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Two new invasive species for Tokat province: *Zaprionus indianus* Gupta, 1970 and *Zaprionus tuberculatus* Malloch, 1932 (Diptera: Drosophilidae)

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Abstract: This study was carried out in peach orchards of Akyamaç, Kemalpaşa and Kömeç villages of Tokat centre in 2023. As a result of the observations made in the orchards of the mentioned villages, damaged peach fruits were cultured in the laboratory. *Zaprionus tuberculatus* Malloch, 1932 and *Zaprionus indianus* (Gupta, 1970) (Diptera: Drosophilidae), which are invasive species, were detected as a result of the culture processes. Especially *Z. indianus* was observed to be intensively reared from the cultures. These species are the first records for the insect fauna of Tokat province.

Keywords: Invasive species, *Zaprionus indianus*, *Zaprionus tuberculatus*, Drosophilidae, Tokat, Türkiye

Tokat ili için iki yeni istilacı tür: *Zaprionus indianus* (Gupta, 1970) ve *Zaprionus tuberculatus* Malloch, 1932 (Diptera: Drosophilidae)

Öz: Bu çalışma, Tokat merkeze bağlı Akyamaç, Kemalpaşa ve Kömeç köylerinin şeftali alanlarında 2023 yılında gerçekleştirilmiştir. Adı geçen köylere ait şeftali bahçelerinde yapılan gözlemler neticesinde zarar görmüş şeftali meyveleri laboratuvarda kültüre alınmış ve kültür işlemleri neticesinde istilacı türlerden olan *Zaprionus tuberculatus* Malloch, 1932 ve *Zaprionus indianus* (Gupta, 1970) (Diptera: Drosophilidae) tespit edilmiştir. Özellikle *Z. indianus*' un kültürlerden yoğun olarak çıktığı görülmüştür. Tespit edilen bu türler Tokat ili böcek faunası için ilk kayıt niteliğindedir.

Anahtar kelimeler: İstilacı türler, *Zaprionus indianus*, *Zaprionus tuberculatus*, Drosophilidae, Tokat, Türkiye

1. Introduction

Drosophilidae is an important family with 4700 species belonging to 77 genera worldwide (Bächli, 2023). The Palaearctic fauna currently consists of 482 species from 27 genera (Brake & Bächli, 2008). The drosophilid fauna of Türkiye, is poorly known with 36 species from six genera (Koçak & Kemal, 2013). The genus *Zaprionus* Coquillett, 1902 is recognised by the longitudinal white stripes on the frons and mesonotum and totally have 59 species, of which 48 are known from the Afrotropical region (Yassin & David, 2010). Among these species, the invasive species that are widely distributed in the African continent are known as *Zaprionus indianus*, *Z. tuberculatus* and *Z. ghesquierei* (Chassagnard & Kraaijeveld, 1991).

Zaprionus indianus is a polyphagous species that has been observed infesting the fruits of over 70 plant species in its native Africa (Raspi et al., 2014; Joshi et al., 2014). This species is currently globally distributed and is accepted as cosmopolitan. It is found in temperate and tropical regions (Commar et al., 2012). It has been reported from different hosts such as fig, loquat, guava, oranges, palm, longan, cashew, pomegranate, grape, apricot, and cherries (Vilela, 2001; Steck, 2005; van der Linde et al., 2006; Al-Jboory & Katbeh-Bader, 2012; Joshi et al., 2014). Although *Z. indianus* is not considered to be a pest in Africa, it spread rapidly in Brazil and caused the loss of more than 40% of the fig crop in one region in 1999 (Stein et al., 2003). This species was initially documented in Türkiye in 2017 within the Eastern Mediterranean Region, and found infesting various fruits such as persimmon, blackberry, peach, mulberry, fig, cherry, peach, and plum (Çatal et al., 2019).

Another invasive species Z. *tuberculatus* originates from the Afrotropical region and the islands of the Indian Ocean and is an invasive species for the European continent (Chireceanu et al., 2015). This invasive species was determined for the first time in Türkiye by Patlar et al. (2012) in Adana. The same researchers suggested that this species may be a potential agricultural pest for fig crops like *Z. indianus*.

In addition, Çatal et al. (2021) reported that this species is widespread in the Mediterranean region of Türkiye.

Over the past few years, *Z. indianus* has escalated to a point where it has the potential to detrimentally impact fruit production and international trade in numerous countries worldwide. Researchers across various nations are actively conducting studies to identify this pest and devise effective solutions. This study was carried out to reveal the presence of *Z. indianus* and *Z. tuberculatus* in peach orchards in Tokat province.

