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Research Article/Araştırma Makalesi

Evergestis Hübner [1825]'in timpanal organ morfolojisinin karşılaştırılması (Lepidoptera: Crambidae)

A Comparativ of the tympanal organs morphology of Evergestis Hübner [1825] (Lepidoptera: Crambidae)

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ABSTRACT

Insects communicate with each other and the environment in different ways such as sound, smell and taste. One of the ways to communicate is through the sense of sound. In insects, sound is received through the tympanal organ. It is known that the tympanal organ structure and placements can be used in the classification of higher categories. In this study, hypothesis regarding to the usage of the tympanal organ features can also be used in the classification of was tested. For this purpose, tympanal morphology of the four taxa (*Evergestis frumentalis* (Linnaeus, 1761) *E. flavifuscalis* Rebel, 1903, *E. mundalis* (Guenée, 1854) and *E. umbrosalis* (Fischer von Röslerstamm, 1841)) belonging to the *Evergestis* genus in the Evergestinae subfamily were examined, analyzed and photographed.

Key Words: Crambidae, Evergestinae, *Evergestis*, tympanal organ, morphology.

ÖZ

Böcekler birbirleriyle ve çevreyle ses, koku, tat gibi farklı yollarla iletişim kurarlar. İletişim kurmanın yollarından biri ses duyusudur. Böceklerde ses, kulak zarı organı yoluyla alınır. Timpanal organ yapısı ve yerleşimlerinin daha üst kategorilerin sınıflandırılmasında kullanılabileceği bilinmektedir. Bu çalışmada timpanal organ özelliklerinin alt kategorilerin sınıflandırılmasında da kullanılabileceğine ilişkin hipotez test edilmiştir. Bu amaçla, Evergestinae alt familyasında yer alan Evergestis cinsine ait dört taksonun (Evergestis frumentalis (Linnaeus, 1761) E. flavifuscalis Rebel, 1903, *E. mundalis* (Guenée, 1854) ve *E. umbrosalis* (Fischer von Röslerstamm, 1841)) timpanal morfolojisi incelendi, analiz edildi ve fotoğraflandı.

Anahtar Kelimeler: : Crambidae, Evergestinae, *Evergestis*, timpanal organ, morfoloji.

Introduction

The Pyraloidea superfamily is one of the richest superfamilies of the Lepidoptera order in terms of the abundance of species it involves. It is in the Microlepidoptera (Hannemann, 1964; Robinson et al., 1994). The Pyraloidea comprises about 16,000 described species world-wide (Heppner, 1991; Munroe and Solis, 1999). The larvae of many species are economically important pests of crops (e. g.: sugarcane, corn, rice), and stored products such as seeds and grains (Solis, 2007). In Europe, 914 pyraloid species have been recorded so far (Nuss et al., 2004). The Pyraloidea consists of two families: Crambidae and Pyralidae.

In the order Lepidoptera, the tympanal organs of hearing are found in various anatomical positions, including the mouth parts, abdomen, and thorax (Minet and Surlykke, 2003; Yack, 2004; Faure et al., 2009). Tympanal organs were only used in the studies of Marion (1954) and Munroe (1972, 1973) as a diagnostic feature for the Pyralidae. It is found in the abdomen in the Pyraloidea family (Hasenfuss, 2000; Scoble, 1995; Yack and Fullard, 2000). The Pyraloidea is characterized by a pair of tympanal organs located on sternite two, each with a tympanum and a conjunctivum, a maxillary palpus that is usually present, a proboscis that is basally scaled, and forewing venation (Minet and Surlykke, 2003; Yack, 2004; Faure et al., 2009; Hasenfuss, 2000; Solis, 2007). The subfamilies Pyralidae and Crambidae are distinguished by the morphology of the tympanal organs (Goater et al., 2005).

