

REPORT OF CONSULTANTS - AFRICAN MALARIA

OFFICE OF HEALTH, (TA/H), AGENCY FOR INTERNATIONAL DEVELOPMENT

INTRODUCTION

This mission had its genesis in a number of disturbing aspects of the malaria situation in tropical Africa which will be reviewed below, but which may be outlined briefly here. Malaria remains one of the most common infections in Africa, causing much infant mortality. While it may be largely asymptomatic in the adults who survive, it undoubtedly drains large amounts of metabolic energy and results in lowered efficiency and vitality. The worldwide malaria eradication campaign assisted by the World Health Organization and the Agency for International Development has never really been implemented on any large scale in tropical Africa. Furthermore, the prospects for initiation of such campaigns, based largely on the application of residual insecticides to domiciles, have recently been sharply reduced due to the inexorable rise in the cost of pesticides in the face of rising costs for crude petroleum - from which such compounds are largely derived.

In addition, WHO has recently called for a return to principles of malaria control, rather than eradication, in areas such as tropical Africa. This represents much more than a semantic difference, rather it involves a fundamental difference in approach. In malaria control programs much more attention must be devoted to such matters as larval control, and to the ecology of the vector mosquito. It also opens up greater possibilities for actions (such as drainage) which may be conducted on a community or self-help basis rather than with the rigid central direction required for a malaria eradication campaign.

Many parts of tropical Africa are undergoing rapid changes, consisting of massive urbanization, and the introduction of hydroelectric and irrigation schemes and other industrialization efforts. These must in turn affect health in many ways, including possible influences on vector-borne diseases such as malaria. This is particularly true of the impoundment and irrigation projects.

The purpose of this mission was three-fold:

1. Determination of the applicability of methods of control for Anopheles vectors of malaria not involving residual spraying, with emphasis on low-cost methods which might be used at the local level.
2. Examination of any novel or innovative methods for control of Anopheles gambiae which might be under development in the areas visited.
3. Assessment of the health effects of development, with particular emphasis on malaria and other vector-borne diseases.

Personnel

Dr. Lloyd E. Rozeboom, Professor, School of Public Health, The Johns Hopkins University, Baltimore, Maryland.

Dr. Michael M. Service, Professor, The Liverpool School of Hygiene and Tropical Medicine, Liverpool, England.

Dr. John E. Scanlon, Professor, The School of Public Health, The University of Texas, Houston, Texas.

Mr. Edgar A. Smith, AID/Washington, TA/Health, Vector Control (London and Geneva only).

Itinerary

The detailed itinerary is presented in Annex I.

The African Malaria Situation: WHO has recently (Anon. 1975) estimated that two hundred and sixty-one million people live in areas of tropical Africa where malaria is considered to be the main cause of morbidity and mortality; 600,000 deaths in the age group 0-4 are annually attributed to malaria. While there were some early promising trials of malaria control and eradication in the early DDT era, only 17% of the exposed population of Africa presently receive some type of protection, mostly in the urban areas. In almost all regions, except those at high altitudes or at the margins of dry areas the malaria is described as "stable", that is, characterized by high infant and child mortality, high levels of immunity beginning in late childhood, and with relatively little frank adult disease. However, Bruce-Chwatt (1975) and others have pointed out the difficulty

In truly assessing the impact of the disease in adults.

In no small measure the characteristics of the disease in Africa depend on the characteristics of the major vectors, Anopheles gambiae and A. funestus, particularly the former. Anopheles gambiae is perhaps the most efficient malaria vector in the world - highly anthropophilic, long-lived, and capable of reaching high population levels in a wide variety of temporary water collections.

A. gambiae consists of a complex of four freshwater species, provisionally named as species A, B, C and D and two salt water species, namely, A. melas in West Africa and A. merus in coastal East Africa. In the areas visited in Nigeria and Kenya only species A and B exist, which are in fact the two most important malaria vectors. In the present report the species complex is simply referred to as A. gambiae, unless there is a need to distinguish between its sibling species.

The malaria situation in Africa, as important as it is, cannot be evaluated without placing it in the context of the general health picture.

Africa's general health situation can be crudely assessed from the following indices: neonatal mortality of 50-80 per 1000 births; infant mortality of 100-200 per thousand (Bruce-Chwatt, 1975). WHO and other sources usually indicate a ratio of one physician for 20,000 population in many African countries, but the ratio must be even more extreme in many rural areas. The most immediate need is for the development of basic health services, made available to as much of the population, rural and urban, as possible. It has been emphasized by many observers that any real progress in malaria control must be coupled to an improvement in basic health services. The economics of this matter are discussed briefly in a later section of this report.

London (27 - 29 April):

Center for Overseas Pest Research (COPR): This organization, a part of the Ministry of Overseas Development, was established to assist developing countries to solve pest problems in the fields of agriculture and public health. They have had extensive experience in Africa, largely in locust control, but encompassing other areas as well. Personnel seen were:

Dr. P. Haskell, Director
Dr. A. Hadaway, Assistant Director, Chemical Control
Dr. C. Lee

These members of the COPR staff were briefed on the elements of the team's mission, and provided a briefing in turn on the elements of the COPR program of interest to us. They have been engaged in research in support of the present effort to eradicate onchocerciasis in West Africa. This program has attempted to find alternative

methods of control of Simulium, but primary reliance is still being placed on use of Abate larvicide. COPR efforts in trypanosomiasis control were also described, but not in great detail.

Based on his experience in Africa Dr. Haskell felt that there might be some possibility of obtaining Anopheles control by source reduction or larviciding by local people, and the others agreed. However, all felt that some organization would be needed to supervise the work, at least periodically. They have had no direct experience with such a self-help program in their areas of primary interest.

Dr. Haskell is also a member of the board of scientific advisors to the International Center for Insect Physiology and Ecology (Nairobi) and briefly discussed the future direction of the program there.

London School of Hygiene and Tropical Medicine, Ross Institute: The team briefed the following members of the staff:

Dr. G. Davidson
Dr. J. Busvine
Dr. D. Bradley

These workers had experience and information much more applicable to the team's mission than COPR. After briefing they were asked to comment on the possibilities for the various parts of our mission.

Dr. Davidson, one of the foremost experts on the genetics of A. gambiae, discussed the unusual efficiency of the vector, due to its anthropophilic habits and longevity. An efficient insecticide is not enough for control, not without the continued mobilization of finances manpower and technical assistance. He did believe that there was some possibility for village level control, with particular emphasis on health education, and the application of personal protective measures.

Dr. Davidson also discussed the gambiae group, now known to contain six species rather than five. Five of these are vectors to varying degrees, and each may require different control techniques. He believes that considerable more biological and ecological research is needed. Species A and B are temporary pool breeders, and some control might be achieved by filling or drainage by villagers in their immediate vicinity. He also felt that access to cheap bed-nets, drugs and sprayers might make an impact, and that they would be used by the villagers.

As for the second aim of the mission, innovative methods of A. gambiae control - Dr. Davidson described briefly his attempt to obtain control of gambiae by genetic means, employing sterile hybrids. He would like to see this work repeated, and believes that a hybrid between two local strains, used against one of the parent strains, would have a good chance of success. This could be done without an elaborate or expensive field trial, by collecting local pupae at a

site in Africa, marking the females and releasing them with sterile hybrid males. An ideal site would be an island. He has, however, had no reply to a proposal of this nature to WHO. He also discussed the possibility of releasing strains of anophelines with a genetic constitution making them refractory to malaria infection. Some work has been done in the laboratory and gambiae are on hand which are refractory to the rodent parasite Plasmodium berghei. There also appears to be some promising leads with P. vivax in a chimpanzee model. This genetic method is, however, still in early stages of development.

Dr. Busvine discussed the impact of development of insecticidal resistance by Anopheles, and stated that it was a severe problem in some areas and getting worse. He believes that there are two great opportunities which should be explored. First is detailed field research on the biology of A. gambiae. This might require as much as 8-10 years for a full pay-off, but is badly needed. He also believes that there is a place for species sanitation, and that one or two demonstration areas should be selected to show the effect - places that people will talk about and copy.

Dr. Bradley spoke of the need for development of new methods for mosquito control based on local products and relatively unsophisticated techniques. He mentioned the use of a surface active agent such as local "butter" for occlusion of larval siphons. He expressed some doubt that source reduction would be effective against A. gambiae unless carried to an unusual degree of perfection. In this connection he stated that in Freetown, Sierre Leone, larval control reduced gambiae levels to less than 1 female per house per night - nevertheless, holoendemic malaria persisted (Walton, 1946).

The group indicated that Tanzania might be a good place to evaluate self-help methods, as sanitarians and field medical assistants were presumably now being trained there to do anti-malarial work as part of village development schemes. This same suggestion was made to us several times and will be discussed later in the report.

One point on which all three workers agreed was the need for much additional research on Anopheles gambiae, including the perplexing question of where the species passes the dry season, particularly in the more arid portions of its range.

NOTE - Two of us (Rozeboom and Scanlon) also spoke to Dr. L.J. Bruce-Chwatt, recently retired Director of the Ross Institute and Professor of Tropical Medicine, London School of Tropical Medicine and Hygiene. Previously he had also been in charge of malaria research for the WHO, and had extensive experience in Africa. While he did not comment in detail on our plans, he was quite dubious concerning the efficacy of self-help methods for the control of malaria in tropical Africa.

World Health Organization, Geneva (31 April - 1 May):

An initial briefing was held with a large group of WHO personnel (primarily from Vector Biology and Control (VBC) and Malaria and Parasite Diseases (MPD)) at which Mr. Smith and the team outlined the general objectives of the mission. This was followed by sessions with smaller groups with specific interests or information. The individuals contacted are listed below in each appropriate section.

NOTE: One member of the party (Rozeboom) had a long discussion with Dr. M. Farid, retired WHO malariologist on the evening of 29 April. Dr. Farid made the following points:

1. Malaria is a serious public health problem in Africa: only one-half of the children (in the highly endemic zones) survive beyond childhood; it seriously affects the pregnant mother and baby.
2. Economic development is dependent upon first alleviating the malaria problem; roads and markets should follow, not precede malaria control.
3. The first step in the antimalaria campaign is to protect those suffering the most. These are the young children and mothers. This can be accomplished - at least in part - by supplying the people with bed nets. These will be used because the very large mosquito populations make it difficult for the people to sleep. If the people sell them or don't use their nets, then it is their fault if they die of malaria. If bed nets are available to everyone, there will not be the incentive to sell them.
4. The second step is the distribution of antimalaria drugs.
5. Houses should be made more mosquito proof with cheap plastic screening.
6. Pyrethrum sprays could be effective. Pyrethrum is grown locally and could be an economic asset.
7. Larvicidal control is problematic, it would be of doubtful effectiveness. However, it might be useful with properly trained and organized personnel to do some filling, drainage, and routine larviciding.
8. Self-help is imperative. Dr. Farid thinks that the African villagers can be trained and will accept the responsibility to carry on. (Note: this is in sharp disagreement with the opinion of a number of other conferees, who insisted that left to

themselves, the African villagers will do nothing to continue vector or pest control.)

9. Malaria control, through the Health Services is, in Dr. Farid's opinion, worthless.

10. Health educators have no impact on malaria control.

11. The person responsible for training must live in the village and set an example for those whom he is training.

General Discussion: There was a general attitude of skepticism that self-help schemes at the village level could work. This should perhaps be viewed in context - in that the devotion of WHO to residual spraying as the primary, if not sole, method of control is proverbial. Force of circumstances has recently moved them to endorse alternative methods of control, including source reduction. There was general agreement on the need for training of local personnel who would live in the villages and be paid to supervise whatever methods would be employed if there was to be any hope of success.

Dr. Noguez (MPD) - felt that at present most Africans do not regard malaria as a problem, since it is asymptomatic, or nearly so, in adults. He felt that self-help in Africa would be extremely difficult through the primary health care centers or at the community level. He still feels that residual spraying is the most effective, or the only, method. This method should be improved, as is being done, but he has no faith in "innovative" methods. Drug distribution might be a useful local level method, supplementary to residual spraying, or alone. He also described a proposal to test the effectiveness of several malaria control methods in the Sahiel region. Each method will have the assurance of cooperation from the local health service agencies, and cost-benefit studies will be included. At present, efforts to control or eradicate malaria in the Sahel have not been effective.

Dr. Gramiccia (MPD) - stated that no panacea was presently available for Africa, but that it might be possible to select a few ecological situations where malaria control by a variety of means might be possible. These could be used as demonstration areas. Some organizations do exist which might be employed for self-help projects, but these are inefficient for the most part. The exception may be in Tanzania, where the authoritarian government appears to be organizing community efforts in many fields. He feels that some advances might be made by drug distribution. He also discussed source reduction, but was less than sanguine about this, mentioning failure to control schistosomiasis by community action - perhaps a simpler problem than controlling malaria vectors.

