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A case study on phenology and colonisation of *Aedes japonicus japonicus* (Theobald, 1901) (Diptera: Culicidae)

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Sáringer-Kenyeres, M., & Kenyeres, Z.: *A case study on phenology and colonisation of Aedes japonicus japonicus (Theobald, 1901)*.
Abstract: We investigated phenology of the invasive *Aedes japonicus japonicus* at Lake Balaton for two years. From July of 2017, the relative abundance of the species showed a sharp increase in the studied breeding-site – at the same time, the frequency of previously dominant species of the local larval assemblage (*Ae. geniculatus* and *Culex pipiens pipiens*) declined. In the spring of 2018, the larval assemblage was already dominated by *Ae. j. japonicus*, and in the rest of the year, following a minor decline in September, the relative abundance of the species continued to increase. Based on our results, *Ae. j. japonicus* occupied rainwater collecting barrel which had been previously considered the main habitat for *Cx. p. pipiens*.

Keywords: invasive, mosquito, Hungary, artificial container, *Culex pipiens pipiens*

Introduction

Aedes japonicus japonicus was the third invasive mosquito species to be introduced into Europe (Medlock et al. 2015). It is a multivoltine species characterised by very variable breeding sites (Becker et al. 2003, Kaufman & Fonseca 2014). In the USA, the species is often found in rock pools (Scott et al. 2001), which is in line with the typical characteristics of its original territory, but has also been captured in a wide variety of artificial containers (tyres, buckets, vessels, troughs) and tree holes (Miyagi 1971, Sota et al. 1994, Scott et al. 1999, Crans & McNelly 1999). In Europe, regarding the occurrence of the larvae of the species, the microtechnotelms mentioned most frequently include cemetery vases (Schaffner et al. 2009), outdoor ashtrays (Kampen & Werner 2014) and similar artificial containers.

The species became known in Hungary in 2012 in a sub-area neighbouring Slovenia (Felsőszölnök: Seidel et al. 2016). In 2017, robust populations of *Ae. j. japonicus* were found at Lake Balaton (Balatongyörök and Badacsonytördemic) in plastic barrels for rainwater collection (Sáringer-Kenyeres & Kenyeres 2018).

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After the detection of the species we investigated its phenology in one of the above-mentioned localities (Balatongyörök). According to our hypothesis, *Ae. j. japonicus* occupies the most typical breeding sites of *Culex pipiens pipiens*.

Material and methods

We collected mosquito larvae twice a month from July to November in 2017 and from April to November in 2018, at Balatongyörök (Bece Hill) (coordinate: N46°46'53.27" E17°21'39.92"). The examined artificial container was in a spatial position from the breeding of *Ae. j. japonicus* (in a green-belt area bordered with small broad-leaved forest patches). The mosquito larvae were collected using a densely woven larvae-collecting net. The sampling was always carried out for the same duration and with covering the same size of water bodies. The size of the breeding location tested (diameter: 80 cm, water depth: 20-40 cm) and its character (continuous rainwater supply, oscillating water level) ensured that the sampling influenced the size of the populations of the species as little as possible. The specimens collected during the samplings were transported to the laboratory and identified to species level. By taking the averaged data of the two collections per month, and using the total numbers of larvae in the samples, we determined the relative abundance of *Ae. j. japonicus* monthly.

To identify native mosquitoes, the determination keys of BECKER et al. (2003), TÓTH (2007) and KENYERES & TÓTH (2008) were used, while we turned to TANAKA et al. (1979) for the identification of *Ae. j. japonicus*. The nomenclature follows SÁRINGER-KENYERES et al. (2018).

Results

We collected 938 individuals of 11 mosquito species. Based on the pooled data, the local larval assemblage was dominated by *Ae. j. japonicus, Ae. geniculatus* and *Cx. p. pipiens* (Table 1).

At the commencement of the study (July 2017), *Ae. j. japonicus* was present in the local larval assemblage as a subordinated species. Until November 2017, the relative frequency of the species showed a sharp increase – at the same time, the frequency of *Ae. geniculatus* declined drastically and *Cx. p. pipiens* showed a decline with a fluctuating relative abundance (Fig. 1). In the spring of 2018, the larval assemblage was already dominated by *Ae. j. japonicus*, and in the rest of the year, following a minor decline in September, the relative abundance of the species continued to increase. The other two species (*Ae. geniculatus, Cx. p. pipiens*) caught in high numbers in total, except in May, were present at the breeding site only as subordinate species (Fig. 1.).

