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Mosquitoes (Diptera: Culicidae) of the Lower Dyje River Basin (Podyjí) at the Czech–Austrian border

Research Article

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Abstract: During 2009–2011, mosquitoes were captured in CDC miniature light traps using CO_2 (dry ice) at six sites in the Lower Dyje River Basin (Czech Republic). Other methods of capture – sweeping from vegetation and collection of larvae and pupae from ponds – were also used for more precise diagnostics. Thirty mosquito species of six genera were confirmed. A total of 415,218 females were captured. Most frequently found were the outbreak species *Aedes vexans* (56.52% of all mosquitoes collected) and *Ae. sticticus* (16.40%). Among other flood species, *Ae. rossicus* (5.17%), *Ae. cantans* and *Ae. annulipes* (2.44% of all females collected), and *Ae. cinereus* s. l. (1.11%) were especially abundant. Females of *Ae. cataphylla* were captured in spring (0.31%) and *Ae. intrudens* was numerous only at one site. Among the other species, *Culex pipiens* s. l. (6.61%) and *Cx. modestus* (8.87%) were abundant. *Anopheles maculipennis* s. l. (1.01%), *An. claviger* (0.43%), *An. plumbeus* (0.08%), *An. hyrcanus* (0.08%), *Coquillettidia richiardii* (0.52%) and *Culiseta annulata* (0.18%) were also detected. Sparsely occurring were *Ae. excrucians, Ae. flavescens, Ae. caspius* and *Ae. geniculatus*. Captured only very sporadically were *Ae. communis, Ae. leucomelas, Ae. dorsalis, Ae. rusticus, Cx. martinii, Cx. territans, Cs. morsitans* and *Uranotaenia unguiculata.*

Keywords: *Aedes vexans* • *Aedes sticticus* • *Culex modestus* • *Culex pipiens*

1. Introduction

The South Moravian region is characterized by a high occurrence of mosquitoes and frequent mosquito calamities. Important breeding grounds are located especially in the lowlands around the lower stream of the rivers Dyje and Morava and their tributaries. The river valleys are very frequently flooded. Relatively extensive alluvial forests, waterlogged meadows and marshlands are found here. There is also a system of ponds. The Lower Dyje River Basin, know as the Podyjí area, has gone through significant changes in recent decades. A system of three reservoirs was constructed here (Nové Mlýny), flooding part of the marshlands and alluvial forests. The significance of the lower Podyjí is increased by the fact that it is a border area, and in the event of a mosquito outbreak the neighbouring regions of Austria and Slovakia are also affected.

The occurrence of mosquitoes in South Moravia traditionally draws much attention [1-7]. The authors of the cited works deal with the occurrence of mosquitoes in the area of Central and South Moravia [1,2], the ecology and medical importance of parasitic Diptera in the Lednice area [3], male mosquitoes in Moravian lowland forest during a period of changing environmental conditions, a flood plain forest mosquito community after man-made moisture changes, changes in biodiversity of mosquitoes in the years 2002–2003 caused by climatic changes in the Morava river basin, and seasonal comparisons of the mosquito fauna in the flood plains of the Czech Republic [6,7]. Regular trapping of females has been extensive only in the

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last few years [8,9]. This activity led to the discovery of *Anopheles hyrcanus*, a new species for the Lower Dyje River Basin [8]. Considerable attention has been devoted to the influence of the constructed reservoirs on the occurrence of mosquitoes and their species composition [5,10,11].

Kramář and Weisser [12] and Novák [13,14] researched mosquitoes in the adjacent lower Pomoraví, as did Lauterer and Chmela [15] in the upper Pomoraví and Labuda [16] in the neighbouring regions of Slovakia. A survey in the upper Pomoraví was conducted in the 1950s to 1970s. In total, 13,090 larvae and 13,000 adult mosquitoes of 29 species were identified. Only *Ae. sticticus* and *Cx. pipiens* showed eudominant representation. Labuda [16] demonstrated based on the identification of 6,000 larvae and 17,700 adult mosquitoes collected between 1971 and 1973 the presence of 27 mosquito species. A survey and distribution of mosquitoes in the entirety of Slovakia were published by Jalili *et al.* [17], Országh *et al.* [18] and Országh [19]), as was another by Tóth [20] for Western Hungary, in the area of Sopron. The occurrence of 47 species of mosquitoes belonging to 6 genera was detected throughout the territory of Slovakia, while 30 species were detected in the area of Sopron. The species composition is very similar to that observed in the lower Podyjí.

The lowlands of south-east Moravia open in a south-easterly direction towards the Balkans, forming an entryway for thermophilous plant and animal species. The occurrence of several types of mosquitoes not occurring in other parts of the Czech Republic has been well established here. In the mid-20th century, the Mediterranean species *Anopheles atroparvus* van Thiel and *An. labranchiae* Falleroni [21] were detected here. Other species were discovered in the 1970s and 1980s: *Uranotaenia unguiculata* Edwards [22], *Cx. martinii* Medjid [23] and *Ae. nigrinus* (Eckstein) [24]. The Mediterranean species *An. hyrcanus* Pallas was only discovered here after 2000 [8,25] and is today relatively common at certain sites. Also numerous are works dealing with mosquitoes as vectors [26-30].

