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Influence of Trap Construction on Mosquito Capture

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Abstract: During 2009 and 2010, 23 night-time mosquito captures were made at Kančí obora in south-eastern Moravia, Czech Republic. It was used in the Centers for Disease Control and Prevention (CDCP) miniature light traps with CO_2 (dry ice) and baited lard-can traps in which sentinel animals were replaced with a container filled with CO_2 (dry ice). In the observed period, a total of 31,882 female mosquitoes were captured by CDC miniature light traps with CO_2. Lard-can traps baited with CO_2 captured 995 females under the same conditions, which is just 3.12% of the quantity from the CDC traps. At the same time, there were significant differences in the proportional captures of various species. Compared to CDC miniature light traps, baited lard-can traps much more often captured *Aedes cinereus* (16.58% of total versus 1.93% in CDC traps), *Culex modestus* (15.48% versus 4.62%), and *Ae. rossicus* (6.13% versus 2.67%). On the other hand, capture of female *Ae. vexans* was proportionally much lower (15.38% versus 36.41%). Capture of *Cx. pipiens* was more or less the same 14.77% (miniature light traps) and 15.76% (baited lard-can traps). The occurrence of the calamity species *Ae. sticticus* was proportionally very high in both trap types (30.05% in lard-can traps baited with CO_2, 33.58% in CDC miniature light traps). The findings prove that a trap's design itself significantly affects not only the overall capture of mosquitoes but also the proportional representation of individual species.

Key words: CDC miniature light traps, baited lard-can traps, *Aedes cinereus*, *Aedes vexans*, *Aedes sticticus*, *Culex modestus*, *Culex pipiens*.

1. Introduction

Research on mosquitoes often depends upon capturing the females. For this purpose, a number of methods have been developed and many ingenious devices created. Mosquitoes are baited using various animals or chemical compounds (most frequently CO_2). Common devices include in particular CDC miniature light traps with CO_2 [1-5], but also traps baited with live animals. Attractants used have included live ducks [6], pigeons [5, 7], chickens [8, 9], starlings (*Sturnus vulgaris*) [7], and horses [2, 6]. Sometimes, even mosquitoes attacking humans are collected [2, 10].

Numerous studies have compared the effectiveness of different trap types and attractants [11-14]. A comparison of CDC traps using various attractants (CO_2, octenol, light) and their combinations were made by Becker et al. [15].

In addition to the type of trap and attractant used, another important factor is the height at which the trap is situated [5, 16, 17]. The present work aims to verify how mosquito captures and their species representation are influenced by the structure of the baited lard-can traps themselves.

2. Material and Methods

2.1 Sites

The Kančí obora site (48°46′N, 16°52′E, 157 m a.s.l.) is located in south-eastern Moravia, Czech Republic (Fig. 1) and is comprised primarily of floodplain forest. The dominating trees are *Quercus robur* L., *Fraxinus angustifolia* Vahl, *Populus* spp.,

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Tilia cordata Mill, and *Carpinus betulus* L.. The floodplain forest is often flooded with water from the Dyje River. The traps were located approximately 500 m from the town of Břeclav.

2.2 Meteorological Data

South-eastern Moravia is characterized by a relatively warm and dry climate. Average daily temperature is 9.3 °C and average total annual precipitation is 490 mm.

The studied period, 2009 and 2010, had above-average precipitation (Fig. 2).

During January-October (end of capturing) 2009, precipitation totaled 594.1 mm (113.8% of the norm). In 2010, this figure was 681.7 mm (161.5% of norm) (data from Czech Hydrometerological Institute's Kobylí station, 19 km north of the site). In 2009, however, only March, June and July had above-average precipitation, which was reflected in a high incidence of mosquitoes especially in summer. In 2010, high precipitation was recorded for the majority of the observed period and the overall mosquitoes incidence was also distinctly higher.