Dr. Hamon (Chief, VBC) - was also pessimistic about the possibilities of source reduction, or other self-help measures. An exception might be in isolated communities, such as villages in the rain forest, where relatively limited areas need be controlled. He felt that drugs might be a better possibility.

This was done in Madagascar, with Red Cross and volunteer distributors, with good public acceptability. For urban malaria vectors source reduction may be more feasible, and where yellow fever is a problem in urban areas a series of fines for permitting mosquitoes on a person's property (as in Singapore) may be useful. However, he did not feel that any of these methods could work on a large scale or in a very dramatic way. What will be needed is a network of communication, perhaps coupled with an agricultural assistance program involving the distribution of seeds, fertilizer, etc. Dr. Hamon doubted that Kenya would be an appropriate site, citing the difficulty of even getting proper malariometric data from that country. Nigeria on the other hand has appropriated the equivalent of thirty million dollars for malaria control in the first year of the next fiscal plan; rising to fifty million per annum in the fifth year. He suggested that a country such as Chad might be even better, since it is quite dry and control of gambiae breeding in wells alone might make a significant difference there.

Dr. Rafatjah (MPD) - An engineer, interested in source reduction, stated his belief that there are major portions of Africa where one should not initiate any control program, unless there is a prospect that it will be continued and expanded. This same point was raised by several others, and has to do with the question of creation of a class of non-immunes who may be stricken in epidemic form should the control program be relaxed. This is an argument which may be difficult to counter, and we will comment on it in our conclusions. Mr. Rafatjah also made a plea for detailed planning before any effort, even a demonstration project is undertaken.

Dr. Gratz (VBC) - was somewhat hopeful concerning self-help, mentioning the experience of China with control of schistosomiasis. However, he noted that they regard malaria as too complex a problem and have discounted control except where "barefoot doctors" distribute drugs.

Dr. Rosen (VBC) - brought up the question of the socio-economic effects of malaria, and the effects of economic development, such as the Kanu water development scheme in Nigeria. More data are needed on the effect of malaria in such circumstances.

Specific Measures for Vector Control:

Biological Control: (Drs. Arata, Copplestone, Muir and Parker)

Primary emphasis was placed on bacteria and fungi for mosquito control. Technology is either available or under development for mass production of several species. Two agents, Bacillus sphaericus and Metarhizium anisoplae have given up to 100% control of A. gambiae in the laboratory and in limited trials in Kaduna, Nigeria. Additional field trials are planned in Kaduna, and in Jakarta, Indonesia in 1975-6. The microsporidia (such as Coelomomyces) also show some promise. The latter, and other agents are now being tested for safety in cooperation with the U.S. Environmental Protection Agency. For some of these agents importation to the site where they are to be used may cause a problem in the future and it would be better if areas such as Africa developed their own capabilities for production. The fermentation industry should be able to handle this problem in almost any country.

Additional work is also needed on methods for evaluation of pathogens for control, based on effect on the ensuing adult populations, rather than the larvae. At any rate, no method is now really ready for field use.

Genetic Control: (Dr. Pal) - Reviewed the work by Dr. Davidson, in which a hybrid of A. gambiae A and B was released in an area where species C was the main species present. He believes that another attempt should be made. He also believes that if the laboratory in Mombasa is to be closed, or diverted from work on aegypti it might work on gambiae. He cited the work with A. albimanus in El Salvador (chemosterilant) and with A. stephensi in Delhi (chemosterilant) as examples of promising programs. The largest obstacle in all of these programs is mass rearing, but the second most important is the lack of an efficient sexing method, to avoid release of females. The New Delhi laboratory has now developed a strain of stephensi in which dieldrin is sex-linked permitting selection of males by use of this pesticide. No further details were provided.

Dr. Pal referred to the recently suspended WHO field studies in northern Nigeria, where no method or combination of methods of A. gambiae control appeared to control malaria in the Sahel region. He feels that with 80 million people at risk in such areas genetic methods should have been tried but they were not. In summary, Dr. Pal indicated that no genetic methods were ready for full scale use. He believes that ultimately the use of translocations may be the most effective measure, particularly since homozygous translocations are now becoming available in some systems. Dr. Pal suggested the following specific areas for further development of genetic control of mosquito vectors:

1. Additional work on Davidson's hybrid sterility technique.
2. Release of sterile males (tse-tse).
3. Use of a systems approach for integrated control of A. gambiae.
4. Development of translocations, in tse-tse and Anopheles.
5. Development of compound chromosomes.
6. Development of methods for putting suitable genes into wild populations, such as refractoriness for infection.

Development of Pesticides: (Drs. Rosen[VBC] and Rishikesh [Project Leader, ACRU-1, Kaduna]). Had a generally negative view of the possibility for self-help, particularly if it involved user application of residual pesticides.

In Africa, mud-hut construction has at any rate made it difficult to get full effect from many residual pesticides. Effectiveness appears to be somewhat restored by increased humidity, and it seems possible that a second spraying with water some time after the original application may restore effectiveness.

Since a single round of spraying at the test site in Kanu costs \$72,000.00, a second round of water only would represent a considerable saving.

At present, development of new pesticides has slowed dramatically, as chemical manufacturers have cut back on new materials supplied to WHO for test. In addition, the available compounds have climbed rapidly in cost. About twenty compounds have been tested at Kaduna, but relatively few have been approved. The outlook for new compounds is bleak. In a recent meeting in Rome the manufacturers asked for guidelines to assure themselves that they will have a market. Given the cost of new compounds such as Landrin (OMS-597) this seems difficult. Consideration might be given to partial, rather than complete application to houses since gambiae rests 75% in the thatch, or to application only during seasons of high vector abundance. Some new developments include treated bed-nets, microencapsulation of pesticides, ULV mist sprayers, and the possibility of application of very low dosages (ULV) of residual pesticides, say 0.1 gm/m², rather than the present 2 gm/m². None of these were described in detail.

Health Services: (Mr. Akerele, Mr. Benyoussef) - These gentlemen were concerned primarily with development of health services for African communities with emphasis on rural areas. They explained their views on the development of such services - which they felt should arise from the interests of the grass-roots villagers. The villagers will resist, or at least not adequately support, programs which originate at the central government level. They believe it essential that any self-help projects be manned by workers selected at the village level and trained not too far from that level, nor for too long a period. They were most emphatic on these matters, but it is difficult to assess their opinions without further data. From published accounts and some personal contact it does appear that a considerable amount of centralized planning and direction is going on in various African countries. Both were also emphatic in stating that the African countries are particularly disillusioned with malaria eradication programs.

They referred in particular to the situation in the Sudan. In the southern portion they described the malaria situation as potentially explosive. These provinces have no coverage at all. The nomadic people reject any worker who does not come from the tribe. The Sudanese villagers also rejected the idea of long training periods for young health workers, since this often results in their not wishing to return to the village or tribe. Based on their experience they suggested the following rules for self-help:

1. Everything must be shaped around the life style of the people.

2. Methods must be simple enough for use at the village level.
3. Methods must involve the people.
4. Workers must be selected by the people themselves.
5. An adequate system of supervision and referral must be available.

Source Reduction: (Mr. Rafatjah, Dr. Parker, Dr. Muir) - Mr. Rafatjah discussed the recent renewal of interest in source control, including the 1972 meeting on larval control in Egypt. Source reduction should be possible, and there are many countries with equipment and engineers which could be used with proper planning. There have been some examples of malaria control in cities, and mention was made of Bruce-Chwatt's program in Lagos, Nigeria.

In the dry season, larvicides for A. gambiae control may be useful. They would not be economical during the rainy season. In the dry season, wells around Kano are also a source of the Guinea worm, but Abate kills the cyclops hosts as well as mosquito larvae. There is a possibility of using aircraft for spraying larvicides; most countries have military aircraft.

Sites Visited in Africa:

Nigeria is a large country, with a total area of 372,647 square miles. There is a wide coastal belt of mangrove swamp, creeks and lagoons and estuaries of the Niger delta. This gives way inland to evergreen forest. Further north the trees become sparse, giving way to Guinea savannah. The northern area of the country is part of the progressively drying area which gives way to the sub-Saharan Sahel. Enroute to Kaduna we traversed the mangrove, forest and lower part of the savannah areas. The human population is extremely dense at Lagos, and as far inland as Ibadan. It then thins out appreciably and typical villages begin to appear along the highway, consisting of small to medium collections of mud walled huts, closely set and some with enclosing walls of brush or mud.

Lagos, Nigeria - A short meeting was held with Dr. Bidwell, WHO country representative for Nigeria, who arranged transportation to Kaduna, due to strike of airline pilots. He also briefed the team on recent developments, including the new health plan, with thirty million dollars allocated for malaria. No firm plans appear to have been developed as yet for use of these funds, but malaria control is now a part of the health service, rather than an independent agency.

Other contacts were made in Lagos, but some impressions of the area may be in order. It is a large city, swollen in population with internal immigrants from rural areas. There are large areas of very sub-standard housing and huge piles of trash everywhere. It is difficult to assess the present impact of the

malaria control program organized some years ago by Bruce-Chwatt, but by 1968 Nnochiri reported that two of every ten slides examined from surgical patients in Lagos were positive for malaria. Also, 12 percent of the children examined in the outpatient service of a large hospital (Nnochiri, 1968) were positive for malaria.

Kaduna - The team's base of operation was the Anopheles Control Research Unit, WHO (ACRU-1), but a formal call was also made on the U.S. Consulate.

The most common anthropophilic mosquito breeding in the township of Kaduna, as in many other towns, is Culex pipiens fatigans. This is a classical urban mosquito, which has been shown to have greatly increased in numbers in Kaduna since the 1940's. Malaria vectors, including A. gambiae and A. funestus, are common on the outskirts of the town but are relatively rare in the township. Although in Kaduna, as in most large towns, there exists some form of mosquito control, mainly by routine larviciding, we concluded from both the present mission and from past experience in this town that present control measures have negligible impact on the mosquito problem. There are insufficient trained staff, lack of supervision and a general apathy towards mosquito control.

ACRU-1: The primary mission of this organization has been the Stage VI testing of candidate insecticides for the malaria eradication program. A list of the unit personnel is presented in the appendix. The acting director, Dr. M. Ramasamy, is a chemist. After a briefing on the team's mission he expressed the belief that a self-help program would be possible, given enough push. He believed that the Ministry of Health, North Central State, was very interested in such an approach. Additional program interests of ACRU-1 of relevance to our mission will be discussed below.

Ministry of Health, North Central State: Dr. I.H. Attah, Permanent Secretary of Health; Dr. Z.A. Shaik, Chief Medical Officer; Dr. A.T. Salawa, Acting Permanent Secretary) - The Permanent Secretary indicated an interest in the self-help idea and indicated that consideration should be given to new methods. He did, however, indicate that a good deal had been accomplished by the old colonial regime in terms of source reduction, etc. - before the introduction of pesticides. He indicated that the villagers are aware of the importance of malaria. A few of them do use bed-nets, and drugs, but relatively few of them can afford these. In addition to the lack of money, the largest problem is the lack of a health infrastructure, particularly in the rural areas. This will be provided by the establishment of Basic Health Services, of which malaria control must be an integral part.

Kaduna Civil Administration: (Mr. Mallam Magaj Mohammed, Administrator/Chairman, Kaduna Local Authority; Dr. Subramaniam, Medical Officer of Health; Mr. Sani Y. Hamza, Community Development Officer, Kaduna) - The present self-help activities were described for the team. In rural areas there is a tradition of

donation of labor for projects of benefit to the community - in urban areas such as Kaduna money donations are taken instead. In some cases youth groups have been organized to clean up the city. As a rule the impetus for projects comes from the citizens through an Area Advisory Committee. These are passed on to a District and thence to a Village Advisory Committee. Funds for such projects are allocated 1/3 from the State, 1/3 from the local administration and 1/3 from the community. The municipality of Kaduna is divided into eleven areas. Projects are coordinated by Community Development Officers who move from area to area, and who coordinate work with the various relevant ministries and agencies. Some examples of self-help programs cited by Mr. Hamza were construction of a bridge, an aid station, school buildings and the construction and clearing of drains.

Each of Kaduna's eleven areas has a health inspector who works closely with the community development officers. The inspectors obtain some volunteer labor from social clubs. The people in the city area are said not to recognize malaria as a particular problem, being more concerned with headache and diarrhea. They are very interested in having access to primary health care. Kaduna has positions for 38 laborers to do mosquito control by drainage or oiling, but we were unsure as to whether these positions are presently filled. It was suggested that if a demonstration project in self-help for malaria control were initiated the people would cooperate. Several possible sites on the fringes of Kaduna were suggested (Unguan Kanawa, Unguan Rimi).

