Chapter One

INTRODUCTION

Purpose of the Publication

This publication is a comprehensive presentation of a study, carried out in an area of northern Nigeria from 1969 to 1976 by a WHO/Government of Nigeria research team, on the epidemiology and control of malaria in the African savanna. This research was planned and directed by a multidisciplinary group at WHO headquarters in liaison with the WHO Regional Office for Africa and in collaboration with the authorities and the staff of the Federal Republic of Nigeria and Kano State.

Although the work is completed with respect to the study of the epidemiology of malaria in the Sudan-type savanna, the planning and evaluation tools forged and tested there remain to be applied to the practical problems of malaria control under various ecological conditions, taking into account the various kinds of constraints. The work is continuing in particular in Bendel State, Nigeria, and its further results will eventually form the basis of a further publication.

This publication is addressed to all those interested in the problem of malaria in Africa and elsewhere. It is obviously not a complete textbook in this respect, because its contents are related to the objectives of the research project considered. Nevertheless, the scientific observations made in that project and the conclusions drawn from them should be useful to all those who either wish to know more about malaria epidemiology in its many aspects or are responsible for administrative and technical decisions for the planning, organization and evaluation of malaria control campaigns. For this second group of persons, the monograph should contain sufficient details and make, we hope, interesting and pleasant reading. For those, however, who are carrying out research on specific aspects of the epidemiology and control of malaria, this book may not contain sufficient details of the observations and results obtained. More detailed reports and analyses do, however, exist and it is from them that the summary tables, graphs and conclusions have been drawn. Some

additional information is available in separate publications, but much of it is to be found in various unpublished WHO documents that are not available in libraries or bookshops. These unpublished documents are included in the list of references, and copies may be requested by applying to the Director, Malaria Action Programme, World Health Organization, Geneva, Switzerland. In addition, most of the original data, including the longitudinal records collected during the work of the project, are stored on tape at WHO headquarters and access to these data for the purpose of further analysis can also be arranged. It is understood that any request for either documents or data will be considered on its merits and no commitment is made for the allotment of the resources that might be required.

The credit for the work described in this book goes to all those who have planned it, and even more to those who have executed it during 6 years of extremely hard field work. It would be difficult and invidious to assign the relative merit due to each one of them; however, the name and the function of all those who contributed to this work are listed at the end of the book, and a note at the beginning of each technical chapter indicates the names of those who were mainly responsible for the work described therein.

In addition to the scientific value of the observations and the practical guidelines to be derived from the conclusions, this book and the original data behind it have an important teaching value. This is especially relevant at a time when the passing of the malaria eradication period demands that the principles, methods and criteria for planning, conducting and evaluating malaria control programmes, adapted to the epidemiological, environmental and socioeconomic conditions of the areas concerned, will have to be learned again.

The book covers the 6 years' period of observations in the field. The technical chapters, dealing with each of the main disciplines applied in the study, caver for each subject the entire period-i.e., the baseline data collected before intervention, the results of the interventions and their analysis, and the observations carried out for two years after discontinuation of the control measures.

Each chapter concerned with a particular category of variables also relates them to what precedes; for instance, the chapter on parasitology cross-references the parasitological findings to the entomological findings previously described. Occasionally, the discussion of a chapter may anticipate some findings from subsequent chapters; for example, the discussion of parasitological results (Chapter 5) calls upon certain serological observations from Chapter 6. Summaries at the end of each technical chapter outline the main features therein of either scientific or practical value. In addition, the main conclusions are recapitulated in Chapter 11.

Previous Epidemiological Studies and Control Trials in Tropical Africa

This section outlines the relationship of the Garki project to previous work in tropical Africa, without, however, constituting a review of the previous work. Some further comparisons, with respect to the practical conclusions, are made in Chapter 11.

Even after the advent of residual insecticides, malariain tropical Africa has resisted most of the attempts made for its control which were started, to a large extent, following the recommendation of the First African Malaria Conference,Kampala, 1950, that "malaria should be controlled by modern methods as soon as feasible, whatever the original degree of endemicity, and without awaiting the outcome of further experiments" (167). The problems of malaria control in tropical Africa have been summarized successively by Wilson (164), Bruce-Chwatt (16), Macdonald (99) and Hamon et al. (80). A number of pilot projects using a variety of control methods, singly or in association, but including indoor spraying with residual insecticides in different epidemiological conditions (Tropical forest: southern Cameroon, Liberia; Lowland savanna: northern Cameroon, northern Nigeria (Sokoto), Senegal, Upper Volta; Degraded forest: Benin, Togo (Palimé); High plateau: Uganda, Madagascar; Oceanic islands: Mauritius, Réunion; southern limits of tropical Africa: South Africa, Swaziland, Southern Rhodesia), have revealed that with the exception of the islands of Mauritius and Réunion, where malaria disappeared following the use of standardized eradication techniques, the results varied from a good response in tropical forest areas and highland savanna (with seasonal, unstable malaria) to a poor response in lowland savanna (87).