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

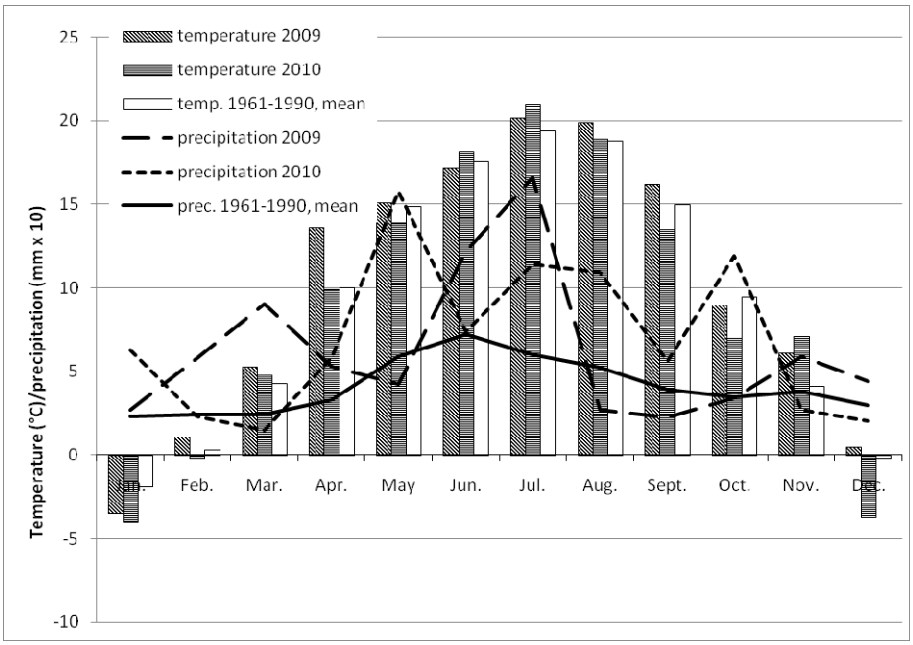

Fig. 2 Monthly sum of precipitation (mm × 10) and Mean monthly air temperature (°C) in the study area, compared with the long-term average (Kobylí; data from Czech Hydrometeorological Institute in Brno).

2.3 Trapping Method

We used two types of traps for trapping female mosquitoes:

(a) CDC miniature light traps with CO_2 (BioQuip Products, Inc., Rancho Dominiquez, CA, USA.), supplemented with 1.5 kg of dry ice.

(b) Baited lard-can traps [7] in which the sentinel animal was replaced by a container with 1.5 kg of dry ice (Fig. 3). The container was made from polystyrene foam with dimensions 260 × 170 mm. Both smaller sides were provided with three circular apertures 0.6 mm in diameter. Two polystyrene barriers 110 mm high were inserted into the container. By inserting the barriers the appropriate discharge of CO_2 was achieved.

The traps were installed 1 m high and approximately 25 m from one another. Lard-can traps without bait were used as control. The exposure was throughout the night from 16:00 to 8:00 Central European Summer Time. Collections were made from the beginning of April until the end of October and a total of 23 collections were made.

2.4 Identification

Keys by Kramář [18] and Becker [19] were used.

2.5 Statistical Analysis

The relative abundance of each species was calculated separately for each monitored period. The following scale of dominance was used: more than 10% of the total number of culicidae captured per studied period was regarded as eudominant (ED), 5-10% as dominant (D), 2-5% as subdominant (SD), 1-2% as recedent (R), and less than 1% as subrecedent (SR). The index of dominance (C), Shannon-Weaver diversity index (H'), and equitability index (E) were monitored for each period.

Fig. 3 Lard-can traps baited with CO_2.

