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PROSPECTS FOR MALARIA CONTROL IN URBAN AND RURAL KINSHASA

by

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Summary - Malaria is a major cause of paediatric illness and death in Kinshasa, and all 3 million inhabitants are at risk. In view of the increasing choroquine-resistance of *Plasmodium falciparum,* the early treatment of fever cases as the sole malaria control measure is no longer acceptable.

The prospects for vector control are determined by the effectiveness, the acceptability and the practicability of the various methods in the local conditions of Kinshasa. Pronounced differences in the level of endemicity exist between the various parts of the town. These differences, and the ecological and socio-economic factors that underlie them, must be taken into account when estimating the potential of a control method.

The reduction of man-vector contact through personal protection with impregnated bednets is the only realistic goal at this moment, but even a very marked decrease of the inoculation rate will produce little apparent effect in the highly endemic (semi-)rural districts at the periphery of town. In the urbanized center of Kinshasa, where the moderate to low intensity of transmission is more susceptible to a critical reduction, the same method may have an impact on malaria morbidity. Moreover, the big nuisance from non-vector mosquitoes in the urban area is an important motivating factor for the acceptance and the use of bednets. A mass effect, on the other hand, only is to be expected in isolated villages.

Field trials are needed to evaluate the short- and long-term effect on malaria transmission and on its' clinical expression, as well as on the build-up of natural immunity, in the epidemiologically distinct areas. However, the final outcome of a large scale implementation of malaria control with impregnated mosquitonets will equally depend on health education, on the availabality of bednets at low cost, on the creation of the appropriate structures for the (re)impregnation and distribution of the nets, and finally on the sustainability of the whole effort.

Introduction

The painting "La Lutte Contre Les Moustiques" by the young Zairean artist Chéri Samba (figure 1) perfectly summarizes the present-day malaria situation in Kinshasa: an overwhelming plague against which the population can only mount a primitive and ineffective defense. We may believe we now have more appropriate

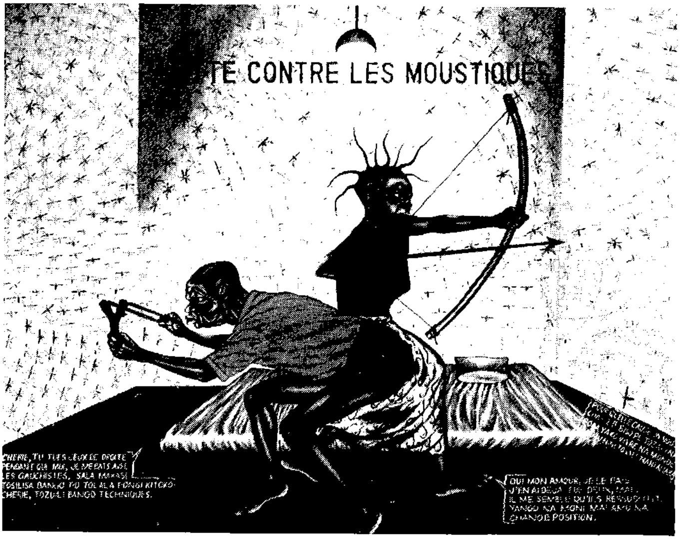

Figure 1.
"Lutte contre les moustiques" by Chéri Samba;
reproduced from "Chéri Samba - Le peintre populaire du Zaïre" (1990)
with the kind permission of the Provinciaal Museum voor Moderne Kunst in Oostende.

weapons against mosquitoes than bow, arrow and catapult, but are the prospects for malaria control therefore any better?