The basic aim of this article is to give a more precise actualization on the occurrence of mosquitoes around the lower course of the Dyje River. A comparison of the data obtained with that published to date may indicate possible changes in the species spectrum of mosquitoes. New circumstances will constitute a basis for monitoring changes in the further development of this group of haematophagous insects, which includes a number of vectors for viral illnesses that could arise in connection with possible changes in climate.

2. Experimental Procedures

2.1 Study sites: characteristics

South-east Moravia is characterized by a relatively dry and warm climate. Annual precipitation averages 490 mm and average daily temperature is 9.3°C (tying with Prague as the warmest area of the Czech Republic). The year 2009 had slightly above-average temperatures (mean annual temperature of 10.1°C) while 2010 was slightly below average (8.9°C). Regarding precipitation, both years were significantly above average (697.2 mm in 2009, 142.3% of the norm; 729.4 mm in 2010, 148.9% of the norm). Summer inundations occurred in both years. In July 2009, there were local floods resulting from repeated violent rainstorms. In 2010, after incessant rains and overflowing of rivers, extensive floods began in June and lasted for practically the entire vegetative period. In 2011, the temperatures were slightly above average, precipitation was about average, and no summer floods occurred.

Research was carried out at six sites located in the basin of the River Dyje (Figure 1). The Sedlec site (48°47´N, 16°42´E, 169 m a.s.l.) is situated on the edge of the Nesyt fishpond. Nesyt is a part of the Lednice Ponds system and, with its area of 322 ha, is the largest pond in Moravia. The site consists of a group of bushes and low trees, mostly willows (*Salix fragilis),* growing on the edge between the pond's embankment vegetation and a meadow. The bank of the pond is densely vegetated, mostly by reeds (*Phragmites australis*). The meadow is part of the Slanisko National Natural Reserve and is characterized by the occurrence of halophilous flora and fauna (e.g., *Scorzonera parviflora*, *Tripolium pannonicum*, and *Spergularia salina*).

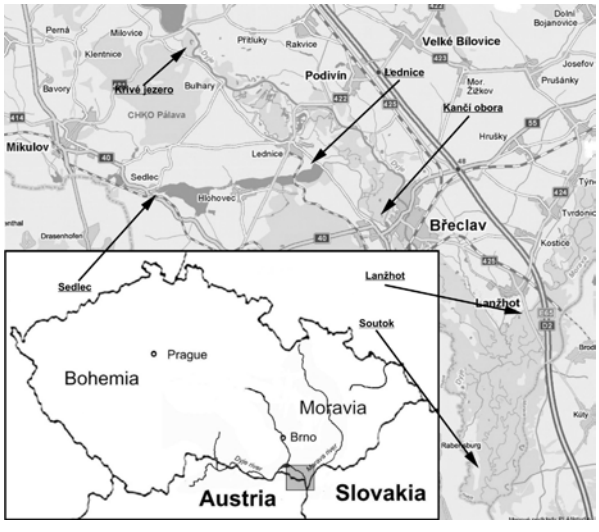

Figure 1. Map of study sites in the Czech Republic.

The Lednice site (48°47´N, 16°49´E, 162 m a.s.l.) is situated on the edge of Mlýnský Pond, which is also part of the Lednice pond system. Mlýnský Pond has an area of 107 ha. The site consists of dense reed vegetation (*P. australis*) and a group of bushes and low trees (*Salix fragilis*).

The sites Křivé Jezero (Curved Lake), Kančí Obora (Boar's Forest) and Soutok (Confluence) are composed mainly of alluvial forest with mixed tree species (*Salix* spp., *Populus* spp., *Quercus robur, Fraxinus angustifolia*, *Tilia cordata,* and *Carpinus betulus*) and wet meadows (*Alopecurus pratensis*, *Poa pratensis*, and *Carex praecox*). The Křivé Jezero site (48°51´N, 16°49´E, 160 m a.s.l.) is situated within the natural preserve by the same name and is only minimally influenced by human activity. It is situated in the valley of the Dyje immediately below the dam of the last lake of the Nové Mlýny reservoir system. The Kančí Obora site (48°46´N, 16°52´E, 154 m a.s.l.) is located approximately 14 km from the Křivé Jezero site, downstream following the Dyje. This site is frequently visited by tourists. The collection site is situated approximately 500 m from the district town of Břeclav. The Soutok site (48°39´N, 16°58´E, 147 m a.s.l.) is situated close to the confluence of the rivers Morava and Dyje and is distinctly remote from all residential areas (9 km from the town of Lanžhot). Its distance from the Kančí Obora site is approximately 15 km.