The team also visited several community developments with Dr. Subramanian, Mr. Hamza, and Mr. Alagiah (A WHO sanitary engineer assigned to the Ministry of Health.) The team was shown what purported to be self-help projects. These included a bridge which appeared to be substantially constructed, but whose abutments were poorly designed and maintained. Of more importance, we were shown a series of ditches, presumably constructed by volunteer labor. These were touted as being for mosquito control, but they were extremely poorly done. Several seemed to end blindly, all were shallow, and several were filled with trash, including one which was reportedly constructed only a few months before. It seemed apparent that their primary function was to carry off rainwater to prevent flooding of houses. If anything, they might provide breeding places for Culex quinquefasciatus, but all were dry during our visit. The WHO sanitary engineer indicated that neither the Ministry of Health, nor community development officers had sought his advice concerning these ditches, nor other similar matters.

We did see a number of municipal housing units under construction, or recently completed which do mark a considerable improvement over the crowded areas presently housing a large portion of the population. The houses were provided with water closets and septic tanks, and this should promote health. It is difficult to assess the protection these homes might offer against mosquito bites, but it seemed minimal.

Nigerian Institute for Trypanosomiasis Research (NITR): Dr. Amadu, Director; Mr. Kevin Riordan, Entomologist.) - Dr. Amadu indicated that the Ministry of Health was already interested in employing drainage and other non-insecticidal methods of malaria control, partially, he believed, because of prompting from the

United States, although he was not clear on this matter. Although NITR has used DDT for control of tse-tse in open savannah areas, and dieldrin in more thickly wooded areas - Dr. Amadu was quite critical of use of persistent pesticides, and expressed concern over environmental pollution. He is exploring the use of biodegradable compounds. He was not very sanguine about the prospects for self-help for malaria control, maintaining among other things that the disease is only an inconvenience for the adults, and that infant mortality has a lessened impact among the Muslim population, who regard such deaths as the will of Allah. When queried as to the possibility of finding villages which would accept the self-help idea for malaria control he indicated that one problem is the practice of villagers maintaining small temporary shelters away from the roads and in their cultivated areas, some of which are quite remote. He believed that in the Yoruba area of West Kwara state there were highly organized villages which might offer some promise. Also, in the River States, in the mangrove area near the coast, the people are very conscious of mosquito bites (presumably from pest species primarily). In the colonial period there was an effective system of sanitary inspectors who fined those with mosquito production on their property. Presumably he referred here to Aedes aegypti, and possibly C. quinquefasciatus (= fatigans) In general, he believed that a self-help program might have better success in the southern portion of the country, where people tend to follow the old traditions. Dr. Amadu himself is from the south, and says some villages there have effective programs. He doubts that this could succeed in the north, due to widespread illiteracy. It would appear that there is still considerable tension between various tribes and parts of the country, and Dr. Amadu himself was in some considerable administrative difficulty, perhaps attributable in part to his coming from the south.

The team was given a tour of the NITR facilities and shown what appeared to be a thriving colony of Glossina morsitans maintained in two insectaries, with goats serving as a blood source. Apparently, some field collected material is still being added to the colony from time to time. Several other laboratories were visited and some sophisticated biochemical apparatus was seen, but few details of the trypanosomiasis research program were discussed. Mr. Riordan showed us the field site in the Anara Forest Reserve, along the Bahago River where much of the pioneering work on West African tse-tse had been accomplished. A large field cage and supporting structures had fallen apart and been vandalized, apparently since Mr. Riordan had last visited the area. A "fly-round" was conducted by a technician, but no tse-tse were collected. Only a few primate tracks were seen in the area and it appears that most of the game animals on which tse-tse might have fed have been eliminated from the area.

Village Structure: With ACRU-1 personnel visits were made to a number of villages to permit the team to see the types of construction, mosquito larval habitats, etc. These included the villages of: Kudansa, Unguan Rimi, Gidden Vatu and Kangimi. Village structures varied considerably, from huts with heavy mud walls to thatch walls. All but a few had thatch roofs, but a few were corrugated metal. Some villages were compact, consisting of a number of mud huts, with mud walls surrounding groups of various sizes. Others were of smaller size,

with the houses separated by some distance from each other. At several sites borrow pits were seen, from which mud is taken for construction. These should be larval sites for anophelines during the rainy season. The general impression conveyed by the ACRU personnel was that breeding sites were ubiquitous and that any attempt to achieve source reduction could affect only a small proportion of the total population. Significant populations of A. gambiae might be found in wheel ruts and animal hoofprints, which abounded. This confirmed statements made by several workers in Geneva, and the experience of one member of the team (Dr. Service).

Huts were characterized by a relatively wide open space between the walls and roof, which might prove difficult to close with screening, even if the cultural traditions of the people permitted it. There was little evidence of bed-nets, but ACRU personnel seemed to feel that they might be used if supplied. However, if would probably only be for the adults as the children (and many adults) slept on mats on the floor.

Alternative Control Measures
(Dr. Bown)

The only alternative control measure now under study is the use of larvivorous fish. Dr. Bown showed the team an area where he has conducted some field trials. In small artificial plots he added fish at 2, 4, 8, 16 per m² with some success. In the stream at releases of 10 fish per linear meter of bank he obtained reductions of 60-70% for the anophelines present, A. funestus, rufipes and nili. He has occasional reductions of 100%. This was in the dry season; in the wet season the streams are rapidly flushed and the fish lost. Bown sees little hope for fish in the Kaduna situation and is preparing to move to another assignment. They obviously are of little use against gambiae given the type of larval habitat employed by that species. The four species with which he has been working are Epiplatys bifasciatus, Aphyosemion gardneri, Tilapia zillii and Barbus sp. Of these, Aphyosemion and Epiplatys are the most efficient, but Aphyosemion will not tolerate crowding, making production difficult. Epiplatys will tolerate high density and is so found in nature.

ACRU-1 General Summary
(Drs. Ramasamy, Mathis, Bown)

There was relatively little enthusiasm for the self-help concept at our final conferences. They did feel that Kaduna offered some advantages as a place for such trials if they were to be attempted, because of their background of knowledge on the local anopheline situation. Their primary mission is the Stage VI testing of fenitrothion, and they believed that the residual spraying still offered the only real hope of malaria control - despite the increased cost. This requires, however, a highly organized effort, and could not be considered on a self-help

basis. They felt that the people were relatively uninterested in malaria, and that while they might respond well at first to a self-help campaign there was little chance that they would sustain this interest without detailed supervision, and perhaps not then.

Kenya - The team's first contacts in Nairobi were with Mr. Rugh, our contact officer at AID, and Dr. B. Teelock, country representative for WHO. Both were briefed on our mission. Mr. Rugh had no background in the health field, and had no suggestions to offer. Dr. Teelock briefed us on the present effort to increase primary health care in Kenya, particularly at the village or rural level. A large number of dispensaries, some quite primitive, are being built, and medical auxiliaries are being trained to operate them. A copy of the 1972 health plan for Kenya indicated that only about 10 shillings per person per annum is available from the central government for health services (about U.S. \$1.43). Malaria is mentioned in the report only to the extent that the target is a 50% reduction in mortality by 1984. There is no centrally organized malaria eradication or control effort, unlike Nigeria.

We were told that any malaria control at the community level will have to be a part of the basic health services. Local people are being trained for health services. (In view of Dr. Farid's and in many other malariologists' opinions, it is discouraging to think of malaria control as a part of the basic health services.)

Kenya has a highly varied topography. Its 224,960 square miles range from the verdant coastal strip, fringed with coral reefs, to highlands rising to 10,000 feet and higher. The Lake Victoria basin, at 3,000-4,000 feet is very fertile and highly cultivated. To the east of this is the central Rift Valley and the eastern highlands, which include Nairobi, at 5,000 feet. Much of the northern and northeastern portion is extremely arid, with some areas of true desert. The eastern plateau is sandwiched between the coastal strip and the eastern highlands, consisting of thorn scrub, with isolated hills. This area is subject to periodic droughts. The team was able to see a transect along most of these major types, except for the northern arid region, and attempted to see the various types of villages in each of the areas traveled.

Before departing from Nairobi, arrangements were made to see two organizations which it was believed might have some insight into the team mission, or which were otherwise of interest: The United Nations Environmental Program (UNEP) and the International Center for Insect Physiology and Ecology (ICIPE).

United Nations Environmental Program: (Mrs. Lititia Obeng, Mr. Jaime Hurturba) - UNEP was established in Nairobi in 1973, following the Stockholm conference on the environment. It has a budget of approximately twenty million dollars a year, 35.5% derived from the United States. We attempted to obtain a definition of its aims and programs, and it appears that they regard themselves as having a coordinating role, striving to make the various UN agencies, national

governments and private organizations work together in the interests of the environment. They point out problems, sponsor meetings, etc. They repeatedly told us that they were not a funding agency, but this does not appear to be strictly true as ICIPE either does or hopes to receive some funds from UNEP on a contract basis.

Mrs. Obeng is the UNEP expert on onchocerciasis and discussed the present Volta River control scheme. She made some surprising statements concerning Simulium biology which do not seem to be substantiated. When questioned concerning self-help she felt sure that self-help programs could succeed. Mr. Hurturba is the UNEP expert on cotton insecticides and malaria. He has had some contact with the AID supported program on integrated control arranged by Dr. Ray Smith of the University of California. He had nothing in particular to offer, and appears to have little if any background in malaria. UNEP, besides receiving a direct U.S. government allowance also hopes to receive AID funds to sponsor meetings, etc. In view of the level of expertise displayed by the personnel contacted one wonders what utility UNEP can have in its self-described catalyst role.

ICIPE: (Dr. Strangeways-Dixon, Deputy Director) - Our original intention was to meet with Dr. Odiambo, the Director, but he was unable to keep the appointment. His deputy reviewed the ICIPE program with us, and explained the relationship of ICIPE to the Mosquito Biology Unit in Mombasa. He expressed the view that MBU was too independent, and indicated that when AID support was withdrawn from MRU they would convert the laboratory to other uses, not involving mosquitoes. At the same time ICIPE has some plans to establish a field unit for anopheline studies, to be located in Kisumu. These plans were not detailed, and appear to be very nebulous. Dr. Dixon reinforced the idea that up to now ICIPE has been interested in pure research only, without immediate application goals. He believes that this stand is changing, and that this will be reinforced at the meeting of the advisory board to take place in Nairobi in June.

Anopheles Control Research Unit-2, Kisumu (ACRU-2): Dr. R. Fontaine, Project Leader (See Appendix I for complete unit roster) - This organization is devoted primarily to Stage VII testing of candidate residual insecticides. The compound under test at present is fenitrothion (sumithion). Stage VII trials differ from the Stage VI trials conducted in Kaduna in having an epidemiological component, as well as entomological evaluation.

The most troublesome mosquitoes biting man in the township of Kisumu are Mansonia africanus and M. uniformis, which breed at the edges of Lake Victoria, and C.p. fatigans. There is only limited breeding of A. gambiae within the actual township, but this species is extremely common on the outskirts of the town and in all surrounding villages. As in Kaduna, there are routine mosquito control operations, mostly larviciding, but also drainage operations. We strongly suspect that the present efforts have very little, if any, impact on the mosquito problem. Much money and effort would be required to achieve any appreciable reduction of the Mansonia mosquitoes breeding along the lakeshore.

Several villages were visited in company with Mr. Joshi, unit entomologist to observe hut catches by pyrethrum spray, and larval collections. The villages are not as highly organized as in Kenya. They consist of a group of family dwellings, of mud or wattle construction, and surrounded by a wall of thorn bush, Lantana, or other dense vegetation. Cattle are corralled within the thorn hedge. The individual family compounds, or "bomas" are irregularly grouped into villages.

The entire test area for ACRU-2 consists of an evaluation zone of 100 km², surrounded by a barrier zone of 113 km², with a total population of approximately 50,000. The site is bounded on one side by Lake Victoria, and is in a basin of rich agricultural land west of the city of Kisumu. Within the test area mosquito populations are evaluated by hut density (pyrethrum spray), man-biting (indoor and out), exit traps, larval collection and pit collections. The results of the present series of trials will be summarized in the final discussion of the Kisumu section. However, it should be mentioned that the unsprayed check houses which we visited were producing 35 to over 100 adult A. gambiae; averaging between 55 and 50. Houses in the sprayed area were free of gambiae, having received a dosage of fenitrothion of 2 gm² three months previously. In the field Mr. Joshi told the team that the people of the area recognize malaria as a health problem, and that it would be possible to make them understand the relationship of mosquitoes and malaria to high infant mortality. The village leadership is not as strong as in Nigeria, but he believes that village elders could be persuaded to influence the people to cooperate. However, when pressed on these matters he indicated that none of the methods we proposed (source reduction, use of pyrethrum, larviciding) would be possible without continued close supervision.

