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.

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 ≥ 6.6; p ≤ 0.001).

The number of mosquitoes collected in the PC for the
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...
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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