3. Results

The capture of female mosquitoes in both types of traps displayed significant differences in both quantity as well as qualitative representation. CDC miniature light traps with CO_2 captured 31,882 females through the season. At the same time, lard-can traps with CO_2 captured 995 females, or just 3.12% of the number captured by CDC traps. Only 19 individuals flew into the empty lard-can traps (Table 1). In samples collected from CDC miniature light traps with CO_2, the calamity species *Aedes vexans* (Meigen) (36.41% of total) and *Ae. sticticus* (Meigen) (33.58%) significantly dominated, followed by *Culex pipiens* Linnaeus (15.76%) and *Cx. modestus* Ficalbi (4.62 %) (Fig. 4). *Aedes sticticus* was also very abundant in lard-can traps with CO_2 (30.05%). Other common species in this type of trap were *Cx. modestus* (15.48%) and *Cx. pipiens* (14.77%). Compared to CDC traps, there was a relatively low occurrence of *Ae. vexans*, which represented just 15.38% of the total here. This type of trap, however, seemed to be attractive for the species *Ae. cinereus* Meigen (16.58% of the total versus 1.93% in CDC traps), and a little less so for *Ae. rossicus* Dolbeskin, Gorickaja and Mitrofanova (6.13% versus 2.67%) (Fig. 5). The numbers of females of individual species captured in the lard-can traps with CO_2 compared to the capture by CDC miniature light traps with CO_2 (expressed in %) and the representation of some of the mosquito species in the different trap types are displayed in Figs. 6 and 7.

Table 1 List of species collected on the locality Kančí obora, including number of individuals (No), relative abundance (%), and classification of dominance (CD) (eudominant–ED; dominant–D; subdominant–SD; recedent–R; subrecedent–SR), ED and D are accentuated by bold face.

Species	CDC miniature traps			lard-can traps baited					
				with CO_2			without CO_2		
	No	%	CD	No	%	CD	No	%	CD
An. maculipennis s. L.	99	0.31	SR						
An claviger	22	0.07	SR						
An. plumbeus	22	0.07	SR	1	0.10	SR			
Ae. cantans s. L.	1,078	3.38	SD	4	0.40	SR			
Ae. caspius	1	0.00	SR						
Ae. cataphylla	116	0.36	SR	3	0.30	SR			
Ae. cinereus	616	1.93	R	165	16.58	ED	1	5.26	D
Ae. excrucians	27	0.08	SR	1	0.10	SR			
Ae. geniculatus	9	0.03	SR						
Ae. rossicus	851	2.67	SD	61	6.13	D	4	21.05	ED
Ae. sticticus	10,705	33.58	ED	299	30.05	ED	13	68.41	ED
Ae. vexans	11,607	36.41	ED	153	15.38	ED	1	5.26	D
Cx. modestus	1,472	4.62	SD	154	15.48	ED			
Cx. pipiens	5,024	15.76	ED	147	14.77	ED			
Cs. annulata	96	0.30	SR						
Cq. richiardii	137	0.43	SR	7	0.70				
Total specimens	31,882				995			19	
Total species	16				11			4	
C	0.27				0.19			0.52	
H´	1.55				1.78			0.90	
E	0.56				0.74			0.65	

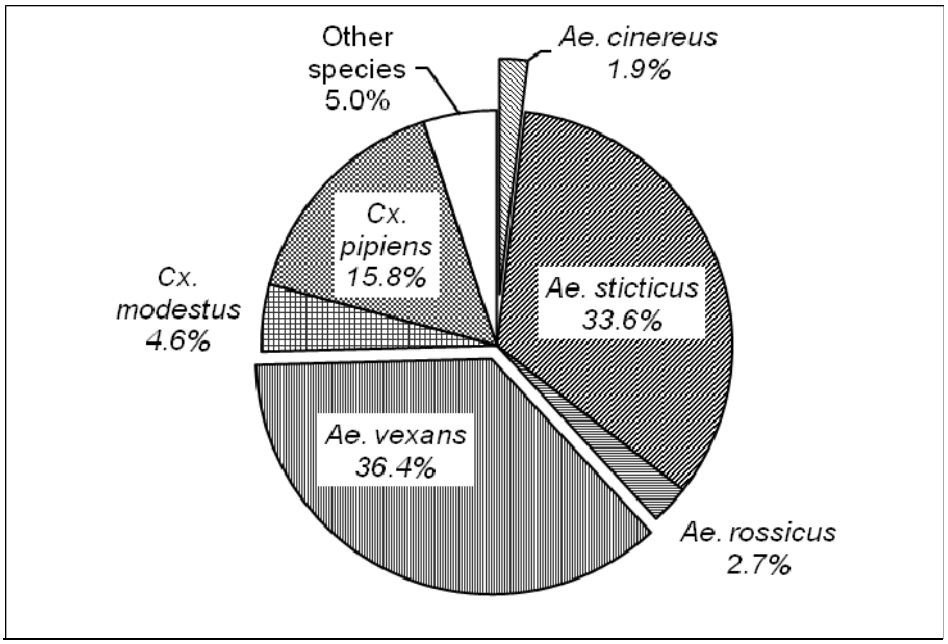

Fig. 4 Representation of the individual mosquito species captured by CDC miniature light traps with CO_2.

