Vector control at Community level in Africa

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INTRODUCTION

Vector control Policies and Strategies

"The strategy of Health for All by the year 2000 made a broad appeal for the participation of communities in primary health care (PHC), one element of which was protection against vector-borne disease"[1].

A study group on malaria control in 1984 has underlined the need to transfer as much as possible of the malaria vector control activities to PHC systems[2]. The policy of PHC development is intended to bring about a gradual shift to the communities of the responsibility for implementing vector control measures for which they are technologically apt.

This policy does not spell the end of vertical programmes which will continue to carry out operations calling for substantial technologies which are beyond the means of the population and even the local government bodies. Yet it does call for harmonization of the two types of activities.

A paragraph of the Declaration of Alma Ata (1978) quoted by the 7th Asian Malaria Conference[3] defines this approach as "The support of other levels of the health system is necessary to ensure that people enjoy benefits of valid and useful technical knowledge that is too complex or costly to apply routinely through primary health care services."

The Onchocerciasis Control Programme in the Volta River Basin, in West Africa funded by more than 20 donor countries and agencies fulfills these criteria. As there is no drug available against the parasite it is based on the blackfly vector control by aerial treatments of 17,000 km of river with insecticide, covering 7,64,000 km^2 in seven countries (Benin, Burkina Faso, Ghana, Ivory Coast, Mali, Niger, Togo). None of these endemic countries has enough resources and technical expertise to undertake such treatments on its own territory. Moreover operations should be planned and implemented on a regional basis due to the long-range flying vector *Simulium damnosum s.l.*[4]

The improvement of technologic capabilities at peripheral level and the development of new appropriate methods and tools of control should give increasing importance to community activities.

Vector control at community level involves integrating different techniques while blending with overall health activities and the development process. For instance, *Anopheles* control may combine house spraying with various antilarval measures and self protection devices e.g., bed nets. However, vector control is merely one aspect of malaria control which can also be combined with effective drugs. This raises the question of the priority of vector control with regard to therapy. Strictly speaking, the two fronts on which the disease is to be fought should be complementary. In actual fact, there is some danger that they may compete with one another in countries where the health budget is very slim, as is the case in most African states. Throughout the African Region at present, drugs are being used in preference to burdensome vector control measures because they are more consistent with the methods presently in use in PHC.

The process of technical, administrative and geographic decentralization will strongly influence vector control as well as disease control strategies. Large-scale activities based on standardized methods will be replaced by activities of a more restricted nature worked out in terms of local health priorities and planned in such a way as to use all available local resources to control one or more diseases.

IMPLEMENTATION AND SUPPORT STRUCTURES

Basic structures

The community is involved at least at three levels in vector control. All its members are concerned in domestic and peridomestic sanitation measures and in their self-protection e.g., by use of bed nets, during a limited period of time or permanently. Vector control also calls for mastery of a number of techniques and, accordingly, specialisation of workers is needed to enable them not only to carry out the required work but also to act as guides to other community members. Whether these workers are agents of the community or of peripheral health services depends on the socio-political organization of the community. They need some kind of remuneration as goodwill may otherwise be difficult to sustain[5]. These agents should in particular explain the objectives and benefits expected from each type of activity and clearly delineate each one's responsibility and the duration of the operations. Work involving engineering e.g., filling marshes to reduce vector breeding sources, involve large groups of people for a limited period of time.

Community representatives should also be kept properly informed and should be involved in decision making regarding each activity, assessing the latter's acceptability for their fellow members and in participating in the planning.

Urban periphery populations have broadly similar problems. Very often the inhabitants are overlooked by the health and municipal services whose collaboration is essential for vector control activity involving environmental sanitation. However, the surroundings in which such communities, composed mainly of recent immigrants without their traditional organization, actually live are poorly developed and the infrastructure is less than the minimum standard for proper sanitation. Municipal services overworked by the fast growth of the population are not able to bring significant help to the communities for controlling vectors through building and maintaining drains, removing garbage, etc., as to solve most of their social problems.

Even though the process started later than in other continents uncontrolled urbanization is now becoming very acute in Africa where it is expected that more than 33% of the population will be urbanized by the year 2000.