Table 1: Species composition and monthly average abundances of larvae samples collected during study on phenology of *Aedes j. japonicus* (locality: Balatongyörök, Bece hill at Lake Balaton, Hungary; studied breeding site: rainfall collector from concrete)

	2017					2018								
Taxon	**VII**	**VIII**	**IX**	**X**	**XI**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**Σ**
Aedes j. japonicus	16	37	12	36	7	43	37	53	49	55	148	9	7	*509*
Aedes geniculatus	102	12	6	2	2	18	36			1	1	1		*181*
Culex p. pipiens	27	73	42	12	2	4	8	5	4		19	1		*197*
Culex torrentium	5	1	10				1	6	2					*25*
Culex hortensis	1		6									5		*12*
Anopheles maculipennis	5													*5*
Culex martinii	3													*3*
Anopheles plumbeus	2	1												*3*
Aedes vexans	1													*1*
Aedes leucomelas						1								*1*
Culex territans											1			*1*
Σ	*162*	*124*	*76*	*50*	*11*	*66*	*82*	*64*	*55*	*56*	*169*	*16*	*7*	

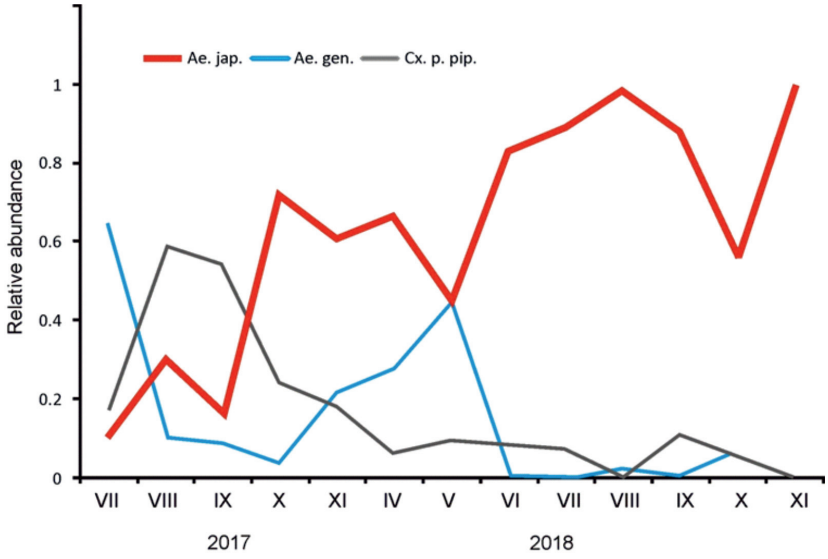

Figure 1: Relative abundances of species being dominant in mosquito assemblage occurring in breeding site studied by phenology of *Aedes j. japonicus* (locality: Balatongyörök, Bece hill at Lake Balaton, Hungary; studied breeding site: rainfall collector from concrete)(Ae. jap.: *Aedes j. japonicus*; Ae. gen.: *Aedes geniculatus*; Cx. p. pip.: *Culex pipiens pipiens*)

Discussion

Aedes j. japonicus occupied the studied rainwater collecting barrel which had been previously considered the main habitat of *Culex p. pipiens*. Our phenological data confirmed the results of DAMIENS et al (2014), whereby at the breeding sites characterized by the high density of *Ae. j. japonicus*, a considerable decrease in the density of *Cx. p. pipens* and *Ae. geniculatus* can also be observed. *Ae. j. japonicus* has competitive advantages not only compared to native species in its invasion areas (breeding in artificial containers, laying eggs on dry surfaces, rapid development, broad food orientation), the tolerance of its larvae to the circumstances of sites and temperature is much higher than that of *Ae. albopictus* (SCHAFFNER et al. 2003); *Ae. j. japonicus* can capture the larvae habitats from *Ae. albopictus*, too (ARMISTEAD et al. 2012). Based on our field experiences, the strategy of *Ae. koreicus*, as a sibling species of *Ae. j. japonicus* and having a significantly more restricted local area in Hungary (KURUCZ et al. 2016), seems similar to *Ae. j. japonicu*s. This latter fact justifies the regular and intense larvae surveillance in the artificial containers found in the anthropogenic zones with gardens bordered by forests in Hungary and other Central European countries.

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