The Pyralidae have a tympanal case that is almost closed, the conjunctivum and tympanum are in the same plane, and the praecinctorium is absent (Faure et al., 2009; Marion, 1954). In the Crambidae family, the conjunctivum and tympanum are in a different plane (Minet 1982; Maes 1985). The prominent maxillary palpi, with distinctive paired abdominal tympanal organs and genitals, generally distinguishes Evergestinae from other subfamilies (Goater et al., 2005). Larvae, when known, feed on Brassicaceae (Munroe, 1972); the full-fed larva spends the winter in a tough subterranean cocoon, pupating in the spring.

Kemal and Koçak (2017) provided male genital and tympanal photographs of *Evergestis flavifuscalis* Rebel, 1903, *E. mundalis* (Guenée, 1854) and *E. umbrosalis* (Fischer von Röslerstamm, 1841) in their study, in which they published Pyralids collected from different regions of Turkey but did not make any definitions. Özyolci and Çalışkan (2022), defined and compared tympanal structures in 4 taxa belonging to Pyralinae and Phyctinae subfamilies in their study.

It is thought that the intraspecies variability in which tympanal organs are used to differentiate the super categories is low. It was compared the hypothesis that tympanal organs can also be used in the differentiation of subcategories. For this purpose, was compared the photographs of the tympanal structures of 4 species belonging to the genus *Evergestis*, (*Evergestis frumentalis* (Linnaeus, 1761) *E. flavifuscalis* Rebel, 1903, *E. mundalis* (Guenée, 1854) and *E. umbrosalis* (Fischer von Röslerstamm, 1841)) together with their parts. Aim of this study to reveal the differences of these structures between closely related species.

Material and Method

The specimens examined in this study are preserved in the Gazi University Zoology Museum and CESA collection. Before the preparation of the samples, their abdomens were cut and their tympanal organs were photographed with an Olympus SZX7 brand stereo microscope. Then, permanent preparations were prepared for detailed examination of the samples. The abdomen as a whole was boiled in 10% potassium hydroxide, passed through water and alcohol series respectively, the inside of the abdomen was cleaned with special needles and brushes, cleaned and closed in a mixture of clove oil and xylol, and turned into a permanent preparation with entellan. Permanent preparations were photographed and compared with Olympus Leica ES7 and Leica DMLB2 microscopes. The information on *Evergestis frumentalis* (Figure 1a,b) is the data of the last author's master's thesis. Tympanal terminology

definitions are taken from Maes (1985) (Figure 2a,b).