In these latter projects, the reasons for the unsatisfactory response to control, although assumed, were not fully investigated, nor were the individual factors fully analysed that had militated against the success of the control measures implemented, often at a cost exceeding the financial resources of the country concerned.In the dry savanna area of northern Cameroon, 2 rounds of DDT spraying at a 6-month interval in 1960-1961 produced a rather moderate reduction of the parasite rate and no interruption of transmission. It was hinted that the irritability of Anopheles ***gambiae*** andA.funestus on deposits of DDT was responsible for this lack of success, and an association of chemoprophylaxis with insecticidal spraying was therefore advocated (23). In Western Sokoto in the northern Nigerian savanna, 6-monthly spraying for 4 years (1954-58) with DDT, dieldrin or HCH in 3 adjoining areas produced a large reduction in indoor-resting vectors, and also in the spleen rate, parasite rate and parasite density, which were more pronounced in infants, but important

also in the age-groups l-2 and 3-4 years. However, no indication was given on the availability and use of drugs by the population in the course of this trial-cum-control campaign (19). An extended spraying with DDT only (1957- 1964) seemed to indicate that transmission was ‘‘interrupted through the greater part of the year, [but was] resumed during the height of the rains and through the season of maximum breeding by ***A. gambiae*** and ***A. funestus”.*** In 1964, the parasite level appeared to have stabilized at levels of a sixth for infants under 1 year, of a third for children l-4 years and a half for older children of those observed before the campaign had started. One round of mass drug administration (MDA) with chloroquine and pyrimethamine at the beginning of the rains in 1961 was surprisingly followed by higher parasite rates at the end of the wet season than those observed in the area where the MDA was not implemented. Again, no indication was given on the drugs available and used independently by the population (47). An intensive study was conducted (26) in the savanna pilot area of Bobo-Dioulasso (Upper Volta) in 1953-1958 on the effect of the use of residual insecticides (DDT and dieldrin once or twice per year) on the local vectors, and on the incidence and prevalence of malaria. Following a number of epidemiological considerations and analyses, that have been largely confirmed in Garki, the authors conclude that with the use of residual insecticides “Inhibition of malaria transmission has not been observed anywhere, restriction is limited to a slackening down, plasmodic and splenic rates remaining very much alike in the treated and in the control areas”. Nevertheless, a number of questions fundamental for an epidemiological understanding of malaria or of its control in Africa, as well as its relation to the health and well-being of indigenous populations of various age-groups, and their vulnerability to malaria consequent on the decrease of immunity after various periods of control, were still awaiting fuller investigation.

After several years of largely unsuccessful attempts at interruption of transmission or effective control, a sense of defeatism arose that led to the exclusion of tropical Africa, and especially of the West African savanna, not only from the world campaign for the eradication of malaria, but also from the adoption of an extended programme of malaria control, in the absence of satisfactory answers to the fundamental questions indicated above. Nevertheless, the Fourteenth, Seventeenth and Twentieth World Health Assemblies drew attention to the need for undertaking intensive studies to solve the problem of malaria in Africa. An attempt to analyse the value of some of the factors determining the epidemiology of holo-endemic malaria in the African Sudan-type savanna through the use of a mathematical mode1 was carried out in 1966-1969 in northern Nigeria at Kankiya (125). It was pointed out that the mathematical mode1 used there presented several inadequacies and that the proposed single indices were

unable to characterize the epidemiological situation, that transmission of malaria was not controlled in spite of DDT spraying every 4 or 23 months together with mass drug administration (MDA) to at least 80% of the population every 2 months, and that there were considerable discrepancies between the predictions of the model and the field observations. Further epidemiological studies and the design of a more realistic mathematical model of the dynamics of malaria were advocated.

Rationale of the Project

In view of the major importance of malaria as a public health problem, in particular in Africa, and considering that knowledge and understanding of the epidemiology of malaria and of its modification by control measures were insufficient, WHO proposed a multidisciplinary, longitudinal study of the epidemiology and control of malaria in an area of the Sudan savanna in northern Nigeria. A consultative group[a] was convened in Geneva in May 1969, and, after discussions with WHO staff in Geneva and a representative of the WHO Regional Office for Africa, concluded that:

"1. With respect to the problems posed by malaria in Africa, a field project is an essential complement to the present policy of improving basic health services.

"2. The project essentially should be concerned with research and fact finding. It is envisaged that the project will develop along the following lines:

(a) adequate study of ecological and demographic factors;
(b) study of epidemiological and immunological baseline data;
(c) elaboration of detailed planning based on a mathematical model of operations;
(d) implementation of operations, using the best techniques and material available at the time;
(e) continuous evaluation of the progress of operations and longitudinal study of the appropriate section of the population and relevant controls.

