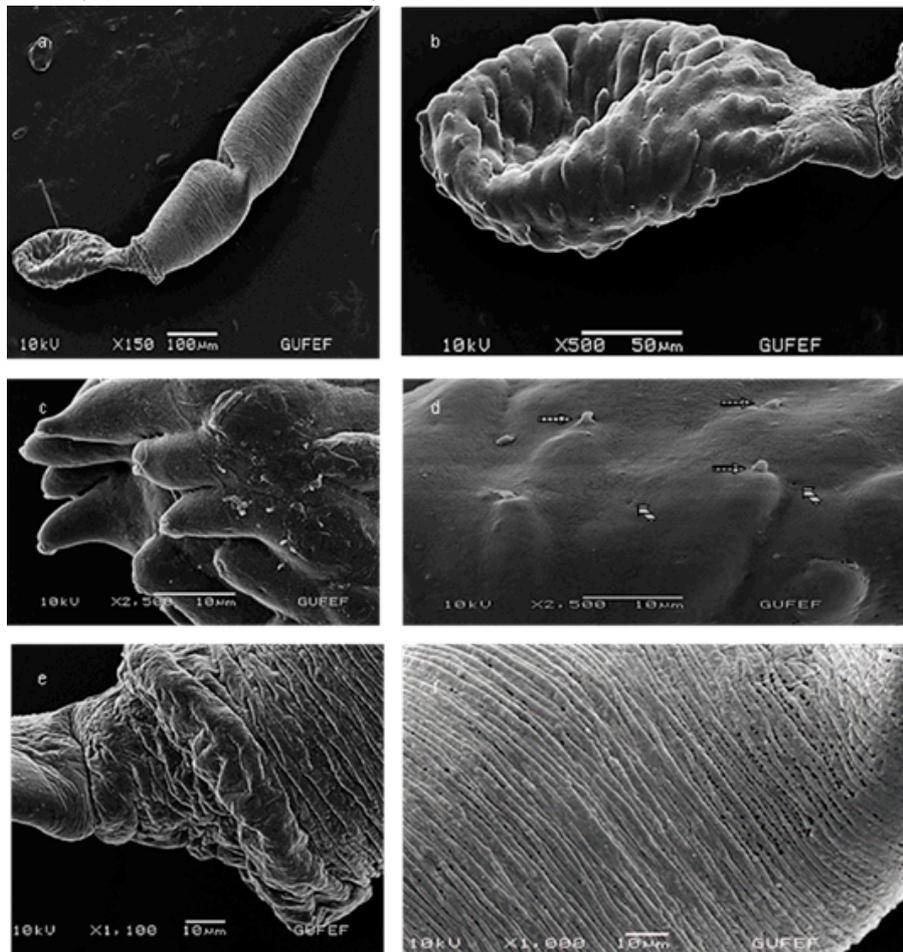


Figure 3. Spermatheca structures of *Terellia quadratula* (Loew, 1869) a) general view of spermatheca, b) spermathecal bulb, c) surface of bulb, d) gland canaliculus and pores, e) valve, and f) muscle fibers and pores.

***Terellia ruficauda* (Fabricius, 1794)**

Spermathecal bulb: width 59 μm , height 136 μm , aspect ratio 0.43; pear-shaped; long fingerlike spicules; denser on apex, few on base; pores in large numbers and of different sizes (Figure 4c); gland canaliculus densely present (Figure 4d). Spermathecal duct: width 28 μm , height 153 μm , aspect ratio-0.18; transverse muscle fibers aligned regularly (Figure 4f); muscles in groove-shaped; valve exists on apex (Figure 4e).