On May 15 a conference was held at ACRU-2, including the following: Dr. Fontaine, Dr. Joshi, Mr. Pradhan (entomologist), Mr. Achappa, Division of Vector-borne Diseases, Ministry of Health, and Dr. Odhiambo Olel, Medical Officer of Health, Kisumu. Dr. Fontaine reviewed the history of the unit, founded in 1966-1967 primarily to evaluate fenitrothion. The compound was tested in 8 rounds or cycles of spraying. In unsprayed areas the gambiae population remained high, but in sprayed areas the adult number went to zero or close to it for most of the period. A marked effect was also noted on the larval populations in the sprayed area. The infant parasite rate dropped off dramatically after the first round of spraying. There have been sporadic cases since, but it is always difficult to be sure that the infants in question have not been out of the sprayed area overnight. In 1975 there have been limited breakthroughs of gambiae and some malaria cases in the sprayed area.

Dr. Odhiambo discussed the present malaria control program in Kisumu, which includes some drainage and larviciding. He also discussed some focal residual spraying conducted with ACRU. In 1973 several areas of the city were surveyed for gambiae and blood slides examined. Significant reduction was obtained in several areas, particularly around a Danish training school. This area had a

pre-spray parasite rate of 42%. This decreased to 11% thirty days later, and was at 20% at 160 days. The people appear to want this repeated, particularly as it killed roaches, bedbugs and body lice as well.

Dr. Odiambo maintained that local people would use self-help measures if available and free. However, they are used to mosquito bites and accept the deaths of their children and will not usually use their small funds to buy insecticides, nets, etc. His statements were somewhat contradictory. However, he and Dr. Fontaine agreed that if properly approached the people would cooperate. The national slogan is "harambee" which can be interpreted to mean self-help. Drainage projects on the harambee principle were mentioned.

The team accompanied Dr. Fontaine, Dr. Odiambo, Mr. Achappa and Mr. Amaya, malaria control superintendant, to see some of these drainage projects. These appeared to be well done, but designed more for water control than as source reduction techniques. Following this, the entire group met with Mr. Chelegut, the Provincial Commissioner (Governor) and his assistant planner, Mr. M. Milne. The Commissioner repeated the theme that adults were little bothered by malaria. Nevertheless, he and Mr. Milne expressed interest in expanding the drainage projects, and in expanding malaria control activities. They were obviously interested in obtaining assistance from AID or other granting agencies. It appeared clear that this matter had been discussed to some extent between ACRU and Provincial authorities before our meeting.

In Nairobi one member of the team (Rozeboom) had a conference in Dr. Teelock's office with Dr. Z. Onyango, Director, Division of Insect-Borne Diseases, Ministry of Health. Dr. Onyango offered no suggestions as to self-help control of A. gambiae. His principal concern was the impending cessation of the WHO testing program in Kisumu. He was anxious for financial assistance so that the spraying of houses with fenitrothion could be continued. He also endorsed the arguments we were given as to the desirability of instituting a source reduction drainage program in and around Kisumu City. Dr. Onyango had no confidence in the efficiency of pyrethrum coils or sprays for malaria control.

Medical Research Council, Great Britain: (Mr. John Chandler, entomologist; Mr. Paul Reiter, entomologist; Mr. M. Hill, entomologist) - Have been conducting studies of the impact of irrigation projects on A. gambiae populations. Similar studies are being conducted by the Ministry of Health concerning schistosomiasis. The team was shown heavy breeding of A. gambiae in small collections of water in the rice fields. However, the MRC group felt that the contribution of the rice project was negligible compared with the general population of the area. Their observations were still in progress. In the project area we also inspected housing which had been provided for the workers and found that it had deteriorated rapidly. Latrines had sunk into the ground, building walls and foundations were cracked. The few bed nets seen had large tears and were useless.

Pyrethrum Board of Kenya Laboratories: (Mr. R. Winney) - On the return route to Nairobi two team members (Rozeboom and Scanlon) discussed the possible uses of pyrethrum with a representative of the Board, who also provided

literature on pyrethrum. It appears that the Board has sponsored work on pyrethrum for Anopheles and malaria control, with some encouraging results. This is discussed at greater length later in this report.

Mosquito Biology Unit, Mombasa: (Dr. Lounibos, Dr. Lorimer, Mr. Peterson) - This laboratory is a field operation of Notre Dame University, functioning as a branch of the International Center for Insect Physiology and Ecology, Nairobi. Control by ICIPE appears to be quite informal. The primary activity of MBU is the testing of control of Aedes aegypti by means of releases of strains carrying chromosome translocations. A summary of this work is included in this report as Appendix II. Briefly, the method, despite its theoretical importance does not appear to be promising in the field, although the third attempt is still in progress. The MBU support from AID has been withdrawn, and the field station will either be closed or devoted to other uses by ICIPE.

The team's interest in this area was primarily in the possibility of using the villages where MBU had worked as sites for malaria self-help projects. The MBU staff had no information on the local malaria situation, and they appeared, in fact, to be rather isolated from the activities of the few other overseas or local medical entomologists in the area. An attempt was made for the team to see the local health officer in charge of malaria control activities, but this failed when he informed Dr. Lounibos that he could not see us unless we had a letter from President Kenyatta.

There is every reason to believe, however, that A. gambiae occurs in significant numbers in the general Mombasa area. This was confirmed for us by Mr. R.B. Heighton, of the Medical Research Council of Great Britain. Mr. Heighton, an entomologist with years of experience in gambiae control in East Africa is presently assigned to the rice irrigation scheme on the Tana River. He accompanied us and the MBU personnel to the villages and in conversations in the field expressed great reservations on the efficacy of a self-help program for malaria control, favoring mass drug distribution as an alternative.

The several small villages visited consisted of mud or thatch huts with thatched roofing, similar to those seen elsewhere, but not very compact or well organized. Several huts of more superior construction, with plastered and whitewashed walls were also seen, some of them used by the MBU for field storage of equipment, etc. The people seemed cooperative, at least partially no doubt because some of the young men were employed part-time by the MBU. The villages did not otherwise appear to offer any particular advantage, and are in fact some distance from the MBU laboratory, being located on the mainland, rather than on Mombasa island, or the north beach area where the laboratory is located. A further disadvantage would appear to be the attitude of the local officials, but this presumably could be overcome by direction from Nairobi. The MBU laboratory itself is a large dwelling, used partially now for unsophisticated insectaries, and a small biochemistry laboratory. It should probably be put to some use by ICIPE, but seems to have no unique qualities.

Nairobi - The team completed its internal discussions in Nairobi and again called on Mr. Rugh at AID. Mr. Lyons, late of the Lagos office had arrived in

Nairobi, and informed one of us (Scanlon) that it was his belief that it would be very difficult to undertake any new projects in that country due to internal difficulties. He indicated that the AID staff in Lagos was being substantially cut. Mr. Rugh had also indicated to us earlier that support for new projects in Kenya would also be difficult because of lack of adequate planning capabilities on the part of the Ministry of Health. The team was not in a position to evaluate either of these statements.

CONSIDERATION OF VARIOUS SELF-HELP MEASURES

In the following section we will enumerate and comment upon the various elements which we considered might make up a part of a self-help program, as well as our observations on innovative methods of Anopheles gambiae control. Our recommendations will make up the final section of the report.

In considering self-help methods for the control of A. gambiae malaria, consideration must be given to several socio-economic problems pertaining to rural and suburban Africa.

Firstly, there is the organization of the villages. Those in the vicinity of Kaduna, Nigeria, are composed of small, compact clusters of dwellings, usually partially or completely enclosed by a high fence of sticks or woven matting. This type of village would be more amenable to a community action program than those in Kenya. The so-called rural village of Kenya is made up of scattered "bomas." Each boma is inhabited by one family, and within the compound there are one or several huts, granaries, and a pen for cattle. Cooperative efforts between these scattered family groups would be difficult.

A more worrisome problem is the fact that the villagers in Kenya and Nigeria are almost entirely engaged in the simplest kind of subsistence agriculture. This is described in "Man in Tropical Africa" (Owen, 1973). We did see some evidence of large scale farming in Kenya, but the overwhelming majority was individual cultivation of the simplest crops, by the simplest methods. One has the impression that the villagers, for whatever reason, do not extend the areas under cultivation much beyond the subsistence level, as indicated by Owen (1973). If this impression is correct it is difficult to see them engaging in source reduction - in which the benefits are much more abstract than the immediate benefits of an agricultural surplus. If this impression is correct it might be overcome by strong leadership and education, but we are not able to evaluate this based in the absence of more data.

In Kaduna, we were assured that the people are enthusiastic about self-help. There exist what were called "social clubs" that volunteer their services for projects such as road and bridge building, and digging drainage ditches. We were shown such ditches in the suburbs of Kaduna; these were shallow trenches,

choked with refuse in many places and would serve only to accumulate rain water and furnish breeding places for Culex fatigans. It was obvious that such self-help would be effective only with constant supervision.

Thirdly, some emphasis was placed on the resistance on the part of the villagers to programs imposed vertically from higher authority. They were said to insist on determining their own needs, which then were passed upwards to authorities at the state and national levels. Nevertheless, it does appear possible that local health officers and other people in an advisory capacity could educate the people as to what they need.

One thing appears certain, that there is a great demand for local Health Services. Any malaria control would have to be carried out as a part of these health services, and unless these services were grossly unbalanced by an effective malaria control program, the impact on malaria incidence would appear to be minimal. It appears that the people would reject a program designed only for the control of malaria.

In the fourth place, one must consider a lack of motivation for malaria control. Most adult Africans in the areas we visited have a strong immunity to the disease as a result of constant reinfections. That this is obtained at the cost of high infant mortality appears to have little impact. However, mothers with young children are concerned. Also, we were warned that if a malaria campaign is initiated, there must be a continuous effort to maintain it indefinitely, as it would be highly dangerous to destroy the peoples' acquired immunity; then allow the disease to reappear in epidemic form after control measures are abandoned.

TECHNICAL CONSIDERATIONS

Source Reduction - As noted above, many of the experts interviewed in London, Geneva and Africa expressed doubt as to the possibility of application of source reduction techniques to malaria vectors in Africa, particularly in rural areas. There was some agreement that it might be possible to obtain control in the limited areas of high economic importance, such as construction sites or industrial sites. Our inspection of sites in Nigeria and Kenya confirmed this impression. Anopheles gambiae is perhaps one of the most ubiquitous species of anophelines. Holstein (1954) has remarked that it might be easier to list habitats where the larvae will not be found rather than the positive sites. One important source is animal hoof-prints, and we were impressed by the number of these at most of the sites visited. There were some limited areas around villages where it might be possible to do some filling, or drainage, but these were probably too few to make a significant difference during the height of the rainy season. We saw no program in the rural areas in which source reduction was under consideration, nor did we hear of any.

The Sixteenth Report of the Expert Committee on Malaria (WHO, 1974) suggests that while source reduction methods were sound, account had to be taken

of the severe budget limitations in most African countries. If the more efficient machine methods of ditching and filling are to be used this is a more serious consideration than our proposal to rely to a considerable extent on the hand labor of the natives. Our experience in Kaduna with the poor ditching there, however, leads us to suspect that in more rural areas the results would be even poorer without adequate supervision.

Another element which enters into the question of source reduction is the amount of reduction of adult populations which could be accomplished, and the included question of the perimeter area which would have to be controlled. As noted above, we heard of instances where the adult A. gambiae population was reduced to almost negligible levels, without interrupting transmission. This too requires further evaluation, and the accumulation of more basic biological information on gambiae.

The situation may be quite different in and immediately around urban areas, where some expertise and labor may be available, and where the concentration of people make such work economically feasible. We heard reports of effective urban mosquito control programs, but really did not see any. Nevertheless, there do appear to be opportunities for source reduction in such places as Kaduna or Kisumu.

Larviciding - Many of the points raised for source reduction obviously apply to larviciding, particularly the questions of the level of control required, and the area over which it must operate. Relatively few of those contacted suggested self-help larviciding operations. There is also the question of the larvicides to be used. The African health authorities appear to be quite exercised at present over concerns of environmental pollution - and at any rate the inexpensive chlorinated carbons are not advisable for larviciding operations for several reasons. The more suitable materials such as Abate would probably prove to be too expensive, except as part of a well financed urban project. Pyrethrum based materials for larviciding are available, and in fact once were widely used in the United States. These might be considered for use in self-help programs in Africa, as they are safe and relatively simple to use. We did not explore the question of costs of these materials. Use of local materials, crankcase oils, fatty agricultural by-products, etc. might be possible, but we found little evidence that this was being considered anywhere. One classical and relatively inexpensive material which might be considered is Paris Green, but we understand that production of this material has all but been suspended.

