

MALARIA VECTORS AND TRANSMISSION IN AN AREA DEFORESTED FOR A NEW INTERNATIONAL AIRPORT IN SOUTHERN CAMEROON

by

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Summary – Nsimalen, a village in Southern Cameroon, has been deforested over a surface of 370 hectares for the construction of the new Yaounde international airport (Cameroon). Mosquitoes night catches on human bait were performed over a year in two hamlets of this village, one adjoining the airport and the other situated 3 kilometers off the deforested area. The aim of the survey was to observe malaria vectors and transmission around the airport and to record malaria epidemiological changes resulting from deforestation. The findings showed that the main malaria vector was *Anopheles moucheti* (95% of the vector population). *Anopheles gambiae* was also present but in very small quantities. The increased density of the latter near the airport combined with the low parity rates, indicated that deforestation favoured the breeding of this species. Malaria transmission was estimated at 106 and 68 infective bites per man per year in hamlets close to and far away from the airport zone respectively. *An. gambiae* accounted for 13% of the transmission in the hamlet adjoining the airport and 0% three kilometers off the airport.

KEYWORDS: Malaria Vectors; Malaria Transmission; *Anopheles moucheti*; *Anopheles gambiae*; Deforestation; Southern Cameroon

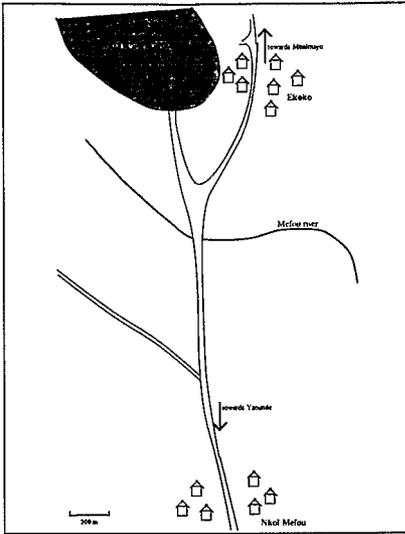
Introduction

Deforestation modifies the epidemiology of certain diseases, particularly those transmitted by vectors. The cases of onchocerciasis and trypanosomiasis are well known (3, 8). The construction of the airport in Nsimalen, a village in southern Cameroon, required deforestation. In order to study malaria epidemiological evolution due to the environmental changes, surveys were conducted to determine malaria vectors and transmission in surrounding hamlets.

Material and methods

The study was carried out in Nsimalen, a village situated 20 kilometers from Yaounde, the capital of Cameroon. It is located in a hilly forested area. The forest is meanwhile scattered because of agriculture which is the main activity of the inhabitants. The climate is equatorial with two dry seasons (July-August and December-January-February) and two rainy seasons (March-April-May-June and September-November-December). The temperature oscillates around 25°C and the level of humidity reaches 80%. Nsimalen is a big village of approximately a thousand inhabitants. It is made up of a number of hamlets which are very sparse. The Mefou river crosses this village. Since the river flows very slowly, it creates suitable sites for the breeding of certain *Anopheles* species like *Anopheles moucheti*.

In order to construct the international airport, with a runway of 3,400 meters, 370 hectares had to be deforested.



The entomological study was conducted for a year in two hamlets (see map), one adjoining the airport and the other situated 3 kilometers away. The study was carried out 3 years after deforestation.

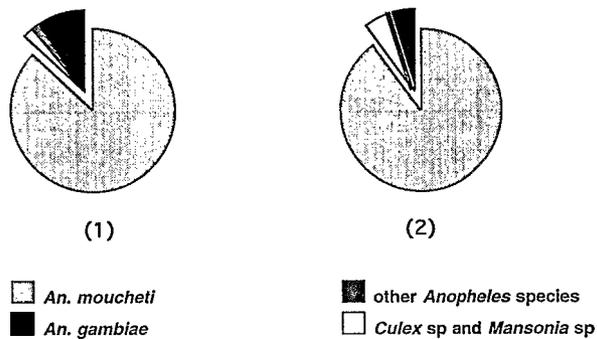
Mosquitoes were sampled by night catches on human bait twice a month in each hamlet. For this purpose, 4 houses were chosen in both hamlets. Two teams of 4 catchers each worked inside houses, every night. The first team worked from 9 pm to 1 am and the second from 1 am to 6 am. The mosquitoes collected were identified and dissected using the Detinova's method (4) to determine their physiological state and to microscopically detect sporozoites in the salivary glands.

