Evaluation of the efficiency of bird-baited traps for sampling potential West Nile Fever mosquito vectors (Diptera: Culicidae) in Senegal

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Summary:

The efficiency of bird-baited traps and collection heights for sampling potential West Nile mosquito vectors was studied during the 2006 rainy season (between September 27 and November 26) in Barkedji area situated in the sahelian area of Senegal (West Africa). Each night, two traps were set on the ground-level and two on the canopy-level (~ 3 m) each containing either a chicken or a pigeon, the traps being rotated the following nights. A total of 1,030 mosquitoes were collected using 66 traps-nights. *Culex* species were predominant and represented 92.2 % of the fauna of which 63 % belonged to *Cx. neavei* group Theobald whereas 23.8 % were *Cx poicilipes* (Theobald). The species of the *Cx. neavei* group were mainly collected by the pigeon-baited trap at canopy while *Cx. poicilipes* was captured similarly by pigeons and chickens placed at the canopy and ground. The implication of these results in West Nile vectors surveillance is discussed.

KEY WORDS: West Nile Fever, *Cx. neavei* group, *Cx. poicilipes*, traps, chicken, pigeon, level of collection, Senegal.

Résumé : Évaluation de l'efficacité de pièges à appât-oiseaux dans l'échantillonage des moustiques (Diptera : Culicidae) vecteurs potentiels du virus West Nile au Sénégal

Cette étude décrit l'influence de la hauteur de la mise en place des pièges et de l'espèce d'oiseau utilisée comme appât dans la collecte des moustiques (Diptera: Culicidae) vecteurs potentiels du virus West Nile. Elle a été réalisée durant la saison des pluies 2006 (entre le 27 septembre et le 26 novembre 2006) dans la localité de Barkedji (Sénégal), située dans la zone sahélienne du Ferlo. Deux pièges ont été placés au sol et deux au niveau de la canopée (~ 3 m), chacun contenant un poulet ou un pigeon par nuit de capture avec rotation des pièges les nuits suivantes. Au total, 1 030 femelles de moustiques ont été collectées avec 66 pièges-nuits. Le genre Culex *a été le plus abondant car représentant 92,2 % de la faune dont 63 % et 23,8 % constitués respectivement par le groupe* Cx. neavei *Theobald et* Cx. poicilipes *(Theobald). Les espèces du groupe* Cx. neavei *ont été principalement collectées par le piège appâté avec un pigeon au niveau de la canopée tandis que* Cx. poicilipes *a été capturé de façon comparable par les pièges avec pigeons ou poulets placés au niveau de la canopée et du sol. L'implication de ces résultats dans la surveillance des vecteurs du virus West Nile est discutée.*

MOTS CLÉS : *fièvre à virus West Nile,* Cx. neavei *group,* Cx. poicilipes*, piège, poulet, pigeon, niveau de capture, Sénégal.*

West Nile Fever (WNF) is an emerging and re-emerging vector-borne disease in many parts of the world (Murgue *et al.,* 2002). West Nile virus (WNV), genus *Flavivirus*, family *Flaviviridae*, has an enzootic transmission cycle involving mosquitoes as vectors and birds as amplifying hosts (Taylor *et al.,* 1956). WNF outbreaks concern principally humans and horses and many other vertebrates as accidental hosts (Campbell *et al.,* 2002).

In Senegal, WNV has been isolated from several mosquito species including *Cx. poicilipes* (Theobald) and species of the *Cx. neavei* group Theobald (Traore-Lamizana *et al.,* 1994; 2001). This group includes two species (*Cx. neavei* et *Cx. univittatus*) difficult to identify on morphological characters – only adult males were firmly identified in Madagascar (Fontenille & Jupp, 1989) – they were pooled here. Previous studies conducted in Barkedji area have shown that: i) *Cx. poicilipes* and species of *Cx. neavei* group reach their highest abundances at the end of the rainy season in October-November, ii) the two species are attracted by chicken, horse and human, and iii) they have been regularly associated with WNV between 1990 and 2003 (Ba *et al.,* 2006; Crora, 2005). Thus, for a better surveillance of WNV amplification, entomological studies should focus on these species. Such kinds of investigations need the accumulation of knowledge of which the search for the most efficient sampling method is important. Thus, the most efficient method for sampling these mosquitoes is still being explored. Information about the most efficient bird bait species and level to collect these vectors in a focal enzootic transmission area of WNV are lacking. Previous studies have shown that some *Culex* species