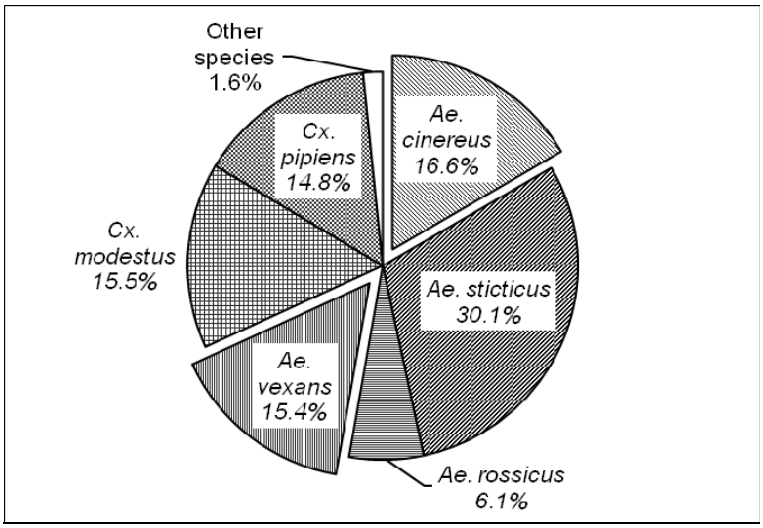

Fig. 5 Representation of the individual mosquito species captured by lard-can traps baited with CO_2.

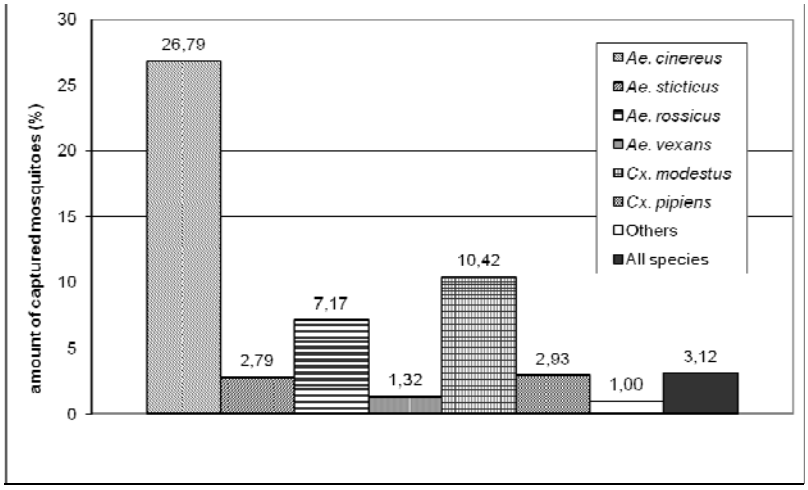

Fig. 6 Representation of the females of individual mosquito species captured by lard-can traps baited with CO_2 in comparison to the numbers captured by CDC miniature light traps with CO_2.