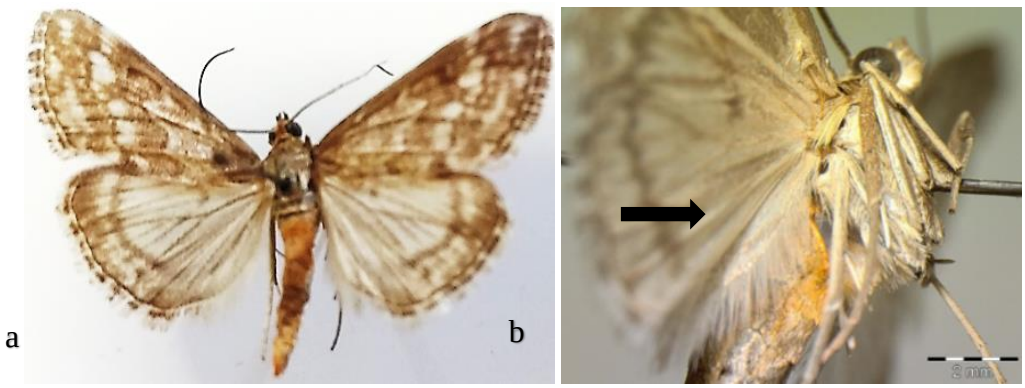

Figure 1. a: Adult of *Evergestis frumentalis* b: Abdominal tympanal organ

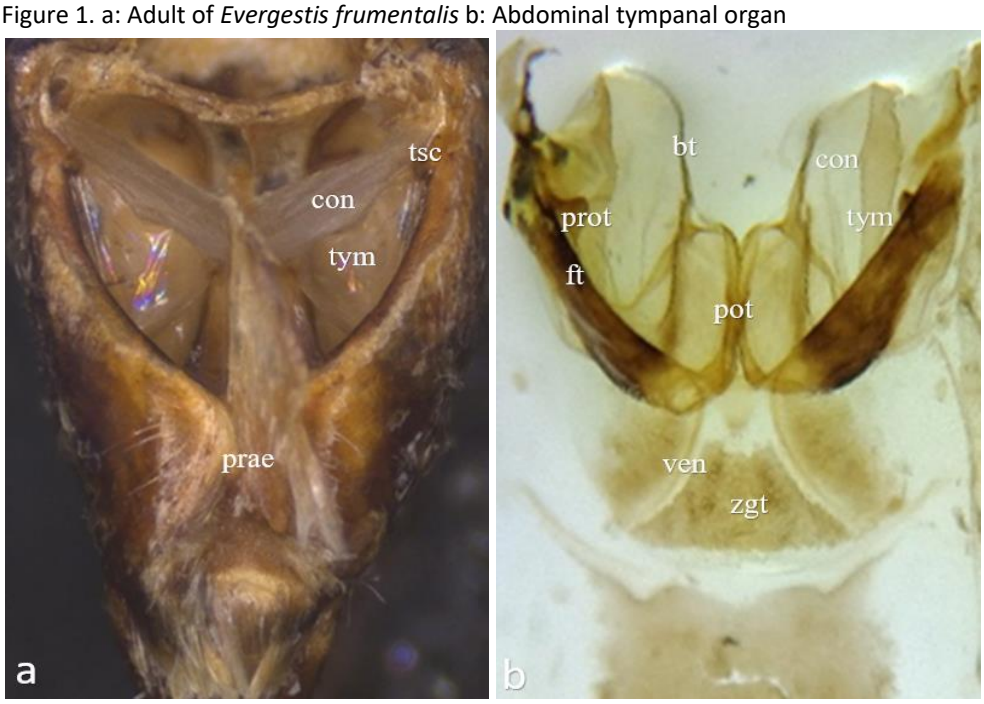

Figure 2. Tympanal organ of *E. frumentalis* a: Before preparation b: After prepation

Bulla tympani (bt): It is formed by the invagination of the first-sternite. Conjunctivum (con): This membrane, which is opaque when dried, attaches to the tympanum. Fornix tympani (ft): Framework supporting the eardrum tympanum. Pons tympani (pot): The median zone of the first sternite which forms a connection between the praecinctorium. Praecinctorium (prae): Extended hairy structure above sakkus tympanum. Processus tympani (prot): lobulus:

Invagination of the bulla tympani below or within the fornix tympani. Tergo sternal sclerite (tsc): Small sclerite anterior to the fornix tympanum and between the tergite and sclerite. Tympanum (tym): The very thin membrane of the organ of hearing that is transparent when dry. Venula (ven): Mid-lateral sclerotized rod inside the sternite. Zona glabra tympani (zgt): Scaly, occasionally curved area behind the pons tympani (Maes, 1985).

Results and Discussion

Results

Seizmair (2021) described some tympanal organ structures of *Evergestis viridifuscalis* Seizmar 2021 and *E. angularis* Seizmar, 2021 species (Table 1 gives the tympanal descriptions of these species according to Seizmar). Kemal and Koçak (2017) presented tympanal photographs of *Evergestis flavifuscalis*, *E. mundalis*, *E. umbrosalis*. It was described that tympanal organ structure of these species. Comparisons of tympanal organ structures are given in Table 1.

Table 1. Comparison of tympanal organs of species of the genus *Evergestis* (pot: pons tympani, con-tym: conjunctivum-tympanum bt: bulla tympani, ft:fornix tympani,prot: processus tympani, prae: praecinctorium, ven:venula, zgt: zona glabra tympani, tsc:tergo sternal sclerite)