Results

A total of 3,108 mosquitoes were caught during 40 nights (168 men nights) in the two hamlets.

The sample was composed of *Anopheles moucheti*, *Anopheles gambiae*, *Anopheles funestus*, *Anopheles nili*, *Anopheles paludis*, *Mansonia sp* and *Culex sp* (Figure 1).

Figure 1: Composition of the sample of mosquitoes collected on human bait in Nsimalen
 (1) in the hamlet adjoining the deforested area
 (2) in the hamlet situated 3 kilometers off



The annual biting rates for all species were 9,161 and 3,285 bites per man in the hamlet close to and away from the airport respectively. In both hamlets,

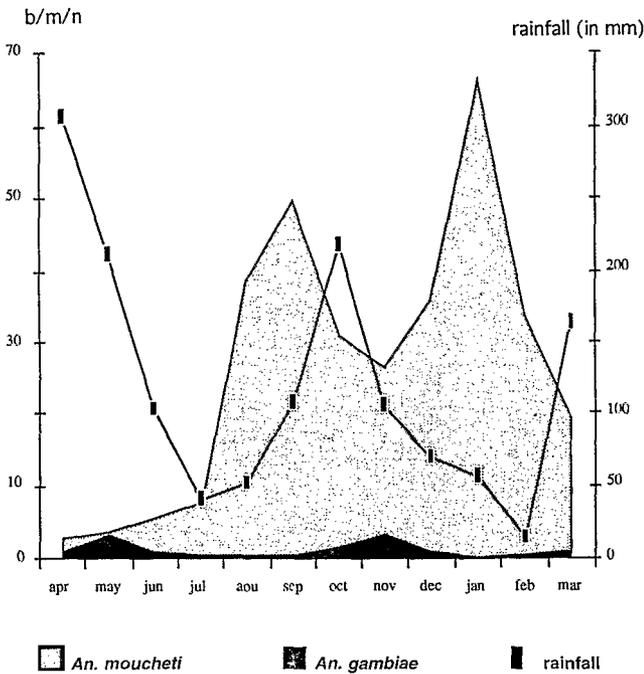
Anopheles mosquitoes represented more than 90% of the sample. *An. moucheti* was the main species (figure 1) with 94.4% near the airport and 96.1% three kilometers off. The rate of *An. gambiae* was significantly different between the two hamlets: 5.2% and 2.3% close to and away from the airport respectively ($\text{Chi}^2 = 9.77$, $p = 0.001$).

The biting rates of An. moucheti and An. gambiae

In the hamlet adjoining the deforested area, the annual biting rate was 8,286 for *An. moucheti* and 438 for *An. gambiae*; these rates represented 2,847 and 73 respectively for *An. moucheti* and *An. gambiae* three kilometers away. The biting rates varied according to seasons.

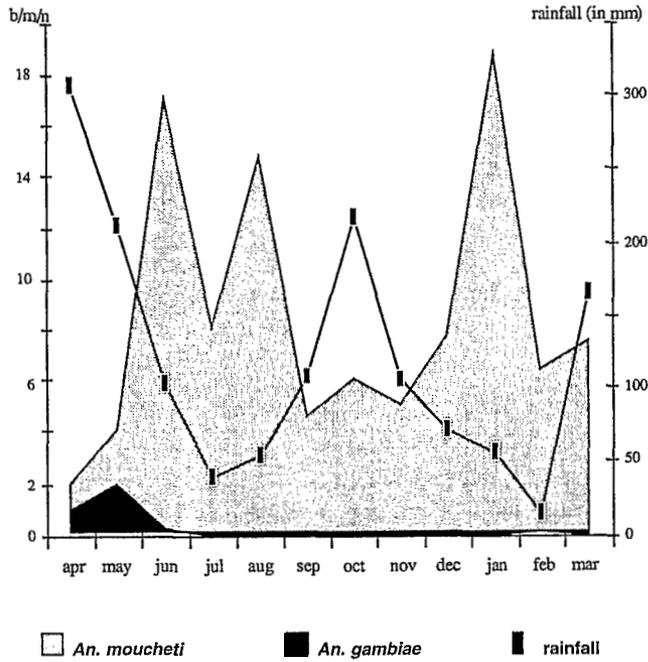
The densities of *An. moucheti* were highest during the dry seasons and lowest during the rainy seasons (figures 2 and 3).