In the final analysis, it probably would not be lack of a suitable larvicide which would make self-help difficult in this area, but the nature of the breeding sites of A. gambiae in the breeding season. There is evidence from the past that larviciding can be a useful part of an integrated control program to protect concentrations where the economic benefits justify the cost, but for rural malaria in Africa at present the prospects do not look particularly promising.

Adulticiding-Residual Spray - The experiments being carried out in Kaduna and Kisumu by the World Health Organization ACRU-1 and ACRU-2 respectively demonstrate

the effectiveness of fenitrothion as a residual spray against A. gambiae. In the non-spray village of Tiengre, flit-killed A. gambiae taken off drop-cloths number from about 35 to over 100, with an average of 55-60 per morning collection. Malaria prevalence rates in the unsprayed areas remain high, about 50%. In the test area of Kaloka before spray was applied, the infant prevalence rates were 54%, and after 18 months it was 12%. The few malaria infections in infants since April, 1975, may indicate some breakthrough; however, it is not unlikely that these infections were acquired during visits to relatives outside the sprayed areas.

Bioassays indicate 95-100% kill of A. gambiae three months after the mud walls of the huts had been sprayed with fenitrothion. A demonstration of flit-killed mosquitoes from drop-cloths in houses of Kaloka revealed no A. gambiae from houses, although from two granaries a total of 6 specimens was found. This was after more than 3 months since the houses had been treated.

The effect of residual fenitrothion on A. gambiae breeding is indicated by the observation that before spraying larval counts of 2.2 or more per dip were obtained, and after spraying these had dropped to 0.6, 0.64, etc. per dip.

The results, as noted, at ACRU-1 and ACRU-2 clearly indicate that fenitrothion is a very effective material for residual spraying under African conditions. Presumably there are at least a few other compounds which might do as well, although as mentioned above the armamentarium is shrinking for various reasons.

A drawback to fenitrothion is its cost. In Kisumu, the area being sprayed with fenitrothion totals 200 square kilometers of which 87 km² constitutes the evaluation area and are centrally located, and 113 form a surrounding barrier zone. Some 50,000 people live in those areas.

The cost of one round of spraying is \$42,000.00 of which 71.79% goes to purchase the insecticide. As the spraying is done every 3 months, in one year the cost of fenitrothion alone would be \$168,000.00 x .7179 or \$119,187.00. For 50,000 people this would be a yearly per capita cost of \$2.38. The yearly per capita cost of the entire program would be \$3.36.

We must conclude that in spite of the effectiveness of fenitrothion as a residual spray against A. gambiae, this method is not suitable as a self-help anti-malarial measure for the African villages. In well organized communities where strict and responsible supervision is available, and where economic standards are high enough to afford a 3 to 4 dollar per capita assessment, this would appear to be the method of choice.

None of those interviewed believed there was any possibility for self-help involving the application of residual spray by villagers. Indeed, considering the cost of the pesticide as compared to total cost it is difficult to see what would be achieved by such a procedure. It must be admitted that a large part of the response of the WHO workers to this question is probably due to their belief that the application must be very meticulous to be successful - while some of the Geneva staff have now begun to question this. It may be recalled that some suggestion was heard in Geneva that only partial coverage, at reduced levels of pesticides, might be sufficient for gambiae control. However, given the relatively dangerous nature of fenitrothion in untrained hands, the need to maintain

spray equipment, etc., it does not appear to us that residual spraying can be placed on a self-help basis in any meaningful way.

Personal Protection -

Screening: With very few exceptions screening is out of the question in rural African housing at present. A small demonstration area might be attempted, particularly in an organized agricultural area, but what this would mean for the average rural situation is hard to see. The 16th Expert Committee report (1974) comments on the need for cheap plastic screening material, and the failure of those interested in tropical housing to develop such materials. In urban areas a demonstration of screening might be feasible, but one wonders if the restriction of air movement would be acceptable to rural people who are used to having free space between roof and wall, particularly where cooking is done in the house.

Repellents: Most repellents are too expensive for consideration for use in Africa at present. Some preparations based on pyrethrum are under development (Sylvester and Weaving, 1967) but these do not appear to be readily available as yet. Of more importance is the question of public acceptance. Even under the best of circumstances, with highly trained and presumably highly motivated troops, one of us (Scanlon) has found it extremely difficult to obtain sustained use of repellents. Where pest mosquitoes are a significant fraction of the local mosquito population people might be expected to use repellent, at least erratically, but they certainly will not use them for protection against anophelines.

Bed Nets: These appear on the face of it to offer one of the best possibilities for self-help. We heard several endorsements of their use - particularly on the basis of free distribution to the villagers. Yet, the testimony is mixed at best. The few nets we saw were in a completely unuseable condition. Some suspicion was voiced that if a test population were given nets they would sell them. In many village huts we examined the sleeping mats were spread directly on the floor - and it is difficult to see how a net could be used effectively under such circumstances. We were told several times that the mother and father might sleep under a net - and do where they can afford them, but that the children, the most susceptible portion of the population, sleep on the floor outside the net. Some people felt that the most likely use for the nets would be to roll them up to provide additional padding on the sleeping platform. Nevertheless, nets are recognized by at least some of the people as a desirable item, and are purchased with their meagre funds. Combined with a strong health education program it is possible that they might make an impact in selected areas.

Adulticiding - Killing of adult anophelines might take several forms under a self-help scheme. Space spraying, using inexpensive "flit-guns" and pyrethrum solution might be effective, if practiced every night and morning. A water based pyrethrum emulsion would be less expensive, but probably would erode the sprayers at such a rate that no savings would accrue. If the villagers were supplied with a kerosene based spray, the most acceptable form, several workers expressed the strong opinion that they would burn the material in their lamps - as fuel for the lamps is one of their constant problems. We thought at first that this might in itself provide insecticidal action, but were informed by Mr. Winney of the Pyrethrum

Marketing Board in Nakuru that the temperature of burning kerosene would degrade the pyrethrum. To avoid burning of the solution, it would have to be priced higher than the price of plain kerosene, and given the economics of the African village scene this does not appear to be a reasonable solution to the problem. Despite the fact that it is produced in Kenya at as pure a grade as found anywhere in the world the extraction of pyrethrum is expensive. We had estimates of cost ranging from U.S. \$107.00 to \$117.00 per liter of 25% concentrate. This would be diluted with kerosene to .025 or .03%, with the addition of a synergist. At this concentration, the cost of 40 gallons of the spray, diluted for use in the huts, would be \$107.00 U.W.. There are 5,120 fluid ounces in 40 gallons; so the cost of one ounce of the final spray would be \$0.021.

If 1 ounce were used per spraying, the cost for one year (365 sprayings) would be \$7.67 U.S. or 54 Kenya shillings. This does not include the cost of the synergist. This may be contrasted with the figure for residual spraying with fenitrothion given above (\$3.36). Russell and Knipe (1940) in their anti-malarial work in India, used 0.3 liters of a mixture of 1 part of pyroicide 20 to 19 parts of kerosens per 10,000 cubic feet; or 0.031, per 1,000 cubic feet. One liter equals 33.4 U.S. fluid ounces; thus 0.03 liters equals approximately 1 ounce.

We were also interested in the use of pyrethrum-based insecticidal coils, and some research has been done on the use of these to kill or repel anophelines in Africa. The pyrethrum coils do not kill more than a small proportion of the mosquitoes in a typical African rural dwelling. Smith and Obudho (1967, Pyrethrum Post 9: 15-17), carried out a study on the effectiveness of coils in a typical mud-walled thatched-roof hut. Most egress of A. gambiae occurred through the space under the eaves. A coil placed near the bed, which burned for 8 hours, cause 75 to 81% of the mosquitoes to leave the hut before feeding; in an untreated hut only 30% of the mosquitoes leaving the hut were unfed. Thus about a fourth or a fifth of the mosquitoes in the hut were able to feed in the presence of the pyrethrum smoke. These mosquitoes were already in the hut and it is not known to what extent A. gambiae and A. funestus would be prevented from entering the hut. Given the figures we have heard on the number of gambiae bites needed to sustain malaria transmission, it is difficult to say what effect burning coils might have on malaria rates. The cost of burning one coil per household per night would be approximately U.S. \$17.00 per annum. On a per capita basis this compares favorably with the cost of fenitrothion residual spraying, but would be considerably more than the cost of a DDT residual.

Distribution of Drugs - This option, either as a sole method or as part of an integrated program was suggested to us by several of the groups we interviewed. It has the attraction of simplicity, and could conceivably be conducted at the village level with little or no direct medical supervision. Mass drug distribution schemes have been attempted in several areas in the past, with very mixed success. These have involved distribution of chloroquin to school children, to pregnant women, even such measures as the use of chloroquinized salt. The 16th Report of the Expert Committee on Malaria, WHO (1974) has recently discussed this method, and indicated that it may have some value. There is some concern that routine use of

prophylactic drugs in the population may interfere with the development of immunity. However, their overall recommendation is for the use of drugs, particularly chloroquine, for the protection of vulnerable persons in malarious areas. The committee estimates the approximate cost of administering chloroquine in some African countries to range from U.S. \$.20 to .80 per person per annum.

We had widely diverse views on how successful a prophylactic program would be in Nigeria or Kenya. The best estimate we heard from an actual program placed the success rate at 65 percent. From the experience of at least one team member in administering prophylactic chloroquine to a tightly controlled military population, this estimate seems high. There is no doubt that the natives will use chloroquine to combat an actual malaria attack, and will use their own funds to obtain the drug when they have the money. Whether prophylactic use would make a significant impact, except in school populations or groups of workers under some control, remains to be seen.

Another publication in the WHO Technical Report Series (1974) reviewed three programs where mass drug administration was employed in Africa (Cameroon, Senegal and Madagascar). In all three countries difficulties were encountered in distribution of the drugs and in supervision, and the coverage was not satisfactory. Some cases of acute chloroquine intoxication occurred in Madagascar.

Innovative Methods for Anopheles gambiae Control - Unfortunately, we heard little promising in this field during our investigation. The proposals from Dr. Pal and Dr. Davidson for extension of work on genetic control have been discussed above and need not be repeated here. We do feel that these methods, employing a variety of genetic and chemosterilant techniques do warrant further investigation. While not directly germane to our mission, the failure of the Aedes aegypti genetic control experiments in Mombasa do contain some disquieting elements. By all odds it should be far easier to control this domestic mosquito than the wide-ranging and adaptable A. gambiae. Furthermore, the genetic background of aegypti is by far the best known of any mosquito species. Dr. Pal did refer to some promising results with Anopheles stephensi in India and perhaps things are not as bleak as they appear. Baker and his colleagues in Pakistan also appear to be on the verge of field trials for genetic control of Culex tritaeniorhynchus, but they are still in the laboratory phase. Thus, while we believe genetic control techniques should continue to receive support we see little on the immediate horizon of interest in gambiae control other than a repeat of Dr. Davidson's sterile hybrid experiment under more favorable conditions.

We saw no work on biological control other than Dr. Bown's work in Kaduna on larvivorous fish. Our conversations with Dr. Arata in Geneva made it clear that little could be expected immediately from other predators or parasites, although here too we believe that continued research should be supported on a wide front.

Effect of Economic Development on Vector-Borne Disease - Time and choice of field sites prevented us from doing much to assess this aspect of the problem, and it is probable that it should be the subject of a separate inquiry - as it is a very

important question. We did see the rice development scheme near Kisumu at which the Medical Research Council (Great Britain) is investigating the impact of impoundment and irrigation practices on mosquito production. They are also testing some control methods, including the use of mono-molecular films. Their contention was that the increased burden of anophelines resulting from rice culture was not significant when compared to the already tremendous A. gambiae population in the rainy season. It does seem apparent, however, that where such irrigation schemes are introduced into more arid regions of Africa there will be an enhanced problem with Anopheles unless adequate water management practices are followed. We also discussed the matter with Mr. M. Choudhury of the National Irrigation Authority of Kenya, whose primary interest is control of schistosomiasis. He indicated that thus far the irrigation schemes in Kenya have not resulted in the spread of schistosomiasis, but we had no hard data on the topic.