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involved in the transmission of WNV feed mainly on the canopy-level (Anderson *et al.,* 2004; Darbro & Harrington, 2006) or at equal efficiency on the ground and canopy (Drummond *et al.,* 2006).
The purpose of this study was to compare the efficiency of bird-baited traps using pigeons and chickens and collection heights for sampling potential WNV vectors in the Sahelian area of Senegal.

MATERIALS AND METHODS

The study was conducted at the edge of the Niakha ponds located about 4 km north-west of Barkedji village (14°47'-14°53' W, 15°13'-15°20' N), a focal area of enzootic transmission of WNV (Chevalier et *al.*, 2006; 2008) in the Sahelian biogeographic area of Senegal (Fig. 1). This area has a short rainy season which usually lasts from June to September and a long dry season which runs on the rest of the year. Niakha is filled by the first rains and remains flooded two or three months after the last rainfalls. Mosquitoes were collected with a trap (Fig. 2) which is a modified version of the "lard can trap" (Lepore *et al.,* 2004) between September 27 and November 26, 2006, period of highest abundance of WN vectors. This period is further the most appropriate for the virus circulation in that area as witnessed by the regular association of mosquitoes, horses and birds with the virus (Ba *et al.,* 2005; Crora, 2005; Chevalier et *al.*, 2006; 2008).
Each night, excepted the three first nights when only two chicken-trap were set on the canopy, two traps were set on the ground-level (0 m) and two on the canopy-level (~ 3 m) each containing either a chicken (*Gallus gallus domesticus*) or a pigeon (*Columba livia*) from dusk to dawn. The traps were rotated the following nights. After each sampling night, collected mosquitoes were recovered by aspiration, killed and identified using the morphological keys of Edwards (1941) and Diagne *et al.* (1994).
For statistical analysis, the data were transformed using log (n + 1) and the differences in abundance were assessed by comparing the mean number of females per trap per night using an ANOVA mixed model with random effects. The ANOVA was followed by Fisher PLSD tests if a difference were significant at $p = 0.05$. The analysis compared sites, days, bird baits species and specific level of collection differences and were done using XLSTAT® 2009 software.

RESULTS

A total of 1,030 mosquitoes were collected in the Chicken-Canopy trap (CC), the Chicken-Ground trap (CG), the Pigeon-Canopy trap (PC) and the Pigeon-Ground trap (PG) using 66 traps-nights (Table I). Among these 950 (92.2 %) belong to the *Culex* genera of which 649 (63 %) were represented by species of the *Cx. neavei* group and 245 (23.8 %) by *Cx. poicilipes*. The mean number of females collected by the four different traps were statistically comparable for *Cx. poicilipes* ($F = 1.8$; $p = 0.16$) whereas these means were significantly different for the species of the *Cx. neavei* group and the whole mosquitoes ($F \geq 6.6$; $p \leq 0.001$). The number of mosquitoes collected in the PC for the