Tympanal organ structures	***E. ftrumentalis***	***E. flavifuscalis***	***E. mundalis***	***E. umbrosalis***	***E. viridifuscalis***	***E. angularis***
pot	thinly elongated	thick,long bifurcation	long,bifurcation	thick,long bifurcation	elongate	dilated
con-tym	different plane	different plane	different plane	different plane	different plane	different plane
bt	narrow	oval	oval	Oval wide	narronly invaginated	narronly invaginated
ft	thick	thin	large	thick	medium thickness	thin
prot	small crest shape	hump	elongated	pointed	pointlike	elliptic
prae	Unilob, fringed	Unilob, fringed	Unilob, fringed	Unilob, fringed	-	-
ven	elongated	long sloping	long corrugated	long straight	distinct	slanted, straight
zgt	prominently	narrow	expansive	wide	short	stroke-shaped
tsc	onion shaped	long-slim	long-slim	long-slim	onion shaped	quadrangular dilatation

Fornix tympani is thinner in *E. flavifuscalis* than the one in *E. umbrosalis*, *E. frumentalis* and *E. mundalis* (Figure 3e,3f,3g,3h). In *E. mundalis* and *E. umbrosalis*, the processus tympani structure is thin and pointed (Figure 3g, 3h), while in *E. frumentalis* and *E. flavifuscalis*, it is larger and humped. (Figure 3e, 3f). Processus tympani is distinctly larger in sp. frumentalis than others (Figure 3e). Bulla tympani structure *E. umbrosalis* is wider than other species (Figure 3h). The structure of the pons tympani is similar in all species but differs in length. The length of the pons tympani is shorter in *E. flavifuscalis* than in the other three species (Figure 3f). Venula and zona glabra tympani differ in all 4 types (Figure 3e, 3f, 3g, 3h). Tergo sternal sclerite is bulb-shaped in *E. frumentalis* and long and thin in other species (Figure 3e). Praecinctorium structure is similar in all species, unilobal and fringed (Figure 3k,3l,3m,3n). Conjunktivum-tympanum structure is in a different plane in all species (Figure 3k, 3l, 3m, 3n).