Support, evaluation and research structures

Community agents or peripheral health services workers have generally limited technical background and they lack resources. Their activities should, therefore, receive operational support at district level, and scientific and technical guidance at national or provincial level[6].

Operational support should consist first of:—

—Training workers and maintaining the standards acquired during the training.
—Providing them with all necessary information and involving them in the evaluation of operations to sustain their interest.
—Advising and supervising the work.
—Finally, above all providing workers with whatever material and logistic means they require.

At national level, a top level inter-disciplinary nucleus should be formed to carry out the following tasks.

—Identify health priorities for each region and make a proper stratification of the diseases for each region.
—Decide on methods of operation for each disease in a multidisease control system.

—Carefully select the techniques to be employed, singly and integrated, in each region and even in each particular situation.
—Break down into their fundamental components the activities to be carried out by peripheral workers.
—Evaluate the results.
—Plan the intersectoral activities.
—Provide in-service training for middle level and junior workers.

These tasks, to be successfully carried out, call for an expertise and epidemiological background that most countries in Africa are far from possessing. It is, therefore, important that necessary research be conducted in order to make up for shortcomings and to improve the machinery of vector control. Reaching beyond the bounds of entomology, it takes in the other sciences, medicine demography, sociology, economics and agriculture. This inter-disciplinary approach goes hand-in-hand with integration of vector control as much into health improving activitites as into socio-economic development.

It should also be pointed out that the cost of vector control, even with community participation will be high; purchase of pesticides, spraying equipment, traps, and control supplies, servicing of equipment and possibly vehicles, and salaries whenever voluntary funds cannot cover needs. To this should be added the cost of salaries and expenses of support teams, particularly of medical entomologists and entomological technicians. In the cost/benefit analysis arises the question of taking into account or not the volunteer work done by community members.

Vector control at community level will have no real impact unless it is provided with appropriate facilities, staff and tools of operation, without these as basics, it will be makeshift and ineffective.

We recall these operational, technical and scientific constraints because in most African countries, scientific and operational support is not yet strong enough considering the enormous tasks of vector-borne disease control. In addition to training qualified personnel of different levels, a proper organization can only be built if there is a political willingness to do so. Health authorities should be taught that vector control even with the magic of community participation is not simple and requires financial involvement.

CULTURAL, SOCIAL AND ECONOMIC FRAMEWORK FOR COMMUNITY PARTICIPATION

The rural and urban populations, though benefiting from vector control, have mostly been passive spectators often uninformed of the aims of the operations. Their collaboration was often asked, e.g., for environmental sanitation through compulsory sanitary regulations. Such an approach which is not always effective, does not encourage community involvement, although in some cases it may contribute to implementing health measures.

The people should turn into agents of vector control. At first they should be kept informed of the aims of any operation before it is undertaken and of its results when it is in progress. But community participation can be sustained only if the community members feel the beneficial effects of the activities in which they are involved and if constraints are compatible with their way of life and their economic capabilities.

Perception of the role of vectors

It was only at the end of the 19th century that the role of insects in the transmission of diseases was discovered. It followed the advances of modern science and the discovery of infective agents.

The perception of disease was part of the philosophical system of society elaborated far before the discoveries of modern western science. In many African cultures as in the Congo for example, disease was not an entity but a particular condition of man often attributed to conflict with his environment or to magical practices*.

The present perception of disease and of the role of vectors is a compromise between traditional concepts and the input of western culture[7]. For example in the Congo and the Niari district, between 1910 and 1940, sleeping sickness became highly prevalent and inflicted high mortality. Its efficient control was due to strong medical action, the basic structures of which are still functioning. The disease is identified and called "nberre tolo" and the role of tsetse flies is known to everybody. Tsetse control by trapping is not only welcomed but requested by the people. A project based on community participation has just been implemented[8]. On the borders of the endemic foci where the disease was less severe its perception is unclear and, if transmission by vectors is generally accepted, all kinds of biting insects are incriminated.

Sleeping sickness epidemics of the first half of this century are still vivid in the collective memory in Burkina Faso in West Africa. Some valleys like the Black Volta infested by tsetse flies are considered to be evil in spite of the absence of new cases during the last 20 years.

In Guinea some people consider onchocerciasis blindness to be caused by the blood of engorged blackflies squashed on the face when biting. Such an interpretation may be recent and results in misunderstanding of the scientific explanation.

