

Distribution of the spotted-wing drosophila (*Drosophila suzukii*) in the north-eastern part of the Carpathian lowlands

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Drosophila suzukii (spotted-wing drosophila) spread rapidly during the first decade of the 2000s and then became widely distributed in Europe except for eastern countries. In Hungary, it was detected in 2012 for the first time, but its distribution in the eastern part of the country had been not studied. During the present investigation nine sampling sites in the north-eastern part of the Carpathian lowlands belonging to Hungary, Ukraine and Romania were studied with baited traps. *D. suzukii* was detected in all seven Hungarian sites and in the one Western Ukrainian site where sampling occurred. Amongst the Hungarian sites, six had not previously been studied and the data provided here are the first for Western Ukraine and the second for this country following the published record from Yalta (Crimea, south-east Ukraine).

Introduction

The spotted-wing drosophila (*Drosophila suzukii*, Matsumura, Diptera: Drosophilidae) is an invasive polyphagous pest originating from South-East Asia (Walsh *et al.*, 2011). As females can pierce the skin of healthy fruits with their ovipositor, this pest has become one of the most dangerous threats to fruit production in the temperate zone (Cini *et al.*, 2012). It was introduced in America and in Europe about ten years ago (Asplen *et al.*, 2015). After that in Europe it rapidly spread and is now distributed over nearly the whole continent: Spain (Calabria *et al.*, 2012), Italy (Raspi *et al.*, 2011), France (Calabria *et al.*, 2012), Slovenia (Seljak, 2011), Croatia (Masten Milek *et al.*, 2011), Bosnia and Herzegovina (Ostojic *et al.*, 2014), Bulgaria (Minkov *et al.*, 2018), Cyprus (Özbeck Çatal *et al.*, 2018), Czech Republic (Máca *et al.*, 2015), Georgia (Japoshvili *et al.*, 2018), Greece (Máca, 2014), Montenegro (Radonjić & Hrnčić, 2015), Netherlands (Helsen *et al.*, 2013), Poland (Labanowska & Piotrowski, 2015), Romania (Chireceanu *et al.*, 2015), Serbia (Tosevski *et al.*, 2014), Turkey (Orhan *et al.*, 2016), Switzerland (Baroffio & Fisher, 2011), Austria (Lethmayer, 2011), Germany (Vogt *et al.*, 2012) and Belgium (Mortelmans *et al.*, 2012). During a large-scale study of *Drosophila* spp. of east Ukraine, it was found in Yalta (Crimea) both in 2014 and 2015 (Lavrinienko *et al.*, 2017). In Hungary, it was detected in 2012 for the first time at a highway rest area (Kiss *et al.*, 2013). Between 2012 and 2014, it was sampled at 34 rest areas along highways (Fig. 1). The areas sampled were not directly connected with orchards, vineyards and inhabited areas (Kiss *et al.*, 2016).

In 2018, the distribution of *D. suzukii* was studied in the north-eastern part of the Carpathian lowlands belonging to Hungary and partly to Western Ukraine and Western Romania, paying particular attention to potentially threatened habitats such as vineyards, orchards and extensively cultivated agroecosystems of lowland villages.

Materials and methods

In 2018, nine sampling sites in the north-eastern part of the Carpathian lowlands were sampled to study the distribution and abundance of *D. suzukii*. The sampling sites consisted of four private gardens (growing vegetables and fruits), two orchards, two vineyards and the botanic garden of University of Nyíregyháza (Fig. 1 and Table 1).

D. suzukii specimens were caught with modified VAR-L traps (CSALOMON®, Budapest, Hungary; CSALOMON, 2019) filled with a mixture of 100 mL commercial apple cider vinegar (5% acid) and 100 mL red vine as attractants. Larger insects were excluded from the trap with a 5-mm net. Traps were hung on trees or bushes at approximately 1.5 m above the ground. The samples were collected and transported to the laboratory, where the occurrence of *D. suzukii* was recorded and numbers of both sexes were counted. For identification, illustrated keys of Miller *et al.*, (2017) were used: male fore tarsus with comb on first (4–6 teeth) and second tarsomeres (1–2 teeth). Male tergites 2–4 are pale yellow with narrow dark unbroken posterior bands while tergites 5 and 6 are completely darkened. Female tergites are all pale yellow with narrow dark unbroken bands. Male wing typically with, but sometimes without, infuscation at apices of R2–3 and R4 + 5 veins. Males do not



Fig. 1 Distribution map of *D. suzukii* based on Kiss *et al.* (2016) (grey spots: sites where the pest was previously found) and sites sampled in 2018 (black squares: sites where the pest occurred, empty square: site where the pest was not found).