RECOMMENDATIONS

1. That AID support additional work on the biology of Anopheles gambiae: We believe that there is an overriding need for additional research on the biology of Anopheles gambiae. Despite the years of work in Africa much of the research up to this point has been aimed at questions arising from application of the eradication technique of residual spraying. For some twenty years other questions have received much less attention, as all efforts were devoted to perfecting the residual spraying technique. Some topics which might be included:

a. A. gambiae enters houses at night to feed on people. After engorging, it will rest in the house until early morning. Do they enter and leave the house mostly through the space between the walls and the thatched roof? Do they rest near this space on the thatch or upper part of the wall? If so, possibly residual insecticides could be applied at much lower cost only to these upper walls and the adjacent areas of thatch. The standard practice in applying residual insecticides is to spray the entire inner walls of the house.

b. According to our conferees, in those parts of Africa where there is a marked dry season, A. gambiae disappears at that time of the year. Early in the rainy season, and even shortly before the onset of the rains, there is an explosive abundance of adults in houses. This suggests that there is a population of aestivating adults. Where does A. gambiae go during the dry season? If there are concentrations of estivating adults in certain circumscribed shelters, an attack on these adults might greatly reduce the numbers of A. gambiae that enter the breeding season after the rainy season begins.

c. The population of resting adult A. gambiae in houses is only a fraction of the entire population. Do the A. gambiae that rest out of doors really belong to the same population as those resting in houses? If so, do they concentrate in readily accessible shelters, where control measures could be applied effectively?

d. The establishment of life tables for A. gambiae would show the natural

increase of the population in a given area and the impact of control measures.

e. The flight range of the species under varying conditions of habitat and season should be determined with greater precision.

2. That AID support additional research on the use of innovative methods for the control of *Anopheles gambiae*: While none of the innovative methods examined by us during this period appear to be anywhere near ready for field use we do believe that there is a real need for additional research in at least the following areas:

a. Genetic control - at a minimum this could involve a reassessment of Dr. Davidson's hybrid sterility method. The state of the art of genetic control in such species as *Aedes aegypti*, *Culex fatigans*, *Culex tritaeniorhynchus* and *Anopheles stephensi* does not appear bright at the moment, but there are a large number of workers in the scientific community who believe that the genetic control systems deserve much additional attention.

b. Control by pathogens and predators - The use of predators or indigenous pathogens for control of *A. gambiae* does not appear to be particularly bright at the moment. However, we believe that additional work should be done on exotic pathogens. In this connection, recent findings in the life cycle of *Coelomomyces* in the United States may be particularly promising.

Before proceeding to the other recommendations it might be well to consider the place and organization for accomplishment of these research goals. We believe that the logical step is to take advantage of the presence of trained cadres and facilities at the ACRU-1 and ACRU-2 units as a nucleus. Additional funds would have to be transferred to the Vector Biology and Control Section, WHO to fund such research, but this would probably be much more cost-effective than funding a new agency. An additional possibility is the use of the Mombasa field station (Mosquito Biology Unit). However, there is no present expertise in that group for *Anopheles* studies, nor baseline data on populations, etc. It is also possibly confounded with the question of support for ICIPE, which will be discussed at greater length below.

3. That AID support a small scale research project to determine the effectiveness of a combination of self-help methods for control of malaria. This clearly should not be labeled as a demonstration project. It would be politically unsound for an outside agency to set up and publicize a demonstration project unless it was guaranteed a good chance of success. Furthermore, the impetus for any such research program should come from the country involved.

Despite the misgivings of many over the basic concept of self-help we believe that there is a potential here for further investigation. A small project in a suitable village, with suitable controls should be attempted. In such a test site various control methods discussed above could be used in combination at

relatively low cost. Once a site is selected a cost estimate for several years (possibly five) could be developed fairly easily. Whatever site is selected, there should be a good basic health service arrangement available which could be made part of the scheme. Without this we believe that there is relatively little chance of success. Also, the role of health education is central to any such scheme and particular attention should be paid to motivation research and cultural anthropology in designing the scheme. Given the wide range of disciplines needed for such a scheme it might be best to consider a contract with an educational institution rather than attempting to assemble a force from WHO or AID resources.

Choice of a site for field research is a difficult matter. Nigeria offers certain advantages in that the villages are for the most part compact and constructed in such a way as to enhance several control methods. Furthermore, there remains in Nigeria, at least in the northern areas, the remnants of a highly developed feudal system in which the sultans and emirs and village chiefs exercise a considerable degree of power, or at least influence over the villagers. We were told frequently that if the local hereditary leaders accepted an idea it could be sold to the people, and that the latter would follow directions, at least at first. However, at the time of our visit the local situation in Nigeria was quite chaotic. Airline pilots and other groups were on strike for startling wage increases and essential services were shut down on an erratic basis; gasoline was all but unobtainable away from the capital city and sporadic shortages developed in food and other basic commodities. We were informed that AID operations were being sharply curtailed in Nigeria - but had no direct evidence of that other than statements by the Population representative (Mr. Lyons) who we later saw in Nairobi after his transfer from AID-Lagos, and the U.S. Consul in Kaduna.

In Kenya, the situation was much more suitable, with no major logistical problems. There appears to be a general belief that the country is entering upon a period of political instability, but we have no means of evaluating this. We were informed by Mr. Rugh, AID-Nairobi, that there was considerable reluctance to start new AID supported projects with the Ministry of Health due to the lack of an adequate management base in the Ministry.

The basic problems in Kenya, however, are in the structure of the villages, and the lack of strong village and traditional leadership. We were told many times that the individual families in their individual compounds, or bomas, have no interest in their neighbors, do not have a strong village system and if anything, are suspicious or hostile toward their neighbors. Again, we have no way to evaluate these contentions in depth, but the mere structure of the bomas leads one to suspect their truth. Even if strong leadership were available, the diffuse nature of rural settlements would make the area to be controlled quite large, compared with the compact Nigerian villages.

The following items should be included in such a self-help scheme:

- screening (where practical)
- bednets
- distribution of pyrethrum sprays and coils
- dispensing of anti-malarial drugs

In a rural setting, destruction of larvae by use of larvicides or drainage or filling of breeding places would probably be impractical. Nevertheless, depending on the local environment and the source of the mosquitoes, larval destruction should be considered as a supplemental measure.

If a rural self-help scheme is undertaken there are obvious advantages to making use of the facilities of ACRU-1 or ACRU-2, but in addition we believe there would be a need for extensive health education, for research on motivation, and for the kinds of techniques employed by cultural anthropologists to assure design of schemes acceptable by the local populations, and perhaps more importantly to analyze the reasons for success or lack of it. In view of this, a contract to a university group which could supply all of these elements might be considered.

(NOTE: One member of the team (Service) does not believe that AID should undertake any self-help scheme at present, because of the technical and political considerations discussed above. While the other two members concur in the belief that residual spraying is the single most effective measure available for rural malaria control in Africa, we also believe that if national authorities in Africa ask for assistance in village oriented control measures they should receive support for research in such procedures.)

4. That AID support a small operational research program for control of malaria in an urban area, if the initiative for such comes from a suitable area. As noted in the body of the report we believe that health and political authorities in the Kisumu area, Kenya, desire to have an AID supported demonstration project for malaria control, and that they will approach AID in Kenya for this purpose. It also seems possible that Kaduna authorities may make such an approach. We believe that considerations should be given to such support by the appropriate office of AID. Even though this does not involve fundamental research, it does involve the application of proven techniques in a coordinated manner in an operational research program. If such approval is sought we believe that certain elements should be insisted upon:

- a. The scheme should emphasize mosquito control, rather than malaria control alone, as the people are most aware of and sensitive to pest mosquitoes, and more likely to cooperate where relief from biting is offered.
- b. Surveillance for a complete year by an experienced entomologist to assess the extent of the mosquito problem before control measures are started.
- c. Surveys for about 6 months, mainly in the rainy season, by both a sanitary engineer and a sanitarian so that a control scheme suitable to the particular needs of the locality and environment can be formulated.
- d. Strict supervision in the field by the entomologist, sanitary engineer and sanitarian when control methods are put into operation.

e. Two years entomological assessment after control methods have been started and periodic inspections by the sanitary engineer and sanitarian to ensure continual implementation of control measures.

f. If successful, arrangements made for handing over to local authorities.

g. Reassessment and inspection of the control operations some 2-3 years later.

The question of what community might be best for such a demonstration deserves some comment - although obviously much will depend on where the initiative might come from. Of the two urban localities we examined (each with a WHO research unit) we might suggest Kaduna (Nigeria) in preference to Kisumu (Kenya) because Kaduna is an area that has a well defined dry season lasting from about November through to April. At this time mosquito densities will be low, thus facilitating the initiation of control measures. Furthermore, the people, mainly Hausa, may be more cooperative than the Luo in Kisumu. A disadvantage of choosing Kisumu is that it will be extremely difficult and costly to get any significant reduction in the main pest mosquitoes (Mansonia). Any control scheme must not only be scientifically successful, but be recognized by the people to have been successful; consequently the reduction in the mosquito biting rate must be drastically reduced to be appreciated.

The political stability of the country should not be neglected. In Nigeria there is an undercurrent of unrest, this is not inter-tribal, but aimed at the Military Government, which has, despite previous promises, not handed back the power to govern to the people. Attitude to foreigners is, however, very friendly. When we were in Kenya there were student riots and arrests at Nairobi University. The students expressed lack of confidence in the government and concern over the apparent liquidation of opposition politicians. Many people believe that there could be political disturbances when Kenyatta dies. Although, unlike Nigeria, Kenya has a big tourist trade and there is significantly more resentment towards expatriates than in Nigeria.

5. That AID make preliminary estimates in other areas of Africa, considering the same elements discussed in this report. We feel that while our time in Nigeria and Kenya permitted us to make a reasonable assessment of the elements of our charge, the time available obviously did not permit evaluation of these topics in other areas of Africa. We would strongly suggest that two general areas deserve an additional look:

a. Tanzania - We heard many references to progress made in self-help projects in Tanzania. We also heard some contradictory stories that the organization or rural populations into self-help villages was beginning to be resisted. If the political situation permits it we suggest that an effort be made to determine the extent of self-help malaria control, and other public health programs in Tanzania.

b. French speaking countries - We also heard several estimates that the village organization, history, national governments, and other factors in the previous French colonies might make these nations more amenable to the employment of self-help methods for malaria control. We believe that an effort should be made to evaluate this further by a visit of a small group of consultants, at least one of whom should be fluent in French.

6. Further recommend that AID explore the question of the health effects of development in Africa in greater depth. We believe that this is a very important question, and regret that our schedule did not permit us to devote greater time to it. Large-scale irrigation and hydro-electric schemes and similar projects are coming into being all over Africa. These cannot help but have an influence on various aspects of health as evidenced by the experiences of various governments in West Africa on onchocerciasis. AID should consider sending a team with the specific purpose of examining other examples of this phenomenon in a variety of habitats. Guidelines should be developed for the assessment of the health impact of development projects in Africa. Such a team should represent a variety of scientific disciplines, including entomology, parasitology and medicine, and should also include some with experience in management of development projects if possible.

7. Recommend that consideration of core support for ICIPE be held in abeyance temporarily. This organization is still undergoing a series of adjustments and decisions on its future missions. We understand that the meeting of the advisory board which took place after our departure from Nairobi failed to settle some of these matters. The field unit in Mombasa (mosquito Biology Unit) could well be supported separately from ICIPE, and maintenance of that station does offer certain advantages discussed in the body of the report. Before it could be used for implementation of any of the research projects we have recommended the status of the Anopheles gambiae population in the study villages would have to be assessed in the dry and rainy seasons.

Regardless of the possible future use of the Mombasa station we do not recommend that funds for general support be allotted to ICIPE by AID at this time.

L. Rozeboom

J. Scanlon

M. Service

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APPENDIX I

ITINERARY

This is a chronological list of the locations and persons visited during this mission, provided for quick reference.

27 April (Sunday)	<u>London</u> , England.	Team members met for preliminary conference with Mr. E. Smith, AID-Washington.
28 April (Monday)	<u>London</u> , England.	Dr. L.J. Bruce-Chwatt, Prof. Emeritus, Ross Institute.
28 April (Monday)	<u>London</u> , England,	Center for Overseas Pest Research, Dr. P. Haskell, Dr. A. Hadaway, Dr. C. Lee.
29 April (Tuesday)	<u>London</u> , England.	Ross Institute, London School of Hygiene and Tropical Medicine. Dr. G. Davidson, Dr. J. Busvine, Dr. D. Bradley.
	Travel to <u>Geneva</u> , Switzerland	
30 April (Wednesday)	<u>Geneva</u> , Switzerland	Conferences with members of the staffs of Malaria and Parasitic Diseases, and Vector Biology and Control, WHO. Included were the following individuals: Dr. J. Hamon, Dr. N. Gratz, Dr. A. Arata, Dr. Grammicia, Dr. Rosen (all VBC). Dr. M. Farid, Dr. Noguier, Dr. Rafatjah (MPD) Dr. Rishikesh - Project Leader ACRU-1 (on home leave) Following the group briefing, discussions were held with individuals and small groups.
1 May (Thursday)	<u>Geneva</u> , Switzerland	Individual conferences with: Rosen, Rishikesh, Mr. Akerele and Mr. Benyoussef (Primary Health Centers/Strengthening Health Services), Noguier, Rafatjah, Parker, Muir.
2 May (Friday)	<u>Geneva</u> , Switzerland	Team conference.
	Travel to <u>Lagos</u> , Nigeria	
3 May (Saturday)	<u>Lagos</u> , Nigeria	Dr. E. Bidwell, Country representative, WHO
	Travel by road to <u>Ilorin</u> , Nigeria	

35

Appendix I
Itinerary
Page 2

4 May (Sunday) Travel by road to Kaduna, Nigeria

5 May (Monday) Kaduna, Nigeria Nigerian Institute for Trypanosomiasis Research - Dr. A. Amadu, Director.

Anopheles Control Research Unit-1, Dr. Ramasamy, Acting Project Leader; Dr. H.L. Mathis, Dr. D.N. Bown, Miss J. King, Mrs. K.N. Grainger.