The linkage between blindness caused by onchocerciasis and rivers has been commonly established in Africa even for those who did not know the patterns

*Information dealing with the Congo has been given by F. Hagenbucher, ORSTOM Anthropologist.

of disease transmission. In savanna areas of West Africa, villages were deserted when the blindness rate was up to 10% but they were sometimes reoccupied when these events were forgotten[4].

In many areas of Africa malaria is identified as "warm body" and the parents themselves give chloroquine tablets to febrile children. In fact 30% to 60% of fevers in children are really due to malaria in the Congo as well as in Burkina Faso[9,10]. Family treatment accounts probably for the low malaria mortality recently observed in these countries[11]. In most of the ethnic groups the role of mosquitoes in malaria transmission is well-known and the term Anopheline is sometimes mentioned, but villagers not being entomologists are unable to differentiate *Anopheles* from *Culex, Aedes* or *Mansonia*. Consequently, they consider the persistence of these mosquitoes as a failure of house spraying treatment for malaria control even when anophelines are efficiently controlled.

In mountainous areas of Cameroon, which are free of malaria, it was forbidden to spend the night in adjacent low valleys which were highly malarious.

The rapid evolution of the concepts about diseases and their transmission is very encouraging for health educators who have to take into account the cultural background of the population to explain the objectives of vector control.

Vector and Pest control

Very often the first results observed by the population determine whether or not they will give their further commitment towards vector control. The reduction of the nuisance due to insects, in other words the number of insect bites, provides the most effective initial incentive. Although it is not the main objective of vector control, the population usually expects it. The success of any campaign is judged more by the disappearance of mosquitoes, tsetse, blackflies or bedbugs rather than by its impact on malaria, filariasis or trypanosomiasis. The popular success of the Onchocerciasis Control Programme in West Africa has mainly been due to the disappearance of *Simulium damnosum s.l.*, allowing people to calmly cultivate the river valleys. Elimination of painful bites of tsetse flies is also making traps very popular among the villagers in the Congo[8] and in Ivory Coast.

Adversely, antimalaria spraying has been rejected in Madagascar and in Sao Tome because DDT resistant flies and bedbugs apparently began to multiply following house spraying according to the population. In the last country it was necessary to add malathion on the spraying.

To maintain the confidence of the community the selected vector control methods should be effective not only against the disease but also, as much as possible, against the pest insects.

Social and economic acceptance

Before introducing vector control measures at community level we should consider whether the technology selected is in harmony with local customs and attitudes to which people are deeply attached and the violation of which is taboo. These obstacles can generally be overcome with a sensitive approach towards the community e.g., tsetse trapping in sacred woods in Mali (Challier, personal communication).

The tasks to be undertaken should be consistent with the style of life of the people. A clear distinction should be drawn between the various tasks entrusted to community agents responsible for vector control (whether operating as volunteers or on a salaried basis) and those attributed to the whole population or to large groups of people. Villagers obviously cannot be expected to devote a large part of their time to vector control when they have to attend to agricultural activities. The form of participation expected from them should be consistent with their many tasks so as to ensure its continuation.

Environmental management is highly dependent on two major factors, namely the population density and the percentage of land under cultivation. In Africa, south of the Sahara, the mean population density is lower than 30 per km^2 and less than 15% of the land is actually cultivated. The villages, often of small size, are far from each other and each community owns large pieces of land. Under such conditions it is very difficult for them to properly manage the environment because of the limited manpower available. Of course, there are exceptions and some areas with high population density are found in Kenya, Nigeria, Cameroon, Rwanda etc.

PAST, PRESENT AND FUTURE OF CONTROL ACTIVITIES IN AFRICA

Impact of vector-borne diseases in Africa

Vector-borne diseases are among the most severe health problems in the African Region and this Region is probably the most affected by these diseases in the world. They cause a high mortality rate in the affected population and high morbidity, mainly in rural areas, which is a serious impediment to socioeconomic development.

Malaria is endemic in 90% of the Region, in most of the places at hyper or holoendemic level. Three hundred million people are affected by the parasite, and only survive because of immunity developed after initial bouts with the pathogenic agent. The disease accounts for 10 to 70% of the dispensaries' consultations depending on seasons and areas. The resistance to chloroquine of the main parasite *Plasmodium falciparum* is rapidly expanding from the east to the west of the continent.