It is expected that (a) and (6) above will be completed within the first two years and that at least two years of longitudinal studies will be necessary after the first implementation of operations. Only after completing (a), (b) and (c) will it be possible to confirm the detailed requirements in staff, equipment and supplies. The immunological studies proposed, while considered important, should not be regarded as the main objective of the project. At the end of the project adequate provisions must be made to offset the effect of resurgence of malaria in the project area.

"3. An important aspect of the project is the construction of mathematical models that will identify and quantify factors of significance in the control of malaria. It is believed

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that such models may eventually be applied with profit to the study of control of malaria in other parts of the world, and with modifications, to the study of other communicable diseases. Mathematical models would be expected to facilitate the forecasting of the effect of control measures.

"4. The project should be sited in an area where successful interruption of transmission of malaria remains to be proved. In this connexion, it is believed that operations which proved successful in savanna areas of Africa are likely also to be successful in other areas. For this reason, a savanna area in which details of population movements are known or can be evaluated is considered the site of choice. A second but inferior choice would be a forest area of Africa.

"5. No element of change of epidemiological factors in the study area should be considered for the first two years of the project. Thereafter the effect of operational measures should be assessed. At the termination of the project the wider applicability of the methods employed may be considered.

"6. Steps should be taken to ensure that the project is not understaffed. The quality and number of staff employed should be sufficient for the collection of adequate and reliable data for their analysis and for the proper supervision of the operational activities. In this connexion special consideration should be given to the appointment of, among others, a field statistician.

"7. Drug administration is necessary for the successful completion of the type of immunological studies that have been envisaged. However, particular consideration should be given to the mode of use of antimalarial drugs because in the past in some other projects the use of drugs has not given uniform results.

"8. Provided that planning and staffing are adequate, the project is likely to prove more successful than similar previous field projects undertaken in Africa. In this connexion, it is expected that the construction of relatively simple mathematical models based on essential elements will guide and facilitate practical intervention. These models may also help in the evaluation of new insecticides within a shorter period of time than is currently required.

"9. The project should be undertaken as soon as detailed planning permits. It is hoped that its existence and operation may stimulate governments in Africa to embark on appropriate antimalaria activities whilst intensifying their efforts to improve national health services.

" 10. Consideration should be given to encouraging, possibly through WHO long-term fellowships, the attachment to the project of young scientists from different countries in Africa. The aim here would be to provide practical field experience in the different scientific disciplines involved in the project and to encourage the development of a high sense of responsibility. It is understood that the secondment of such personnel should not in any way prejudice the efficient operation of the project.

"11. WHO is the most suitable organization currently capable of conducting such a project in view of the availability of expertise in the different scientific disciplines concerned. The need for close collaboration among the units concerned is recognized and consideration should be given at an early stage as to the best methods of ensuring the necessary coordination" (170).

In the light of these conclusions, the Garki Project was organized and commenced its work in September 1969.

Another consultative group[a] met in February 1975 to review and analyse the results obtained and to advise on the future of the project. The group concluded that the programme had been well executed, that the information collected provided a better basis for the understanding of

malaria and for the planning of malaria control than was previously available, and that the project was an example of successful multidisciplinary research. The group stressed the teaching value of the project, and recommended the publication of the results, not only as individual scientific papers on various new specific findings, but also in the form of a comprehensive monograph (182).

Objectives of the Project

The specific objectives of the project, as actually implemented, may be described as follows:

1. TO study the epidemiology of malaria in the lowland rural Sudan savanna This means in particular a concentration of the study on the measurement of entomological, parasitological and seroimmunological variables and on their relationships. Also included were some meteorological, demographic and clinical variables, and the study of the prevalente of abnormal haemoglobins in the population.

2. TO measure the effect of specified interventions, namely, spraying with a residual insecticide, propoxur, alone and in combination with mass drug administration, at two different frequencies, using a combination of sulfalene and pyrimethamine.

3. TO construct and test a mathematical mode1 of the transmission of malaria, and develop it into a planning tool allowing the comparison of alternative control strategies in terms of their expected effects. Specifically, the mode1 was developed with the purpose of linking entomological and parasitological variables, in particular vectorial capacity and the prevalence of ***Plasmodium falciparum,*** and of calculating the expected parasitological effect of given changes in the entomological situation, natural or man-made, and of given mass drug administration schemes, taking into account the estimated role of immunity.

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a The members of this group were: Professor A.F. Fleming. Department of Pathology, Ahmadu Bello University, Zaria, Nigeria; Professor P.G. Janssens, Director, Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium; Professor A.O. Lucas, Department of preventive and Social Medicine, University of Ibadan, Nigeria; Dr LA. McGregor, National Institute for Medical Research, Medical Research Council, London, England; Dr L.F. Delfini, WHO Regional Adviser on Communicable Diseases for the African Region, Brazzarille, Congo; Dr T. Matsushima, Team Leader, MPD-012, Kano, Nigeria.