In this communication, I would like to examine some of the theoretical possibilities for vector control in view of the complex reality of the capital of Zaire. A first characteristic of the malaria situation in Kinshasa, and already a first obstacle to defining, applying and evaluating a control strategy, is its' heterogenicity: all 3 million inhabitants are at risk, but the intensity of the transmission varies considerably from one district to the other (4, 5). At the semi-rural periphery of town, a rich and complex anopheline fauna (2) and a high sporozoite rate of *An. gambiae* result in an average inoculation frequency of more than one per day. This is ten to twenty times higher than in the urbanized centre where both the man-vector contact and the infectivity of the anopheles are reduced (Coene J: Malaria in urban and rural Kinshasa, Zaire: entomological results; in preparation). The different levels of endemicity, and the natural and socio-economic conditions that underlie them, have to be taken into account when discussing control strategies.

My remarks and speculations are based on field experience and paludometric data acquired in two epidemiologically distinct areas: a poor, densely populated, urbanized 'cité' in the centre of town (Kimbangu 3), and a small suburban village (Kwamuthu) just south of Kinshasa.

Knowledge, attitude and practice

A first point of interest with respect to vector control in a specific area is the attitude of the target population. How do the people of Kinshasa look at mosquitoes, and what do they try to do about it themselves?

On the occasion of an opinion survey conducted among 200 households in the 'cité' of Kimbangu 3, all interviewees confirmed they were disturbed by mosquitoes at night - the average biting density in this district is 126 bites per person per night-, and 148 (74%) connected these insects with malaria. Actually, over 95% of these mosquitoes are innocuous culex.

On the contrary, in the village we were told it was of no use to collect mosquitoes there, because there weren't almost any. Consequently none of the villagers seemed to worry about protecting himself or his family, not knowing that the relatively rare mosquitoes around invariably were anopheles.

The big nuisance from non-vector mosquitoes in the central parts of town is an important incentive for the acceptance, the use or even the development of protective methods (table 1). Only 16% of the households in our survey did not undertake some specific anti-mosquito action. Unfortunately, the spontaneously used methods are mostly elementary and ineffective. 7.5% mention the closing of doors and windows in the evening as (one of) their means of defence against mosquitoes.

Table 1.
Use of mosquito control methods in Kimbangu 3 (results of an interview survey of 200 households, open-ended question).

	Number of users (%)	
Control Method	As only method	Total
No protection used		27(13.5)
Close doors and windows	5 (2.5)	15 (7.5)
Plug the holes in the walls		90(45.0)
Screen the ventilation openings		50(25.0)
Chase the mosquitoes	35(17.5)	59(29.5)
Paraffin & Smoke	14 (7.0)	34(17.0)
Mosquito coils	41(20.5)	63(31.5)
Insecticide sprays	22(11.0)	31(15.5)
Bed nets	9 (4.5)	16 (8.0)
Repellents		2 (1.0)

Plugging the ventilation- and other holes in the walls with rags and paper is another one (45%). A little more spectacular, but not more effective, is the so-called "ventilation mécanique", which simply means chasing away the mosquitoes with a cloth before closing the house for the night (29.5%). Smoke or smell producing devices, either home-made like smouldering sawdust and pulverized paraffin (17%), or commercial mosquito coils (31.5%), are popular, mainly because of their low cost and wide availability. However, woodsmoke has been shown not to protect against malaria in the Gambia (9), and the low-quality brand of incense coils available in Kinshasa reduced the number of mosquito bites by no more than one third (3). This is unlikely to affect malaria transmission, and even for coils of proven entomological efficacy the clinical effect remains to be evaluated. Moreover, the frequent complaints (table 2) about the disagreeable odour and the toxicity of the coils indicate that their generalized and systematic use would not be easy to implement. The poor success of bed nets, used by less than 10%, is in the first place due to their high price, but 10.7% of the respondents also doubt their practicability. Individual repellents, such as di-ethyl toluamide (deet), are not well known and rarely used. Insecticide sprays, on the contrary, are the method of choice for many people, but only few can afford to buy them regularly.

Table 2.
Inconvenients of mosquito coils and bed nets, according to non-users (results of an interview survey of 200 households in Kimbangu 3, open-ended questions).