More than twenty million people are at risk from onchocerciasis and probably more than ten million are infected. The more severe foci are in the savanna belt north of the equator. The blindness rate could reach 10% in affected communities. The disease, a major impediment to the development of agriculture in river valleys, has now been eliminated by the Onchocerciasis Control Programme from large areas of West Africa[4].

Foci of lymphatic filariasis are widespread in the Region leading to serious health problems on the East African coast, in Madagascar and in the Comoros Islands.

Dracunculiasis is found in most of the countries of the Region in discontinuous foci and is considered an important problem by many states.

African human trypanosomiasis, affecting probably less than 2,00,000 people, is nevertheless a serious threat since its resurgence can lead to severe epidemics like the one occurring now in Uganda.

Kala-azar has been mainly reported from Kenya and Sudan with scattered cases in Algeria and Ethiopia. Cutaneous leishmaniasis cases are found in the driest parts of the continent on the Sahara borders and in some mountainous areas.

Circulation of yellow fever virus between monkeys and sylvatic *Aedes* has been reported in many countries of West and Central Africa. Several outbreaks with different epidemiological patterns have been reported in the last 20 years in West Africa, the last being in 1983 in Ghana and Burkina Faso.

Sylvatic dengue fever has been identified in the same mosquitoes and monkeys as yellow fever and in the same foci. Urban epidemics occurred in the East Coast and in West Africa (Burkina Faso, 1982)[13,14].

Louse-borne typhus has mostly disappeared but has again become a problem in refugee camps.

Plague persists in its natural foci in the Central African Plateau and in Madagascar.

Possibly 50 million people of the Region are infected by schistosomiasis (*S. haematobium, S. mansoni, S. intercalatum*). Building dams and irrigation schemes everywhere is a major factor in increasing its spread.

This short review highlights the paramount vector-borne diseases in Africa. One can say that some diseases like malaria or schistosomiasis are so extensive that they can be considered as part of the human environment.

CONTROL METHODS THAT MAY BE IMPLEMENTED WITH COMMUNITY PARTICIPATION

Tsetse fly control

Clearing the forests and galleries which were considered as the base of non-chemical control of tsetse flies is now banned as forest protection has become a major ecological problem. Destruction of game is also unacceptable. Massive spraying of insecticides, apart from its side effect on non-target fauna, is extremely costly and has to be repeated when flies reinvade cleared areas.

Traps aimed for tsetse sampling have proven to be very effective for control mainly when they are insecticide treated. Outstanding results have been obtained against riverine species of tsetse flies (*Glossina palpalis* group) in Ivory Coast[15] and in the Congo[16]. A trial of non impregnated traps in the Congo was successful[17]. Introduction of trapping into tsetse fly control makes it possible to envisage the transfer of this type of activity to the communities. Trials are in progress in Congo, traps are provided by health services but their maintenance is done by villagers, who check the catches and eventually move the traps to better catching sites, so far the experiment is very satisfactory and is used for training rural volunteers[8]. The trapping could be integrated in inter-sectoral activities in stock breeding areas to protect both human and animal health. It is a good tool to protect ranches which are being developed in many tsetse infested areas where at present only trypanotolerant strains of cattle can be bred.

Malaria vector control

In view of the importance of malaria in Africa, destruction of its vectors is a primary objective. At present there is no general method of achieving this aim in Africa, while the integrated approach appears difficult to put into effect. This is borne out by the report of the *adhoc* consultation of the Scientific Working Group on Applied Field Research in Malaria held in Nairobi in October 1983[18]. Not only does it show the inadequacy of available control systems, it also reveals a disquieting lack of new proposals, and one may reasonably ask which particular elements may be integrated to some purpose and, consequently, what action is possible at community level.

House-spraying of dieldrin and DDT gave excellent results in the forest areas of Cameroon[19] and Liberia, yet failed to interrupt the transmission of malaria in the savanna regions of West Africa, such were the results of the various pilot projects carried out before 1963[20]. Since that time, the spread of resistance to dieldrin and development of resistance to DDT among species of the *A. gambiae* complex invalidate the use of organochlorine insecticides in many African countries. Alternative organophosphorus compounds are far more costly and have only been used on occasions or in pilot projects, some of them e.g., fenitrothion, gave excellent results. House-sparying is the only *Anopheles* control method that has been properly evaluated in Africa.

