# Anthropophilic mosquitoes and malaria transmission at Edea, Cameroon

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**Abstract**

An entomological study was carried out during 1990 in the town of Edea in the south of Cameroon to study anthropophilic mosquitoes with special reference to malaria transmission. Man-biting mosquitoes were caught regularly during one night each month in two different districts: Bilalang which is a well planned suburb with 160 houses on a hill-top, provided with a piped water supply; and Pongo which is a densely urbanised suburb in a valley. From 188 man-nights 1030 mosquitoes were collected, comprising 700 *Culex quinquefasciatus* (68 %), 262 *Anopheles gambiae* (25 %) and others species (7 %) belonging to the genus *Anopheles*, *Mansonia*, *Culex* and *Aedes*. The estimated annual biting rates of mosquitoes were 811 bites per man in Bilalang and 2 866 in Pongo. The estimated yearly malaria inoculation rates were 3.8 and 30.2 infective bites per man in Bilalang and Pongo, respectively. In different parts of Pongo district much variation existed; extreme values of the estimated yearly inoculation rate were zero and 86.3 in two houses 200 m apart, located on the top of a hill and in the bottom of a valley, respectively. This study is one of the first conducted on malaria transmission in a moderate sized African town; it shows that the mosquito populations are typically urban and differ greatly from rural ones.

## Introduction

In tropical Africa, urban malaria had not been considered as a major research topic until Bruce-Chwatt (1983) considered the implications of increasing urbanisation. No cities in tropical Africa had a population of one million in 1960, but there will be more than 40 cities of this size in Africa by the year 2000; 8.9 % of the population was urbanized in 1950, this proportion will reach 36 % in the year 2000 (Anonymous, 1985).

Malaria transmission in large urban areas is characterized by two elements: it is less than that observed in the neighbouring rural area and the intensity of transmission is very heterogeneous from one district to another.

Our study of the anthropophilic mosquitoes and of malaria transmission in the town of Edea, in south-west Cameroon, gives information on the hitherto poorly documented malaria with mention in humid tropical African towns of medium size.

## Materials and methods

*Description of study area.* The region of Edea, in south-west Cameroon, is a lowland area where the annual mean rainfall is about 2 500 millimetres. Usually rains occur throughout the year, with a maximum in September and a minimum in December-January. In 1990 the precipitation totalled 2123 mm with maxima in May and October (Fig. 1). Mean temperatures were 25 °C in August and 30 °C in February.

The town of Edea is located in the department of Sanaga Maritime, beside the Sanaga river. The town has a population of about 45,000 inhabitants distributed in numerous districts. Our study focused on two districts:

Bilalang district is located on the right side of Sanaga river, on top of a small hill, about 100 m from the river. It is an estate of 160 single storey houses with 1,600 people who are workers at an aluminium factory and their families. The habitat is very homogenous, with every house built at the same time and on the same pattern, serviced by running water and electricity. Domestic wastes are regularly taken away, but the rainwater drainage system is poorly maintained. The landscape appears rural, but is in fact densely populated.

Pongo district is located on the left side of Sanaga river, two kilometres away from it, with single storey houses covering both slopes of a valley where a smaller permanent river flows. Urbanization is disorganised, the habitat is heterogeneous and densely populated. In the two quarters the use of mosquito bed nets is uncommon.

*Organisation of mosquitoes catches.* In each of the two districts, mosquitoes were sampled during the year 1990, one night each month, from 21.00 to 05.00 hrs by 8 collectors. At Bilalang, catches were conducted in three houses and at one outdoor location in front of one of these houses. At Pongo, catches were carried out in four houses: two located at the bottom of the valley, one on the slope 100 m from the small river, and one on top of the hill 200 m from the small river. In most cases the houses used were those normally occupied by the young men who were the volunteer catchers. The inhabitants were encouraged to continue their normal domestic habits while collections were made. Anopheline salivary glands were examined microscopically for the presence of sporozoites. To assess

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**Table 1** Numbers of mosquitoes collected on human bait (n) and daily biting rate on human (ma), in two districts of Edea town, Cameroon, 1990.