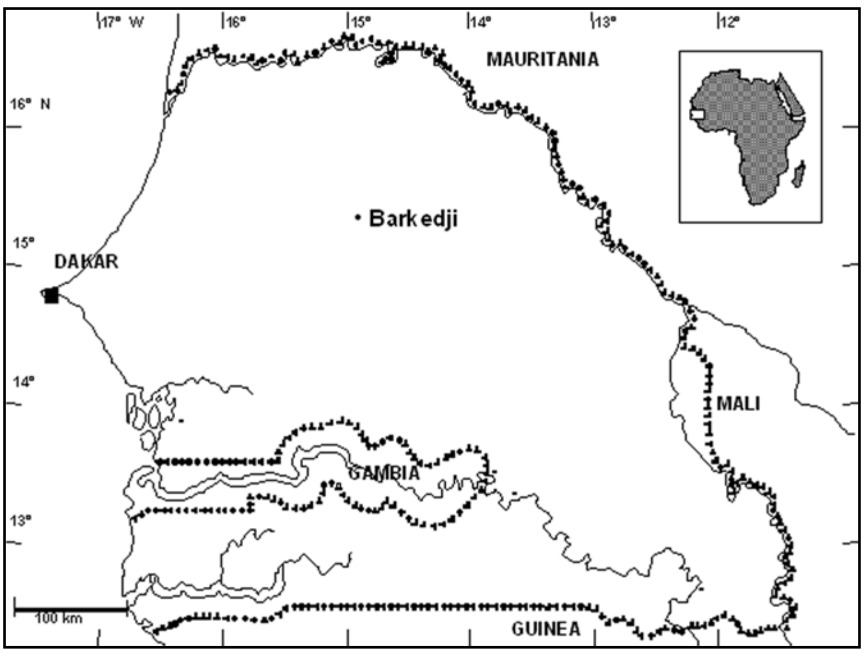

Fig. 1. – Localisation of the study sites.

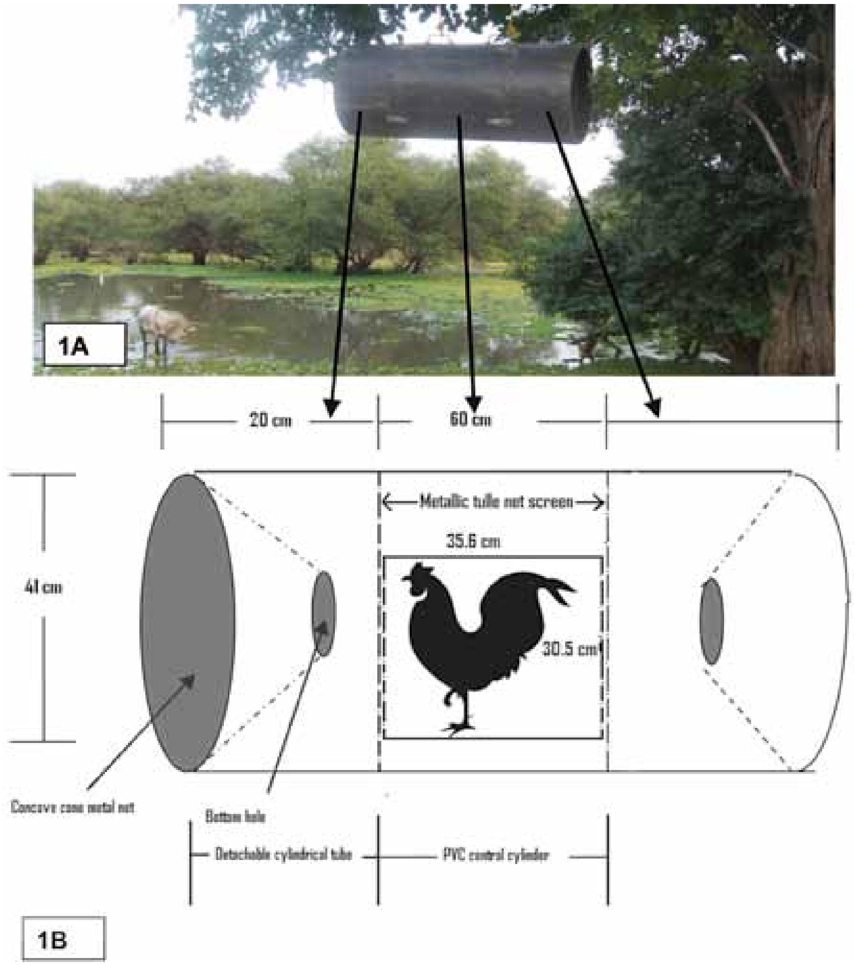

Fig. 2. – Photograph (1A) and diagram (1B) of the bird-baited trap (adapted from Lepore *et al.,* 2004).

species of the *Cx. neavei* group (25.5 ± 4.3) and the whole mosquitoes (35.9 ± 5.6) was higher than those obtained in the others traps (Table II). For these two groups, the CG and PG collected significantly fewer mosquitoes than the others traps.

DISCUSSION

The dominance of *Culex* species in the mosquito fauna collected is due to the fact that this genus is composed mainly by ornithophilic species (Clements, 1999).