Ministry of Health, Northern States: Dr. I. Attah, Permanent Sec. of Hlth.; Dr. Z. Shaik, Chief Medical Officer; Dr. A. Salawa, Acting Perm. Sec.

Kaduna Municipal Office: Mr. Mallam M. Mohammed, Administrator; Dr. Subramaniam, Medical Officer of Hlth.; Mr. S. Hamza, Community Development officer.

6 May (Tuesday) Kaduna, Nigeria Visit village sites with Dr. Mathis.

7 May (Wednesday) Kaduna, Nigeria Visit field site - fish for larval control, with Dr. Bown.

Consultation with ACRU staff.

8 May (Thursday) Kaduna, Nigeria Visits to community development sites, Kaduna City, with Dr. Subramanian, Mr. Hamza, and Mr. C. Alagiah, WHO Sanitary Engineering consultant.

Site visit to tse-tse field research with Mr. K. Riordan, NITR.

9 May (Friday) Kaduna, Nigeria Team conference on report.

Final consultation with ACRU-1 staff.

Departure for Lagos, Nigeria

10 May (Saturday) Lagos, Nigeria Team meeting.

Departure for Nairobi, Kenya

11 May (Sunday)	<u>Nairobi</u> , Kenya	Team conferences.
12 May (Monday)	<u>Nairobi</u> , Kenya	USAID: Mr. Rugh, Project Officer; WHO: Dr. Teelo Country Representative; United Nations Environmental Program (UNEP): Mrs. Lititia Obeng, Mr. Ja Hurtuba.
13 May (Tuesday)	<u>Nairobi</u> , Kenya	Team meeting, planning and report.
14 May (Wednesday)	<u>Kisumu</u> , Kenya	Travel by road to Kisumu. Preliminary planning meeting with Dr. R. Fontaine, Project Leader, ACRU-2.
15 May (Thursday)	<u>Kisumu</u> , Kenya	Visit to field sites in villages with Mr. G. Joshi ACRU-2 entomologist. Conferences at ACRU-2 with staff: Dr. Fontaine, Mr. Joshi, Mr. G. Pradhan (Parasitologist). Also present: Dr. Odhiambo-Olel, Health Officer, Kisumu, Mr. S. Achappa, Div. of Vector-borne Disease, Ministry of Health.
16 May (Friday)	<u>Kisumu</u> , Kenya	Visit to field site - village, with Mr. Joshi. Visit to irrigation scheme (rice) with personnel of the Medical Research Council: Mr. J. Chandler, Mr. P. Reiter, Mr. M. Hill, all entomologists.
17 May (Saturday)	<u>Kisumu</u> , Kenya	Visit to drainage projects in Kisumu area with Dr. Fontaine, Dr. Odhiambo-Olel, Mr. Achappa, Mr. J. Amayo, Malaria Control Supt. Visit to Office of the Provincial Commissioner (Governor), Mr. Chelegut with those listed above, plus Mr. M. Milne, Asst. Provincial Planning Officer. Visit to Kakamega Forest, site of successful control of <u>Simulium neavei</u> .
18 May (Sunday)	Depart <u>Kisumu</u> for <u>Kericho</u> , Kenya	
19 May (Monday)	Depart <u>Kericho</u> for <u>Nakuru</u> , Kenya	Visited pyrethrum factory and laboratory of the Pyrethrum Marketing Board, Mr. R. Winney, Chemist.
	Depart <u>Nakuru</u> for <u>Nairobi</u> , Kenya	

Appendix I
Itinerary
Page 4

20 May (Tuesday)	<u>Nairobi</u> , Kenya	Meeting in Dr. Teelock's office, WHO, with Dr. Z. Onyango, Director, Div. Vector-borne Disease, Min. Health. Team meeting on report.
21 May (Wednesday)	<u>Nairobi</u> , Kenya	Team meetings, report.
22 May (Thursday)	<u>Nairobi</u> , Kenya	International Center for Insect Physiology and Ecology (ICIPE); Dr. Strangeways-Dixon, Deputy Director. Departure for <u>Voi</u> , Kenya by road
23 May (Friday)	Departure from <u>Voi</u> , Kenya, arrival in <u>Mombasa</u> , Kenya	Mosquito Biology Unit (MBU); initial discussions with Dr. P. Lounibos, Dr. N. Lorimer and Mr. J. Peterson.
24 May (Saturday)	<u>Mombasa</u> , Kenya	Visit to field sites with Dr. Lounibos and Mr. Peterson. Villages on mainland.
25 May (Sunday)	<u>Mombasa</u> , Kenya	Team conferences on report.
26 May (Monday)	<u>Mombasa</u> , Kenya	Conference at MBU with staff.
27 May (Tuesday)	<u>Mombasa</u> , Kenya	Team conferences, report.
28 May (Wednesday)	Departure for <u>Tsavo</u> , Kenya	
28 May (Wednesday)	Departure from <u>Tsavo</u> , Kenya, arrival in <u>Nairobi</u> , Kenya	
29 May (Thursday)	<u>Nairobi</u> , Kenya	Team conferences, visit AID.
30 May (Friday)	<u>Nairobi</u> , Kenya	Team conferences. Depart <u>Nairobi</u> - END OF MISSION.

1975 ICIPE Research Review: Activities of Mosquito Biology Unit

I. Backgrounds: 3 years ecological research on Aedes aegypti in rural villages, Mombasa.

- A. The village model - 20 houses, 1000 adult mosquitoes, 100 emerging/day.
- B. Ecological isolation reasonable, as measured by mark-release-recapture.
- C. Target population for control by chromosome translocations = domestic.

II. Release 1. (Hausermann, McDonald)

- A. Period - 10 weeks, March-May, 1974.
- B. Material - HETEROZYGOTE, mixed single and double, giving 100% sterility.
- C. Pattern - daily release, more than 8000/day in one village; dispersal from center.
- D. Results -
 - a. Egg hatchability dropped from 90% to 35%; remained below 70% ten weeks after.
 - b. Oviposition rate = unchanged.
 - c. Adult landing-biting = drop during release, but of uncertain significance.
 - d. Laboratory markers still present in population more than 30 weeks after test.
- E. Conclusion - maximum sterility induced but inadequate to suppress adult popul.

III. Release 2A. (Lorimer, Lounibos, Petersen)

- A. Period - 11 weeks, Oct.-Dec., 1974.
- B. Material - HOMOZYGOTE (1:3T) marked with red eye. Purpose: population replacement.
- C. Pattern - daily release in 3 villages, 1 previously defaunated.
 - a. 500 pupae of both sexes, in tins on trees (7 weeks).
 - b. 500 adults, both sexes from village center (4 weeks).
- D. Results - negligible recovery of marker in ovitrap or landing-biting catch.
- E. Conclusion - reduced visual acuity of red eye stymied house entry.

IV. Release 2B. (Lorimer, Lounibos, Petersen)

- A. Period - 11 weeks, Jan.-March, 1975.
- B. Material - HOMOZYGOTE (1:3T) - wild type eyes, marked with spot abdomen.
- C. Pattern - daily release, 500 adults of both sexes in two villages.
- D. Results -
 - a. Adult landing-biting: 80% spot phenotype in release villages vs. 5% in reference.
 - b. Ovitrap: 45% eggs in release villages are spot vs. 5% in control.
 - c. Pupal samples from clay pots - no significant deviation from control.
- E. Conclusion - Released mosquitoes entered houses, mated, took blood meals and oviposited on ovistrips, yet failed to colonize the native habitat. Subsequent experiments indicated that the release mosquito preferred not to oviposit in clay pots and had reduced larval and adult competitive ability.

V. Release 3. (Lorimer, Lounibos, Petersen)

- A. Period - April-July, 1975 (in progress).
- B. Material - HETEROZYGOTE, double, giving 75% sterility.
Purpose: population suppression by sterilisation.
- C. Pattern - over 500 cc/day in one village.
- D. Results -

ANCILLARY ACTIVITIES

VI. Suppression of Village Mosquito Populations through Biweekly Pet Cleaning.
(Source Reduction)

- A. Period - Village 1: 26 weeks March-Sept., 1974.
Village 2: 16 weeks Oct.-Jan., 1974-75.

- B. Results -
a. Complete elimination of local breeding population.
b. Few adults persist due to immigration.
c. Return to equilibrium population - slow.

VII. Long-term Monitoring of Mosquito Populations.

- A. Weekly assessments in 3-8 villages of:
a. adult, pupal, and egg numbers per house.
b. naturally occurring phenotype frequencies: spot and sex distorter.
c. species frequencies in peridomestic habitats.

VIII. Relationship of domestic A. aegypti "type form" vs. "feral" ssp. formosus.

A. Distributions:

A. aegypti formosus = more than 95% of peridomestic collections (indoors on ovitraps only).

A. aegypti "type form" = more than 95% of indoor collections.

B. Behavioral differences:

	<u>Type form</u>	<u>Formosus</u>
<u>oviposition</u>	clay substrate	non-clay
<u>biting</u>	anthropophilic	non-anthropophilic

MSU TEAM

N. Lorimer
P. Lounibos
J. Petersen

INFORMATION MEMORANDUM FOR THE ADMINISTRATOR

30 DEC 1974

THRU: EXSEC

FROM: AA/TA, Curtis Farrar

John Long

SUBJECT: RAC Recommendations to A.I.D. on Proposals Reviewed at the December 12-13, 1974 Meeting

Attached is a summary of RAC actions at the December 12-13, 1974 meeting. We are proceeding with the implementation of the projects in line with the recommendation of the RAC as outlined in the attached summary. We shall adhere to the Agency's established policy on the forward funding.

Enclosure

Summary of RAC Recommendations

Clearance:

AA/TA: EJLong

EJL

Date 12/24/74

TA/PM: CFritz

CF

Date 12/24/74

dlr

TA/RIG: MRehcigl:dlr:12/20/74

Recommendation: That the requested extension be approved as a terminal extension.

4. Research on Integrated Control of Crop Protection Systems with Emphasis on the Root-Knot Nematodes (*Meloidogyne* spp.) -- North Carolina State University. Duration of project, two years; estimated total cost, \$400,000. M. Peterson, Ruttan, Tanter, Whitney.

Recommendation: That the project be approved subject to: (a) AID administration satisfaction that the time assignment of senior staff and cooperators is adequate to supervise the staff still to be recruited and staff in the field; (b) inclusion of all approaches to nematode control, including chemical control where this is the best approach; (c) inclusion of studies that will evaluate crop response to nematode control; (d) a plan showing how and by whom plant resistance to root-knot nematode is to be used; and (e) a tight review of activities, as soon as it is reasonable to do so.

5. Malaria Immunity and Vaccination (extension) - University of New Mexico, New York University, and one other to be selected. Duration of extension, three years; estimated additional cost, \$2,850,000. Wishik, Carter, Merrill, Schweigert.

Recommendation: That (a) the proposal for New York University (Dr. Ruth Nussenweig) be approved as requested; (b) the proposal for contracting for tissue culture work and in vitro vaccine development be approved as requested; (c) the proposal for the University of New Mexico (Dr. Paul H. Silverman) be funded at the proposed rate for one year after March 1975; (d) a Review Subcommittee be set up consisting of three persons from RAC and three outside consultants chosen by them to make a comprehensive study of the New Mexico project, including site visiting, and make a recommendation report to the next meeting of RAC (March 1975); and (e) RAC setup an ad hoc subcommittee with the broad mission to review the whole malaria immunization program of AID.

6. Influence of Maternal Nutrition on Infant Mortality and Morbidity (new) - Institute of Nutrition of Central American and Panama (INCAP). Duration of project, three years; total estimated cost, \$150,000. Carter, Connell, Merrill, Milner.

Recommendation: That the project be approved as proposed with the understanding that the RAC suggestions and comments be noted and considered.