2. Material and methods

Surveys were carried out in peach orchards in Akyamaç, Kemalpaşa and Kömeç villages of Tokat (Türkiye) in 2023. The infected peach fruits were gathered and transferred to 5-liter plastic jars (containing 4-5 cm of sterile soil) with ventilation holes and stored at 25±2 ℃ and 60±5% relative humidity conditions in the Entomology Laboratory of the Middle Black Sea Transitional Zone Agricultural Research Institute, Tokat, Türkiye for the emergence of flies. Adult emergence was monitored by checking every 24 hours and the adults obtained were placed in 70% alcohol. To prepare the female genitalia, the last part of the abdomen was removed, boiled in 10% KOH solution and cleaned from the other parts (Tschorsnig, 1985). The genitalia were then preserved in glycerine. Species identification was made according to van der Linde (2010) and Yassin and David (2010) and confirmed by Dr. Asime Filiz ÇALIŞKAN KEÇE (Çukurova University, Department of Plant Protection, Faculty of Agriculture, Balcalı, Adana, Türkiye). Flies were photographed using a Leica MC170 digital camera that was attached to a Leica M205 C stereomicroscope and Leica DM 2000 microscope. The drosophilid specimens are deposited in the Plant Protection Museum in Tokat Gaziosmanpaşa University, Agricultural Faculty, Tokat, Türkiye.

3. Results

Zaprionus indianus and *Z. tuberculatus* adults were obtained from infested peach fruits in 2023. Both species are new records for the insect fauna of Tokat province.

3.1. *Zaprionus indianus* Gupta, 1970

Diagnosis: White stripe surrounded by black from the head to the end of the scutellum**.** The black stripes are of equal width everywhere (Figure 1a,b). There are a row of composite spines on the fore femur. These spines are directly on the leg, not on any tubercles (Figure 1c). Abdominal tergal bristles with dark spots at the base (Figure 1d) (van der Linde, 2010). Female of ovipositor and spermatheca as Figure 2a,b.

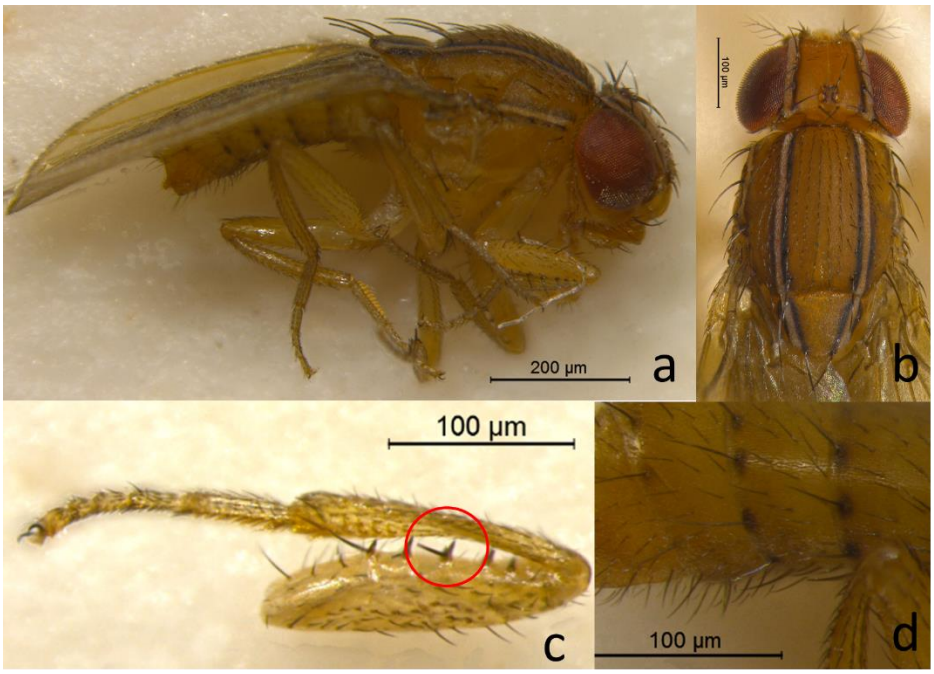

Figure 1. *Zaprionus indianus* adult-female. **a)** General view, **b)** Head and thorax (dorsal view) **c)** A row of composite spines on the fore femur, **d)** Abdominal tergal bristles