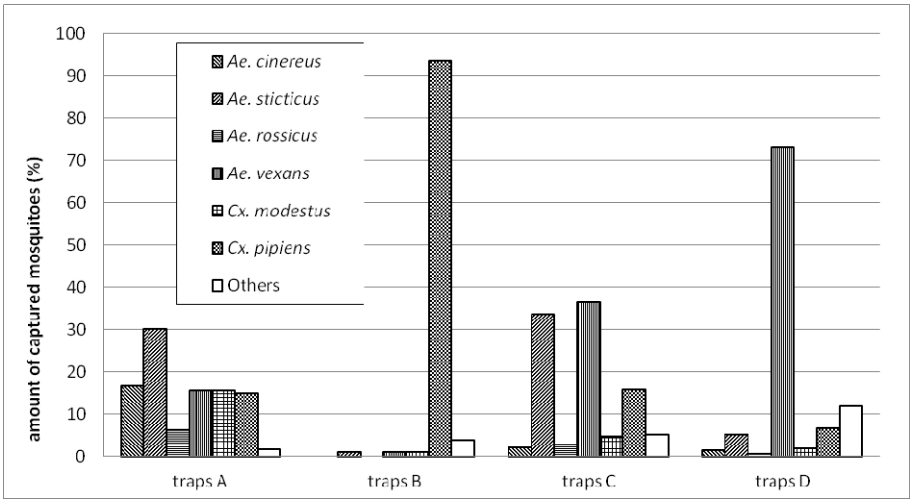

Fig. 7 Percentage representation of selected mosquito species in different trap types.

A: lard-can traps baited with CO_2 (2009-2010); B: lard-can traps baited with a live pigeon (2007-2008); C: CDC miniature light traps with CO_2 (2009-2010); D: CDC miniature light traps with CO_2 (2007-2008).

4. Discussion

Hoel et al. [20] made a comparison of six traps from the viewpoint of capturing *Ae. albopictus*. These authors compared the following traps: mosquito magnet professional, fay-prince, CDC wilton, mosquito magnet-X, mosquito magnet liberty, and the standard CDC light trap. In addition to CO_2, the attractants L-lactic acid and octenol were used. Individual traps differed not only by total number of captured mosquitoes (in a range of 2,145-11,143 adults) but also by proportional representation of individual mosquito species. The monitored *Ae. albopictus* comprised 14.2% of the total number of captured adults (in individual types of traps ranging from 3.3% to 63.6%). The mosquito species represented in that work included no species occurring on the territory of the Czech Republic.

Research on species composition comparing the two trap types also had been conducted in south-eastern Moravia during 2007 and 2008 [5]. Female mosquitoes were captured at two sites nearby to one another: Nesyt (located 12 km from Kančí obora) and Soutok (about 15 km away) (Fig. 1). At that time, CDC miniature light traps with CO_2 and lard-can traps baited with a live pigeon had been used. During this research, 6,836 female mosquitoes were captured using three CDC miniature light traps hung at 1 m height. The most abundant species was *Ae. vexans* (72.95% of total). Another species with higher occurrence were *Cx. pipiens* (6.60%), *Ae. cantans* s.l. (Ae. cantans + Ae. annulipes Meigen) (5.82%) and *Ae. cinereus* 1.24%. Meanwhile, three lard-can traps baited with a live pigeon captured 213 females (3.06% of the number captured by CDC miniature light traps). *Cx. pipiens* comprised 93.42% of the total, *Ae. vexans* only two females in total, and *Ae. cinereus* was not represented here. The trap was clearly selective, with high dominance of the ornithophilous species *Cx. pipiens* compared to CDC miniature light traps with CO_2 (Fig. 7, Table 1).

In comparing the results of the two studies, it is evident that the numbers of mosquitoes captured by lard-can traps baited with CO_2 or with a live pigeon are distinctly lower compared to the numbers captured by CDC miniature light traps with CO_2. The two cases using lard-can traps are comparable to one another when their capture numbers are expressed as percentages of the corresponding CDC traps capture (3.12% with CO_2 and 3.06% with a pigeon). The spectrum of species captured by baited lard-can traps is markedly influenced by the species of sentinel animal used, but the trap structure itself was partially selective (Fig. 7). When using just CO_2 as the attractant, baited lard-can traps were preferred by the species *Ae. cinereus*, *Ae. rossicus* and *Cx. modestus*, while the findings of the most abundant species *Ae. vexans* were decisively and negatively influenced.

Differences in mosquito captures, both quantitative and qualitative, when using various types of traps have been established also by other authors [11, 12]. This points to the need to take into account this fact when interpreting results and emphasizes the importance of correct trap choice for a specific situation.

5. Conclusion

The results of this work show that the type of trap and its design significantly influence not only overall mosquito capture but also the proportional representation of the individual species. When planning research, therefore, due attention must be given to the choice of traps.

Acknowledgments

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