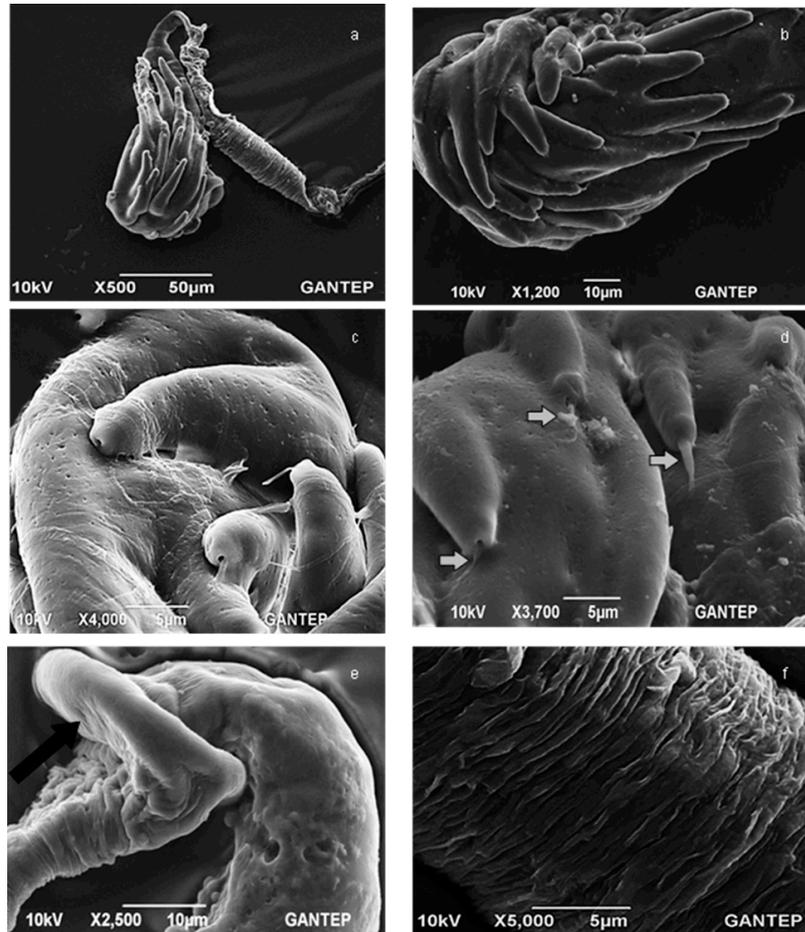


Figure 4. Spermatheca structures of *Terellia ruficauda* (Fabricius, 1794) a) general view of spermatheca, b) spermathecal bulb, c) pores, d) gland canaliculus, e) valve, f) muscle fibers.

Discussion

There are few published studies on the surface morphology of spermatheca compared to studies on egg morphology. There are some studies and descriptions about spermatheca structures of some *Terellia* species using light microscope (Korneyev, 2006; Korneyev et al., 2013; Zarghani et al., 2017). Surface morphology of spermatheca of genus *Terellia* has not been examined using electron microscope. Therefore, there is insufficient information on spermathecal structure of *Terellia*. In this report, we present descriptions and detailed images of spermathecal structure of some *Terellia* species.

Scanning electron microscopy revealed major differences in spermatheca ultrastructure of the four *Terellia* species studied. *Terellia colon* could be easily separated from the other species due to its corncob-shaped spermathecal bulb. In *T. gynaecochroma*, the spermathecal bulb was spatulate with thick thorn-shaped spicules. Moreover, pores were not evident on the bulb surface, unlike in the other *Terellia*

spp. Whereas, *T. quadratula* could be distinguished by its elliptically shaped spermathecal bulb with a blunt apex. Only in this species were pores have been found in the channel structure. *Terellia ruficauda* was also differentiated by its pear-shaped bulb, larger number and different sizes of pores, gland canaliculus being densely present. A valve structure was not evident on the apexes of the spermathecal ducts of *T. quadratula* and *T. ruficauda*.

The aspect ratio of the spermathecal bulbs was also differed between the four *Terellia* species. The aspect ratios were 0.49 and 0.24 for *T. quadratula* and *T. gynaecochroma*, respectively. Aspect ratios of spermathecal ducts were 0.18 in both *T. gynaecochroma* and *T. ruficauda*. This ratio (0.55) was greatest in *T. quadratula*. Transverse muscle fibers aligned regularly in the ducts of *T. quadratula* and *T. ruficauda*.

Consequently, it is clear that spermatheca structure is particularly useful for the systematics of *Terellia*. Also, spermatheca morphology of species could be used for species definition just as other morphological properties. Also, it is likely that more accurate identification and classification can be made using this morphological criterion, especially in otherwise similar species. Spermatheca morphology will provide an extra criterion for reliable identification of new species. Consequently, the results of this study make a significant contribution by demonstrating the value of spermatheca morphology as a diagnostic character for distinguishing similar species.

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