Reason for not using	Number of responses	% of non-users
Mosquito Coils		
Too expensive	8	6.6
Not available	1	0.8
Smells bad	59	48.8
Toxic, irritates	56	46.3
Ineffective	7	5.8
Bed nets		
Too expensive	149	88.2
Not available	1	0.6
Not practicable	19	10.7

Table 3.
Suggestions for mosquito control in Kimbangu 3
(results of an interview survey of 200 households, open-ended question).

Control Method	Number of responses	(%)
Nothing suggested	16	(8.0)
Environmental sanitation	33	(16.5)
Distribution of insecticides	4	(2.0)
Insecticide space spraying	164	(82.0)
Larviciding	3	(1.5)

Table 4.
Sleeping conditions in Kimbangu 3
(results of an interview survey of 211 households).

Average number of persons per house:	5.4
Average number of beds per house:	1.6

Sleeping place	Number of responses	%
No bed	366	31.9
In a bed alone	78	6.8
In a bed shared by 2	240	20.9
In a bed shared by 3	270	23.5
In a bed shared by 4	197	17.2

In the second part of the interview survey, we asked for suggestions. As a reply to the question "What do you want us to do against the mosquitoes in your district?" (table 3) 82% of the 200 people interviewed asked for the pulverization of insecticides, thereby often referring to the space spraying by aircraft as practiced in colonial days. Those spraying campaigns are reputed very effective because "even the fish died from it!". Sanitation was suggested by 16.5% of the interviewees only, larvicide treatment of breeding sites by 1.5%. This attitude is reflected in the mosquito control activities organized by the authorities over the last few years: some space spraying in the streets used up most of the budget, without effect.

Integrated Vector Control

The prevention of malaria through the judicious and combined use of all appropriate anti-vectorial measures available (individual protection, source reduction, destruction of larvae and of adult vectors) has become known as Integrated Vector Control, a notion that is invariably linked to a number of other fashionable expressions like Community Participation and Intersectorial Collaboration. Because of its flexibility and its broader basis for co-operation, this approach holds many promises for a more situation-adapted and durable solution of a country's malaria problem. On the other hand, it requires a profound knowledge of the local malaria epidemiology, a continuous and long-term commitment of all the people involved and the existence of a comprehensive program of socio-economic development into which vector control measures can be fitted.

Source reduction appears to be the first logical step on the road to vector control. Unfortunately, in Kinshasa like anywhere else, man tends to make breeding sites for mosquitoes rather than to destroy them. Leaks in the waterdistribution system are welcomed by the inhabitants of the "cité" because they offer free water for washing and cooking, but they also create permanent pools, full of mosquito larvae. True environmental sanitation will be required to eliminate other breeding sites like the ones formed by seepage water in some lower parts of the 'cité', and the street drains typical of most poor urban areas. Ironically, many of these water collections, even the polluted ones, contain *Poecilia reticulata*, better known as 'guppies' and sometimes used as larvivorous fish in biological mosquito control (11). However, their presence and feeding activities in half of the puddles and gutters does not keep the anopheles and culex from breeding in the other half.

Source reduction will be even more difficult in the semi-rural districts at the periphery of Kinshasa where different species of anopheles propagate in an almost endless variety of habitats: rice fields at the edge of the swampy area near the Zaire river, ravines caused by erosion in the hilly parts of Kinshasa, wells and footprints filled with seepage water in the gardens, riverside vegetation etc.. In one suburb, ponds for the culture of *Tilapia nilotica*, also a larvivorous fish, turned out to be the major source of vector mosquitoes during the dry season. Larvae of *Anopheles gambiae* and *An. funestus* were collected in 40% of the ponds, mainly in those where weeds and aquatic vegetation prevent the fish from preying on them (Coene J, unpublished results). Emptied fish ponds, without fish but with numerous residual puddles left in the bottom, provide even better breeding grounds. The most beautiful breeding sites though are build by the fish themselves: the female tilapia's habit of digging shallow pits in the soil to lay their eggs in (figure 2) leads to the formation

Figure 2.
Culture of *Tilapia nilotica* in rural Kinshasa; several crater-like nests, dug by the female fish, can be seen in the bottom of the pond.