Anopheles larval control is especially difficult in Africa. As the population density is low and the breeding sites of both *A. gambiae s.l.* and *A. funestus* very extensive, the ratio of the breeding sites versus man is very high. Moreover, *A. gambiae s.l.* larval sites are scattered and of very temporary nature in rainy season. A. *funestus* breeding sites occupy vast expanses of territory and are covered by dense aquatic vegetation which makes any control agent difficult to employ. Larval control measures, whether in the form of insecticides, biological agents or environmental sanitation, can only be implemented at the present time in a limited number of cases where breeding sites are easy to identify and not too extensive. Such measures cannot be applied generally, but rather on a local basis.

Mention should be made of the case of Somalia where *A. arabiensis* sites, consisting of man-made water reservoirs, were brought under control using larvivorous fish *Oreochromis spilurus*, resulting in a substantial decrease of malaria indices[21]. It may be possible to use the same technique in the Grande Comore where there is no ground water. Research on larvivorous fish use has been undertaken in Sudan.

In forest areas, *A. gambiae* breeding sites are often fewer in number, less extensive and found in clearings, some of them could well be treated or destroyed. In 1957, one of the authors observed that road repairs, thereby filling the ruts, led to the disappearance of *Anopheles* and, as a result, of malaria transmission in the village served by the road.

Such examples are exceptional in the context of Africa, south of the Sahara. The possibility and effectiveness of treating larval breeding sites should be reviewed very carefully on local basis.

Replacing chemical larvicides such as temephos, which is not very harmful to the environment, by bacterial preparations such as *Bacillus thuringiensis* H 14 is not a very significant step forward, formulations of the latter are not residual, because the active ingredient does not remain in suspension and treatment has to be repeated every week, thereby costing far more than house-spraying[22,23]. Fish cannot be used in scattered temporary water-beds even with restocking, there has been talk for more than 20 years of introducing *Notobranchius* whose eggs are resistant to drying, but no progress has been made in this direction. Reducing breeding sites is such an undertaking considering their size and the available manpower that it would be quite unrealistic to attempt it in most rural areas. In towns where it might well be envisaged it would require action on the part of the municipal authorities and serious technical and sociological approaches.

Wherever it is envisaged, feasibility of *Anopheles* larval control and its real impact on clinical manifestations of malaria should be carefully evaluated under African conditions. Wihout proper evaluation, there is a danger of making, the people pay a heavy price for poor results.

In some countries like Ethiopia, Guinea and Mozambique, community participation in house spraying operations has already been experienced. In Ethiopia organized community participation involving local farmers' associations began in 1979 and has resulted in an increase in the number of houses sprayed as well as a general increase in efficiency[2].

However, in Africa, the main thrust of community participation to malaria control has been on therapy, in compliance with the WHO Regional Committee Policy.

Control of other vector mosquitoes

Aedes aegypti would be an ideal target for nonchemical control particularly in urban areas. Cleaning or eliminating the containers acting as larval breeding sites can be done by the communities where good health education activity can be carried out.

The threat of yellow-fever epidemics before the vaccine was available led to a very severe legislation regarding the suppression of any potential breeding place including tree holes and certain plants. These measures were said to have been very effective during the first half of the century. When yellow fever vaccine appeared, thereby providing total protection these measures were no longer easily accepted. In the last 20 years urban yellow fever outbreaks have appeared in unvaccinated people, involving *Aedes aegypti*. Moreover, dengue epidemics spread in East Africa as well as in West Africa[6] emphasizing the importance of *Aedes aegypti* control.

In towns and even villages the number of receptacles as potential breeding places of *Aedes aegypti* is continuously increasing with the popularisation of plastic packing. In towns, the municipality should remove or burn used containers if breeding sites are not simply to be transferred from houses to rubbish dumps a few yards away. Keeping drinking water in houses is a traditional practice[24] of certain ethnic groups which can persist even when tap water becomes available. Serious health education efforts are needed to change such behaviour. If treatment with insecticides (temephos) or microbial preparations (*B. thuringiensis*) is needed, it could be done by community agents.