Şekil 1. *Zaprionus indianus ergin-dişi. a) Genel görünüm, b) Baş ve toraks (dorsal görünüm) c) Ön femur üzerinde bir sıra kompozit dikenler, d) Abdominal tergal setalar*

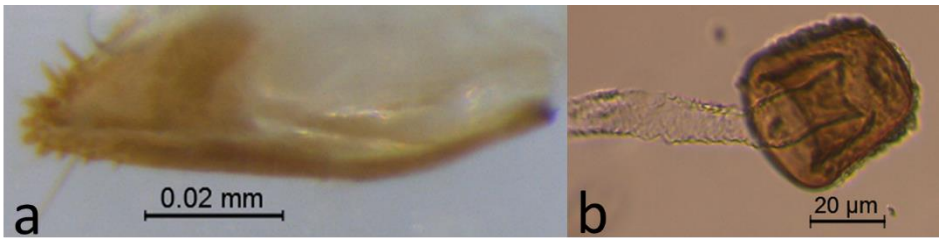

Figure 2. *Zaprionus indianus*-female. **a)** Ovipositor, **b)** Spermatheca
Şekil 2. *Zaprionus indianus-dişi. a) Ovipozitör, b) Spermateka*

Material examined: Tokat (Centre, Akyamaç), N40°21'17" E36°29'34", 627 m, 34♂, 47♀; 23 August 2023. Host plant: peach.

Distribution in Türkiye: Adana, Hatay, Mersin, Osmaniye (Çatal et al., 2019; 2021).

Distribution in the World: Avrupa, Africa, Asia, Central, North and South America (EPPO, 2020b, c).

3.2. *Zaprionus tuberculatus* Malloch, 1932

Diagnosis: The frons has a white median stripe (Figure 3b). There is a protruding tubercule bearing a bristle on the fore femur (Figure 3a,c) (Yassin & David, 2010). Female of ovipositor and spermatheca as Figure 4a,b.

Material examined: Tokat (Centre), Akyamaç, N40°20'45" E36°29' 36", 593 m, 13♂, 7♀; N40°20' 53" E36°29'18", 593 m, 12♂, 5♀; Kemalpaşa, N40°20'45" E36°31'11", 611 m, 3♂, 5♀; Kömeç, N40°20' 56" E36° 27' 23", 610 m, 5♂, 4♀; N 40°21'1" E36°27' 15", 621 m, 3♂, 2♀; 19 September 2023. Host plant: peach.

Distribution in Türkiye: Adana (Patlar et al., 2012; Çatal et al., 2021), Aydın (Başpınar et al., 2022), Uşak (Zengin, 2020), Hatay, Kahramanmaraş, Mersin, Osmaniye (Çatal et al., 2021).

Distribution in the World: Africa, Cyprus, Greece, Israel, Italy, Malta, Spain, Romania (EPPO, 2020a).

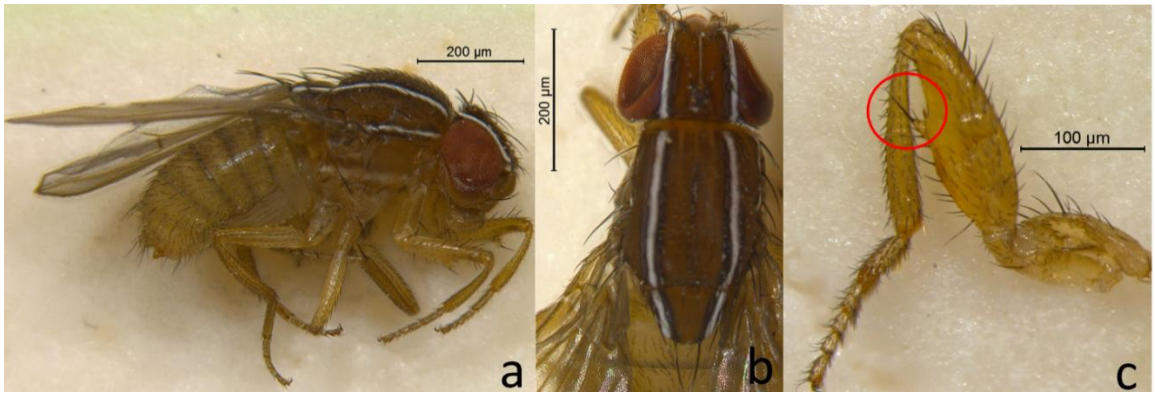

Figure 3. *Zaprionus tuberculatus* adult. **a)** General view (female), **b)** Head (frons with a median white stripe) and thorax (dorsal view-female), **c)** Protruding tubercule bearing a bristle on the fore femur (male)
Şekil 3. *Zaprionus tuberculatus ergin, a) Genel görünüm (dişi), b) Baş (bir beyaz şeritli frons) ve toraks (dorsal görünüm-dişi), c) Ön femurda, üzerinde bir seta bulunan tüberkül (erkek)*