Figure 2: Number of *Anopheles* bites per man per night (b/m/n) near the deforested area of Nsimalen from April 1991 to March 1992



An. gambiae was collected throughout the year near the airport (figure 2). Its densities were low but higher than those observed away from the airport zone (the maximum was 3.3 b/m/n (bite per man per night)). *An. gambiae* appeared sporadically in the hamlet situated away from the deforested zone with a very low daily biting rate. The maximum was 1 b/m/n in the rainy season (figure 3).

Figure 3: Number of *Anopheles* bites per man per night (b/m/n) 3 kilometers from the deforested area of Nsimalen from April 1991 to March 1992



The lowest densities of *An. gambiae* were obtained when the highest densities of *An. moucheti* were observed and vice versa.

Parity rates

The parity rates for *An. moucheti* were 67.6% (n = 1,784), 67.3% (n = 426) close to and away from the deforested area respectively.

In the hamlet adjoining the airport, the parity rate of *An. gambiae* was 54.9% over 91 dissections. The difference between the rainy seasons (51.4%, n = 48) and the dry seasons (74%, n = 23) was significant (p = 0,04). In the hamlet situated 3 kilometers away, the density of *An. gambiae* was not high enough to allow a serious evaluation of the physiological state.

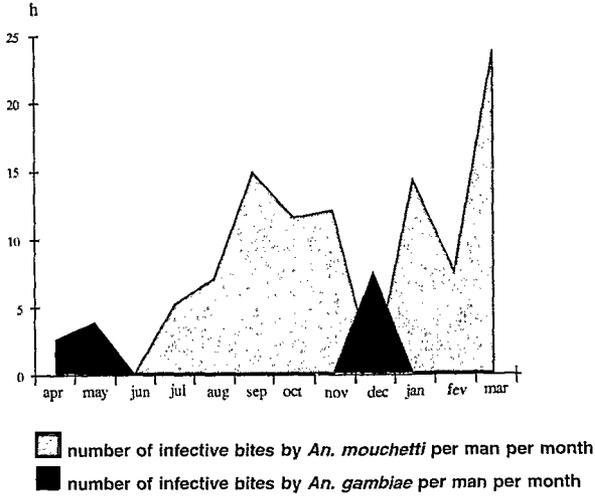
Malaria transmission

The sporozoitic rates were 1,1% (2,039 dissections) and 2,5% (117 dissections) for *An. moucheti* and *An. gambiae* respectively in the hamlet situated close to the deforested area. Three kilometers away the value was 2.4% (501 dissections) for *An. moucheti*; none of 10 *An. gambiae* dissected were found infected in that hamlet.

The entomological inoculation rates were estimated at 106 and 68 infective bites per man per year respectively close to and away from the deforested

zone. *An. gambiae* which represented only 5% of the vectors accounted for 13% of the transmission in the hamlet adjoining the airport area.

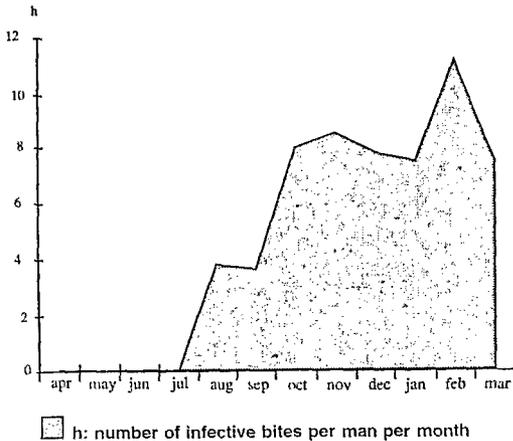
Figure 4: Variation of inoculation rate (h) by species close to the deforested area of Nsimalen from April 1991 to March 1992



Malaria transmission generally varied with the biting rates (figures 4 and 5). Two periods of intense transmission corresponded to the dry seasons. Near the deforested area, no transmission by *An. mouchetti* was recorded in May, June and December. It was only during those periods that *An. gambiae* transmitted. *An. gambiae* then ensured the maintenance of transmission.

In the hamlet away from the airport zone, no infected mosquitoes were caught between April and July. This was certainly due to the low density of mosquitoes. The peak transmission there was in February.

