

The Drosophilid Fauna (Diptera, Drosophilidae) of IPM Vineyards in Croatia

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Summary

The drosophilid fauna was studied in two integrated production vineyards in the northern part of Croatia (Međimurje County). The flies were sampled using apple vinegar trap during the autumn of 2016. A total of 317 drosophilid individuals belonging to eight species and two genera were collected. Seven species come from the genus *Drosophila* Fallen 1823, while only one came from the genus *Chymomyza* Czerny 1903. The most abundant species, with 69% of the total catch, was *Drosophila suzukii* (Matsamura, 1931) followed by *Drosophila simulans* Sturtevant, 1919 (19%) and *Drosophila melanogaster* Meigen, 1830 (6%). Four species were characterized as alien to Europe (*Chymomyza amoena* (Loew 1862); *Drosophila immigrans* Sturtevant, 1921; *Drosophila melanogaster* and *Drosophila suzukii*). Invasive alien species, *D. suzukii*, first recorded in Croatia in 2010, has become the dominant species in the investigated area. Results from this research represent the first faunistic insights of the family Drosophilidae in Croatian agroecosystems.

Key words

species composition, invasive alien species, *Drosophila suzukii*, fruit production

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Introduction

Over the course of the past century, flies of the Drosophilidae family have been important models for understanding genetic, developmental, cellular, ecological, and evolutionary processes (Markow and O'Grady, 2007). The fly *Drosophila melanogaster* Meigen, 1830 is one of the most intensively studied organisms worldwide, where over one thousand active research groups use *Drosophila* as a key insect model (Clark et al., 2003). The whole genome of *D. melanogaster* was among the earliest to be completely sequenced (Adams et al., 2000) and by sequencing *Drosophila pseudoobscura* (Richards et al., 2005), *Drosophila* was the first genus to have multiple species completely sequenced (Clark et al., 2003; Gregory and Johnston, 2008).

To this date about 3500 species of drosophilids have been identified globally (Bächli, 2008). In the whole Palearctic region only 370 species are recorded and about 120 species are found in Europe (Kekić et al., 2005). During the past 45 years drosophilids have been studied at more than 60 geographic localities within southeastern Europe, including Bosnia and Herzegovina, Croatia, Macedonia, Slovenia, Montenegro and Serbia. This region is considered to be faunistically very rich when considering Drosophilidae with a total of 59 species from 9 genera described from this part of the Balkan Peninsula (Kekić, 2002). In Croatia, the drosophilid fauna was relatively poorly investigated and the majority of investigations were made along the Adriatic coast and islands (Coe, 1958; Kekić, 2002). According to the database on Taxonomy of Drosophilidae (Bächli, 2008) about 60 species of this family are described from Croatia. The continental part of Croatia has been mainly excluded from studies, so there are large geographical areas that were never or insufficiently investigated.

This paper represents the first faunistic survey of the family Drosophilidae in semidomestic habitats in the northern part of continental Croatia.

Materials and methods

The Drosophilidae survey was conducted in two IPM vineyards situated in the northern part of Croatia (Međimurje County). Vineyards were located at a distance of 15 km from each other and selected based on similar microclimatic conditions prevailing in the region. The climate of the region is of a

moderate continental type, with warm summers and maximum precipitation in the spring and summer (Meteorological and Hydrological Service, 2017).

The flies were sampled by using apple vinegar traps during a one month period in autumn 2016. The first vineyard, Donji Zebanec (DZ), is situated at N 46°28'1.2", E 16°24'0" (the collection period lasted from 6th September until 6th October) and the second vineyard is located in Sveti Urban (SU), at N 46°28'20", E 16° 16' 15" (the collection period lasted from 15th October until 15th November).

The identification of the collected drosophilids was based on the work of Bächli et al. (2004). The database on Taxonomy of Drosophilidae (Bächli, 2008) was used for the systematic classification of species. The dominance of drosophilid species was calculated according to Tischler (1949) as follows: eudominants (10-100%), dominants (5-10%), subdominants (2-5%), recedent (1-2%) and subrecedent (<1%).

The 70% alcohol preserved flies are deposited in the Department for Agricultural Zoology, University of Zagreb, Faculty of Agriculture (Det. G. Seljak, leg. M. Šubić).

Results

In semidomestic habitats of vineyards a total of 317 individuals of drosophilids belonging to eight species and two genera were collected (Table 1). In the vineyard DZ, 237 specimens were collected, while in the vineyard SU, 80 specimens were collected. Seven species belong to the genus *Drosophila* Fallen 1823, while only one was found to belong to the genus *Chymomyza* Czerny 1903. In the vineyard DZ, all eight species of flies were collected, while in vineyard SU, four species of flies were collected (Table 1).