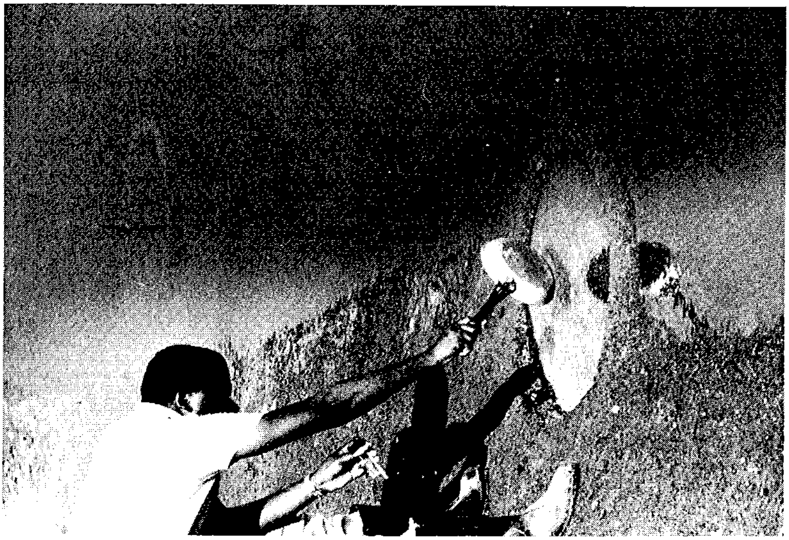

Figure 3.
Culture of *Tilapia nilotica* in rural Kinshasa; marginal nests, isolated from the main body of water and inaccessible for the larvivorous fish, become excellent breeding sites for *An. gambiae*

of small, round, sunlit puddles on the edges of the pond, ideal for breeding of *An. gambiae* (figure 3). Apart from rousing a degree of scepticism with respect to the usefulness of biological control methods, the case of the fishponds also could be a reason for optimism, as the factors contributing to their becoming breeding sites theoretically can be eliminated by simple measures: cutting the weeds and keeping the water level high. However, such opportunities for intervention through information and participation of the community are rather exceptional, and they are meaningless if they can not be integrated in a global program of health promotion and development in general, and of vector control in particular. The main problem is that no such program exists, nor probably will exist for several years to come. Similar considerations also rule out the use of insecticides. Chemical larviciding, for instance, makes little sense if not complemented with measures of environmental sanitation. In contradiction with the popular beliefs, space spraying alone is not effective and has no place in the control of endemic malaria. Residual indoor spraying is out of the question in urban Kinshasa for obvious reasons.

Impregnated bed nets

If active vector control is not feasible, then there is only one strategy left: individual protection against mosquito bites. With the advent of impregnated bed nets, we now have for the first time a truly protective method, even in sub-optimal conditions. The entomological efficacy of insecticide-treated mosquito nets has been well established by several authors over the past five years (8): not only do the deterrent and the repellent effect of the insecticide amplify the barrier function of the net, there is also increased mortality among the mosquitoes who have been in contact with the treated net. The effect on malaria transmission can be easily computed from the entomological data: a drop by 90 % of the indoor biting density normally means a similar reduction of the inoculation rate. In addition, most village-scale field trials also demonstrated a significant decrease of the sporozoite rate, i. o. w. of the infectivity of the vector mosquitoes. This is the so-called mass effect, obtained when the generalized use of insecticide-treated bed nets in an isolated community affects mosquito survival. In general, impregnated bed nets reduce, by a factor 10 to 20, the risk of inoculation with malaria parasites. The effect on the parasitological and on the clinical output is less clear. Much depends on the level of malaria endemicity in the area of application. Only in low-endemic areas, as in China (8), a reduction of parasite prevalence has been observed. In areas of moderate to high endemicity, like the Gambia (10) or Burkina Faso (1), no change of the parasite rate followed the introduction of impregnated bed nets, but the number of heavy infections and the clinical incidence decreased.