| District | Bilalang | | | | Pongo | | Total |
|---|---|---|---|---|---|---|---|
| | in 3 houses | | outside | | in 4 houses | | |
| Number of man-nights | 72 | | 22 | | 94 | | 188 |
| | n | ma | n | ma | n | ma | n |
| *An. gambiae* | 63 | 0.87 | 106 | 4.81 | 93 | 0.99 | 262 |
| *An. nili* | 4 | 0.05 | 2 | 0.09 | 0 | 0 | 6 |
| *An. coustani* | 2 | 0.02 | 1 | 0.04 | 0 | 0 | 3 |
| *An. funestus* | 0 | 0 | 1 | 0.04 | 0 | 0 | 1 |
| *Cx. quinquefasciatus* | 51 | 0.71 | 10 | 0.45 | 639 | 6.80 | 700 |
| *Cx. tigripes* | 0 | 0 | 2 | 0.09 | 0 | 0 | 2 |
| *Cx. poicilipes* | 0 | 0 | 0 | 0 | 2 | 0.02 | 2 |
| *Ma. africana* | 28 | 0.39 | 8 | 0.36 | 1 | 0.01 | 37 |
| *Ma. uniformis* | 9 | 0.12 | 2 | 0.09 | 2 | 0.02 | 13 |
| *Ae. aegypti* | 2 | 0.03 | 0 | 0 | 1 | 0.01 | 3 |
| *Ae. vittatus* | 1 | 0.01 | 0 | 0 | 0 | 0 | 1 |
| Total | 160 | 2.22 | 132 | 6.00 | 738 | 7.85 | 1030 |

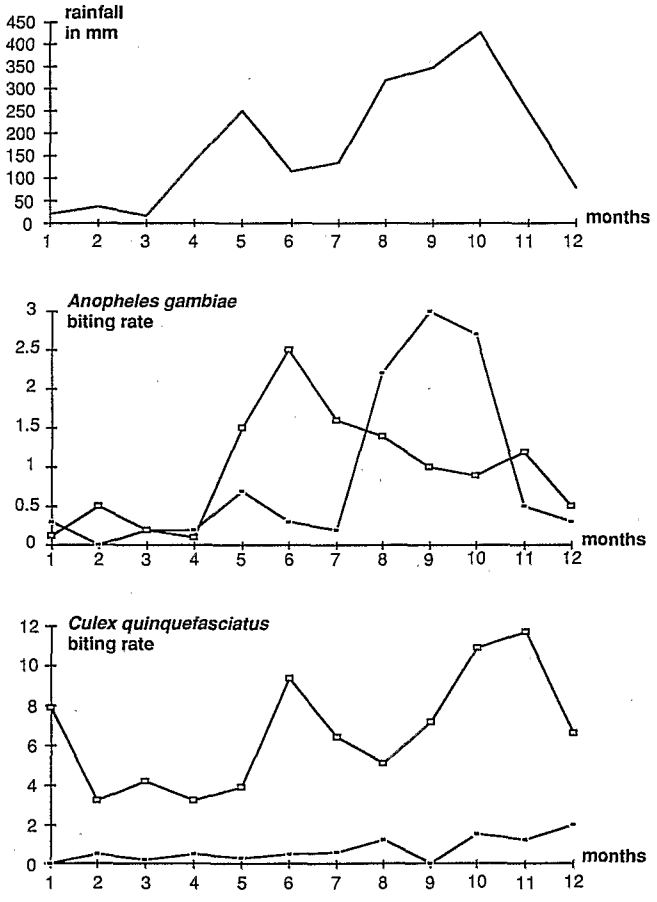


**Fig. 1** Temporal changes during 1990 at Edea, Cameroon, in the rainfall, in the *Anopheles gambiae* and *Culex quinquefasciatus* daily biting rate indoors in each month at Pongo district (pale squares) and Bilalang district (black squares).

parity as an index of their physiological age, the ovaries of anopheline females and of *Culex quinquefasciatus* were examined for the degree of tracheolar coiling (Detinova, 1962). Catches using CDC miniature light traps were also made indoors and outdoors. Larval searches were undertaken to determine the anopheline breeding places.

The only member of the *Anopheles gambiae* complex known from this part of southern Cameroon is *An. gambiae sensu stricto* (Gillies and Coetzee, 1987).

## Results

*Breeding places.* In the two districts all anopheline larvae observed were *An. gambiae*. At Bilalang, the anopheline breeding places were found in fresh rain pools and other small water collections due to inadequate rainwater drainage. The Sanaga river flows fast enough to prevent any possibility of larval development. At Pongo, the breeding places were also in rainwater pools, mainly at the bottom of the valley but not in the small river. The rainfall pattern is shown in Fig. 1.

*Mosquitoes collected with CDC light traps.* At Bilalang 31 trap-nights collected 2 female *Anopheles gambiae*, 1 male *Culex quinquefasciatus* and 3 female *Mansonia africana*. At Pongo 35 trap-nights collected 1 female *An. gambiae*, 19 female *Culex spp.*, 24 male *Culex spp.* and 1 female *Ma. uniformis*.