The Lanžhot site (48°43´N, 16°58´E, 151 m a.s.l.) consists of a farmstead with houses and several small stables. Farm animals are stabled here, in particular horses. It is situated on the edge of an alluvial forest (the Soutok game preserve) about 800 m from the town of Lanžhot.

2.2 Trapping method and identification

Female mosquitoes were captured in Centers for Disease Control and Prevention (CDC) miniature light traps using CO_2 (BioQuip Products, Inc., Rancho Dominiquez, CA, USA, supplemented with dry ice [2 kg of dry ice in a 2700 cm^3 box]) hung in a protected place at a height of 1 m. Collection in the years 2009–2011 was from the beginning of April to the end of October in 14-day intervals. To minimize the effect of sudden weather changes, collections were performed on two consecutive days on each occasion. Traps were hung at approximately 16:00 CEST and samples were collected at about 8:00 the next morning. Sweeping of adults from the vegetation using an entomological net and collection of larvae from ponds were used as supplemental methods. For determination of *An. maculipennis s. l.*, blood-fed females were captured using an exhauster and left to lay eggs in laboratory conditions.

Captured mosquitoes were transported in closed, chilled containers to laboratories where they were classified and stored for further processing in freezers at a temperature of −60°C. O. Šebesta performed the identification using keys by Kramář [31] and Becker [32]. Species which were not possible reliably to determine according to females are listed under a common name in the results. In the species overview, the inventory was completed with species ascertained by determination of females, larvae and eggs.

3. Results

A study of changes in mosquito biodiversity was conducted in the years 2009–2011 at 6 sites representing the various types of biotopes of the Lower Dyje River Basin. During these three seasons, a total of 415,218 female mosquitoes were captured into CDC miniature light traps. This figure comprises a total of 30 species belonging to 6 genera. Tables 1–3 and Figure 2 contain the data obtained. The species and genus composition of captured mosquitoes was confirmed using supplementary methods of collection – sweeping and preservation of collected larvae and pupae, or eggs laid by captured females (*Anopheles*).

Large differences were recorded in the occurrence and species composition at individual sites (Figures 3–8, Table 2), as well as between individual seasons. In 2009, *Aedes vexans* and *Ae. sticticus* were the most prevalent of the total captured mosquitoes. In the following season of 2010, *Ae. rossicus, Culex pipiens,* and *Cx. modestus* also were among the most dominant species. In the 2011 period, however, these

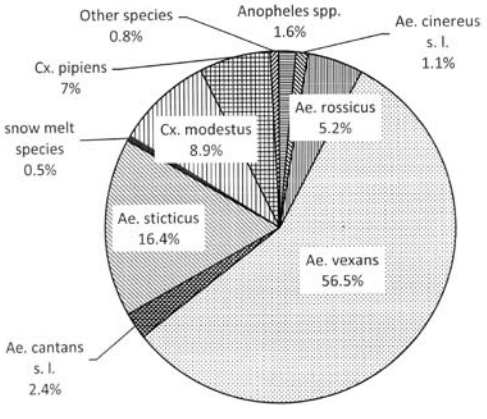

Figure 2. Representation of individual mosquito species during 2009–2011 at the monitored sites (snow melt species = *Ae. cataphylla, Ae. communis, Ae. leucomelas* and *Ae. intrudens)*.

	Year 2009		Year 2010		Year 2011		Total	
	abundance	%	abundance	%	abundance	%	abundance	%
An claviger	484	0.66	1,128	0.36	224	0.67	1,806	0.43
An. hyrcanus	15	0.02	148	0.05	142	0.43	305	0.07
An. maculipennis s. l.	702	1.02	2,668	0.85	822	2.47	4,192	1.01
An. plumbeus	218	0.32	59	0.02	54	0.16	331	0.08
Ae. cantans s. l.	2,480	3.61	3,960	1.26	**3,678**	**11.07**	10,118	2.44
Ae. caspius	17	0.02	53	0.02	6	0.02	76	0.02
Ae. cataphylla	789	1.15	428	0.14	62	0.19	1,279	0.31
Ae. cinereus s. l.	1,676	2.44	2,514	0.80	427	1.29	4,617	1.11
Ae. communis	0	0.00	2	<0.01	1	<0.01	3	<0.01
Ae. dorsalis	1	<0.01	0	0.00	0	0.00	1	<0.01
Ae. excrucians	56	0.08	76	0.02	34	0.10	166	0.04
Ae. flavescens	20	0.03	57	0.02	17	0.05	94	0.02
Ae. geniculatus	1	<0.01	38	0.01	13	0.04	52	0.01
Ae. intrudens	405	0.59	371	0.12	26	0.08	802	0.19
Ae. leucomelas	2	<0.01	4	<0.01	0	0.00	6	<0.01
Ae. rossicus	3,022	4.40	**18,226**	**5.82**	200	0.60	**21,448**	**5.17**
Ae. rusticus	0	0.00	1	<0.01	0	0.00	1	<0.01
Ae. sticticus	**23,206**	**33.79**	**40,325**	**12.87**	**4,544**	**13.68**	**68,075**	**16.40**
Ae. vexans	**31,704**	**46.16**	**182,998**	**58.41**	**19,978**	**60.13**	**234,680**	**56.52**
Cq. richiardii	461	0.67	691	0.22	1,001	3.01	2,153	0.52
Cx. martinii	0	0.00	1	<0.01	0	0.00	1	<0.01
Cx. modestus	1,238	1.80	**34,134**	**10.89**	1,475	4.44	**36,847**	**8.87**
Cx. pipiens s. l.	2,069	3.01	**24,941**	**7.96**	377	1.13	**27,387**	**6.60**
Cx. territans	1	<0.01	2	<0.01	4	0.01	7	<0.01
Cs. annulata	135	0.20	477	0.15	136	0.41	748	0.18
Cs. morsitans	0	0.00	6	<0.01	1	<0.01	7	<0.01
Ur. unguiculata	5	0.01	6	<0.01	5	0.02	16	<0.01
Total specimens	68,677		313,314		33,227		415,218	
Total species	23		26		23		27	
C	0.33		0.38		0.40		0.36	
H´	1.49		1.39		1.42		1.47	
E	0.47		0.43		0.45		0.44	