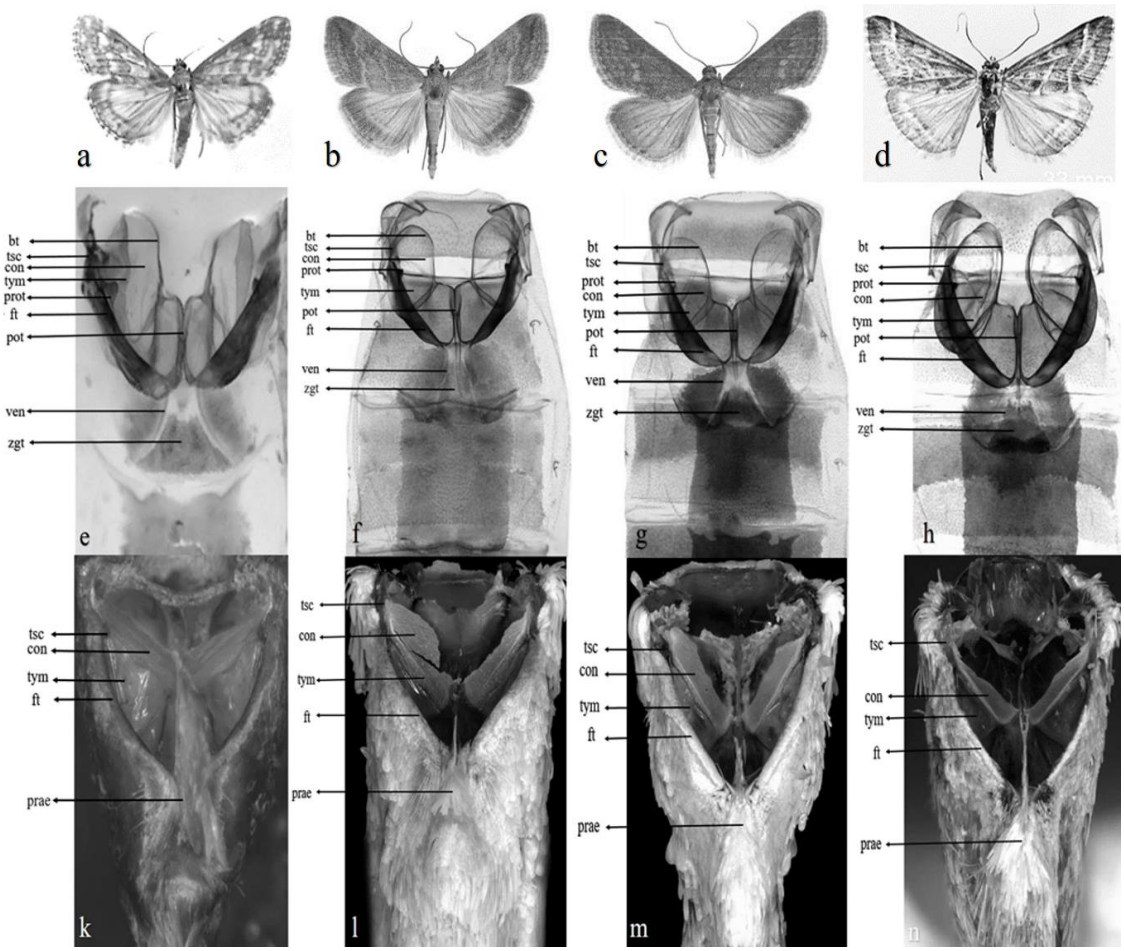

Figure 3. *Evergestis frumentalis* (a), *Evergestis flavifuscalis* (b), *Evergestis mundalis* (c), *Evergestis umbrosalis* (d) adults. *Evergestis frumentalis* after preparation tympanal organ (e), *Evergestis flavifuscalis* after preparation tympanal organ (f), *Evergestis mundalis* after preparation tympanal organ (g), *Evergestis umbrosalis* after preparation tympanal organ (h). *Evergestis frumentalis* before preparation tympanal organ (k), *Evergestis flavifuscalis* before preparation tympanal organ (l), *Evergestis mundalis* before preparation tympanal organ (m), *Evergestis umbrosalis* before preparation tympanal organ (n).

Discussion

The genus *Evergestis* Hübner, which was placed in its own Evergestinae, is currently associated with the subfamily Glaphyriinae according to the suggested classification supported by the phylogenetic study of Regier et al. (2012). The subfamily Glaphyriinae includes 326 species in 51 genera (Regier et al. 2012) and *Evergestis*, which is the largest genus of this subfamily with 79 known species worldwide. There are 32 known species in the genus *Evergestis* in Europa (Goater et al., 2005). This genus is known to be the most diverse genus in the Holarctic region (Munroe & Solis 1999) with few representatives in India, Africa, and South America (Goater et al. 2005).

One of the features that characterize the Pyraloidea, which includes *Evergestis*, is the location and morphology of the tympanal organs.

Evergestis is a genus of moths of the family Crambidae. In Crambidae, the tympanal membrane is open anteriorly, the tympanum and conjunctivum lie at an obtuse angle and the lobulus and praesinctorium structures are present (Goater et al., 2005). In subfamily Evergestinae, the bulla tympani is open; the praesinctorium is unilobal; the tympanum and conjunctivum are in a different plane (Maes, 1985; Minet, 1982). Solis (2007) gives the following features for Evergestinae: Fenestra media forms a true dorsal counter-tympanum; praecinctorium is usually sagittal, rarely bilobed; spinulae are spiny, inserted in the anterior region of the eardrums; antero-lateral tympanic projections. In the species that was examined, the praecinctorium is single-lobed. Results support the literature information.

The intraspecies variability of tympanal organs is low. Sometimes the relative length of the venula secunda/saccus tympani can be used at the specific level. Differences in some parts of these organs of the interspecies are usually clear enough to allow for

species differentiation (Maes, 1985). The this study reveals that some parts of the tympanal organs differ between species. Characteristics such as venula, zona glabra, pons tympani and fornix tympani, which have high chitin structure, were determined as distinctive.

Conclusion

The tympanal organs of the investigated *Evergestis* genus species show Crambid type morphological design features. The result of the study supports the hypothesis that the tympanal structure can be used to differentiate subcategories. Comparative studies on the tympanal structure with more taxa will undoubtedly make important contributions to the Crambidae systematics.

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