Figure 5: Variation of inoculation rate (h) 3 kilometer from the deforested area of Nsimalen from April 1991 to March 1992



Discussion

The results of this study show that *An. moucheti* is the main vector of malaria in Nsimalen. This species represented more than 90% of endophilic and anthropophilic vectors and was responsible for about 90% of the transmission. Its density varied from one hamlet to another because of the course of the river Mefou along which the breeding places were situated and because of the low dispersion of this species (1). Nevertheless its relative importance among the vectors was the same.

As *An. gambiae* reproduces in temporary ponds generally created by man, the rate of *An. gambiae* was higher near the airport because of many breeding sites due to deforestation. This was certified by the low parity rates showing a population near its breeding places. The parity rates varied significantly between seasons, showing a proliferation during the rainy seasons.

Other species (*An. funestus*, *An. nili* and *An. paludis*), because of their ecology were not affected by deforestation.

Malaria transmission was permanent particularly near the deforested area because of the relay role played by *An. gambiae* when transmission due to *An. moucheti* was interrupted. This situation was similar to that noticed in certain riverside villages of the Sanaga river in southern Cameroon, between *An. nili* and *An. gambiae* where *An. nili* was the main vector (2).

Considering the fact that Nsimalen is situated only 20 kilometers from Yaounde, an increase in settlement could be expected in the near future. This could accelerate the growth of *An. gambiae* which is known as a peri-domestic species. This environmental change could lead to the situation in peri-urban areas where malaria transmission is high because of favourable conditions for the breeding of *An. gambiae* (5, 6, 7). The density of *An. moucheti* could suffer a progressive decrease by deforestation and urbanization.

In conclusion, the construction of the airport in Nsimalen, a forested village, and the urbanization of the village could change malaria vectors and transmission in that area. Further studies should be conducted to follow up the predicted changes.

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Vecteurs et transmission du paludisme dans une zone déforestée pour un nouvel aéroport international au sud du Cameroun.

Résumé – Dans le village de Nsimalen au sud du Cameroun, la construction récente d'un aéroport international a nécessité une déforestation sur 370 hectares. Une enquête entomologique des vecteurs et de la transmission du paludisme a été réalisée pendant un an dans deux hameaux de ce village. L'un était situé en bordure de l'aire de déforestation, l'autre 3 kilomètres plus loin. L'enquête était basée sur les captures nocturnes de moustiques sur sujets humains à l'intérieur des habitations. Les résultats obtenus montrent que *Anopheles moucheti* est le vecteur principal du paludisme dans ce village, il représente en effet plus de 90% des anophèles capturés. *Anopheles gambiae* est plus abondant en bordure de l'aire de déforestation (5% des effectifs capturés) que 3 kilomètres plus loin (2%). Le faible taux de parturité de cette dernière espèce dans le hameau proche de la zone aéroportuaire (54,9%) montre que la déforestation a créé des gîtes qui lui sont favorables. Le taux d'inoculation entomologique a été estimé à 106 et 68 piqûres infectées par homme par an respectivement dans les hameaux proches et éloignés. *An. gambiae* assurait 13% de la transmission à côté de l'aéroport alors que sa transmission était nulle 3 kilomètres plus loin.

Vectoren en overdracht van malaria in een ontbost gebied voor de aanleg van een nieuwe internationale luchthaven in het zuiden van Kameroen

Samenvatting – Nsimalen, een dorp gelegen in het zuiden van Kameroen, werd ontbost over een oppervlakte van 370 hectaren, voor het aanleggen van een internationale luchthaven. Eén jaar lang werden muggen 's nachts op mens gevangen in twee verschillende gehuchten van het dorp,

het ene naast de luchthaven en het andere 3 km verwijderd van het ontboste gebied. De voornaamste vector was *Anopheles moucheti* (95% van de vectoren). *Anopheles gambiae* was eveneens aanwezig maar in lage proporties. De hogere densiteit van *A. gambiae* naast de luchthaven en de lage pariteitsindex wijzen erop dat ontbossing deze soort bevoorrecht. De overdracht van malaria in gehuchten dicht bij de luchthaven en in verder afgelegen gehuchten werd geschat op respectievelijk 106 en 68 positieve steken per mens per jaar. *A. gambiae* is verantwoordelijk voor 13% van de overdracht in het gehucht naast de luchthaven en komt als vector niet in aanmerking op drie kilometer van de luchthaven.

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