Table 1. Comprehensive overview of the numbers of female mosquitoes captured using CDC traps. Eudominant (>10%) and dominant (5–10%) species are indicated in bold.

species recorded a significant drop in their numbers. *Ae. cantans s. l.*, however, did not record a decrease in that year, thereby resulting in a sharp increase for this species in relative terms. Other captured species also exhibited seasonal fluctuations in population size in relation to the weather (*i.e.* heat and precipitation). *Ae. vexans* and *Ae. sticticus* were the only species dominant in each year (Table 1). Differences in the abundance of captured species also were recorded among individual study sites (Table 2). The only eudominant species (over 10%) at all studied sites was *Ae. vexans*. *Ae. sticticus* was a eudominant species at Křivé Jezero and Kančí Obora and a dominant species (5–10%) at Soutok and Lanžhot. At the Sedlec and Lednice sites, it did not exceed 5%. *Cx. modestus* also was among the eudominant species at Sedlec, Lednice and Kančí Obora. *Cx. pipiens s. l.* was another eudominant species at the latter site, while it was a dominant species at Sedlec and Lanžhot. *Ae. cantans s. l.* was a dominant species at Sedlec and Kančí Obora, while *Ae. rossicus* was dominant at Soutok and *Ae. sticticus* at Lanžhot. Other species did not reach the 5% level of occurrence at individual sites. The species composition corresponds to the type of

	Sedlec		Křivé Jezero		Lednice		Kančí Obora		Soutok		Lanžhot	
	abundance	%	abundance	%	abundance	%	abundance	%	abundance	%	abundance	%
An claviger	1,108	4.31	400	0.78	12	0.03	91	0.10	69	0.04	126	0.45
An. hyrcanus	272	1.06	2	<0.01	22	0.07	0	0.00	1	<0.01	8	0.03
An. maculipennis s. l.	314	1.22	344	0.67	550	1.67	424	0.48	613	0.32	1,947	6.99
An. plumbeus	9	0.03	75	0.15	1	<0.01	78	0.09	165	0.09	3	0.01
Ae. cantans s. l.	**1,916**	**7.45**	1,681	3.29	228	0.69	**5,033**	**5.75**	1,092	0.58	168	0.60
Ae. caspius	5	0.02	4	0.01	2	0.01	2	<0.01	3	<0.01	60	0.22
Ae. cataphylla	50	0.19	220	0.43	82	0.25	665	0.76	127	0.07	135	0.48
Ae. cinereus s. l.	947	3.68	572	1.12	86	0.26	2,136	2.44	764	0.40	112	0.40
Ae. communis	1	<0.01	0	0.00	0	0.00	0	0.00	2	<0.01	0	0.00
Ae. dorsalis	1	<0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Ae. excrucians	2	0.01	11	0.02	0	0.00	92	0.11	57	0.03	4	0.01
Ae. flavescens	87	0.34	0	0.00	0	0.00	1	<0.01	6	<0.01	0	0.00
Ae. geniculatus	2	0.01	23	0.05	0	0.00	21	0.02	5	<0.01	1	<0.01
Ae. intrudens	0	0.00	0	0.00	0	0.00	5	0.01	795	0.42	2	0.01
Ae. leucomelas	3	0.01	0	0.00	3	0.01	0	0.00	0	0.00	0	0.00
Ae. rossicus	231	0.90	1,636	3.20	32	0.10	2,503	2.86	**16,642**	**8.77**	404	1.45
Ae. rusticus	1	<0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Ae. sticticus	971	3.78	**16,614**	**32.52**	1,332	4.04	28,307	32.32	18,488	9.74	2,363	8.49
Ae. vexans	5,907	22.97	25,506	49.93	8,195	24.81	32,030	35.57	143,012	75.27	20,030	71.94
Cq. richiardii	684	2.66	388	0.76	150	0.46	579	0.66	310	0.16	42	0.15
Cx. martinii	0	0.00	0	0.00	0	0.00	1	<0.01	0	0.00	0	0.00
Cx. modestus	**10,792**	**41.96**	1,130	2.21	**18,955**	**57.52**	**5,325**	**6.08**	428	0.23	217	0.78
Cx. pipiens s. l.	**2,233**	**8.68**	2,348	4.60	**3,315**	**10.01**	**10,093**	**11.52**	7,382	3.88	**2,016**	**7.24**
Cx. territans	2	0.01	1	<0.01	4	0.01	0	0.00	0	0.00	0	0.00
Cs. annulata	167	0.65	130	0.25	19	0.05	206	0.24	21	0.01	205	0.74
Cs. morsitans	4	0.02	2	<0.01	0	0.00	0	0.00	1	<0.01	0	0.00
Ur. unguiculata	10	0.04	0	0.00	5	0.01	0	0.00	1	<0.01	0	0.00
Total specimens	25,719		51,087		32,993		87,592		189,984		27,843	
Total species	25		19		18		19		22		18	
C	0.25		0.36		0.40		0.26		0.59		0.54	
H´	1.81		1.37		1.21		1.64		0.92		1.09	
E	0.56		0.47		0.42		0.56		0.30		0.38	