Significant differences can be observed when the levels in which some species are collected according to the geographical and ecological context are compared. Indeed, the species of *Cx. neavei* group, were frequently collected at all levels between 0 and 6 m over open farmland in The Gambia (Gillies & Wilkes, 1976), at the ground-level in irrigated rice fields (Snow, 1979) and beyond 3 m height over open ground (Snow, 1975), while at Niakha it was mainly collected at the canopy-level (~ 3 m). Similarly to the observations made by Snow (1975) in The Gambia, our study found that *Cx. poicilipes* was common at all levels.

Among the factors explaining the vertical dynamic of the mosquito vectors, the habitat of their host is probably the most important. Indeed, Snow (1975) investigated the vertical distribution of mosquitoes in The Gambia and observed that zoophagic mosquitoes were mainly collected near the ground, ornithophilic mosquitoes in the canopy and mosquitoes feeding on mammals and birds at all levels.

Contrary to a study conducted in California, showing an attraction and a feeding preference of *Culex* mosquitoes on chickens rather than pigeons (Reisen *et al.,* 1992), our results indicated the preference of mosquitoes for pigeons instead of chickens at least for species of the *Cx. neavei* group. This means that the pigeon-baited trap could be better than the chicken-baited trap in WNV vector surveillance in Senegal. Moreover, the use of pigeons could be encouraged by the fact that they were frequently found infected by WNV in New York (Komar *et al.,* 2001) and their size make them easier to manipulate compared to chickens (Reisen *et al.,* 1992). Our study shows finally that, in the case of

Species	Number of mosquitoes collected Ground-level	 Canopy-level	 Total	%
Ae. aegypti		1	1	0.1
Ae. ochraceus	1		1	0.1
Ae. vexans	1		1	0.1
An. ziemanni	2		2	0.2
Ma. africana	72	1	73	7.1
Ma. uniformis	2		2	0.2
Total mosquitoes except *Culex*	78	2	80	7.8
Cx. antennatus		2	2	0.2
Cx. bitaeniorhynchus		1	1	0.1
Cx. ethiopicus	3	34	37	3.6
Cx. neavei group*	33	616	649	63.0
Cx. perfuscus	1	14	15	1.5
Cx. poicilipes	139	106	245	23.8
Cx. tritaeniorhychus		1	1	0.1
Total *Culex*	176	774	950	92.2
Total mosquitoes	254	776	1030	100

* *Cx. neavei* group includes *Cx. neavei* and/or *Cx. univittatus*.

Table I. – Mosquitoes collected by bird-baited traps on the canopy and the ground levels between September 27 and November 26, 2006, at Barkedji, Senegal.

Trap	Abundance (Females/ Trap/ Night ± Standard Error) *Cx. poicilipes*	 *Cx. neavei* group	 Mosquitoes
Pigeon-ground	2.9 ± 1.2 [a]	0.7 ± 0.2 [c]	9.4 ± 2.0 [b]
Pigeon-canopy	2.5 ± 1.1 [a]	25.5 ± 4.3 [a]	35.9 ± 5.6 [a]
Chicken-ground	5.8 ± 1.6 [a]	1.4 ± 0.4 [c]	6.6 ± 2.0 [c]
Chicken -canopy	3.4 ± 1.1 [a]	8.7 ± 2.0 [b]	11.8 ± 2.0 [b]

[a b c] For *Cx poicilipes*, *Cx. neavei* group and mosquitoes, the means with the same letter (a, b or c) are statistically comparable. The mean with the letter (a) is significantly higher followed by (b) and (c).

Table II. – Means number of mosquitoes collected by pigeon and chicken bait on the ground and canopy levels between September 27 and November 26, 2006, at Barkedji, Senegal. Means with different letters are significantly different at p = 0.05.

Barkedji, the bird-baited trap should be elevated in the canopy for better efficiency. Anderson *et al.* (2004) in the context of the New World showed that a significantly higher number of WNV strains were isolated in traps placed in the canopy-level compared to ground-level traps. Thus, the canopy is the ideal level where should be placed the bird-baited traps to sample ornithophilic mosquitoes for virus isolation attempts.

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