Control of sylvatic *Aedes* (*A. simpsoni, A. africanus, A. luteocephalus, A. furcifer/taylori* and feral forms of *A. aegypti*) is practically impossible unless their breeding places are in a peridomestic situation where they can be eliminated (filling tree holes, removing some plants like *Colocasia, Musa ensert* etc.) or treated. Any measure can only be planned according to the local ecology of these mosquitoes.

Culex quinquefasciatus is a growing problem linked to urbanization. As it is one of the few species resistant to household detergents it has no competitors and few predators in the polluted urban waters[25]. Apart from its role in the transmission of filariasis it is a serious nuisance pest in towns. This mosquito is spreading out to rural areas as more and more detergent is used by householders. The insecticide treatments by chlopyrifos or fenthion are restricted by the development of resistance. *Bacillus sphaericus* holds out promise and so do insect growth inhibitors of the juvenile groups[26]. Such treatments are mostly applied by municipal health employees but could be transferred to community agents if properly trained. The reduction of breeding sources through urban sanitary measures, including proper drainage and cleaning of drains and sewage systems, needs major civil engineering operations on the part of municipal authorities. Community agents can participate in the maintenance and functioning of the sanitary network.

Periodically there are proposals for better latrines or cesspits but no one, up to now, has been able to reduce mosquito production and an effort in this area is desirable.

Locally imaginative solutions have been introduced by the people. For example, in some coastal areas of East Africa they introduce salt in the latrines to curb the development of *Culex quinquefasciatus*.

Black fly control

As mentioned before the onchocerciasis control in Africa is mainly carried out by the Onchocerciasis Control Programme in the Region of the Volta River Basin (OCP). It is based on weekly aerial treatments of every productive breeding place with temephos, chlorphoxim, Teknar ® or, recently, permethrin.

From the very beginning OCP was interested in community participation in its huge vertical programme structure and was aware of the difficulty of involving people in the control operation. An information campaign was undertaken to make people aware of the effects of the diseases, their transmission patterns and the aims of the programme. It was a success and now in most of the villages of the exposed areas people are strong supporters of OCP. Moreover, governments and people outside the treated areas are asking to be included.

Except in rare situations, such treatment is not within the capabilities of the communities or of health peripheral units. But when participation appeared possible, it has been fully exploited. In the Selingue dam watergates are used alternatively to dry the breeding place on the spillways. In the Bandiagara Plateau, at the extreme north of its distribution area the disease is only seasonal and most of the breeding sites result from small dams, recently built for irrigation. Community agents under the supervision of Programme technicians participate in the surveillance system, reporting the appearance of flies. They also contribute to the mechanical elimination of the breedings sites on the spillways and they are trained for limited chemical ground treatment. This approach has been very successful[12,4]. But the Bandiagara area is an exception and such simple control methods cannot be applied to more than 5% of the whole river system of the OCP area.

If drugs usable for mass administration would become available community participation should be reconsidered.

It has been recommended to build villages far from infested rivers. Of course it is a good preventive measure but the goal of onchocerciasis control is precisely to reoccupy the infested valleys. It has been proved in the OCP area that when the population density reaches 50 per km^2 the gravity of the disease decreases considerably even in the most infested places[27]. Dense occupation of land can to a certain extent be considered a prophylactic measure.

Control of Guinea-worm

Although it is possible to control the *Cyclops* with insecticides e.g., temephos, DDT, in the breeding places or in drinking water, the main approach for Guinea-worm control is by improvement of water sources. Spectacular results have been obtained in India. In Africa good results have been achieved in Ivory Coast in building suitable wells[28]. As part of the Water Decade, a great effort is being made in many African countries to improve the supply of potable water which will probably decrease the prevalence of the disease. A campaign of health education has been undertaken in several countries of West Africa by OCCGE, (Office de Cooperation et de Coordination pour la lutte contre les Grandes Endemies, Bobo-Dioulasso, Burkina Faso) which produced a leaflet to inform and guide the population[29]. In particular it is recommended that the worm carriers do not put their legs in drinking water sources when they are swollen and the villagers are advised to filter water when no safe source of drinking water is available.