Table 2. Number of female mosquitoes captured by CDC traps at individual sites. Eudominant (>10%) and dominant (5–10%) species are indicated in bold.

individual location and reflects the changes in weather between individual years of the study.

Mosquitoes of the genus *Aedes*, especially *Ae. vexans* and *Ae. sticticus*, were the most captured at the monitored sites. *Ae. vexans* (Meigen) was the most abundant species in lower Podyjí (234,680 individuals, 56.52%). It was especially abundant at the Soutok game preserve (143,012, 75.28%) and at the adjacent Lanžhot site (20,030, 71.94%). Imagines were flying from late April until the end of the season, their occurrence peaking in July and August. *Ae. sticticus* was the second most abundant mosquito species (68,075 individuals, 16.40%). It was common at all sites, and especially the alluvial forests. The highest capture was at the Kančí Obora (28,307, 32.32%) and Křivé Jezero (16,614, 32.52%) sites. Imagines were flying from the end of April until the end of the season, their occurrence peaking in July.

Cx. modestus Ficalbi was abundant especially at the Lednice (18,955, 57.45%) and Sedlec (10,792 individuals, 41.96%) sites. Across all sites a total of 36,847 females (8.87%) were captured. The species was captured from late April until September, but a noteworthy peak in its occurrence was recorded in July. The occurrence of *Cx. pipiens s. l.* was relatively

Species	Lower Podyjí 2009–11	South Moravia Vaňhara 1991	Moravia Minář and Kramář 1987	Moravia Országh *et al.* 2009
Anopheles atroparvus	-	-	+	+
An. claviger	+	+	+	+
An. hyrcanus	+	-	-	+
An. labranchiae	-	-	+	-
An. maculipennis	+	+[3]	+	+
An. messeae	+	-	+	+
An. plumbeus	+	+	+	+
Aedes annulipes	+	+	+	+
Ae. cantans	+	+	+	+
Ae. caspius	+	+	+	+
Ae. cataphylla	+	+	+	+
Ae. cinereus	+	+	+	+
Ae. communis	+	+	+	+
Ae. diantaeus	-	-	+	+
Ae. dorsalis	+	-	+	+
Ae. excrucians	+	+	+	+
Ae. flavescens	+	+	+	+
Ae. geminus	+	-	-	-
Ae. geniculatus	+	+	+	+
Ae. intrudens	+	+	+	+
Ae. leucomelas	+	+	+	+
Ae. nigrinus	-	+	-	+
Ae. pullatus	-	-	+	-
Ae. punctor	-	+	+	+
Ae. refiki	-	+	+	+
Ae. rossicus	+	+	+[5]	+
Ae. rusticus	+	-	-	+
Ae. sticticus	+	+	+	+
Ae. vexans	+	+	+	+
Coquillettidia richiardii	+	+	+	+
Cx. martinii	+	+	+	+
Cx. modestus	+	+	+	+
Cx. pipiens	+	+	+	+
Cx. pipiens molestus	-[1]	-	+	+
Cx. territans	+	+	+	+
Cx. torrentium	-[2]	-	+	+
Culiseta alaskaensis	-	-	+	+
Cs. annulata	+	+	+	+
Cs. glaphyroptera	-	-	+	+
Cs. morsitans	+	+	+	+
Cs. subochrea	-	+[4]	+4	+
Uranotaenia unguiculata	+	+	+	+
No. of species and subspecies	30	29	38	39

Table 3. List of mosquitoes verified in Moravia.