Table 1. Location and main characteristics of the sampling sites in the north-eastern part of the Carpathian Lowlands with total number of sampled *D. suzukii* specimens (N_{total}) and proportion of females

	Coordinates		Site	Habitat	N_{total}	% of females
	N	E				
HU	47°35.4'	21°38.4'	Debrecen	Small vineyard	7	57.1
	47°58.4'	21°42.6'	Nyíregyháza	Botanic garden	280	50.4
	47°49.3'	21°40.3'	Újfehértó	Plum plantation	20	60
	47°52.9'	21°50.5'	Nagykálló	House garden with cherry, plum, raspberry, blackberry	3	100
	47°56.7'	22°38.6'	Jánkmajtis	House garden with cherry, plum, apple	13	53.9
	48°4.0'	22°42.3'	Kölcse	Apple plantation	6	66.7
	48°7.8'	21°21.0'	Tarcal	Large vineyard	7	85.7
UA	48°25.6'	22°23.8'	Velyka Dobron'	House garden with plum, grape, raspberry, apple	2	0
RO	47°15.9'	22°15.2'	Misca	House garden with strawberry, raspberry and other fruits	0	0

have a dorsal branch of the epandrial ventral lobe, while females have large darkened, serrated ovipositor.

Sampling was carried out between 10 August and 24 November 2018, and traps were checked and emptied every 2 weeks.

Results and Discussion

D. suzukii causes significant economic loss in a wide range of soft-skinned tree fruits and berry crops in temperate regions (Saguez *et al.*, 2013), thus monitoring its spread and population abundance are important objectives.

During the present study carried out in the north-eastern part of the Carpathian lowlands, *D. suzukii* was found in nearly all sampled sites (8/9) in Hungary (7) and Ukraine (1), but it was not found in Romania. Distribution data obtained by the present study and earlier ones show a

continuous dispersion of the species from south-west to north-east in the Carpathian basin. After the appearance of *D. suzukii* in Crimea (south-eastern Ukraine, Lavrinienko *et al.*, 2017), the present study revealed its presence in Transcarpathia (Western Ukraine). In the case of the Crimean population, molecular studies showed that the invasion resulted from multiple sources of invasion (Lavrinienko *et al.*, 2017). Considering the distribution pattern and its changes the authors of the present paper hypothesize that the Western Ukrainian population originates from the genetically less diverse European source.

Currently, the north-eastern part of the Carpathian lowlands forms the eastern limit of the distribution of *D. suzukii* in Europe and is made up of fragmented populations with a generally low level. The Carpathian Mountains constitute a considerable barrier for this species. However, if this barrier was to be crossed, e.g. via trade of fruits, this

would open a new invasion route for *D. suzukii* towards the central part of Ukraine.

The relatively high abundance of *D. suzukii* in the Botanic Garden of Nyíregyháza showed that the centre of large cities provided suitable habitats for the establishment of *D. suzukii* populations due to their warmer and more temperate climate. On the contrary, villages and open fields where less dense populations were found seem to be less suitable. The proportion of females varied between sampling sites, as observed in the earlier studies of Kiss *et al.*, (2016) using the same trap type.

The results of the present study showed that *D. suzukii* is already generally distributed in north-eastern Hungary and Western Ukraine. Although its relatively low abundance does not allow *D. suzukii* to cause large economic losses at present, climate change could rapidly change this situation.

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Répartition géographique de la drosophile du cerisier (*Drosophila suzukii*) dans la partie nord-est des basses terres des Carpates

Drosophila suzukii (la drosophile du cerisier) s'est rapidement disséminée en Europe au cours des années 2000. Elle est maintenant largement présente sur le continent, à l'exception des pays de l'est de l'Europe. Elle a été détectée pour la première fois en Hongrie en 2012, mais sa répartition dans la partie orientale du pays n'avait pas été étudiée. Au cours de la présente enquête, 9 sites de la partie nord-est des basses terres des Carpates, et situés en Hongrie, Ukraine et Roumanie, ont été échantillonnés à l'aide de pièges à appât. *D. suzukii* a été capturée sur tous les sites hongrois (7) ainsi que sur l'unique site échantillonné à l'ouest de l'Ukraine. Parmi les sites hongrois, 6 d'entre eux n'avaient pas été étudiés auparavant. Les présentes données sont les premières pour l'Ukraine occidentale et les secondes pour ce pays, suite à la publication d'un signalement de *D. suzukii* à Yalta (en Crimée, au sud-est de l'Ukraine).

Распространение пятнистокрылой дрозифилы (*Drosophila suzukii*) в северо-восточной части Карпатской низменности

Drosophila suzukii (пятнистокрылая дрозифила) быстро распространилась в течение первого десятилетия 2000-х годов и получила широкое распространение в Европе, за исключением восточных стран. В Венгрии она была впервые обнаружена в 2012 году, но её распространение в восточной части страны изучено не было. В ходе

настоящего исследования с помощью ловушек с приманками были изучены девять пробных участков в северо-восточной части Карпатской низменности, принадлежащей Венгрии, Украине и Румынии. *D. suzukii* была выявлена на всех семи венгерских участках и на одном западноукраинском участке, где проводился учёт. Среди венгерских участков шесть ранее не были изучены, и данные, представленные здесь, являются первыми для Западной Украины и вторыми для этой страны после опубликованного сообщения из Ялты (Крым, юго-восточная часть Украины).

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