*Mosquitoes biting man.* 188 man-nights of collection yielded a total of 1,030 female mosquitoes belonging to four genera (Table 1).

At Bilalang, indoors *An. gambiae* represented 39% of catches and *Cx. quinquefasciatus* 32%. The overall mean density was 2.22 bites per man per night, that is to say 811 bites per man per year. Outdoors *An. gambiae* represented 80% of catches and *Cx. quinquefasciatus* 8%. The overall mean outdoor biting density of 6 bites per man per night was 2.7 times higher than that indoors (Table 1).

**Table 2** *Culex quinquefasciatus* and *Anopheles gambiae* annual man biting rate and annual malaria inoculation rate (h) in the districts of Bilalang and Pongo, town of Edea, Cameroon.

| Bilalang | house 1 | house 2 | house 3 | mean indoor | outdoor 1 |
|---|---|---|---|---|---|
| *Cx. quinquefasciatus* biting | 350 | 91 | 334 | 258.3 | 152 |
| *An. gambiae* biting | 441 | 274 | 243 | 319.3 | 1612 |
| h | 5.3 | 3.3 | 2.9 | 3.8 | – |
| **Pongo** | **house 1** | **house 2** | **house 3** | **house 4** | **mean 1–4** |
| Distance from breeding places | 200 m | 100 m | 10 m | 10 m | 80 m |
| *Cx. quinquefasciatus* biting | 5094 | 2148 | 2067 | 547 | 2464 |
| *An. gambiae* biting | 0 | 198 | 1049 | 223 | 367.5 |
| h | 0 | 16.3 | 86.3 | 18.3 | 30.2 |

**Table 3** Numbers of mosquitoes caught per month and results of *Anopheles gambiae* and of *Culex quinquefasciatus* dissections.

| district | | season<br>month | dry<br>Ja+Fe+Ma+De | small rains<br>Ap+Ma+Ju+Ju | great rains<br>Au+Se+Oc+No | Total |
|---|---|---|---|---|---|---|
| Bilalang | | caught | 7 | 35 | 127 | 169 |
| | *Anopheles gambiae* | PR | $\frac{5}{7}$ | $\frac{17}{31}$ | $\frac{75}{115}$ | $\frac{97}{153}$ = 0.63 |
| | | s | $\frac{0}{7}$ | $\frac{2}{34}$ | $\frac{0}{126}$ | $\frac{2}{167}$ = 0.012 |
| | *Culex quinque fasciatus* | caught | 17 | 17 | 27 | 61 |
| | | PR | $\frac{8}{10}$ | $\frac{7}{11}$ | $\frac{9}{13}$ | $\frac{24}{34}$ = 0.70 |
| Pongo | | caught | 11 | 46 | 36 | 93 |
| | *Anopheles gambiae* | PR | $\frac{8}{9}$ | $\frac{30}{41}$ | $\frac{21}{26}$ | $\frac{59}{76}$ = 0.78 |
| | | s | $\frac{1}{10}$ | $\frac{6}{43}$ | $\frac{0}{32}$ | $\frac{7}{85}$ = 0.082 |
| | *Culex quinque fasciatus* | caught | 176 | 183 | 280 | 639 |
| | | PR | $\frac{50}{150}$ | $\frac{71}{142}$ | $\frac{142}{249}$ | $\frac{263}{541}$ = 0.49 |

$PR = \frac{\text{parous}}{\text{parous + nulliparous}}$ = parity rate; $s = \frac{\text{no. with sporozoites}}{\text{no. dissected}}$ = sporozoite index

At Pongo, indoors *An. gambiae* represented 13 % of catches and *Cx. quinquefasciatus* 87 %. The overall mean density was 7.85 bites per man per night, that is to say 2 866 bites per man per year. The number of *An. gambiae* was very dependent on the situation of houses: zero in the house located on top of the hill, 1 049 per man per year in one of the houses located in the bottom of the valey (Table 2).

*Seasonal variations of An. gambiae and Cx. quinquefasciatus densities. An. gambiae* and *Cx. quinquefasciatus* were present during the whole year in the town of Edea (Table 3).

The density of *An. gambiae* showed distinct seasonal variations with contrasts between the two districts (Fig. 1). At Bilalang, the density was highest from August to October coinciding with the second peak of rainfall. The daily biting rate indoors varied from zero in February to 3.0 in September. At Pongo, the density of *An. gambiae* was high from May to November (Table 3). The maximum was in June, shortly after the first peak of rainfall in May. The daily biting rate varied from 0.12 in January and April to 2.5 in June.