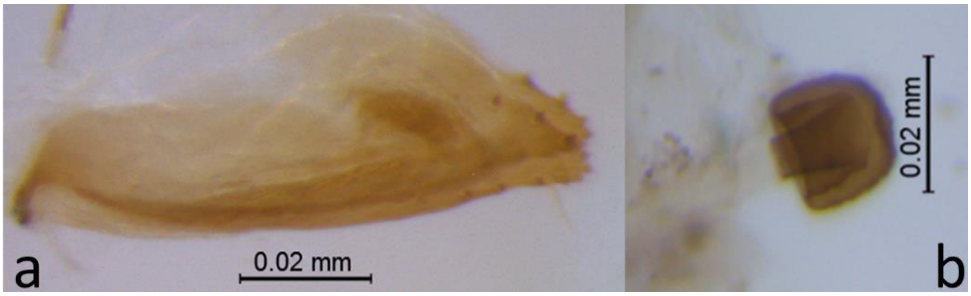

Figure 4. *Zaprionus tuberculatus* female. **a)** Ovipositor, **b)** Spermatheca
Şekil 4. *Zaprionus tuberculatus dişi. a) Ovipozitör, b) Spermateka*

Discussion

Most drosophilid species are saprophagous and feed on decaying plant material (Schmitz et al., 2007). However, differently, some species cause significant economic losses by damaging unripe fruit and are also invasive species. The most important of these is *Drosophila suzukii* (Matsumura), which is widespread throughout the world and causes economic damage to many fruit species. It is known that up to 80% of the strawberries in Europe have suffered crop losses due to this pest (Lee et al., 2011). Another invasive species, *Z. indianus*, is recognised as the primary pest causing significant economic losses especially in figs in many countries of the world. (Commar et al., 2012). In 1999, *Z. indianus* caused a 40% crop loss of figs in the state of São Paulo (Stein et al., 2003). In addition, Bernardi et al. (2017), reported that this species prefers strawberry fruits mechanically injured by various factors or damaged by *D. suzukii* females. The pest status of the other species *Z. tuberculatus* and its potential risk for agriculture is not clear. However, the fact that this species was obtained from 49 fruit species suggests that it may pose a risk in agricultural production in the future. In addition, the similar feeding patterns and ecological requirements of this species with *Z. indianus* also reveal its potential to pose a risk in the future.

These species, which are generally adapted to warm regions, can spread to colder regions with global climate change. Türkiye, as a country with different climates and elevations, is a suitable country for the spread of species belonging to the family Drosophilidae. Until now, species belonging to this family were not considered as a threat to Turkish agriculture. However, interest in this family has increased after it was discovered that invasive species such as *Drosophila suzukii* (Matsumura) and *Zaprionus indianus* (Gupta) caused major economic losses in fruit production (Orhan et al., 2016; Çatal et al., 2019).

In this study conducted in the centre of Tokat, *Zaprionus indianus* and Z. *tuberculatus* adults were obtained from ripe peach fruits cultivated in August and September. In particular, *Z. indianus* was much more intensively were reared from cultures. Çatal et al. (2021), reported that both species were detected in peach fields in the Mediterranean region. Also, Çatal et al. (2019), stated that *Z. indianus* caused significant damage to some fruits, including peaches, in the Eastern Mediterranean region. Santos et al. (2003) reported that *Z. indianus* caused damage to ripe peaches in Brazil.

Tokat province has a transition climate between the Black Sea climate and the steppe climate in Central Anatolia. In general, the summer season is hot in low areas. The climatic characteristics and agricultural production pattern of the province provide an advantage for the spread and population increase of the invasive species *Z. indianus* and *Z. tuberculatus*. In this study, the presence of *Z. indianus* and *Z. tuberculatus* in peach fields in Akyamaç, Kemalpaşa and Kömeç villages of Tokat province where peach production is important was revealed. It is thought that especially *Z. indianus* may pose a threat to peach cultivation in the future. For this reason, it is important to carry out studies to determine the detection, prevalence, density and damage status of these invasive species both in peach areas and in other fruits which are the hosts of these species.

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