[1] Occurrence confirmed. Within the present study, not distinguished from Cx. pipiens. [2] Species was verified at the monitored sites. Within the present study, reported together with Cx. pipiens. [3] An. maculipennis s. l. [4] As a subspecies of Cs. annulata [5] As a subspecies of Ae. cinereus

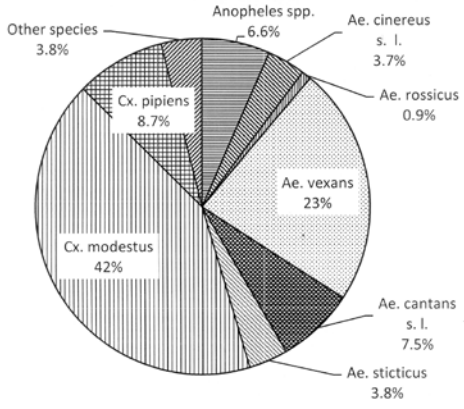

Figure 3. Representation of individual mosquito species during 2009–2011 at the Sedlec site (pond edge).

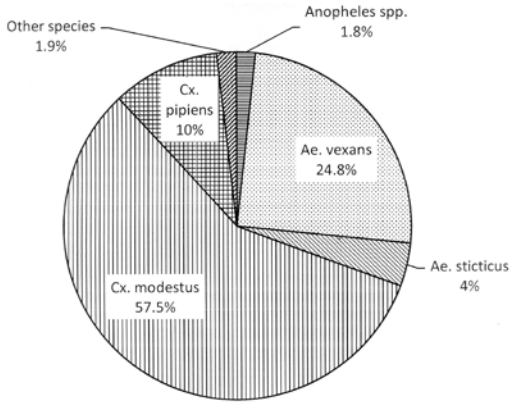

Figure 4. Representation of individual mosquito species during 2009–2011 at the Lednice site (pond edge). For both sites located at the pond edge, relatively low occurrence of flood mosquitoes and high representation of mosquitoes from the *Culex* genus, especially *Cx. modestus*, are typical.

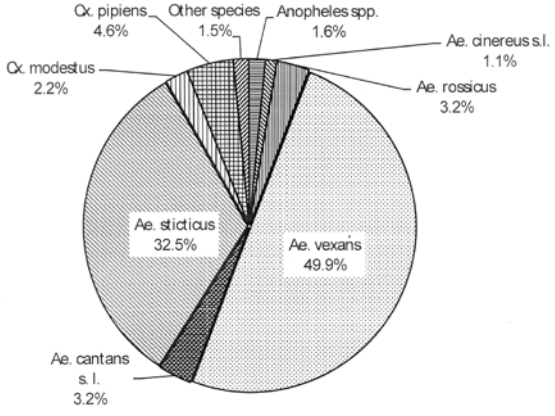

Figure 5. Representation of individual mosquito species during 2009–2011 at the Křivé Jezero site (alluvial forest).

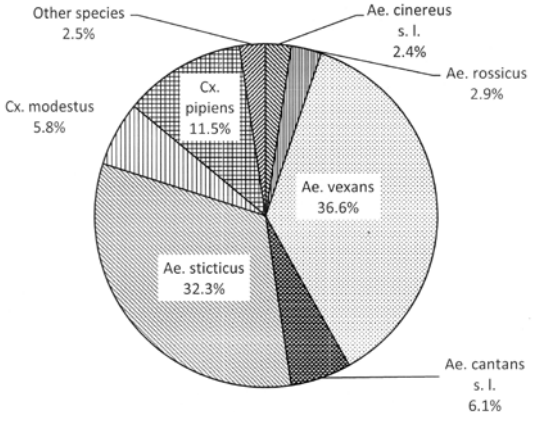

Figure 6. Representation of individual mosquito species during 2009–2011 at the Kančí Obora site (alluvial forest.)

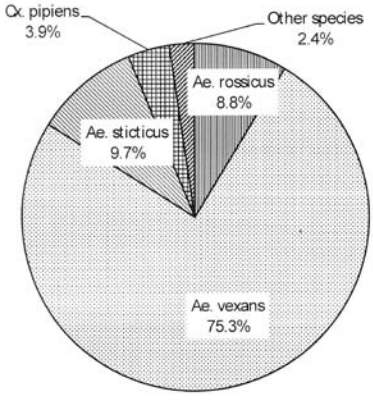

Figure 7. Representation of individual mosquito species during 2009–2011 at the Soutok site (alluvial forest). For sites located in alluvial forest, high occurrence of flood mosquitoes of the *Aedes genus, especially Ae. vexans* and *Ae. sticticus,* and only isolated representation of *Cx. modestus* are typical.