In some places in the Sahel area where wells are functioning, people continue to drink water from the infested pools, which they consider tastier Such behaviour can only be changed by health education.

Snail control

There is a lot of literature on the link between population behaviour and schistosomiasis contamination, health education remains one of the bases of disease prevention. But the recommendations are rarely followed because they are too restrictive. They need to be locally adapted to the way of life of the populations who generally are not frightened by schistosomiasis. Presence of blood in urine is even considered as a normal event of the life of young people in many areas.

In Niger, in an irrigated rice-field area near Niamey the community is now taking charge of cleaning the water channels which are the main, if not the only source of *Bulinus* snails. This action is undertaken through a national development agency in charge of irrigation and water management. In Mali there is an attempt to involve the community agents in using molluscicides in the treatment of the schistosomiasis foci.

The use of local molluscicidal plants like *Phytolacca dodecandra* has been encouraged but more information about their chronic toxicity and mutagenicity is desirable. Upto now there is no report on their utilisation by the communities.

At the present time schistosomiasis control in Africa is mainly based on chemotherapy. Complementary snail control should be strongly coordinated with the medical approach. The full set of activities should be planned locally. The use of snails predators and antagonists is still at an experimental stage[30].

Integrated control and Inter-sectoral activities

Integrated control is another magical approach thought to solve all the difficulties encountered by vector control. In fact it is a philosophy and not a method and its efficacy will depend on the methods and tools which could be integrated. They have been reviewed by a WHO Expert Committee in 1983[1]. Their ability to be utilized at community level in Africa was discussed in a WHO consultation in Brazzaville in 1985[12].

Integrated control should be planned locally according to the epidemiological situation, vector ecology and socioeconomic situation taking into account all the possible methods of control which have already been envisaged in this paper. Again we stress the need of a highly qualified team of specialists to select appropriate technologies and methods.

In Africa no organized effort has yet been undertaken to build up experimental projects taking into account specific African conditions already described. This is a pre-requisite to the development of integrated control in the region.

Although man is little inclined to alter his environment for the good of his health, he is nonetheless transforming it radically in order to carry out development projects. Dams are being built whose reservoirs cover wide areas, whole tracts of land are being irrigated, partly for the cultivation of rice, while land is often cleared at the expense of wooded areas that are shrinking away and are rarely replaced through reforestation. These ecological alterations lead to significant changes in vector distribution. Whereas the populations of tsetse flies have shrunk with the disappearance of gallery forests in the Sahel region, breeding sites of intermediate hosts of schistosomiasis and of *Anopheles* larvae abound in dammed reservoirs and irrigated land. Black flies tend to breed in the spillways of dams and can cause serious local outbreaks of onchocerciasis in areas where the disease did not exist before, as on the Dogon Plateau in Mali. Urban development leads to proliferation of *Culex quinquefasciatus* and *Aedes aegypti.*

It is at the planning stage of construction that decisions should be made regarding the necessary steps to minimize establishment and multiplication of vectors. For instance, operating sluice gates on an alternating basis can prevent the development of *Simulium damnosum* breeding sites[7].

In the new situations arising from the modification of environment by agricultural practices it is necessary to be cautious in the choice of vector control to be implemented. In this respect, the approach in paddy-fields is quite revealing. Generally speaking, the development of flooded rice fields leads to a significant increase in the number of anophelines in nearby villages when the plots are actually being flooded[31]. Research carried out in Burkina Faso[32] has shown that the "Mopti" cytotype of *Anopheles gambiae* prevailing in the paddy-fields was not as good a vector as the "savanna" cytotype of the same species prevailing in villages outside the rice cultivated area. Paradoxically the malaria transmission is lower in the villages of the rice area than in the other villages even when people received five times more *Anopheles* bites. Nevertheless malaria was hyperendemic in the two situations but in the rice field area people had a better access to curative drugs. The priority given to vector control in rice fields in such a situation will depend on the general health policy of the country.

Individual protective measures

Mosquito-nets are excellent means of individual protection, they would cost far less if manufactured locally from available materials, thus leading to their wider use. Impregnating the net with pyrethroid insecticide reduces man-mosquito contact even when mosquito netting has holes. Impregnated mosquito nets of this type have been successfully tested at present in several research centres in Burkina Faso[33], Mali and Tanzania[34]. Nets under which people sleep strongly attract anthropophilic mosquitoes. Their treatment can be considered as a highly selective house spraying. This has to be evaluated epidemiologically. In Burkina Faso, the Health Services intend to make widespread use of nets, both for malaria prevention and to improve population welfare.