FILL

Report of the Consultants to the RAC Subcommittee
Convened to Review the University of New Mexico
Malaria Immunity and Vaccination Research Project

The following is a statement of the five consultants, listed in alphabetical order:

Dr. T.G. Akers
Dr. Michael Katz
Dr. R.B. McGhee
Dr. Peter Ward
Dr. Thomas Weller

It is based on a comprehensive review conducted during a site visit on February 9th through 11th, 1975. We, the consultants, express the following opinions on the basis of a thorough discussion among ourselves and assert that our views are unanimous.

We first wish to emphasize that we consider it appropriate and -- in the absence of adequate funding from other governmental sources -- essential that AID continue to support research designed to explore the potentialities of prevention of malaria by vaccination. However, we do not subscribe to the view that a useful malarial vaccine is necessarily feasible. Nor do we agree that available evidence supports the thesis presented in Dr. Paul Silverman's Project Statement and Application that "an immunity can be induced which is better than the immunity that develops naturally".

We consider it important to emphasize that evidence regarding induction of immunity in monkeys by use of a vaccine is fragmentary and incomplete. There is no information whether a vaccine prepared from blood stages of the Plasmodium will protect against a natural mosquito-derived infection. Duration of the partial blood stage vaccine-induced protection is unknown. The question of possible extension of partial protection to heterologous species, or even to antigenic variants of the same species of Plasmodium remains unanswered. Some killed vaccines sensitize the human host so that a subsequent natural infection with a specific agent may give an enhanced and bizarre clinical response. The adverse consequences of use of an inactivated vaccine, even if it were partially protective, have yet to be considered.

Even if an inactivated vaccine does produce a degree of protection of sufficient value for consideration for use in man, it will not be feasible unless logistical problems, inherent in malaria vaccine production, can be resolved. There is no evidence that these problems are near solution.

43

During our review, data were presented indicating that in a variety of experiments approximately 2/3 (22/35) Rhesus monkeys inoculated with a crude preparation of Plasmodium knowlesi antigen survived lethal challenge. These specific experiments varied in design in that different regimens of vaccination were used. They varied with respect to content of the inoculum, inclusion of adjuvants and use of one or two inoculations. Moreover, the number of animals in each experiment was quite small. However, in all the experiments a single time of challenge, arbitrarily chosen at 30 days, was used. Therefore no information is now available about the duration of this partial protection. Reference was made to three monkeys which survived the 30 day challenge and then were refractory to a second challenge one year later. Unfortunately the investigators failed to exploit this interesting lead and no appropriate followup experiments were carried out.

Even if one accepts the possibility that the foregoing is an indication of a potential effectiveness of the antigens used, the above experiments do not permit the judgment of potential efficacy of the vaccine in the field, because that could only be established by resistance to mosquito inoculation of sporozoites.

The investigators have initiated, under a subcontract, a study on Aotus monkeys infected with P. falciparum, under the direction of Dr. Karl Rieckman. We were impressed with his careful studies of the characteristics of blood induced infection in these monkeys. A matter of concern was the apparent failure of protection of the natural infection against heterologous strains of the same species. With respect to future studies, the following difficulties can be anticipated: (1) the blood volume of the Aotus monkey is quite small, in comparison to that of the Rhesus monkey, and therefore it will be difficult to prepare sufficient blood stage antigen for experimental use; (2) there are strong indications that the Aotus monkeys will soon be unavailable for research because of world-wide shortage of these animals and restriction on export by South American governments.

The data presented relating to the studies of P. berghei revealed that inoculation of ribosomal antigen preparations of the parasites prolonged survival of challenged mice, but did not prevent their ultimate death. These results are encouraging, but the data are somewhat difficult to interpret in terms of mechanisms of protection. Control experiments using ribosomes from a different Plasmodium species, or from non-related organisms, would have to be done in order to test whether the protection was specific. Nevertheless these studies of Dr. Mary Barr appear promising and certainly should be extended. However, we are of the opinion that she is in great need of informed biochemical consultation.

The immunologic aspects of the studies conducted in the past and those proposed are broad and vary considerably in quality. Reasonably good progress has been made in the area dealing with the development of lymphocyte blastogenic assays and Dr. Edelberto Cabrera has provided data that suggest that this assay may be useful and predictive of immunity. His work on the development of a radioimmunoassay is likewise promising and needs to be continued. On the other hand, the skin test studies are less likely to be useful, because they are considerably less precise and their evaluation often subjective. We felt that Dr. Cabrera also could profit by expert guidance in his work.

Great efforts have been expended and some limited progress made in the realm of the in vitro development of the sexual stages of malaria. Dr. Maria Rosales was able to establish a number of primary tissue cultures from mosquitos. In addition she used with success the Fat Head Minnow cell lines. We are aware that ookinete development has been accomplished in the past in vivo without tissue culture. Therefore this part of Dr. Rosales' work is not innovative. Indeed it seems to be a complex technique replacing a somewhat simpler one. However her claim that she was able to develop oocysts is unique and if it is independently confirmed and developed as a standardized process, may be quite important. (We note that studies of mosquito stages will be phased out of the project, any way.)

Although not described for us, some work apparently is being carried out on the sporozoites themselves, since the New Mexico facility has a very large colony of Anopheles stephensi. (Otherwise there would be little justification for maintaining the colony at its present size.)

Data presented regarding the claimed success of cultivation in vitro of the erythrocytic stages of Plasmodium berghei were unconvincing to us. Dr. Clarence Speer claimed that inoculation of infected blood into cell cultures of primary bone marrow cell lines (mouse and hamster) and the Leydig carcinoma cell line resulted in in vitro replication of the Plasmodium. He claimed that the numbers of parasites increased approximately fourfold, but he admitted that the counting did not distinguish between intracellular schizonts and merozoites; the "increase" appeared to represent parasites undergoing intracellular dissolution. Moreover there appeared to be a sharp fall-off on days eight and 10 in the number of parasites and there was no evidence of secondary infection parasite-free cells. Since it was quite likely that phagocytosis was responsible for the intracellular presence of these parasites, we are of the opinion that certain essential controls should have been included. It would have been appropriate to perform control experiments using heat-inactivated plasmodia as well as uninfected red blood cells to determine whether they would be found within the cells.

45

Presence of pigment in the Leydig cells indicated that phagocytosis did take place. We were forced to conclude that there was absolutely no evidence of intracellular replication of the plasmodia in tissue culture.

We were quite disturbed that the Project Director has accepted these results as valid and indicative of in vitro replication and has given them first priority in the projected studies.

In general we were concerned with the degree of naivete exhibited by the Project Director and his associates in the design of their experiments, in the interpretation of their data, and in their plans for future investigations. They seem to have an unrealistic assessment of their achievements as evidenced by the fact that they believe human vaccine testing could be begun within two years.

Conclusions. We recommend that the present proposal be disapproved. In view of the fact that two key investigators (Drs. Rosales and Speer) are leaving to take posts at other universities, there is an opportunity to re-structure the project and redefine its objectives in more realistic terms. It would seem that support of a project limited to studies of rodent malaria would be appropriate and we suggest therefore that the investigators apply for support of such studies.

We further recommend that the AID proceed with appointing an expert committee to assist in the management of the New Mexico contract and especially to help in the design and monitoring of the rodent malaria studies.

T.G. Akers, PhD.
Michael Katz, M.D.
R.B. McGhee, PhD
Peter Ward, M.D.
Thomas Weller, M.D.

AGENCY FOR INTERNATIONAL DEVELOPMENT
RESEARCH ADVISORY COMMITTEE

Minutes of the Forty-eighth Meeting
(March 20-21, 1975)

The meeting was opened by Dr. Ralph H. Smuckler, Chairman of the Research Advisory Committee (RAC). He commented on the heavy agenda of 12 items: seven project reviews, three project reports, a RAC subcommittee site visit report, and a review of the A.I.D. utilization program. Issues of the RAC process will be discussed at a special meeting to be scheduled in May.

Dr. Erven J. Long introduced Marjorie S. Belcher, who has recently joined the Technical Assistance Bureau as an Associate Assistant Administrator; and Robert House, who has recently joined the Technical Assistance Bureau under the Executive Exchange Program. Mr. House was formerly the Director of the Social Science and Economics Division of the Battelle Memorial Institute in Columbus, Ohio and has spent a six month period in the Latin America Bureau.

The minutes of the forty-seventh meeting were opened for discussion, and were approved without comment. Dr. Montgomery spoke of the value of the procedure of reviewing minutes in draft to facilitate their formal acceptance.

Site Visit Report:

Dr. Wishik, Chairman of the Subcommittee on Malaria Immunity and Vaccination, reported on the recent site visit to the University of New Mexico by Drs. Carter, Schweigert, Wishik, and their consultants. He distributed copies and read statements which follow: (1) Report of the Consultants to the RAC Subcommittee dated March 10, 1975, and (2) the Subcommittee Report to the RAC dated March 20, 1975.

Dr. Schweigert commended Dr. Wishik, AID for its leadership, and the review team. He indicated that he thought the activities of the project director were spread too thin. He would have preferred to have had AID staff present at the review, and urged more guidance for the research review team.

Dr. Carter stated that this had been a difficult assignment. He also commended Dr. Wishik for a very thorough and comprehensive report. In commenting on the technique of peer review, he strongly recommends this type of assistance. Outside help was needed in this complex project since the reviewers contributed qualifications in a variety of malaria specialties. He requested that the record show his recommendation to use peer review more in the future. He spoke of the excellent cooperation of Dr. Lee Howard and Edgar Smith, TA/H. The outcome of this review was very satisfactory.

Motion: That (1) project support continue until March 31, 1976, and that AID staff arrange for program adjustment in the light of expectations of staff changes and the content of the subcommittee report; (2) that the project terminate as of March 31, 1976; and (3) that if AID succeeds in developing a network of research groups in malaria vaccine, the New Mexico University group should be given consideration for membership in this network.

Moved by Dr. Wishik; seconded by Dr. Schweigert

Dr. Howard stated that he accepted these recommendations; he expressed his appreciation to the subcommittee; and had no issue. He would like a three year program, rather than a one year program, since malaria is on the increase. He agreed that it may not be possible to get the best consortium resources in any one place, and has no criticism of the network approach. He expressed a need for continued guidance as to the level of effort with the implied need for depth of effort, concerning the reported lack of evidence on the immunity conclusion, and in other areas of conflicting opinion.

Dr. Long expressed his gratitude to the subcommittee for a hard job well done. In response to the RAC recommendation for the establishment of an Ad Hoc Subcommittee for the Review of the Malaria Vaccine Program he announced that he would appoint the members of the present project review subcommittee to the new Ad Hoc Subcommittee 1/ with their approval and with the possibility of some expansion of the Ad Hoc Subcommittee. With reference to Dr. Carter's comment on the use of peer group review, this procedure is possible and is preferred. With reference to the project subcommittee recommendation on page 11 of their report that a Malaria Vaccine expert working group be formed to assist in establishing a research network, he proposed to invite the Ad Hoc Subcommittee for the Malaria Vaccine Program Review to advise on how to assemble the structure.

Edgar Smith stated that they can work with the recommended approach. He stressed the importance of work on the primate model rather than the rodent model as consistent with the recommendations and priorities of the expert advisory group following the National Academy of Sciences workshop. Problems identified in the consultant's report are recognized and solutions are being developed. As an example the shortage of the Aotus monkey can be met by arrangements to conduct research collaboratively in Colombia.

Dr. Wishik commented on Dr. Long's concern for advice on the network structure to the effect that the recommendation in the report is not contained in the motion so that AID could work out the appropriate protocol. There is some danger that consultants working on the priorities of program research may feel required to rule themselves out for possible conflict of interest. Dr. Wishik expressed strong support for the AID staff with no implication of difference of opinion or lack of unanimity among the subcommittee

1/ consisting of: Dr. Wishik (Ch), Dr. Carter, Dr. Schweigert, Dr. Merrill

members. The question of the feasibility of the malaria vaccine is no longer open to doubt. The expert group did not doubt the theoretical and biological feasibility, but there is concern about the practical and logistic solution availability. On the question of natural immunity versus achieved immunity due to injection of some material the experts support the view that this is merely one of amount. The example given of unwarranted claims was not the only doubt about the New Mexico group; the several approaches do not represent a sound scientific experiment. This is indicative of the sloppiness of the approach and the over-enthusiastic claims for results. The best work was that which called for the remark that they really needed some help in immunology and biochemistry because their levels of sophistication were not equal to the ingenuity of the work. This was intended as a supportive statement rather than otherwise. He commended the AID staff for the tremendous foresight and the courage to have pushed this program over the years. In hindsight they were probably right in building one center, and all might have done the same thing. However, the problem is now too complex, and it should not be handled by this group alone.

Vote: Unanimous approval