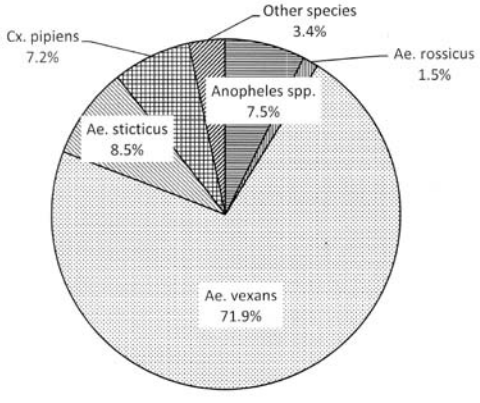

Figure 8. Representation of individual mosquito species during 2009–2011 at the Lanžhot site (farmstead). For a farmstead, relatively high incidence of *An. maculipennis s. l.* is typical. The proximity of alluvial forest is reflected in the high occurrence of flood species of the *Aedes genus*, especially *Ae. vexans*.

uniform at all sites; the highest capture was at Kančí Obora (10,093 individuals, 11.52%). An overall total of 27,387 females (6.60%) was captured. Imagines were flying for the entire monitored period, the greatest occurrence coming in July. In addition, the species *Cx. pipiens* Linnaeus and *Cx. torrentium* Martini have been detected in the lower Podyjí. In the present study, however, these species were not distinguished (as an insufficient number of males was acquired).

Ae. rossicus Dolbeskin, Gorickaja & Mitrofanova was among the most abundant mosquito species during the flooding period (a total of 21,448 individuals, 5.17%). It was especially frequent at the Soutok game preserve (16,642 individuals, 8.76%). Imagines were flying from May until the end of the season. Its occurrence peaked in July. *Aedes cantans s. l.* was comparatively abundant at all sites. A total of 10,118 females were captured (2.44%). It was more abundant at the Sedlec site (1,916 individuals, 7.45%) and at Kančí Obora (5,033, 5.75%). In addition to *Ae. cantans s. s.* (Meigen) there also occurred *Ae. annulipes* (Meigen). As the females of the two species could not always be reliably distinguished, they were counted together. Of the 286 captured males, 123 individuals were of the *Ae. cantans* species and 163 of *Ae. annulipes*. *Ae. cinereus s. l.* occurred at all sites. A total of 4,617 individuals were captured (1.11%). In addition to *Ae. cinereus s. s*. Meigen, the species *Ae. geminus* Peus also was identified based on the anatomy of the hypopygia of males captured during 2009–2010 at the Křivé Jezero and Kančí Obora sites. *Ae. cinereus s. l.* occurred from May until the end of the season, the peak occurrence being in late June and early July.

An. maculipennis s. l. occurred at all monitored sites. A total of 4,192 females were captured (1.01%). Higher occurrence was recorded at the Lanžhot site: 1,947 individuals (6.99%). Imagines were flying for the entire season, and the highest occurrence was recorded in July. Of 32 blood-fed females captured in a stable at the Lanžhot site, 28 individuals were classified as the species *An. messeae* Falleroni (87.5%) and 4 (12.5%) as *An. maculipennis s. s*. Meigen based on determination of the eggs. Occurrence of the species *An. labranchiae* and *An. atroparvus* also has been reported in the lower Podyjí [21], but their eggs were not detected during this research.

Coquillettidia richiardii (Ficalbi) occurred at all sites (2,153 individuals, 0.52%), with higher occurrence at the Sedlec site (684 individuals, 2.66%). They were flying from June to September, their occurrence peaking in late June and early July. *An. claviger* (Meigen) occurred at all sites. A total of 1,806 females were captured (0.43% of all individuals captured into CDC traps). More frequent occurrence was recorded at the Sedlec site: 1,108 individuals (4.31% of all mosquitoes captured at the given site). The species was captured from the end of April until the end of the season, the largest occurrence being in July and August.

Ae. cataphylla Dyar was among the most abundant species during the spring. It occurred at all sites, and a total of 1,279 individuals were captured (0.31%). It was flying from April to June, peaking in early May. *Ae. intrudens* Dyar occurred especially at the Soutok game preserve (795 females, 0.42%). A total of 802 individuals of this species were captured (0.19%). Imagines were flying from April until early June. The highest occurrence was recorded in early May.

Cs. annulata (Schrank) occurred in small numbers at all sites. A total of 748 females were captured (0.18%). They were flying for the entire monitored period, but a higher occurrence was recorded from late May until the end of August. *An. plumbeus* Stephens occurred especially in forest biotopes. In total, 331 individuals were captured (0.08%). It was flying from May to October. *Anopheles hyrcanus* had been determined in the Czech Republic only after 2000 (8, 25). All the individuals captured during the present research belonged to ssp. *pseudopictus* Grassi. Across all sites, 305 females were captured (0.08%). It was more frequently found only at the Sedlec site (272 individuals, 1.06%), and its discovery elsewhere was sporadic (Table 2). It was flying from May until mid-October.