As for the prospects for malaria control with impregnated bed nets in Kinshasa, we can only make an inspired guess, based on the well-known entomological efficacy and on the epidemiological data for the different parts of the town. 3 Questions must be answered:

1. Can impregnated bed nets protect against malaria -as a disease, in the first place- in Kinshasa? (effectiveness)

2. Will the population sufficiently agree to use this method? (acceptability)

3. Is proper use of impregnated bed nets possible in the local conditions? (feasibility)

In the case of the highly endemic suburban village Kwamuthu, a bite reduction of 90% - eventually complemented with a mass-effect on the sporozoite rate - signifies that people are injected with sporozoites once in a fortnight instead of every night. This will most probably not affect the prevalence of *P. falciparum* infections, but the decrease of the frequency of reinfection and superinfection may preclude the parasitic overload that leads to disease in the semi-immune. Thus we can expect a reduction of the prevalence of heavy parasitaemias and of clinical malaria among the small children, without negative effect on the build-up of natural immunity. The latter might even be enhanced by the reduction of the incidence of immunosuppressive clinical attacks (6). Fewer superinfections also might mean fewer gametocyte carriers, and thus a decrease of the infectiousness of man to vector (7). All these speculations justify closely monitored trials with impregnated bed nets in the rural parts of Kinshasa. On the other hand, the acceptability of bed nets in an environment where the people hardly notice any mosquitoes is not be taken for granted.

In the urbanized central parts of Kinshasa, the clinical effectiveness of the impregnated bed nets probably will be better on account of the lower baseline endemicity of malaria. Once again assuming a bite reduction of 90%, -but without counting on a mass effect- we here can expect a decrease of the inoculation rate from around 1 per month to 1 per year. Such a change of the frequency of infection is likely to be accompanied by a substantial reduction of malaria morbidity, at least, initially. There is indeed the theoretical possibility of a rebound of clinical malaria if the natural immunity in the population weakens after long-term use of impregnated bed nets.

Also with respect to acceptability, the prospects for malaria control with impregnated bed nets appear better in the central parts of Kinshasa. They here constitute an attractive solution to the important problem of nuisance from non-vector mosquitoes. The protection they offer against other common biting insects, like bedbugs, will be appreciated too.

However, the uncommon usage of bed nets in the cité's of Kinshasa today indicates that some impediments to their use exist and will have to be overcome. A first one is their relative expensiveness. The price of a bed net, although probably much lower than the total amount spent annually by most people for protection against mosquitoes, is too high for a single expenditure. A second impediment is connected with local sleeping conditions that make correct use of a bed net difficult (table 4). 31.9 % of the inhabitants in Kimbangu 3 do not sleep in a bed, but on the floor or in the living room. Only 6.8 % sleep in a bed alone. The remaining 60% share their bed with one or more other persons. The importance of this practical constraint is confirmed by the observation (Dr. Zandu A., personal communication) that 83.3% of the babies sleeping in a cradle are protected by a small mosquito net. This protection is omitted when the child joins the parental bed.

It is self-evident that effectiveness and acceptability alone of impregnated bed nets will not solve the malaria problem in Kinshasa. Above all, a strong motivation at all levels and a good organization will be required to turn this potentially effective method into a sound malaria control strategy. New structures will be needed for the impregnation and the distribution of the bed nets, but their integration with existing channels for health promotion and health care delivery is of equal importance.

Lastly, we should not forget the legendary ingenuity of the people of Kinshasa: the ingenuity that makes a man use his old torn bed net to screen the ventilation openings of his house. This practice shows a possibility of combining the effectiveness of impregnated bed nets and impregnated curtains at little additional cost.

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