Mosquito-proof wire mesh can only be fitted to doors and windows of certain types of building and as a rule is not suited to the dwellings of the poorest rural communities.

Insecticide coils are now used widely in Africa. They provide excellent protection against all types of mosquitoes and particularly against *Culex quinquefasciatus* and *Mansonia*. This will considerably reduce the rate of mosquito bites and thereby contribute significantly to *Wuchereria bancrofti* control.

The action of commercial repellents is generally short-lived. Many types of local products are regarded as being repellent, their effectiveness and harmlessness have to be evaluated.

RESEARCH NEEDS

The relatively short list of vector control methods that can be used in tropical Africa, coupled with the problem of defining the particular potentialities of each one, highlights the very pressing need for appropriate research to implement the new policy of integrated vector control. The research needs may be listed under four headings.

a. *General epidemiological research* in order to stratify the various diseases in each region and identify the vectors responsible for transmission, this requires research on vector ecology and behaviour in relation to human habits and housing.

b. *Research on control methods* development of traps for control and sampling, research on use of pesticides, bacterial preparations and biological control agents (larvivorous fish, snail antagonist, predator, etc.), research on local insecticides or repellents both for *in situ* use and to identify new molecular leads, evaluation of the potential of individual protective measures.

c. *Evaluation* of each of the measures planned and of the association of several of them such evaluation should extend to the epidemiological level and also their social and economic feasibility. The benefits and constraints of vector control activities may be assessed in comparison with the use of drugs, possibly leading to a combination of the two approaches.

d. *Anthropological, social and economic research* on the conditions which facilitate or constrain the participation of rural and urban communities in control activities.

TRAINING

As we have already said, the implementation of an integrated and decentralized vector control policy calls for the acquisition of a sound scientific background, including the training of senior specialists in medical entomology and epidemiology as well as in social sciences. WHO has made a special effort in these two fields in Africa since three courses of medical entomology (at third- cycle level in French-speaking countries and Master's degree level in English-speaking countries) have been started at the Universities of Abidjan (Bouake Centre), Jos and Nairobi. Various courses in epidemiology have also been started. It would be of some value if these training courses were specifically to include activities at community level involving an approach in which theory is inseparable from practice and technology, to take full account of cultural and social realities. Collaboration between developing countries in the field of medical entomology training, in itself carries a meaningful message. Appropriate training should be developed for social scientists working in health activities.

Middle-level workers should be trained in the country itself, as should peripheral health workers. They should receive general instruction in other fields as well as learning the techniques they shall be called upon to use. This is an effective way of motivating them and earning credit for them in the eyes of the community.

CONCLUSION

Placing vector control in the hands of the community means converting its members, who up to now have been spectators, into active participants. Communities should be motivated to participate on a lasting basis through the use of positive actions that are also seen to be effective. In view of the rudimentary technical level of peripheral health workers, this means choosing the simplest methods. Simplicity and effectiveness can only be achieved through first-rate knowledge of disease epidemiology, vector bioecology and human ecology, thereby necessitating a top-level interdisciplinary team. Community activity can only succeed through the meticulous preparation and selection of appropriate techniques and methods followed by permanent technical, scientific and material support. What is called for, therefore, is the organisation of staff training at several levels, senior workers charged with analysing situations and promoting appropriate new control methods, middle-level workers charged with organizing, monitoring and evaluating operations, and basic workers charged with putting the selected methods into effect.

Ever since the development of primary health care has come to be regarded as the means of promoting health for all, a spate of articles, often the work of theorists rather than practitioners, has highlighted the need to develop simple vector control methods based on community involvement and calling for the greatest possible use of environmental management. No doubt, the aim of their authors is praiseworthy, yet their efforts may lead to confusion. The fact is that their writings give the impression that such methods are available for immediate use, whereas in fact they are actually at an experimental stage.

It is even more important that actions to be undertaken must be geared to the specific conditions. Global strategies need to show a greater sensitivity to local situations.

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