Ae. caspius (Pallas) occurred only sparsely. Just 76 individuals were captured (0.02%), and most of those at the Lanžhot site (60 females, 0.22%). Other species of the *Aedes* genus occurred only sparsely. *Ae. communis* (De Geer), *Ae. dorsalis* (Meigen), *Ae. leucomelas* (Meigen) and *Ae. rusticus* (Rossi) were determined only very sporadically. Findings of *Ae. geniculatus* (Olivier), *Ae. excrucians* (Walker), and *Ae. flavescens* (Muller) were also few (Table 2).

Uranotaenia unguiculata Edwards occurred sporadically from late July until September at the Sedlec and Lednice sites (with a single finding also at the Soutok site). Other species (*Cx. martinii* Medschid, *Cx. territans* Walker, *Cs. morsitans* (Theobald)) were captured only very sporadically.

4. Discussion

The presented results reveal differences in the species spectrum of mosquitoes, on the one hand, at individual study sites and, on the other, between individual years of the study. The results also indicate differences in this spectrum compared to those presented by various authors describing the species composition over the

course of the 20th century. The first extensive monograph dedicated to the occurrence of mosquitoes in the Czech Republic (Czechoslovakia) was published in the mid-20th century [31]. It reported on the territory of the Czech Republic the occurrence of 36 mosquito species (including *Cx. molestus* Forskål, which is considered to be an independent species here), of which 26 are in Moravia. Another list of mosquitoes in Czechoslovakia [33] already shows 38 species and subspecies for Moravia, while a later one [34] lists only 37. According to the most current catalogue of mosquitoes in the Czech Republic and Slovakia [35], 39 species and subspecies of mosquitoes have been confirmed in Moravia (Table 3. In the monitored area, for example, Palička repeated the surveys [1] and determined the occurrence of 25 mosquito species in Central and South Moravia. Hájková and Minář [2] found 24 species in the inundation area of the River Dyje. The later work by Vaňhara [5] states the occurrence of 34 species and subspecies of mosquitoes. Vaňhara [5] himself confirmed 29 species during 1976–1990 (Table 3).

While collecting during 2009–2011, the authors recorded the occurrence of 30 mosquito species (Table 3). In comparison with older literature, the change in occurrence of some species is notable, and especially regarding the spring species. The species *Ae. communis*, which Kramář [31] had noted as being very abundant, occurred only sporadically in the collected samples (Tables 1,2). On the other hand, the now rather common *Ae. cataphylla* is in the early publication characterized as rare. For one of the most abundant flood mosquito species – *Ae. rossicus* (Figure 2) – Kramář [31] had reported only a single finding in the whole of Czechoslovakia, that being on Žitný Island in Slovakia. *Aedes intrudens*, which according to Kramář was occurring only in South Moravia, and then only rarely, was among the common spring species at the Soutok site.

The absence of the species *An. atroparvus* and *An. labranchiae*, which had been reported to be relatively abundant here in the mid-20th century [21], can be due to the fact that the number of egg-layings which the authors had at their disposal for closer determination of *An. maculipennis s. l.* was insufficient and the collection was made only at the Lanžhot site. Other findings of thermophilous species (*Cx. martinii*, *Ur. unguiculata,* and *An. hyrcanus*) can be related to the presumed global warming. During the period 2001–2010, only once was an average annual temperature recorded lower than the average from the years 1961–1990. In 3 years, on the other hand, this value was exceeded by more than 1°C. In the whole of Europe in this period very hot weather dominated [36-38]. *Aedes geminus* undoubtedly had occurred also earlier in the researched area, but the authors had not distinguished it from *Ae. cinereus*.

In addition to rising average temperature, higher total annual precipitation also was recorded in the past decade, though this increase was not so pronounced. In 3 years, the 1961–1990 average was not reached. In 3 other years, however, this average was exceeded by more than 100 mm. Appreciable differences in the occurrence of mosquitoes in connection with the amount of precipitation in the monitored period indicate that climate change can influence not only the spread of certain potential vectors, but especially the total number of mosquitoes (Table 1). Data from Olejníček *et al.* [6,39] and Minář *et al.* [40] also confirm these findings. Excessive occurrence of mosquitoes necessitates effective protection of the human population. In the case of the lower Podyjí, moreover, cooperation with the neighbouring regions of Austria and Slovakia is expedient. Increasing incidence of extreme phenomena such as strong storms, extended periods of rainfall, and associated flooding is evident in the last decade.

The percentage representation of the individual species in the study is somewhat distorted by the method of collection, which does not take into account the differences in activity of the individual mosquito species through a full 24-hour day. This negatively influenced the capture of species with significant daytime activity, and most notably of the species *Ae. sticticus* [41].

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