Four species (*Chymomyza amoena*; *Drosophila immigrans* Sturtevant, 1921; *Drosophila melanogaster* and *Drosophila suzukii* (Matsamura, 1931)) were characterized as alien to Europe which represents 50% of the caught species in vineyard DZ and 75% in vineyard SU. The most abundant species, with 69% of the total catch, was *D. suzukii*, followed by *Drosophila simulans* Sturtevant, 1919 (19%) and *D. melanogaster* (6%). The species *D. suzukii* and *D. simulans* were classified as eudominant species, *D. melanogaster* was classified as dominant species, while the other species were recedent. In vineyard DZ the species which dominated the drosophilid assemblage were *D. suzukii* (90%),

Table 1. List of drosophilid fauna including the total number of specimens in IPM vineyards in northern Croatia (Međimurje County)

Genus	Subgenus	Species group	Species	Donji Zebanec	Sveti Urban
<i>Chymomyza</i>		<i>Chymomyza fuscimana</i>	<i>amoena</i> (Loew 1862)	2	0
	<i>Drosophila</i>		<i>immigrans</i> Sturtevant, 1921	3	1
			<i>melanogaster</i> Meigen, 1830	5	15
<i>Drosophila</i>	<i>Sophophora</i>		<i>simulans</i> Sturtevant, 1919	2	58
			<i>suzukii</i> (Matsamura, 1931)	213	6
			<i>obscura</i> Fallén, 1823	2	0
			<i>subobscura</i> Collin, 1936	7	0
			<i>tristis</i> Fallén, 1823	3	0

Drosophila subobscura Collin, 1936 (3%) and *D. melanogaster* (2%). While in vineyard SU the most common species were *D. simulans* (73%), *D. melanogaster* (19%) and *D. suzukii* (7%).

Discussion

The number of collected specimens and species differed significantly between the two study sites which could be explained by differences in ecological conditions of habitat that prevailed at the time of collection (Kekić et al., 1985). The collection period in vineyard DZ started more than a month earlier than in vineyard SU, such than in specific microhabitats the weather conditions were considerably different (e.g. lower air temperatures).

The species composition in both sites studied were expected for semidomestic habitats of vineyards in which cosmopolitan and synantropic species such as *D. melanogaster*, *D. simulans* and *D. immigrans* are represented (Kekić et al., 1995/98). The human influence on the development of different species varied significantly and depended upon many different factors, such as available resources, degree of habitat disturbance and physical environmental conditions (Stanić et al., 2001). The best indicator of a human environment "contamination" by products and activities is the presence of species *D. melanogaster*. This species is considered to be the most synantropic, entering human houses and cellars, and using his ex-products (litters) to lay eggs, while their larvae develop on fermented fruits, vegetables, mushrooms and other vegetative materials (Kekić et al., 1995/98).

In vineyard DZ another polyphagous species (*D. subobscura*) with adaptation potential to local conditions (Kekić et al., 1995/98), was recorded. However, *D. subobscura* is known as a forest species which dominates the majority of wild habitats in southeastern Europe (Kekić et al., 1995/98). In the contrast to vineyard SU, collecting site of vineyard DZ, is surrounded by forest so the presence of this species in this microhabitat was expected. Particularly interesting was the finding of other two species from *Obscura* group (*Drosophila obscura* Fallén, 1823 and *D. tristis* Fallén, 1823) at the same locality, whose ecology is quite unknown (Kekić et al., 1995/98).

Surprisingly, the most abundant species of the total catch in vineyard DZ was the invasive alien species *D. suzukii*. This species was firstly recorded in Croatia in 2010 (Masten Milek et al., 2011) and evidently has become the dominant drosophilid species in the area. This species is able to infest and reproduce in a wide range of cultivated and wild hosts (Seljak, 2011). It prefers soft skinned fruit including grapes *Vitis vinifera* L. which resulted in the first observed economic damage to fruit production in Croatia (Mešić et al., 2017).

Invasive alien arthropods can affect the economy and society, through their impact on agriculture, horticulture, forestry, stored products, human and animal health, or various services (Kenis and Branco, 2010). In recent decades, as a consequence of intensive global trade, a passive migration of alien *Drosophila* species has occurred (Kekić, 2002). In this research half of the detected drosophilid species have foreign origin and are characterized as alien (and invasive: *D. suzukii*) to Europe. One new alien phytophagous drosophilid species (*C. amoena*) native to North America was detected (Pajač Živković et al., 2017). Although

the appearance of alien species in new habitats presents a potential threat to biodiversity and agriculture, it also presents an important opportunity to follow up changes in the environment (Kekić, 2002). Considering the fact that the drosophilid fauna of Croatia has never been intensively investigated, discoveries of new alien and invasive species are likely to continue.

Conclusion

The faunistic research of drosophilids in agroecosystems revealed that alien species suppressed the synantropic species of semidomestic habitats of the investigated vineyards. These results represent the first insight into the still minimally explored Croatian drosophilid fauna and will serve as a benchmark for further faunistic research of family Drosophilidae in agroecosystems.

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