Densities of *Cx. quinquefasciatus* were always low at Bilalang. At Pongo, on the other hand, they followed the rainfall pattern (Fig. 1).

*Physiological mean age of An. gambiae and Cx. quinquefasciatus.* At Bilalang the weighted mean annual parity rate of *An. gambiae* parous rate (parous/(parous + nulliparous)) was 63 % and was not significantly different between indoors and outdoors ($\chi^2 = 0.09$; $p = 0.765$). At Pongo this rate was 78 %, significantly higher than at Bilalang ($\chi^2 = 4.74$; $p = 0.03$).

At Bilalang the *Cx. quinquefasciatus* parity rate was 70 %. At Pongo it was 49 %, significantly lower than at Bilalang.

*Transmission of malaria.* The transmission of human malaria in the town of Edea was almost entirely due to *An. gambiae*, since other anopheline species occurred in only very small numbers (Table 1) and were not found infected.

At Bilalang, malaria sporozoites were found in 1.2 % of 167 *An. gambiae* salivary glands. Both positive mosquitoes were caught in the same house, during the same night of October, between 2 and 3 am. With an indoor daily biting rate for *An. gambiae* of 0.875 and a sporozoite index of 1.2 %, the daily malaria inoculation rate is estimated to be 0.0105, that is to say 3.8 bites of infective *An. gambiae* per man per year. Because the biting rates are similar in all 3 houses, the inoculation rate is also similar. Because nobody sleeps outside the houses, it is unrealistic to calculate the outdoor inoculation rate (Table 2).

At Pongo, malaria sporozoites were found in 8.2 % of 85 *An. gambiae* salivary glands. The 7 positive mosquitoes occurred as follows: 3 in May, 3 in June and 1 in December; 1 between 21.00 and 22.00 hrs, 2 between 22.00 and 23.00 hrs, 2 between 23.00 and 24.00 hrs, 1 between midnight and 01.00 hrs, 1 between 03.00 and 04.00 hrs. With an indoor daily biting rate for *An. gambiae* of 0.989 and a sporozoite index of 8.2 %, the daily malaria inoculation rate is estimated to be 0.0814, that is to say 30.2 bites of infective *An. gambiae* per man per year. Because the biting rates are very different among the houses, the inoculation rate vary greatly: zero on the top of the hill and 86.3 infective bites per man per year in the bottom of the valley (Table 2).

In the two quarters, *An. gambiae* parous rate and sporozoitic index are different (respectively $\chi^2 = 4.7$; $p = 0.03$ and Fisher exact probability $p = 0.0079$).

## Discussion

Anopheline breeding places at Bilalang were located within the district, not on the bank of Sanaga river. At Pongo they were numerous in the bottom of the valley. Malaria control projects using antivector activities must consider these observations.

Collecting with CDC light-traps yielded very few mosquitoes compared with catches on human bait. The light traps were in competition with numerous other public and private light-sources, all night along, whereas in rural areas these traps showed their efficiency (Odetoyinbo, 1969). Perhaps the interesting use of the CDC traps beside occupied bed nets, as proposed by Lines et al. (1991), would increase the efficiency of these device for catching anopheline mosquitoes.

Comparing the two districts, the composition of the mosquito fauna varied in number and in relative frequency of species. At Bilalang, which has a rural appearance, 10 species were observed. At Pongo, which is more typically urban, the mosquito fauna is less rich: only 6 species were observed among which *Cx. quinquefasciatus*, a typically urban species (Subra, 1981), represented 87 % of the total mosquitoes, compared with 32 % at Bilalang.

*An. gambiae* parity rate and sporozoite index were lower at Bilalang than at Pongo. These data and the tendency for *An. gambiae* to bite outdoors at Bilalang could be related to the frequent domestic use of insecticides in this district.

Previous studies conducted on urban malaria in tropical Africa revealed the great variability of malaria transmission intensity (Robert et al., 1986; Trape and Zoulani, 1987). In the town of Edea our observations confirmed this view. Transmission can vary between two houses 200 m apart, from zero in a house built on a hill to 86.3 infective bites per man per year in house built in the bottom of a valley where breeding places were numerous. In contrast, White (1969) found more *An. gambiae* in hill-top houses than in those at bottoms of valleys in rural Tanzania. The data in Edea town confirm that the dispersal power of *An. gambiae* is very limited in urban areas (Sabatinelli et al., 1986).

Malaria transmission in these districts of Edea can be compared with that in Yaounde, capital of Cameroon, 800,000 inhabitants, where extreme values of the yearly malaria inoculation rate are 3 in a central district (Manga et al., 1991) and 30 in a peripheral situation (Fondjo et al., 1992).

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